2010

Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River, Vol. 1 and 2

US Army Corps of Engineers
Omaha District

Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Volume 1:
Draft Programmatic Environmental Impact Statement

October 2010

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Cover Sheet

Responsible Agency and Lead Federal Agency: U.S. Army Corps of Engineers (Corps)

Title: Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat on the Riverine Segments of the Upper Missouri River

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This Draft PEIS is available at:

http://www.moriverrecovery.org/mrrp/mrrp_pub_dev.download_documentation_esh

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ABSTRACT

This Draft Programmatic Environmental Impact Statement (PEIS) analyzes the potential environmental consequences of implementing the Emergent Sandbar Habitat (ESH) program on the Upper Missouri River. The purpose of the ESH program is to support least tern and piping plover populations on the Missouri River by supplementing natural habitat through the mechanical creation and replacement of ESH. The PEIS allows the public, cooperating agencies (the U.S. Fish and Wildlife Service (USFWS) and the National Park Service (NPS)), and Corps decision makers to compare impacts among a range of alternatives. The PEIS is meant to inform the selection of a preferred alternative that allows for the support of tern and plover populations on the Missouri River through creation and replacement of sufficient habitat in a safe, efficient and cost-effective manner, that minimizes negative environmental consequences.

The ESH program is a part of the Corps' Missouri River Recovery Program (MRRP). The PEIS is tiered from the Final EIS and Record of Decision for the Master Water Control Manual Review and Update (March 2004). The Corps has identified an Adaptive Management Implementation Process (AMIP) as the preferred alternative. The key concept to the AMIP is that rather than selecting a specific acreage alternative, actions would be progressively implemented until the desired biological response is attained and sustained. While the exact number of acres needed to be constructed and replaced is uncertain at this time, this document discloses the impacts associated with constructing and replacing up to the acreage of Alternative 3.5 (4,370 acres). As the level of habitats created reach lesser alternative acreages, an assessment of the biological response will be completed to determine if it indicates that adequate habitat is in place to support the species. If the desired tern and plover population and productivity levels are being met and sustained at lower acreage levels, these acreages would be maintained and biological metrics would continue to be monitored to ensure project success. The preferred AMIP alternative provides a flexible approach to meeting the biological metrics for the least tern and piping plover identified in the 2003 BiOp Amendment. The success of the preferred alternative in meeting the needs of the species will be evaluated annually and refined through monitoring, assessment and the use of predictive models through a formal Adaptive Management process. The Corps will be coordinating with the Cooperating Agencies (USFWS and NPS) on an ongoing basis to establish and refine the timeline to meet benchmark acres.

The alternatives considered represent a range of ESH acreage goals from Alternative 1 (11,886 acres) through Alternative 5 (1,315 acres). Two "no action" alternatives are considered: 1) the implementation of the ESH Program at current levels of construction, approximately 150 acres per year (Existing Program), and 2) the environmental impacts of not implementing any construction program for ESH (No Program). The "no action" alternatives are consistent with the two definitions provided by the Council on Environmental Quality (CEQ) of "continuing with the present course of action" and "taking no action", respectively [46 Fed. Reg. 18026 (March 23, 1981), as amended]. Neither of these levels of implementation meets the purpose and need for the project.

As part of consultation with USFWS under the Endangered Species Act (ESA), the Corps has made a commitment to work within its authorities to contribute to species recovery. Specifically addressed in this PEIS is the commitment to promote the recovery of the species in segments of

the Missouri River identified in the 2000 BiOp, as amended (2003). However, "recovery" in the sense of de-listing the species from endangered or threatened status is outside of the scope of this document because the action area is just one portion of each of the birds' ranges.

Only Alternative 1 would fully meet proposed acreage recommendations for habitat goals of RPA IV(b)3 (11,886 acres); however, based on more recent monitoring data, the five remaining alternatives could reasonably meet biological metrics for the least tern and piping plover. In addition, all of the action alternatives require the creation of habitat within the 39-mile and 59-mile Districts of the Missouri National Recreational River (MNRR), potentially affecting the outstandingly remarkable values for which these Districts were originally designated for protection. The National Park Service (NPS) has expressed concerns that implementing the program within the MNRR may create unacceptably significant and permanent effects to the MNRR.

The displayed alternatives provide a broad range of alternatives to evaluate the environmental consequences of, and benefits from, different acreage goals juxtaposed with the potentially conflicting agency missions. The lesser acreage alternatives minimize or avoid environmental impacts associated with implementation of the ESH program. This approach, in addition to being consistent with the CEQ's guidance on reasonable alternatives currently outside an agency's jurisdiction to implement, also allows the program to be developed in an Adaptive Management context where the flexibility to consider new information is an essential component for program implementation.

Public Comments

Prior to preparation of this Draft PEIS, public involvement was conducted by holding public meetings in October 2004 and the publishing of a Notice of Intent in the Federal Register August 12, 2005. Additionally, coordination with resource agencies was conducted through agency coordination letters that solicited their comments. The Corps considered these comments received by letter and formal statements made at public meetings (Appendix E), and comments are addressed throughout the main document and many of the appendices, as outlined in Section 2.2.1 and Chapter 12. A min 45-day comment period on this Draft PEIS began with the publication of the U.S. Environmental Protection Agency Notice of Availability in the Federal Register. In this case the public comment period is open from November 1, 2010 through January 21, 2011. Public hearings to discuss and receive comments on the Draft PEIS will be held at the times and locations announced in the Notice of Availability. Individuals and agencies may present written comments relevant to the Draft PEIS or request to be placed on the mailing list for announcements and for the Final PEIS by sending the information to Cynthia Upah at the address provided in the cover sheet of this document. The comments received during the comment period will be considered in the preparation of the Final PEIS. Late comments will be considered to the extent practicable.

EXECUTIVE SUMMARY

Major Findings

The Emergent Sandbar Habitat (ESH) program is being implemented by the U.S. Army Corps of Engineers (Corps) for the benefit and eventual recovery of the interior population of the least tern (least tern) and the northern Great Plains piping plover (piping plover). This implementation program resulted from a Biological Opinion (BiOp) issued by the U.S. Fish and Wildlife Service (USFWS) in which the Corps needs to provide sufficient ESH acreage in order to meet biological metrics (fledge ratios) and avoid jeopardizing continued existence of the species. However, implementation of some action Alternatives within the program could result in significant adverse impacts on other resources and to the Outstandingly Remarkable Values (ORVs) within the 39- mile District and 59-mile District of the Missouri National Recreational River (MNRR), designated as components of the National Wild and Scenic Rivers System.

Northern Great Plains Piping Plover

An Adaptive Management Implementation Process (AMIP) has been identified as the preferred alternative. The key aspect of the AMIP is that, rather than selecting a specific acreage alternative and then implementing it, actions would be focused on progressive implementation accompanied by monitoring a combination of biological and physical metrics. Implementation of progressively larger acreage amounts of habitat would continue until the desired biological response is attained and sustained. While the exact number of acres needed to be constructed and maintained is uncertain, this document disclosed the impacts associated with up to the acreage of Alternative 3.5 (4,370 acres) at this time. This alternative is anticipated to meet the purpose and need of this program by achieving bird metrics prescribed in the 2003 BiOp Amendment. This selection is based on the premise that an AMIP strategy allows for monitoring and assessment of success as actions are progressively implemented, and that Alternative 3.5 (average acres between 1998 and 2005) represents a midrange of habitat available during a timeframe when the birds were highly productive. Both species were meeting, or approximating, the fledge ratio goals of the 2003 BiOp Amendment until 2005.

By implementing the ESH program, adult bird numbers are projected to increase over the life of the program under all action alternatives (Alternatives 1 through 5). There are also anticipated biological benefits for other shorebirds, amphibians and reptiles that utilize the sandbar habitats. Significant beneficial effects on socioeconomics could also be expected related to the amount of construction activity necessary to implement the given alternatives. However, adverse effects to resource areas, including wetlands, fish and wildlife, recreation, water quality, etc., may also be expected, especially under the larger alternatives.

Project History and Authority

The Missouri River drainage basin (Figure S-1) is approximately 530,000 square miles in area, occupying approximately one sixth of the continental United States. Originating at Three Forks, Montana, the river flows more than 2,300 river miles to its confluence with the Mississippi River just above St. Louis, Missouri. The Missouri River Main Stem Reservoir System is comprised of six dam and reservoir projects operated by the Corps and authorized by the Rivers and Harbors Act of 1935 and the Flood Control Act of 1944.

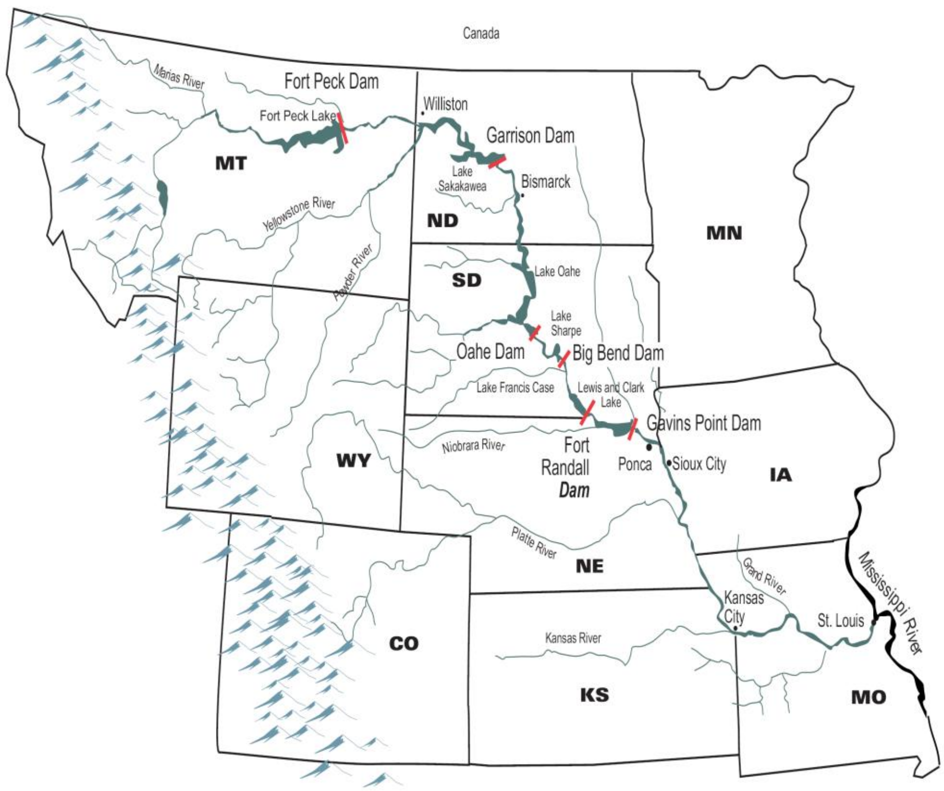

Figure S-1. Missouri River Mainstem Reservoir System

ESH is proposed for five riverine segments of the Missouri River downstream from four of these dams. As defined in the 2003 BiOp Amendment, these segments are:

- Fort Peck River Segment: Fort Peck Dam to Lake Sakakawea Headwaters near Williston, ND, Segment 2, RM 1771.5 – 1568.0 (203.5 river miles);
- Garrison River Segment: Garrison Dam to Lake Oahe Headwaters south of Bismarck, ND, Segment 4, RM 1389.9 – 1304.0 (85.9 river miles);
- Fort Randall River Segment: Fort Randall Dam to upstream of Niobrara River Confluence, Segment 8, RM 880.0 – 845.0 (35.0 river miles);

- Lewis & Clark Lake Segment: Upstream of Niobrara River Confluence to Lewis and Clark Lake Headwaters, Segment 9, RM 845.0 – 828.0 (17.0 river miles); and

- Gavins Point River Segment: Gavins Point Dam to Ponca, NE, Segment 10, RM 811.1 – 753.0 (58.1 river miles).

The least tern was federally listed as endangered in 1985 and the piping plover as threatened in 1986. The Corps initiated consultation in 1989 with the USFWS under the provisions of Section 7 of the Endangered Species Act, which requires federal agencies to consult with the USFWS when the agency's proposed actions may affect the status of species federally listed as endangered or threatened. The species addressed were the endangered interior population of the least tern (*Sternula antillarum*), the threatened northern Great Plains piping plover (*Charadrius melodus*), and the then-endangered bald eagle (*Haliaeetus leucocephalus)*. Subsequently, the pallid sturgeon (*Scaphirhynchus albus*) was federally listed as endangered in 1990 and was addressed by the Corps and the USFWS.

Throughout the 1990s, the USFWS and the Corps conducted informal and formal consultations, resulting in the issuance of a BiOp in 2000. The USFWS found that the proposed drought management actions in the Corps' Master Water Control Manual for the river would result in jeopardy to the least tern, pallid sturgeon, and piping plover, but not the bald eagle.

The USFWS provided a Reasonable and Prudent Alternative (RPA) that would avoid the likelihood of jeopardizing the three species. In November 2003, the Corps reinitiated formal consultation. Reinitiation of consultation was largely due to a hydrology and hydraulics analysis that found that the flow modifications proposed in the 2000 BiOp for ESH creation would erode more habitat than they would create. In addition updated information regarding baseline environmental conditions and the current status of terns and plovers became available, as well as information on the affects of the Corps' new proposed RPA elements. In December 2003, the USFWS issued an amended BiOp that specified a single RPA for the three species. It allows for the mechanical creation and replacement of ESH to avoid jeopardy to the bird species. While there have been ongoing discussions between the Corps and USFWS regarding the interpretation and implementation strategy for the RPA, both agencies are committed to resolving this issue and ensuring that management actions support tern and plover populations on the Missouri River.

In March 2004, the Corps published a Final EIS and Record of Decision on the *Missouri River Main Stem Reservoir System Master Water Control Manual*, and completed the formal revision of the Master Manual. These documents can be found at: http://www.nwd-mr.usace.army.mil/mmanual/mast-man.htm. The Notice of Intent for the preparation of this PEIS was published in the Federal Register in 2005 and tiered off of the Master Water Control Manual EIS; the collection and analysis of data necessary to prepare the technical appendices and this PEIS have been ongoing since then.

Relationship between MRRP and the ESH Program

The Corps initiated the Missouri River Recovery Program (MRRP) to implement the RPA. The mechanical creation of ESH is specifically related to RPA IV (b) 3 for the least tern and the piping plover. This PEIS is intended to meet National Environmental Policy Act (NEPA) requirements for the mechanical creation for the ESH program.

Purpose and Need of the PEIS for the ESH Program

The purpose of and need for Corps action results from formal Section 7 consultation under the Endangered Species Act and by a defined regulatory process. The 2003 BiOp Amendment, states that when habitat goals (as measured in acres of available ESH for bird nesting) are not met through flow regulation, and tern and/or plover fledge ratio goals have not been met for the 3-year running average, other means (e.g., mechanical creation of habitat) will be necessary to ensure the availability of habitat to meet fledge ratio goals. The 2003 BiOp Amendment describes optimum [ESH] habitat as "a complex of side channels and sandbars with the proper mix of habitat characteristics required by the birds" on page 195 and describes the physical conditions recommended by the USFWS for nesting habitat, brood rearing habitat, and foraging habitat on pages 194-197. Criteria used for ESH delineation are based on these recommendations and are found in Sections 1.3.1 and 2 of Appendix B.

The purpose of this action is that the Corps will take appropriate actions to support least tern and piping plover populations on the Missouri River by supplementing natural habitat through mechanical creation and replacement of ESH when conditions on the Missouri River do not result in sufficient ESH. The need for this action is to ensure that operation of the Missouri River Main Stem Reservoir System will not result in jeopardy to these listed species.

Interior Least Tern

Alternatives

Range of Alternatives

The ESH PEIS allows the public, cooperating agencies (USFWS and NPS), and Corps decision-makers to compare the impacts among a range of alternatives for the program. The goal is to implement a program to support least tern and piping plover populations on the Missouri River by supplementing natural habitat through mechanically creating and replacing sufficient habitat, as described in RPA IV (b) 3 of the 2003 BiOp Amendment. As such, the acre goals of each Alternative are expressed as the total acres of habitat present, including mechanically created and any naturally occurring sandbars). This PEIS allows a review of alternatives that will accomplish this in a safe, responsible, and efficient manner that minimizes the environmental consequences. The range of alternatives includes the maximum ESH program (Alternative 1), which fully meets the RPA acreage, and others of lesser acreage intended to minimize or avoid environmental and social impacts. Only Alternative 1 would fully meet proposed acreage recommendations for habitat goals; however, the five remaining alternatives could reasonably meet biological metrics for the least tern and piping plover.

For the purposes of this document, the primary method that will be employed is assumed to involve "Mechanical Creation" (See Appendix C, construction assumptions). It is recognized that other construction methods (such as vegetation removal or overtopping) hold promise and will be further tested, and incorporated if proved successful. Such methods may be incorporated through the Adaptive Management strategy (Appendix H) if they prove effective at creating habitat. In addition to mechanical creation, creating habitat through flows or on the reservoirs was considered but eliminated at this time. These other options are anticipated to be explored more fully through other ongoing study efforts.

Because various features, habitats, engineering considerations and activities in the Missouri River channel limit the actual areal extent of the riverine habitat available for program implementation, significant effort has been made to coordinate with states and resource agencies to identify sensitive riverine resources that should be avoided when implementing the ESH program. The available acres are summarized in Table S-1. This effort led to the development and application of environmental buffers, which is discussed in more detail at the end of this Executive Summary, and throughout the PEIS and Appendix B.

Table S-1

Total Acres in Segment vs. Available Area (Acres) for ESH after Environmental Buffers are Applied

Segment	Total Acres in Segment	Available Area (Acres) for ESH after Env. Buffers Applied
Fort Peck River	39,009	3,324
Garrison River	24,518	4,361
Fort Randall River	13,790	2,784
Lewis & Clark Lake	17,157	4,711
Gavins Point River	23,228	3,881
TOTAL	117,702*	19,061*

*****Alternative 2 does not include ESH Acres for the Fort Peck Segment. Therefore, Alternative 2 lists "Total Acres in Segment" as 78,693 and "Available Area (Acres) for ESH after Env. Buffers Applied" as 15,737.

These alternatives also address issues raised during the public scoping process. A common concern was the geographic scale of the project. Data collected over approximately the last 10-15 years indicates that biological goals for the least tern and piping plover (as measured by fledge ratios and adult bird populations) could be met with lesser acreage while avoiding or minimizing impacts to other resources related to project implementation. All alternatives would be implemented within an Adaptive Management framework which recognizes that lesser acreage alternatives will be reached prior to accomplishment of the Preferred Alternative. These will serve as check-in points along the way to full implementation of the acreage goals of the preferred alternative and will allow for adjustments to be made based on biological responses and other data collected.

Constructed Sandbar in the Gavins Point River Segment

In addition, concerns have been raised because all of the alternatives require the creation of ESH within the MNRR. The NPS has stated that implementing the program within the MNRR may create unacceptably significant and permanent effects (see Table 5.13 in Appendix B for NPS comments regarding the MNRR). The NPS and the Corps manage the MNRR through a cooperative agreement. The NPS is represented on the ESH Project Delivery Team (PDT) and therefore is heavily involved in the selection of and design of potential sites. In working with the NPS, the Corps identified different scales of implementation through the various alternatives, discussed how to minimize impacts, and utilized GIS buffers to identify sensitive resources (see Section 4.2.1). The NPS retains overall administrative authority under the Wild and Scenic Rivers Act, including the responsibility for preparing determinations under Section 7(a) of the Act (NPS 1999). There have been concerns raised regarding construction in the Fort Peck Segment, due to its designation as part of endangered pallid sturgeon Recovery-Priority Area 2 (RPA 2 also includes the lower Yellowstone River), one of only six priority management areas for restoration and recovery of that species. Implementation of many of the larger alternatives risks construction-related effects to the endangered pallid sturgeon. Because of this, and lower bird usage in this segment as documented in the 2003 BiOp Amendment, Fort Peck is considered a lower priority segment for ESH creation, and any future construction needs would be identified through the adaptive management process. Local monitoring data and consultation with state and federal experts knowledgeable of specific sites and habitats important to pallid sturgeon would be used to identify and avoid high risk areas. Finally, concerns expressed by North Dakota regarding the amount and locations of habitat constructed, have been recognized and will involve further coordination among the agencies and the State prior to implementation.

Sensitive Resource Identification

The major federal action being evaluated in this PEIS is to quantify the effects to the human environment from mechanically creating and replacing ESH within 440 miles of the upper Missouri River when river flows do not produce enough suitable sandbar habitat. The Corps intends to use this PEIS to make project-specific construction decisions.

The Corps' analysis of effects was built on a principle of systematic avoidance of potentially sensitive resources and the de-selection of less suitable project areas. The primary assumption is that in most cases sufficient ESH can be created and replaced within a definable project area, while avoiding adverse effects to sensitive resources.

Many key data were needed to predict both the potential negative environmental consequences and the potential benefits of implementing this program. The items listed below were necessary to conduct the analysis of effects.

> "Sensitive Resources" include known locations of protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment.

- The extent of existing ESH within each segment (Appendix B, Section 2.3, *Habitat Mapping*)
- The rate at which ESH eroded within each segment (Appendix B, Section 2.3, *Habitat Mapping*; Appendix B, Attachment 4, *Sandbar Geometry and Composition*),
- The rate of vegetation growth (natural succession) on ESH (Appendix B, Section 2.3, *Habitat Mapping*; Appendix B, Attachment 5, *Vegetation*),
- Construction assumptions to quantify the intensity of actions necessary to mechanically build (and replace) ESH in accordance with the design criteria (Appendix C, *Emergent Sandbar Habitat Creation and Replacement Assumptions*),
- An expectation of the biological output (nests per acre and fledged birds per acre) that mechanically created habitat contributed to the fledge ratios (Appendix B, Attachment 2, *Indices of Reproduction*),
- An understanding of the distribution of nesting and nesting success within each segment (Appendix B, Section 2.5, *Analysis of Nests, Nest Success and Nest Habitats*),
- An identification and mapping of riverine features conflicting with ESH creation and replacement to plan to avoid them (Appendix B, Section 2.6, *Sensitive Features and Protective Buffers Assessment)*,
- A characterization of the physical features of ESH to identify aspects that were correlated with nesting success (Appendix B, Section 2.5, *Analysis of Nests, Nest Success and Nest Habitats).*
- A description of the segment-specific site selection criteria to be used to establish locations for creation and replacement (Appendix B, Section 2.6, *Sensitive Features and Protective Buffers Assessment*; Appendix G, *Site Selection and Pre-Construction Surveys*). One key assumption was that significant environmental consequences could be avoided if sufficient data were developed with regard to those resources that may be impacted. Habitat was delineated and environmentally, socially or culturally important features were identified and mapped in the Geographic Information System (GIS). These are referred to as "sensitive features."

Affected states and agencies were asked to indicate if the resources and associated buffer distances were a regulatory limit, published in the scientific literature, or based on best professional judgment (responses were a mix of all of these). As a result, this data provided a reasonable approximation of area that should be avoided, but not an exact limit/boundary. Their recommended sensitive resources and associated buffer distances were compiled and entered into the GIS. Federal agencies (NPS, USFWS), states (Montana Water Center, Montana Department of Environmental Quality, North Dakota Game and Fish Department, South Dakota Game Fish and Parks, South Dakota Department of Environment and Natural Resources, and Nebraska Game and Parks Commission) and non-governmental organizations (Montana-Dakota Utilities) responded to the request.

Once these features and buffers were defined and quantified the data was used to define three categories – available, restrictive and exclusionary. The remaining area after application of environmental buffers within each segment was defined as the "available area." This is the subset of the total corridor habitat within which the Corps could undertake ESH construction while fully avoiding sensitive resources. "Restrictive areas" are defined as areas where ESH may be placed at relatively low risk, but construction activities could be within the buffer limits of some sensitive resources (additional coordination with federal and state agencies would take place). For example, borrow areas may be located outside the "available area," and move into the "restrictive area" depending on whether dredging activities could adversely affect sensitive resources nearby. "Exclusionary areas" are defined as areas where construction would generally not be undertaken because of proximity to particular sensitive resources, such as a water intake.

When considering impacts to environmental and other resources, the total area impacted includes the borrow areas for construction. For each acre of ESH constructed, an estimated 2.75 total acres are impacted. At certain levels, construction activities, including borrow areas, would require actions in the restrictive or exclusionary areas (Table S-2). Additional information regarding specific acreage requirements of each alternative by segment is included in Section 4.6, particularly in each "Area Disturbed Effects" table for each segment. This information is then utilized throughout Chapter 6 as a way to gauge the level of potential impacts to specific resources. The potential risk of incurring significant environmental effects is minimal (green) when construction activities would occur within the "available area." When construction activities of an alternative would occur in "restrictive areas," the risk of incurring significant impacts would be considered moderate (yellow). When construction activities of an alternative would occur within "exclusionary areas," the risk of incurring significant impacts would be considered high (red). Finally, the site selection process for ESH is defined in Appendix G.

Table S-2

Summary of Available Area** by Acres Required (Including Borrow)

SEGMENT	# Acres in Available, Restrictive & Exclusion Areas By Segment	Area Impacted*: # Acres Required, Including Borrow Areas (By Alternative, By Segment)						
		ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist
Ft Peck	Exclusion > 19,753 Restrictive 3,825 - 19,753 Available 0 - 3,825	2,623	--	2,623	1,681	737	89	--
Garrison	Exclusion > 9,678 Restrictive 4,361 – 9,678 Available 0 – 4,361	12,756	6,380	6,136	3,941	1,746	1,485	--
Ft Randall	Exclusion > 8,065 Restrictive 2,784 – 8,064 Available 0 – 2,784	2,079	1,040	876	630	380	401	--
L&C Lake	Exclusion > 13,969 Restrictive 4,711 – 13,969 Available 0 – 4,711	2,594	1,297	1,080	675	271	153	95
Gavins Pt	Exclusion > 9,880 Restrictive 3,881 – 9,880 Available 0 - 3,881	13,805	6,902	8,744	5,679	2,614	1,693	2,474

For each acre of ESH constructed, an estimated 2.75 acres are impacted

** Green/Low = Available Area; Yellow/Moderate = Restrictive Area; Red/High = Exclusionary Area

Figure S-2 is a screen capture of the GIS analyses performed and provides an example of what applying the buffers looks like. Exclusionary (Red), Restrictive (Yellow) and Available (Green) Areas are shown.

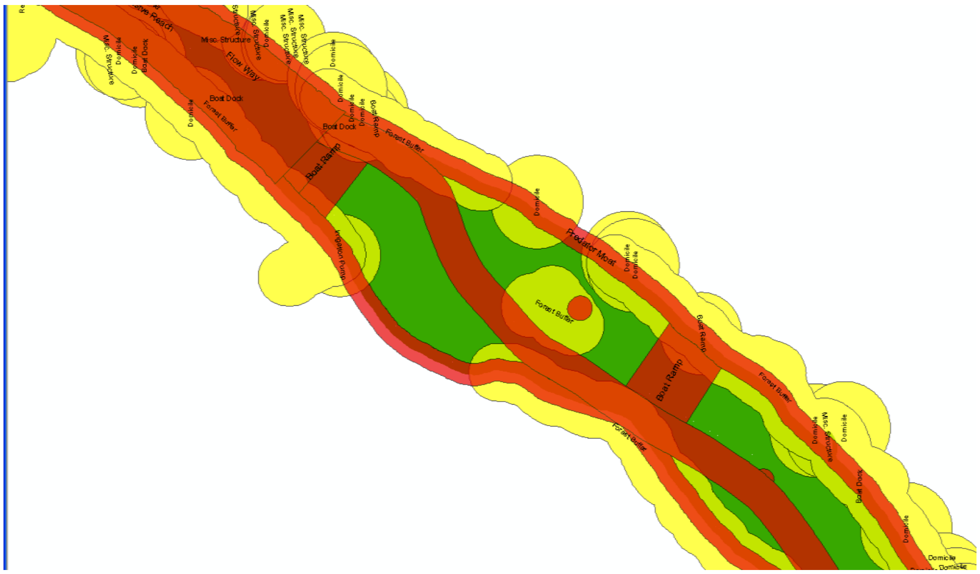

Figure S-2: Example of Influence of Buffers on Available Area for ESH Creation in the Gavins Point River Segment.

An analysis of the availability of sediment in relation to each alternative was also performed and provides an additional measure of impacts. This information is summarized in the "Potential Adverse Impacts" discussion of each Alternative in this Executive Summary. Full discussion is in Section 6.2 of the main document.

Although features to be avoided have been mapped, knowledge of environmental conditions at any site remains incomplete until pre-construction evaluation as described in Appendix G. Many of the resources that state and federal agencies request that the Corps avoid (e.g., mussel beds, turtle hibernating areas, cultural resources) may require site surveys prior to clearing, and their presence will not be ascertained until project sites are identified and examined. This process of site-selection and pre-construction surveys will identify features that need to be avoided, but were not identified in the GIS. This process will be part of project-specific planning which will require individual NEPA compliance (including documentation such as Environmental Assessments).

Summary of Alternatives

Alternative 1: Create and Replace 2015 ESH BiOp Goals

All Segments Combined (Alternative 1)

The Corps would mechanically create and replace ESH to meet the goals for 2015 established in the 2003 BiOp Amendment (Table S-3). These goals represent the largest possible amount of habitat manipulation required by the RPA.

Table S-3: Alternative 1: Emergent Sandbar Habitat Goals for 2015

Segment	ESH Acres	ESH Acres / River Mile (from BiOp)	Estimated Total Acres Disturbed
Fort Peck River	883	----	2,623
Garrison River	4,295	50	12,756
Fort Randall River	700	20	2,079
Lewis & Clark Lake	1,360	80	2,594
Gavins Point River	4,648	80	13,805
TOTAL	11,886		33,857

Implementation of the acreage amounts described in the RPA recommends the creation and sustained replacement of 11,886 acres of ESH within the high-bank to high-bank riverine habitat of the Fort Peck River, Garrison River, Fort Randall River, Lewis & Clark Lake, and Gavins Point River segments. High-bank to high-bank is based on current flows, 2005 aerial photos, and ground truthing. These segments of riverine habitat total approximately 117,702 acres. Achieving the full ESH acreage goal is anticipated to require 10 or more years of ESH creation and replacement activities. The total area disturbed, including the ESH area and the area needed for materials borrow (i.e., sand), is approximately 33,857 acres (29% of total riverine habitat); of this, approximately 13,540 acres (11% of total riverine habitat) may be disturbed in any given year.

Annual construction to mechanically create and replace ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH, could require moving over 28 million cubic yards of material, with 2,451 days of dredge operation and 1,926 days of mechanical work.

The estimated annual costs to fully implement and continuously replace ESH under Alternative 1 are $197,100,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Alternative 1)

The implementation of Alternative 1 could result in significant impacts amongst the segments. The Fort Peck River Segment is one of only six priority management areas that still provide suitable habitat for the pallid sturgeon. The geomorphologic conditions that would denote favorable sites for ESH creation and replacement are also conditions favored by pallid sturgeon.

This may result in perpetual construction-related effects to the endangered pallid sturgeon. Creation of ESH and borrow areas for Alternative 1 in the Garrison River and Gavins Point Segments would require activities in areas identified as "exclusionary areas" after environmental buffers are applied. This could result in significant environmental consequences and long-term conflicts with other uses, function, resources, and processes that are of value to other organisms and to humans. Both the Fort Randall and Gavins Point River Segments are part of the Missouri National Recreational River (MNRR). The NPS's mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience. The magnitude of construction required for building and replacing Alternative 1 could predictably lead to significant effects along the MNRR, which is subject to the provisions of the Wild and Scenic Rivers Act.

> The Wild and Scenic Rivers Act provides management mandates to agencies responsible for administering components of the System. Section 10(a), which establishes a non-degradation and enhancement policy, states: *Each component of the national wild and scenic rivers system shall be administered in such manner as to protect and enhance the values which caused it to be included in said system without, insofar as is consistent therewith, limiting other uses that do not substantially interfere with public use and enjoyment of these values.*

Mapping of the wetlands habitat within the Lewis & Clark Lake Segment from the 2005 aerial photography identified approximately 49% of total riverine habitat as wetlands. Dredging could suspend large quantities of silt and sediment throughout the segment beginning in mid-September, affecting the last 2-3 months of the growing season by inhibiting photosynthesis. This chronic reduction in primary productivity of plankton as well as hydrophytes and vascular plants could diminish the vigor of wetlands and submerged aquatic vegetation, having affects on species abundance and diversity, success of invasive species and regionally-significant waterfowl hunting. Concerns can also be raised when comparing estimates of total sediment load to the volume of sediment required to meet the acre goals of Alternative 1. Estimates suggest that a large amount of material is required relative to annual sediment load in all segments, indicating the risk of eventual significant effects on aggradation, degradation and erosion is likely to be high (See Section 6.2 and Table 6-2 of the main document).

Alternative 2: Create and Replace 2005 BiOp Goals

All Segments Combined (Alternative 2)

The Corps would create and replace ESH to meet the acreage goals established for 2005. These acres represent one-half of the acres established for Alternative 1, but do not include any acres in the Fort Peck River Segment (Table S-4). The 2003 BiOp Amendment goals for 2005 did not include a requirement to create any ESH in this segment.

Table S-4: Alternative 2: Emergent Sandbar Habitat Goals for 2005

Segment	ESH Acres	ESH Acres / River Mile (from BiOp)	Total Acres Disturbed.
Fort Peck River	None	---	-----
Garrison River	2,148	25	6,380
Fort Randall River	350	10	1,040
Lewis & Clark Lake	680	40	1,297
Gavins Point River	2,324	40	6,902
TOTAL	5,502		15,619

Implementation of Alternative 2 requires the mechanical creation and sustained replacement of 5,502 acres of ESH within four of the five designated segments, not including the Fort Peck River Segment. The total riverine habitat in the four segments is approximately 78,693 acres. Achieving the full ESH acreage goal is anticipated to require 10 or more years of ESH creation and replacement activities. The total area disturbed is approximately 15,619 acres, which constitutes only 13% of the total riverine habitat. Of this, approximately 4,943 acres (4.1% of riverine habitat) may be disturbed in any given year.

Annual construction to mechanically create and replace ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH, could require moving nearly 10.5 million cubic yards of material, with 961 days of dredge operation and 656 days of mechanical work.

The estimated annual costs to fully implement and continuously replace ESH under Alternative 2 are $73,300,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Alternative 2)

There would be no environmental consequences to the Fort Peck River Segment with Alternative 2 because no ESH is proposed for this segment, since the 2003 BiOp Amendment did not establish habitat goals there. In both the Garrison and Gavins Point River Segments, the total area disturbed for ESH creation and replacement would require activities in areas identified as “restrictive areas” after environmental buffers are applied. Therefore, there would be moderate risk of environmental consequences and long-term conflicts with other uses with the implementation of Alternative 2 in those segments. The concerns regarding the MNRR designation of both the Fort Randall and Gavins Point River Segments, and the effects on wetlands in the Lewis and Clark Lake Segment, remain similar to Alternative 1. Concerns can also be raised when comparing estimates of total sediment load to the volume of sediment required to meet the acre goals of Alternative 2. Estimates suggest that a large amount of material is required relative to annual sediment load in most segments, indicating the risk of eventual significant effects on aggradation, degradation and erosion is likely to be high in the Ft. Peck, Garrison, Ft. Randall and Gavins Point River Segments, and moderate in the Lewis and Clark Lake Segment (See Section 6.2 and Table 6-2 of the main document).

Alternative 3: Create and Replace ESH Area as Present in 1998/1999

All Segments Combined (Alternative 3)

Water releases at system dams in 1996 and 1997 due to near period of record flooding resulted in the creation of large acreages of ESH. Due to the unique conditions, the large amount of ESH created in 1997 is now viewed as an approximation of the maximum possible on the current system. Photos taken in 1998 were used to delineate the riverine habitat for the Gavins Point River, Lewis & Clark Lake, Fort Randall River, and the Garrison River segments. Because a 1998 photoset was not available for the Fort Peck River Segment, a 1999 photoset was used. Using the same methods to delineate interchannel sandbars as performed to prepare the 2003 BiOp Amendment, the areal extent of interchannel sandbar was measured for each segment. This new evaluation identified discrepancy between the 2015 BiOp acreage goals and the actual number of acres that existed after the high releases of 1996 and 1997. The level of habitat following these releases leading to a significant rebound in tern and plover numbers. This alternative characterizes the consequences of creating and replacing the amount of ESH that was actually present after the 1997 high releases. Table S-5 identifies the acres measured in the lower four segments in the 1998 photoset and the upstream segment in the 1999 photoset.

Table S-5: Alternative 3: Emergent Sandbar Habitat Area as Present in 1998/1999

Segment	ESH Acres	ESH Acres / River Mile (Calculated)	Total Acres Disturbed
Fort Peck River	883	4.3	2,623
Garrison River	2,066	24.1	6,136
Fort Randall River	295	8.4	876
Lewis & Clark Lake	566	33.3	1,080
Gavins Point River	2,944	50.7	8,744
TOTAL	6,754		19,458

Implementation of Alternative 3 requires the mechanical creation and sustained replacement of 6,754 acres of ESH in the five designated segments. The total riverine habitat within these segments is approximately 117,702 acres. Achieving the full ESH acreage goal is anticipated to require 10 or more years of ESH creation and replacement activities. The total area disturbed is approximately 19,458 acres (16.5% of the total riverine habitat). Of this, approximately 6,055 acres (5.1% of total riverine habitat) may be disturbed in any given year.

Annual construction to mechanically create ESH and to replace ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH, could require moving more than 12.5 million cubic yards of material, with 1,096 days of dredge operation and 891 days of mechanical work.

The estimated annual costs to fully implement and continuously replace ESH under Alternative 3 are $87,800,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Alternative 3)

The effects to the Fort Peck River Segment would be identical to those from Alternative 1 because the acreage goals are the same. Creation and replacement of ESH for Alternative 3 on the Garrison and Gavins Point River Segments would require activities in areas identified as "restrictive areas," resulting in a moderate risk of significant environmental consequences and long-term conflicts with other uses. The concerns regarding the MNRR designation of both the Fort Randall and Gavins Point River Segments, and the effects on wetlands in the Lewis and Clark Lake Segment, remain similar to the previous alternatives. Concerns can also be raised when comparing estimates of total sediment load to the volume of sediment required to meet the acre goals of Alternative 3. Estimates suggest that a large amount of material is required relative to annual sediment load in most segments, indicating the risk of eventual significant effects on aggradation, degradation and erosion is likely to be high in the Ft. Peck, Garrison, Ft Randall and Gavins Point River Segments, and moderate in the Lewis and Clark Lake Segment (see Section 6.2 and Table 6-2 of the main document).

Alternative 3.5: Create and Replace Average of Acreage between Habitat Present in 2005 and Habitat Present in 1998/1999

All Segments Combined (Alternative 3.5)

This range of habitat approximates the average amount of habitat available between 1998 and 2005. This alternative was not included in the Notice of Intent for this PEIS published in the Federal Register, but a need to develop an alternative that reflected the average between the habitat present in 1998/1999 and 2005, known periods of high productivity for the species, was subsequently identified. Moreover, this alternative was added after the scoping phase in order to represent present impacts associated with a "mid point" between two existing alternatives. This alternative was added to ensure that a full range of options was presented to decision-makers. In addition, since 2005, fledge ratios for both species have dropped below the goals as prescribed in the 2003 BiOp Amendment, raising concerns that habitat levels present after that time may not be adequate to meet the needs of the species.

Table S-6 identifies the average acres present using the acres measured in the lower four segments in the 1998 photoset and the upstream segment in the 1999 photoset, and the acres measured from aerial photography in 2005.

Table S-6: Alternative 3.5: Average of Acreage Between Habitat Present in 1998/1999 and 2005

Segment	ESH Acres	ESH Acres / River Mile (Calculated)	Total Acres Disturbed
Fort Peck River	565	2.8	1,681
Garrison River	1,327	15.4	3,941
Fort Randall River	212	6.1	630
Lewis & Clark Lake	354	20.8	675
Gavins Point River	1,912	32.9	5,679
TOTAL	4,370		12,606

Implementation of Alternative 3.5 requires the mechanical creation and sustained replacement of 4,371 acres of ESH in the five designated segments. The total riverine habitat within these segments is approximately 117,702 acres. Achieving the full ESH acreage goal is anticipated to require 10 or more years of ESH creation and replacement activities. The total area disturbed is approximately 12,606 acres (11% of total riverine habitat). Of this, approximately 3,323 acres (2.8% of total riverine habitat) may be disturbed in any given year.

Annual construction to mechanically create and replace ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH, could require moving more than 6.9 million cubic yards of material, with 621 days of dredge operation and 481 days of mechanical work.

The estimated annual costs to fully implement and continuously replace ESH under Alternative 3.5 are $48,600,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Alternative 3.5)

In the Fort Peck River Segment, under Alternative 3.5, the amount of acres disturbed would not exceed "available area;" however, concerns regarding impacts to the pallid sturgeon would still be present. The concerns regarding the MNRR designation of both the Fort Randall and Gavins Point River Segments, and the effects on wetlands in the Lewis and Clark Lake Segment, remain similar to the previous alternatives. In addition, in the Gavins Point River Segment only, creation and replacement of ESH would result in activities in areas identified as "restrictive areas," indicating a moderate risk of environmental consequences and long-term conflicts with other uses in the segment.

There are still some concerns when comparing estimates of total sediment load to the volume of sediment required to meet the acre goals of Alternative 3.5. Estimates suggest that the amount of material required would be nearing annual sediment load in most segments. The risk of eventual significant effects on aggradation, degradation and erosion is likely to be high in the Garrison River Segment, moderate in the Ft. Peck, Ft. Randall and Gavins Point River Segments, and low in the Lewis and Clark Lake Segment (see Section 6.2 and Table 6-2 of the main document).

Alternative 4: Create and Replace ESH Area as Present in 2005

All Segments (Alternative 4)

This alternative is based on Corps data indicating that biological metrics for population and productivity (as expressed by fledge ratio goals identified in the 2003 BiOp Amendment) were met or approximated with the amount of ESH acreage existing during the 2005 field season. In 2005, fledge ratios for least terns were above the goal, but fledge ratio for piping plovers fell below the goal. After 2005 (2006 field season), fledge ratios for both species were declining and fell below goal levels. Population and productivity estimates used in formulating Alternative 4 were based on data from the riverine segments and the Lewis & Clark Lake Segment, but on no other reservoir segments. Aerial imagery was collected during the 2005 breeding season for all river segments to accurately measure how much ESH was present. Table S-7 summarizes the Alternative 4 segment-specific goals.

Table S-7: Alternative 4: Emergent Sandbar Habitat as Present in 2005

Segment	ESH Acres	ESH Acres / River Mile (Calculated)	Total Acres Disturbed
Fort Peck River	248	1.2	737
Garrison River	588	6.8	1,746
Fort Randall River	128	3.7	380
Lewis & Clark Lake	142	8.4	271
Gavins Point River	880	15.1	2,614
TOTAL	1,986		5,748

Implementation of Alternative 4 requires the mechanical creation and sustained replacement of 1,986 acres of ESH in the five designated segments. The total riverine habitat within these segments is approximately 117,702 acres. Achieving the full ESH acreage goal is anticipated to require 10 or more years of ESH creation and replacement activities. The total area disturbed is approximately 5,748 acres (5% of total riverine habitat). Of this, approximately 955 acres (0.8% of total riverine habitat) may be disturbed in any given year.

Annual construction to mechanically create and replace ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH, could require moving more than 2 million cubic yards of material, with 196 days of dredge operation and 131 days of mechanical work.

The estimated annual costs to fully implement and continuously replace ESH under Alternative 4 are $14,300,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Alternative 4)

Under Alternative 4, "available area" would not be exceeded in any of the Segments. The concerns regarding pallid sturgeon in the Fort Peck River Segment, the MNRR designation of both the Fort Randall and Gavins Point River Segments, and the effects on wetlands in the Lewis and Clark Lake Segment, remain similar to the previous alternatives. There are minimal concerns when comparing estimates of total sediment load to the volume of sediment required to meet the acre goals of Alternative 4. Estimates suggest that the amount of material required would be near annual sediment load in most segments. The risk of eventual significant effects on aggradation, degradation and erosion is likely to be moderate in the Garrison River Segment, and low in the Ft. Peck River, Ft Randall River, Gavins Point River, and the Lewis and Clark Lake Segments (see Section 6.2 and Table 6-2 of the main document).

Alternative 5: Create and Replace ESH Area Derived from Nesting Patterns

All Segments Combined (Alternative 5)

In 2005, nesting productivity from artificially created habitat was found to be as successful as that from naturally occurring sandbars in the Gavins Point River Segment. Constructed sandbars had 136 piping plover adults with a fledge ratio of 2.03 and 206 least tern adults with a fledge ratio of 1.76; non-constructed sandbars had 204 piping plover adults with a fledge ratio of 1.97 and 270 least tern adults with a fledge ratio of 1.01. During the formulation of alternatives, Alternative 5 was conceived to represent an amount of acreage used for nesting by terns and plovers during the period of analysis. The analysis used to develop this alternative, detailed in Section 3.4 of Appendix B, used nesting records and other GIS data to approximate the number of acres of nesting habitat and used the BiOp design criteria for the amount of foraging and brood-rearing habitat that should accompany nesting habitat, to derive an estimate of the total acreage of ESH that was utilized by terns and plovers during the period of analysis. Development of Alternative 5 is based on analyses of nesting patterns from 1999-2006, detailed in Appendix B, Section 3.4.

Table S-8 summarizes the Alternative 5 segment-specific goals.

Table S-8: Alternative 5: Manipulate Sufficient Habitat to Replace Fledge Ratios

(Construction focused on highly productive nesting habitat)

Segment	ESH Acres	ESH Acres / River Mile (Calculated)	Total Acres Disturbed
Fort Peck River	30	0.1	89
Garrison River	500	5.8	1,485
Fort Randall River	135	3.9	401
Lewis & Clark Lake	80	4.7	153
Gavins Point River	570	9.8	1,693
TOTAL	1,315		3,821

Implementation of Alternative 5 requires the mechanical creation and sustained replacement of 1,315 acres of ESH in the five designated segments. The total riverine habitat within these segments is approximately 117,702 acres. Achieving the full ESH acreage goal is anticipated to require 10 or more years of ESH creation and replacement activities. The total area disturbed is approximately 3,821 acres (3% of total riverine habitat). Of this, approximately 445 acres (0.4% of total riverine habitat) may be disturbed in any given year.

Annual construction to mechanically create and replace ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH, could require moving nearly 1 million cubic yards of material, with 95 days of dredge operation and 56 days of mechanical work.

The estimated annual costs to fully implement and continuously replace ESH under Alternative 5 are $6,700,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Alternative 5)

Under Alternative 5, "available area" would not be exceeded in any of the Segments. In the Fort Peck River Segment, only about 9 acres would be disturbed in any given year, with limited risk to the pallid sturgeon. The concerns regarding the MNRR designation of both the Fort Randall and Gavins Point River Segments would be greatly reduced, although potential impacts are assessed using a higher standard in segments within the MNRR. Among the action alternatives, Alternative 5 would result in the least amount of ESH being created and replaced, and therefore result in the least potential localized deterioration in water quality in the Lewis & Clark Lake Segment. Because of this, Alternative 5 could be accomplished without creating significant recreation conflicts. There are minimal concerns when comparing estimates of total sediment load to the volume of sediment required to meet the acre goals of Alternative 5. Estimates suggest that amounts of material required for implementation would be near annual sediment load in all segments. The risk of significant effects on aggradation, degradation and erosion would likely be low in all segments (see Section 6.2 and Table 6-2 of the main document).

Existing Program Alternative

All Segments Combined (Existing)

This alternative is considered one of the "No Action" alternatives, continuing existing low-level construction efforts. This alternative was added after the drafting of the 2005 Notice of Intent when there was no ongoing ESH program. Since then, annual habitat construction has been proceeding at levels that will result in a total of approximately 883 acres of ESH at a time in the future when 150 acres of ESH will need to be replaced annually. This total ESH acreage does not meet the needs of the species for maintenance of sufficient habitat to support population and productivity metrics. This alternative would not meet the Purpose and Need for the project. Table S-9 summarizes the Existing Program segment-specific goals.

Table S-9: Existing Program

Segment	Total Acres in Segment	ESH Acres	ESH Acres / River Mile (Calculated)	Acres Disturbed	Available Area (Acres) for ESH after Env. Buffers Applied
Fort Peck River	---------	0	0	0	--------
Garrison River	---------	0	0	0	--------
Fort Randall River	---------	0	0	0	--------
Lewis & Clark Lake	17,157	25 / year, 50 total	1.5 / year, 2.9 total	48 / year, 95.4 total	4,711
Gavins Point River	23,228	125 / year, 833 total	2.2 / year, 14.3 total	371 / year, 2,474 total	3,881
TOTAL	40,385	150 /year, 883 total		419 / year, 2,569 total	8,592

The Existing Program Alternative requires the annual construction of 150 acres of ESH, which includes construction activities to replace eroded ESH and remove vegetation as well as mechanical creation of new ESH. The Existing Program is only implemented in the Lewis & Clark Lake Segment and Gavins Point River Segment. Assuming loss rates of 50% and 15% due to erosion and vegetative growth in the Lewis & Clark Lake and Gavins Point River segments respectively, the Existing Program is anticipated to provide approximately 883 acres of mechanically created and replaced ESH. Achieving the full ESH acreage goal may require approximately 10 years of ESH creation and replacement activities. The total area disturbed could be approximately 2,569 acres (2% of total riverine habitat). In any given year, approximately 419 acres (0.3% of the total riverine habitat) may be disturbed.

Each year, creation and replacement activities could require moving nearly 880,000 cubic yards of material, with 73 days of dredge operation and 56 days of mechanical work.

The annual construction cost for the Existing Program is estimated to be $6,100,000 at 2009 price levels (See Table S-11).

Potential Adverse Impacts within the Segments (Existing Program)

Under the Existing Program, “available area” is not exceeded in either the Lewis and Clark Lake or Gavins Point River Segments. The direct effects of constructing 25 acres of ESH annually would be minor with regard to recreation in the Lewis & Clark Lake Segment. The concerns regarding the Gavins Point River Segment are greatly reduced, although potential impacts are assessed using a higher standard in segments within the MNRR. There are no concerns regarding required sediment volume for the existing program (see Section 6.2 and Table 6-2 of the main document).

No Build Program

The No Build Alternative assumes that the Corps would no longer do any ESH construction. It also assumes that other environmental processes will continue to occur, thus changing the existing environment in the absence of the Corps implementing a proposed action. This alternative assumes no action by the Corps to budget for or implement any type of ESH creation or replacement. The effects of this alternative reflect the continuation of existing economic, social, and environmental conditions and trends in the absence of activities to create ESH.

Without any construction, all construction impacts would be avoided; however, the trends of habitat loss and declines in least tern and piping plover productivity are anticipated to continue.

Summary of Potential for Significant Effects Associated with Alternatives

The ESH program intends to utilize a system of avoidance and minimization (to the extent possible, which varies by alternative) in order to limit adverse effects to resources. The potential for significant adverse effects on each resource by the various alternatives are summarized for each of the five segments in Table S-10. This table is derived from segment-based tables in Chapter 6 that summarize the potential for significant adverse effects of each alternative. These values are based on the descriptions of impacts for each resource, by segment, by alternative and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

Table S-10: Summary: Potential Significant Adverse Segment-Specific Effects, by Alternative

Segment-Specific Summary of Potential Significant Adverse Effects by Alternative

Parameter	Alt 1 2015 Goals					Alt 2 2005 Goals					Alt 3 1998/1999 ESH					Alt 3.5 Intermediate					Alt 4 2005 ESH					Alt 5 Nesting Patterns					Existing Program					No Program				
	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP
Air Quality	N	N	N	N	N	na	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Aesthetics	H	H	H	H	H	na	M	M	M	H	H	M	M	M	H	M	M	M	M	M	M	L	L	L	L	N	L	L	L	L	N	N	N	N	N	N	N	N	N	N
Surface Water H&H	N	H	L	L	H	na	M	L	L	M	N	M	L	L	M	N	L	L	L	M	N	L	L	L	L	N	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Degredation Aggradation Erosion	H	H	H	H	H	na	H	H	M	H	H	H	H	M	H	M	H	M	L	M	L	M	L	L	L	L	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Water Quality	L	L	M	M	H	na	L	L	M	M	L	L	L	M	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Vegetation	L	L	L	L	M	na	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Wetlands	L	H	L	H	H	na	M	L	M	M	L	M	L	M	M	N	L	L	L	M	N	L	L	L	L	N	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Fish & Wildlife	L	H	H	H	H	na	M	M	M	M	L	M	M	M	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Pallid Sturgeon	H	H	H	M	H	na	H	M	M	M	H	H	M	M	H	M	M	L	L	M	M	L	L	L	L	N	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Terns & Plovers	N	N	N	N	N	na	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Recreation	N	H	H	H	H	na	H	M	H	H	N	H	M	H	H	N	M	L	M	M	N	M	L	L	L	N	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Noise	N	H	H	H	H	na	H	M	H	H	N	H	M	H	H	N	M	L	M	M	N	L	L	L	L	N	L	L	L	L	N	N	N	L	L	N	N	N	N	N

FP = Fort Peck GA = Garrison F = Fort Randall LC = Lewis & Clark Lake GP = Gavins Point
N = None H = High M = Moderate L = Low na = Not Applicable

Summary of Estimated Acreage Requirements & Costs for the Alternatives

Table S-11 provides an alternative-by-alternative comparison of the segment-based estimated acreage goals, total acres and costs. Because the program would be implemented in an Adaptive Management framework, costs are estimates. To provide a basis of comparison, it is assumed the program is fully implemented using mechanical creation. However, it is recognized that during implementation, costs could be affected by the following:

- If opportunities arise for the Corps to utilize more cost effective methods of creation (e.g. vegetation removal or geotextile tubes), cost efficiencies could be gained.
- Full implementation may not be necessary if species metrics or measurements (e.g. population and productivity) are met at lower acreage levels (see Adaptive Management, Appendix H).
- Acreage goals are expressed as the total habitat present, including created and naturally occurring sandbars. The number of acres required to supplement naturally available habitat would likely fluctuate each year.

Table S-11: Comparison of Alternatives: Estimated Emergent Sandbar Habitat Acreages & Costs for Alternatives if Fully Implemented

Segment	Alt. 1	Alt. 2	Alt. 3	Alt. 3.5	Alt. 4	Alt. 5	Existing Program	No Build
Fort Peck River (Acres)	883	-----	883	565	248	30	0	0
Garrison River (Acres)	4,295	2,148	2,066	1,327	588	500	0	0
Fort Randall River (Acres)	700	350	295	212	128	135	0	0
Lewis & Clark Lake (Acres)	1,360	680	566	354	142	80	50	0
Gavins Point River (Acres)	4,648	2,324	2,944	1,912	880	570	833	0
Total ESH Acreage Goal	**11,886**	**5,502**	**6,754**	**4,370**	**1,986**	**1,315**	**883**	**0**
Estimated Annual Construction (Acres)	4,802	1,786	2,140	1,182	347	164	150	0
Const. Cost/Year ($ M) *	$ 147.7	$ 54.9	$ 65.8	$ 36.4	$ 10.7	$ 5.0	$ 4.6	$ 0
Total Cost/Year ($M) **	$197.1	$73.3	$87.8	$48.6	$14.3	$6.7	$6.1	$0.0

** Construction cost is calculated in Appendix C. Cost estimations are based on actual historical costs from past ESH projects over a number of years. Therefore, factors such as contractor inefficiency/unavailability or weather are accounted for in the calculations. These estimates were prepared based on an estimated annual level of effort to construct and replace habitat.*

*** Total cost is calculated utilizing estimated costs for engineering and design, field supervision and administration, program management, planning and NEPA compliance, as well as an overall contingency (10%).*

Annual costs are projected to remain constant over time to maintain a given acreage of habitat, but shift from new creation to replacement of lost (eroded or vegetated) ESH. The goal levels could be attained over an approximate 10-year period, during which the goal level would be approached gradually until construction amounts would level off (see Figure S-3), or adjusted based on biological performance (see Appendix H). After that initial construction period, the acreage goal would be retained with a constant annual acreage replacement program for these four alternatives (annual construction acreage is essentially the same as the subsequent replacement acreage). Alternatives 1, 2, 3, and 3.5 would require an initial construction (combination of ESH creation and replacement) period during which the habitat goal of these alternatives would be met. Although the actual rate of construction will follow an adaptive management framework, for comparison purposes the table shows the annual construction acres/costs to reaching target acreage over ten years and sustaining them. Alternatives 4, 5, and Existing Program do not show an initial period with increasing creation acres because the acreage goal would be already met or exceeded with the amount of habitat available in 2005 (assumed to exist for all of the alternatives, when implemented). Under these three alternatives, a constant annual replacement program would be implemented in the first year, and the 2005 acreage amount would be replaced (Alternative 4) or allowed to deteriorate to a reduced amount of habitat (Alternatives 5 and Existing Program). Figure S-3 depicts the amount of habitat that would exist assuming that the starting point is the 2005 acreage and the creation or replacement (whichever is the case) period begins the first year (as early as 2012). The Corps will be coordinating with the Cooperating Agencies (USFWS and NPS) on an ongoing basis to establish and refine the timeline to meet benchmark acres.

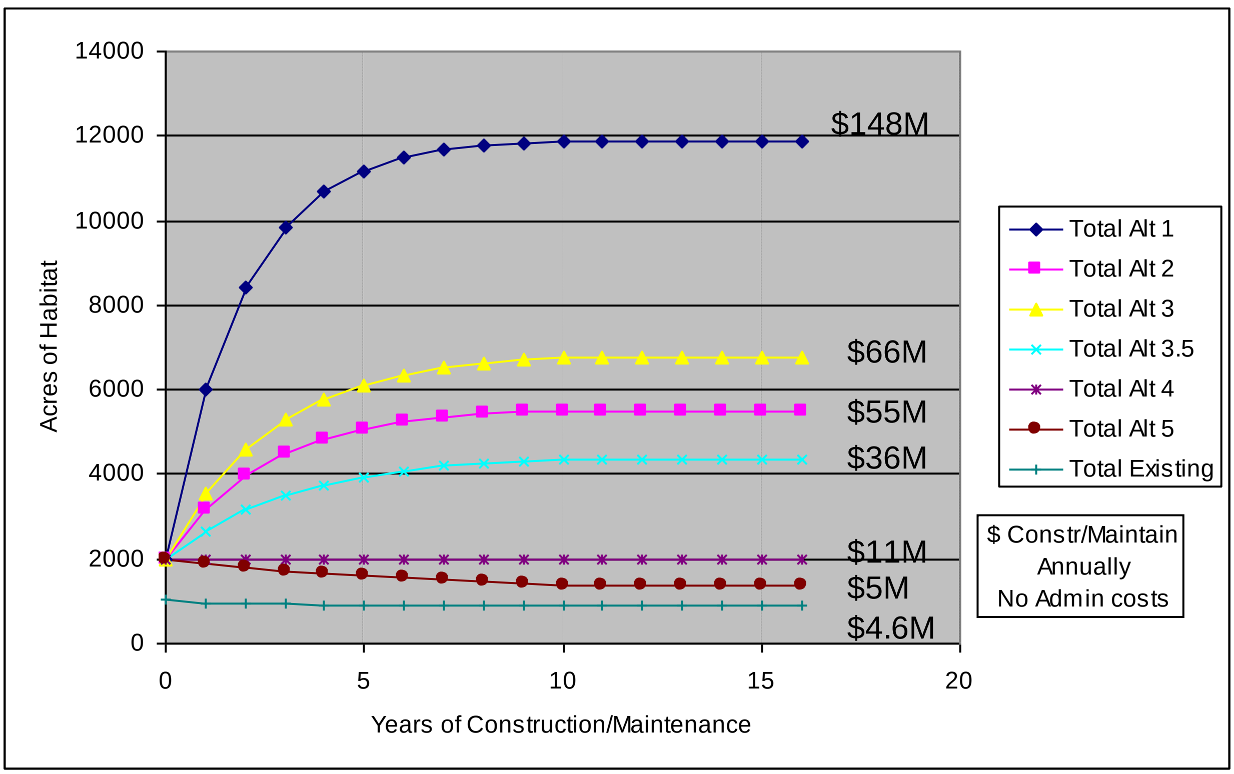

Figure S-3: Estimated Amount of Habitat that Could Exist within Various Construction Timeframes

Figure S-3 demonstrates how acreage goals could be approached gradually until construction amounts would level off; however it does not account for adjustments due to biological response of initial actions based on an Adaptive Management approach (see Appendix H). If the funding levels specified in Table S-11 are not provided when the Program is initiated, the construction period to reach the specified acreage goal (Alts. 1, 2, 3, and 3.5) would be longer or the assumed acreage to exist (2005 levels) would be somewhat less due to continuing erosion and vegetation encroachment. Construction levels would be subject to available funding and other program priorities.

Summary of Cumulative Effects

Since this is a "programmatic" approach to impacts within an ongoing program over various segments over time, in essence, the "cumulative" impacts of program implementation (from Alternative 1 – 11,886 acres to Alternative 5 – 1,315 acres, and the existing program) have already been addressed in Chapter 6, Environmental Consequences.

The construction and operation of the Missouri River Main Stem Reservoir System altered the Missouri River. The six dams and their associated lakes affect the geomorphologic, hydrologic, ecological, social, cultural and economic conditions along the Missouri River. The hydrologic and geomorphic processes that would have created habitat for least terns and piping plovers are greatly reduced. The Cumulative Impacts section of the 2004 Final Master Manual EIS discusses this as well as summarizes other projects or facilities within the basin that could affect or be dependent upon the Mainstem Reservoir System.

Operation of this reservoir system was reviewed and subsequently modified via the 2004 Master Manual EIS to benefit the listed species, including the least terns and piping plovers. The operation changes include spring rises and intrasystem regulation changes that affect tern and plover habitat. However, as discussed in the Cumulative Impacts section of the Final Master Manual EIS, these effects are anticipated to be minimal for creating habitat naturally

As described throughout Chapter 6, implementation of the RPA as published in the 2003 BiOp Amendment has the potential for high/significant cumulative impacts to other uses, functions, resources, and processes of the riverine corridor that are of value to other organisms and to humans. For the implementation of the Preferred Alternative (AMIP with a maximum up to 4,370 acres associated with Alternative 3.5), the area disturbed is within the available area for the Fort Peck River, Garrison River, Fort Randall River, and Lewis and Clark Lake Segments. However, construction of the maximum acres in the Gavins Point River Segment would require construction activities in the restrictive area, requiring additional coordination with state and federal agencies to avoid sensitive resources as the program is progressively implemented. The impact of implementation of the lesser alternatives could still result in moderate to low cumulative impacts, including impacting the MNRR with regard to noise, view shed, and recreational conflicts.

Cumulative impacts to the 59-Mile District (Gavins Point River Segment) and the 39-Mile District (Fort Randall River Segment) of the MNRR were considered. Based on analysis and a construction methodology designed to avoid impacts to the cross-section of the river (e.g. borrowing material from active channel; placement and borrow area buffers; restrictions on dredging depth), we do not anticipate significant impacts that would affect bank erosion or stability of the river. However, public concern regarding bank erosion, as well as interest in bank stabilization, have been ongoing even prior to the ESH program, and are anticipated to continue as additional acres of ESH are created in these two segments. Because the program would be implemented incrementally, unique opportunities for monitoring and Adaptive Management (Appendix H) allow for a flexible approach to meeting the biological metrics for the least tern and piping plover. The Corps will continue to address concerns as they arise and coordinate with the USFWS, NPS, state agencies and landowners.

Beneficial Effects of ESH Program Implementation

Construction of ESH would significantly benefit least tern and piping plover production. ESH also benefits other shorebirds and many native fish species, as well as amphibians and reptiles. In addition, construction of ESH is expected to have a net positive effect in stimulating the local and regional economy. It is anticipated that any net local reductions in visitation and visitor spending would be more than offset by local increases in employment, income, and spending of ESH construction companies and their workers.

Conclusion

The ESH PEIS allows the public, cooperating agencies (USFWS and NPS), and Corps decision makers to make comparisons of the impacts of the range of alternatives for the ESH Program. The goal is to implement a program to support the least tern and piping plovers through mechanically creating and replacing ESH in a safe, responsible, and efficient manner that minimizes the environmental consequences.

An Adaptive Management implementation Process (AMIP) has been identified as the preferred alternative. While the exact number of acres needed to be constructed and replaced is uncertain at this time, this document discloses the impacts associated with up to the maximum of Alternative 3.5 (4,370 acres). This selection was based on the premise that 1998/1999 to 2005 was a highly productive period for least terns and piping plovers whereby fledge ratios were being met, or approximated, on the riverine segments of the Missouri River. It is also based on current knowledge that after 2005, productivity of both species has declined. Moreover, the Corps believes that the AMIP implementation of up to the acreage of Alternative 3.5 provides sufficient flexibility to implement and adjust the program. As the program is progressively implemented, necessary monitoring will be conducted, and acreage goals for lesser alternatives will be used as interim benchmarks, in coordination with the USFWS. As a planned part of the AMIP strategy, if fledge ratios and other objectives are met with an acreage amount lesser than those prescribed by Alternative 3.5, the Corps may reduce the amount of acreage constructed. Likewise, if the habitat amounts identified within Alternative 3.5 are inadequate to meet biological targets, greater habitat amounts or alternative action could be pursued following subsequent NEPA documentation (issuance of a new Record of Decision/new analysis). The Corps believes the preferred alternative will be protective of human health and the environment, comply with all applicable laws and requirements, and will be cost effective.

Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

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Acronyms and Abbreviations

39-Mile District	MNRR from Ft. Randall Dam to Running Water, South Dakota
59-Mile District	MNRR from Gavins Point Dam to Ponca, Nebraska
ACHP	Advisory Council on Historic Properties
ac	Acre
ACT	Agency Coordination Team
ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effect
ARPA	Archaeological Resources Protection Act
ASTM	American Society for Testing and Materials
BEA	Bureau of Economic Analysis
BiOp	Biological Opinion
BSNP	Bank Stabilization and Navigation Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet-per-second
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DSP	Daily-inundated Sand Plain
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
FR	Federal Register
ft	Feet
GIS	Geographic Information Systems
GMP	General Management Plan
HCRS	Heritage Conservation and Recreation Service
HTRW	Hazardous, Toxic and Radioactive Waste
IDNR	Iowa Department of Natural Resources
ISP	Integrated Science Program
kcfs	Thousand cubic feet-per-second

Least tern	Interior population of the endangered least tern
LiDAR	Light Detection and Ranging (remote sensing)
M&E	Monitoring and Evaluation
MAF	Million acre feet
Master Manual	Missouri River Main Stem Reservoir System Master Water Control Manual
MNRR	Missouri National Recreation River
MOU	Memorandum of Understanding
MRAPS	Missouri River Authorized Purposes Study
MRERP	Missouri River Ecosystem Restoration Plan
MRMSRS	Missouri River Main Stem Reservoir System
MRNRC	Missouri River National Resource Committee
MRRIC	Missouri River Recovery Implementation Committee
MRRP	Missouri River Recovery Program
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NDIRC	North Dakota Intertribal Reinternment Committee
NEPA	National Environmental Policy Act
NGPC	Nebraska Game and Parks Commission
NHPA	National Historic Preservation Act
NPS	National Park Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSHS	Nebraska State Historical Society
NWI	National Wetland Inventory
NWP	Nationwide Permit
O&M	Operation & Maintenance
ORV	Outstandingly Remarkable Values
PEIS	Programmatic Environmental Impact Statement
PDT	Project Delivery Team
PIR	Project Implementation Report
PL	Public Law
Piping plover	Great Plains population of threatened piping plover
RM	River Mile

ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
SDGFP	South Dakota Game, Fish and Parks
SHPO	State Historic Preservation Office
SRA	State Recreation Area
Pallid sturgeon	Endangered pallid sturgeon
THPO	Tribal Historic Preservation Office
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WSRA	Wild and Scenic Rivers Act

1 BACKGROUND

1.1 PROJECT HISTORY AND AUTHORITY

The Missouri River drainage basin is approximately 530,000 square miles in area, occupying approximately one-sixth of the continental United States. The Missouri River originates from the confluence of the Gallatin, Jefferson and Madison rivers in Three Forks, Montana, flowing over 2,300 miles from east to southeast and eventually merging with the Mississippi River just before St. Louis, Missouri (Figure 1-1). Comprised of six dam and reservoir projects operated by the U.S. Army Corps of Engineers (Corps), the Missouri River Mainstem Reservoir System is authorized by the Rivers and Harbors Act of 1935 and the Flood Control Act of 1944.

To formalize the management and operations of the system, nearly 40 years ago the Corps developed the Missouri River Main Stem Reservoir System Master Water Control Manual (Master Manual). Within the Master Manual, the Corps identifies the congressionally authorized project purposes and sets forth a management plan to best meet the needs for the reservoir system. The Master Manual describes the water control plan and the objectives for the integrated regulation of the system by providing guidance for the regulation of the Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point projects.

Intended to be a living document, responding to the changing conditions of the Missouri River and those who use the resource, the Master Manual was formally revised in 1973, 1975, and 1979. In the late 1980s, the Corps began to revise the Master Manual again in response the first major drought since the reservoir system had become operational. The changes to the Master Manual described management changes of the river that began saving water in the three biggest reservoirs (Fort Peck, Sakakawea, and Oahe) earlier in a drought than under the previous Water Control Plan and that halt navigation earlier during periods of extreme drought. These changes were believed to best meet the overall uses along the Missouri River and the needs of the people of the basin during periods of drought.

Revision of the Master Manual was considered a major federal action with the potential for causing significant environmental impacts. In accordance with the requirements of the National Environmental Policy Act (NEPA), the Corps evaluated the effects to the human environment from the Master Manual's water management alternatives in an Environmental Impact Statement (EIS). The administrative process defined by NEPA requires the Corps to consult with other federal and state agencies and comply with various other laws, regulations, and procedures.

Within the context of the ongoing NEPA evaluation for the Master Manual revision, the Corps initiated consultation in 1989 with the U.S. Fish and Wildlife Service (USFWS) regarding operation of the Missouri River Main Stem Reservoir System and the Master Manual revision. This consultation was conducted under the provisions of Section 7 of the Endangered Species Act (ESA), which requires federal agencies to consult with the USFWS when the agency's proposed actions may affect the status of species listed as endangered or threatened. For the Missouri River operations by the Corps, the species being addressed in the 1989 consultation were the endangered interior population of least tern (*Sternula antillarum*) (least tern), the threatened northern Great Plains piping plover (*Charadrius melodus*) (piping plover), and the then endangered bald eagle (*Haliaeetus leucocephalus).*

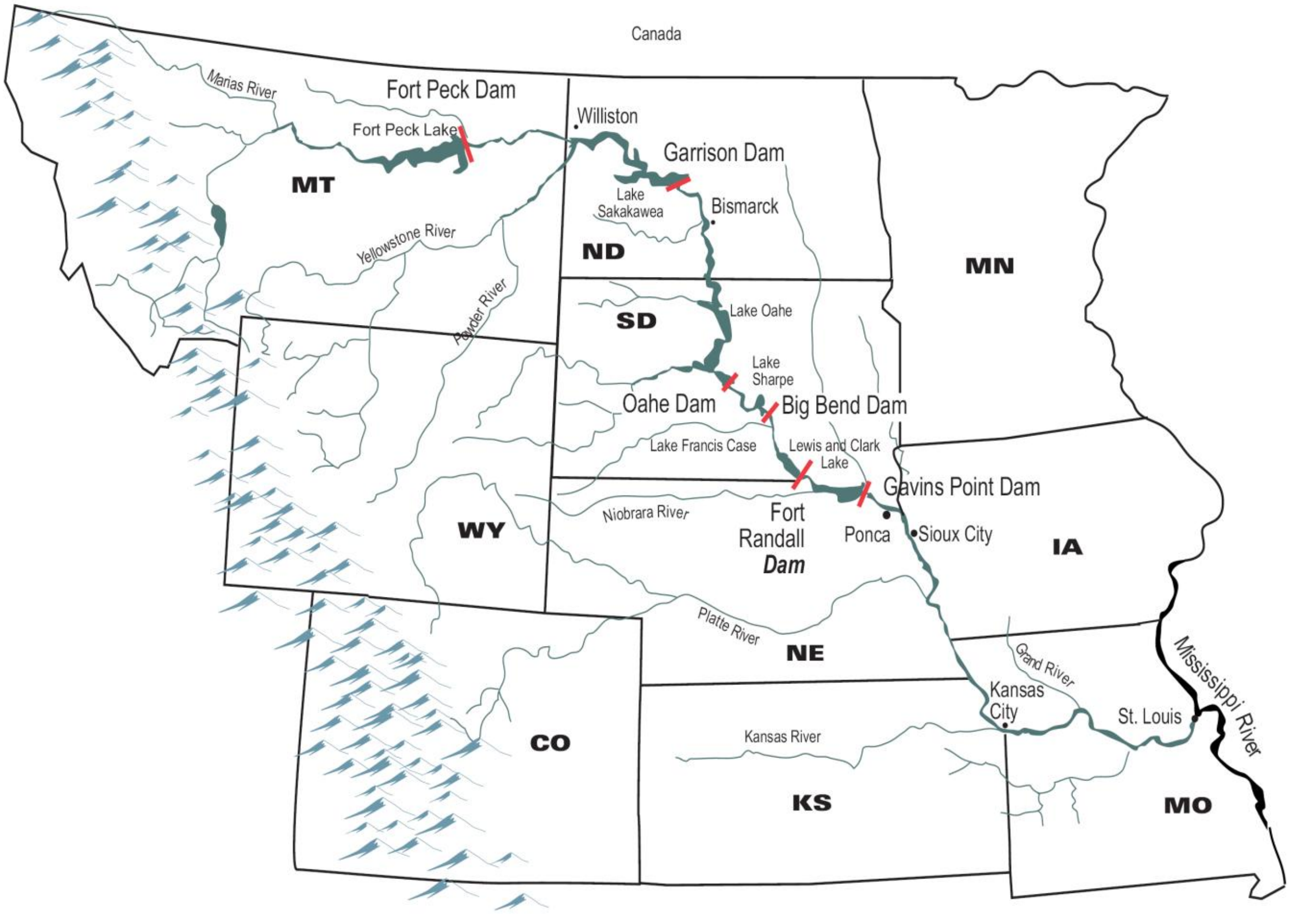

Figure 1-1: Missouri River Mainstem Reservoir System

Subsequently, the pallid sturgeon (*Scaphirhynchus albus*) was listed as endangered in 1990 and was addressed by the Corps and the USFWS.

Throughout the 1990s, the USFWS and the Corps conducted informal and formal Section 7 consultations, resulting in the issuance of a final Biological Opinion (BiOp) by the USFWS in 2000 (USFWS, 2000). In the 2000 BiOp, the USFWS found that the proposed drought management actions in the Corps' revised Master Manual would result in jeopardy to the least tern, pallid sturgeon, and piping plover, but no jeopardy to the bald eagle.

The USFWS provided the Corps with a Reasonable and Prudent Alternative (RPA)[1] to the current Water Control Plan at that time, which, if implemented, would avoid the likelihood of

[1] The regulations implementing section 7 of the ESA (50 CFR 402.02) define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that (1) can be implemented in a manner consistent with the intended purpose of the action, (2) can be implemented consistent with the scope of the action agency's legal authority, (3) are

jeopardizing the three species. In November 2003, the Corps reinitiated formal consultation under Section 7. Re-initiation of consultation was largely due to a hydrology and hydraulics analysis that found that the flow modifications proposed in the 2000 BiOp for ESH creation would erode more habitat than they would create. In addition updated information regarding baseline environmental conditions and the current status of least terns and piping plovers became available, as well as information on the affects of the Corps' new proposed RPA elements. In December 2003, the USFWS issued an amended BiOp (USFWS, 2003) that specified a single RPA (RPA IV.B.3) for the pallid sturgeon, least tern, and piping plover. That single RPA allows for the mechanical creation and replacement of emergent sandbar habitat to avoid jeopardy to the bird species. The need for Corps action results from this formal Section 7 consultation and this RPA, and is described in Section 2.1.

In March 2004, the Corps published a Final EIS and Record of Decision on the *Missouri River Main Stem Reservoir System Master Water Control Manual* and completed the formal revision of the Master Manual. The Master Manual Final EIS, Record of Decision, and 2003 Amended BiOp can be found on line at: http://www.nwd-mr.usace.army.mil/mmanual/mast-man.htm.

1.1.1 The Missouri River's Importance to the Species

Channelization, irrigation, construction of reservoirs and pools, and managed river flows have contributed to the elimination of much of the least tern's and piping plover's sandbar nesting habitat. Under the Missouri River Bank Stabilization and Navigation Project (BSNP), the Missouri River was engineered into a single, narrow navigation channel. Most sandbars virtually disappeared between Sioux City, Iowa and St. Louis, Missouri. Reservoir storage and irrigation depletions of flows responsible for scouring sandbars has resulted in encroachment of vegetation onto sandbars along many rivers, further reducing least tern nesting habitat. In addition, river main stem reservoirs now trap much of the sediment load resulting in less aggradation and more degradation of the river bed, reducing formation of suitable sandbar nesting habitat.

In September 2002, critical habitat was designated for the United States portion of the northern Great Plains piping plover breeding population. About 440 miles of river habitat were designated in Nebraska. On the Missouri River, 77,370 acres associated with Fort Peck Reservoir were designated as were about 438 miles of reservoir habitat and 330 miles of riverine habitat.
An over-riding primary constituent element was the dynamic ecological process that creates and maintains piping plover habitat. This process includes local weather, hydrological conditions and cycles, and geological processes. The reservoir habitat and riverine habitat on the Missouri River had different primary constituent elements. For reservoirs, the primary constituent elements included sparsely vegetated shoreline beaches, peninsulas, and islands composed of sand, gravel, or shale and their interface with the water bodies. On the river, the primary constituent elements were sparsely vegetated channel sandbars, sand and gravel beaches on

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economically and technologically feasible, and (4) that the Director believes would avoid the likelihood of jeopardizing the continued existence of listed species and avert the destruction or adverse modification of critical habitat.

islands, temporary pools on sandbars and islands, and the interface with the river. Overall, the status of critical habitat on the Missouri River declined on the river segments due to vegetation encroachment and erosion, though habitat was supplemented by the construction of habitat below Gavins Point Dam in 2004 and 2005. Due to the drawdown of the reservoirs because of drought conditions during this time, substantial shoreline habitat was created on Lake Sakakawea and Lake Oahe.

As of the 2005 breeding season, the Missouri River was home to 904 least terns, which represents approximately 5% of the total interior population, and 1% of the entire species. In the period of 1991-2006, the Missouri River piping plover populations have accounted for anywhere from 6 – 28% of the total Great Plains population and 3 – 13% of the entire species.

1.1.2 Life Histories of the Least Tern and Piping Plover

Least tern and piping plover productivity is discussed in detail in Appendix B. Below are short summaries of the life histories of each bird.

1.1.2.1 Least Tern

The least tern (*Sternula antillarum*) is the smallest member of the tern family in North America. The species is migratory and are believed to winter primarily along coastal areas adjacent to the Pacific and Atlantic Oceans. On the Pacific Coast least terns have been reported wintering in southern Mexico and Columbia. On the Atlantic Coast, least terns have been reported along the coast of Brazil and as far south as northern Argentina. In March through May least terns will migrate to the breeding grounds, which includes the Atlantic and Gulf Coasts of North America, Caribbean islands, on the Pacific Coast of southern California and the Baja Peninsula and on sandbars of several rivers of the United States. The interior population breeds primarily on the following major rivers and their tributaries: the lower Mississippi, the Red, the Arkansas, and the Missouri. Migration to the wintering grounds may occur as early as late June for the interior population. By the end of August, the majority of the least terns have left the breeding grounds.

The least tern is a slender bird with long narrow wings, a forked tail, and pointed bill. The adults weigh 40 to 45 grams (1.5 ounces), are about 22 cm (8.5 inches) in length, and have a wingspan of 50 cm (20 inches). Both sexes are similar in size and color, with upper parts that are gray and under parts that are white. The least tern will undergo a molt to its alternate (breeding) plumage before leaving the wintering grounds. Distinguishing characteristics of this plumage include a black head cap, a white triangular forehead, and a black stripe from the beak across the side of the head.

Least terns nesting on the Missouri River prefer areas on open sand/gravel sandbars with high elevation above the water and that contain sparse (< 10%) vegetation. Least terns are gregarious (social) and on the Missouri River will nest in colonies of ten or more nests at a site. However, small colonies of less than five nests and solitary nests will also be found. Initiation of first nests seems socially facilitated and is fairly synchronous within a colony. The preferred prey of least terns are small fish, though mollusks and insects are also consumed. The prey are generally small (1-4 inches in length, less than half inch depth), surface swimming, non-spiny fish. Fish capture is done by hovering from three to thirty feet above a shallow water area, then diving to the water to grasp the fish in the open mandibles. The nest is a scrape in the sand with a clutch of two to three eggs. Eggs are oval to short oval. The eggs are smooth with a pale olive to buff color. Tern eggs have brown splotches that help camouflage them in the surrounding substrate. The eggs are laid at a rate of one per day. After the last egg is laid, incubation will start. The adults share egg incubation; however the female performs the majority of this duty. One partner will forage for fish and will bring back minnows to feed the mate sitting on the nest

Chicks hatch after 19-25 days of incubation. Both adults care for the growing chicks, catching minnows, which are then fed to the chicks. The chicks take 18-22 days to fledge (fly). Fledglings congregate with adults and other fledglings, practicing foraging techniques for several weeks. The parents continue to feed the juveniles after they have fledged and may continue to do so during migration to the wintering grounds.

If successful, a least tern pair will raise just one brood during the breeding season. If a pair suffers nest destruction or loses a young brood, they will likely re-nest.

Adult censuses have been conducted with various degrees of precision for least terns in the United States. (Adult numbers are not generally known for Mexico and the Caribbean.) On the Atlantic Coast adult numbers have been estimated at 42,000, on the Gulf Coast at 12,000, in the interior at 17,500, and on the Pacific Coast of southern California at 14,000. The adult numbers for the Gulf Coast are suspect due to incomplete surveys, but least tern adult population in the United States can be conservatively estimated at 85,500. The interior and California populations of the least tern are listed as endangered under the Endangered Species Act. The Atlantic and Gulf Coasts populations are not listed.

1.1.2.2 Piping Plover

The piping plover (*Charadrius melodus*) is a small, stocky shorebird. The species is migratory and spends the fall, winter, and early spring on beaches along the south Atlantic Coast from North Carolina to Florida, the Gulf Coast from Florida to Mexico, the coast of the Yucatan peninsula in Mexico, the Bahamas, and Caribbean Islands. In March and April piping plovers will migrate to the breeding grounds, which include three primary regions: the mid and north Atlantic Coast of the United States and Canada, the Great Lakes and the Great Plains of north central United States, and south central Canada. Migration to the wintering grounds may occur as early as June. By the end of August, the majority of the piping plovers have left the breeding grounds.

Adult piping plovers weigh between 43-63 grams (1.5 to 2.0 ounces), have a length of 17-18 cm (7 inches), and a 38 cm (15 inch) wingspread. The dorsal (upper) parts are a pale grayish brown color, resembling the color of dry sand. The ventral (under) parts are white. Before undertaking the spring migration, the piping plover undergoes a molt into the alternate (breeding) plumage. Distinguishing characteristics of this plumage include a single black band around the neck and a black band across the forehead between the eyes.

Piping plovers on the Great Plains make their nests on open, sparsely vegetated, sand/gravel beaches adjacent to alkali lakes and wetlands; on beaches of reservoirs and lakes; and on sandbars of rivers. Piping plovers are territorial; after arriving on the breeding grounds, a male will establish a territory to defend potential nest locations and foraging areas. The piping plover eats worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates, which are plucked from the sand. The nest is a scrape in the sand, usually lined with pebbles, with a clutch of three to four eggs. Eggs are oval to pyriform (pyramid) shaped, the shell is smooth with no gloss. The eggs are light buff in color and evenly marked with fine spots of dark brown. This cryptic pattern acts as camouflage and allows the eggs to blend with the surrounding substrate. Eggs are laid about every other day and incubation does not begin until the final egg is laid. After 28-31 days of incubation, chicks hatch. Chicks are precocial and begin feeding shortly after they hatch. Chicks forage near a parent and immediately use the "peck and run" foraging behavior of adults. The female may desert the brood and migrate to the wintering grounds before the chicks fledge. The male will continue to tend the brood, often even after the chicks fledge. The chicks take 21-28 days before they fledge (able to fly). If successful, a piping plover pair will raise just one brood during the breeding season. If a pair suffers nest destruction or loses a young brood, they will likely re-nest.

Every 5 years an international census of both the breeding and wintering grounds has been conducted for the piping plover. The last census was completed in 2006. In that year the breeding census counted 8,092 adults. In 2006 the Atlantic Coast population was 3,320, the Great Lakes population was 110, and the Northern Great Plains population was 4,662 adults. In 2006, 3,884 adults were counted on the wintering grounds. In the United States, the Atlantic Coast and northern Great Plains populations are listed as threatened and the Great Lakes population is listed as endangered under the Endangered Species Act.

1.1.3 Current Status of the Least Terns and Piping Plovers on the Missouri River

No range-wide adult censuses had been conducted for least terns and piping plovers on the Missouri River before the two species were listed in 1985 and 1986 respectively. Although certain parts of the Missouri were censused in 1986 and 1987, it was not until 1988 that a census was completed for all Missouri River segments known to contain the two species. Since 1988 an adult census has been conducted on the Missouri River. Piping plover adult numbers from 1988 through 2009 have ranged from a low of 86 in 1997 to a high of 1,764 in 2005, with an average of 793 adults. By way of comparison, the USFWS's recovery plan sets a goal of 425 piping plover pairs for the Missouri. Least tern adult numbers from 1988 through 2009 have ranged from a low of 427 in 1997 to a high of 1,010 in 2007 with an average of 679 adults. By way of comparison, the USFWS's recovery plan sets a goal of 900 least tern adults for the Missouri.

1.2 RELATIONSHIP BETWEEN MRRP AND ESH

The Corps initiated the Missouri River Recovery Program (MRRP) to implement the RPA from the 2003 BiOp Amendment for the referenced species. Funding within the MRRP is prioritized among all recommended tasks within the RPA. The mechanical construction of emergent sandbar habitat (ESH) is a subset of the MRRP and is referred to as the ESH program and is specifically related to RPA IV (b) 3 for the least tern and the piping plover. This Programmatic Environmental Impact Statement (PEIS) is intended to provide NEPA coverage for the mechanical construction for the ESH program and is an independent regulatory action narrowly focused on compliance of RPA IV (b) 3 of the 2003 BiOp Amendment. Other NEPA documents have been completed, or are ongoing, related to other aspects of MRRP (e.g. Notice of Intent to prepare an EIS for the Missouri River Ecosystem Restoration Plan (MRERP), Missouri River Basin, was posted January 26, 2009).

1.3 National Environmental Policy Act Overview and Programmatic EIS Objective

The National Environmental Policy Act (NEPA) of 1970 established a national environmental policy and goals for the protection, maintenance, and enhancement of the environment. It also provides a process for implementing these goals within federal agencies. It requires all federal agencies to incorporate environmental considerations in planning and decision-making. NEPA also established the President's Council on Environmental Quality (CEQ) and empowered the CEQ to develop regulations by which all federal agencies would comply. These regulations are published in the Code of Federal Regulations (CFR) at 40 CFR 1500-1508.

The endangered species legal and administrative authorities include the Endangered Species Act, implementing regulations, and the Section 7 Handbook (and several others). The Corps is required to support activities to determine the effects their actions may have on listed and proposed species or designated or proposed critical habitat. During this review, the USFWS biological judgment included a two-step protocol consisting of a policy and scientific mixture in order to make a jeopardy determination. Jeopardy or no jeopardy decision separates acceptable from unacceptable impacts on listed species. While there is no specific number above which a population is secure or below which it is headed for extinction, this decision-making is about deciding an acceptable risk positioned against the risk that constitutes jeopardy to the listed bird species. Section 7 consultations involved discussion between the Corps and USFWS, resulting in the USFWS suggesting the Reasonable and Prudent Alternatives (RPA's) as part of a Biological Opinion.

The Corps has promulgated its own Procedures for Implementing NEPA, Environmental Regulation 200-2-2, to provide guidance for the procedural provisions of NEPA. ER 200-2-2 supplements, and is used in conjunction with, the CEQ regulations.

Within the CEQ NEPA regulations and ER 200-2-2, a process is set forth where the Corps must assess the environmental impact of proposed major federal actions and consider reasonable alternatives to their proposed actions. For those actions with the greatest potential to create significant environmental effects, the consideration of the proposed action and alternatives is presented in an environmental impact statement, or EIS. Major federal agency actions typically fall within one of the following categories: 1) adoption of official policy (i.e., rulemaking), 2) adoption of formal plans, 3) adoption of programs (i.e., a group of concerted actions to implement a specific policy or plan), and 4) approval of specific projects (i.e., construction or management activities located in a specified geographic area) (40 CFR 1508.18).

EISs may be prepared by agencies for each of these types of actions; this EIS is the third type for the adoption of a program, thus the title of "Programmatic EIS", or PEIS. The following PEIS is comprehensive in nature and considers numerous related actions being decided within the context of a significant program and, therefore, targets the environmental consequences as a whole. One purpose is to assess impacts, which are similar, cumulative, and connected under a programmatic umbrella.

The information developed in the PEIS has led to alterations in project design, implementation of mitigation measures, and an enhanced opportunity for public involvement in the decision-making process. Preparation of the PEIS has also allowed the Corps to address compliance with other environmental laws as part of a single review process rather than through separate reviews to reduce paperwork and ensure comprehensive compliance. The Corps has incorporated environmental values into its decision-making process.

Ongoing NEPA compliance has occurred to date in the form of site-specific Environmental Assessments (EAs) prepared for ongoing ESH creation actions (see Section 2.2.1). After the Final PEIS is published, project-specific EAs would continue to be produced to discuss site-specific design, environmental and other issues, and to provide ongoing NEPA compliance, including the opportunity for public review and comment.

1.4 RELATIONSHIP OF THE PROGRAMMATIC EIS TO THE MASTER MANUAL EIS AND ROD

The 2000 BiOp states as part of its RPA (page 247), "When habitat goals are not met through flow regulation and tern and/or plover fledge ratio goals have not been met for the 3-year running average, other means (e.g., creation of habitat) will be necessary to ensure the availability of habitat to meet fledge ratio goals." Subsequently, the Master Manual EIS discussed least tern and piping plover habitat in the Cumulative Impacts section of the Revised Draft EIS (August 2001), with the wording retained in the Final EIS (March 2004), under the impacts of past, present, and foreseeable actions. This discussion states that flow changes alone are not adequate for the two listed bird species, and considerable additional habitat will have to be constructed to meet the needs of the least terns and piping plovers.

This PEIS, therefore, evaluates the environmental consequences of alternatives to execute the Corps' program to implement the USFWS's RPA for the mechanical maintenance and creation of emergent sandbar habitat. This PEIS describes and evaluates the group of concerted actions that the Corps proposes to implement as the "emergent sandbar habitat program." The record of decision based on this PEIS will set forth the Corps' program to implement the mechanical maintenance and creation of emergent sandbar habitat (i.e., RPA), thus avoiding jeopardy to the least tern and the piping plover from managing the Missouri River system as currently defined in the Master Water Control Manual.

1.5 TIERING AND INCORPORATION BY REFERENCE

Federal agencies are encouraged to tier[2] their EISs to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review. Whenever a broad EIS has been prepared (such as the Master Water Control Manual EIS) a subsequent proposed action within the entire program or policy (such as this PEIS) may need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference. This practice enables greater focus on the issues specific to the subsequent action with regard to NEPA. Agencies are instructed to incorporate material into an EIS by reference when the effect will be to cut down on bulk without impeding agency and

[2] Tiering is a NEPA-compliance term defined by the Council on Environmental Quality NEPA-Implementing Regulations (40 CFR 1508.28). The term refers to the process of covering general matters in broader environmental impact statements and addressing more detailed decision-making with narrower EISs. The subsequent EISs incorporate by reference the general discussions from the broader EIS and concentrate solely on the issues specific to the lower tiered EIS.

public review of the action. The incorporated material is to be cited in the EIS and its content briefly described.

The Corps and other academic, state, federal, and tribal entities have been studying the affected environment of the Missouri River for decades. As such, there exists a continually expanding multidisciplinary library of technical literature. Many NEPA documents (NPS, 1997, 1999, 2005; USACE, 2004; USFWS, 2000, 2003) or similar summary-type literature overview works (National Research Council, 2002; Biedenharn et al, 2001; USGS, 2006) have been completed on the segments in question. In an effort to develop this document as an analytical tool rather than an encyclopedic presentation of what is known about the Missouri River, the discussion of the affected environment will rely heavily on "incorporation by reference[3]" as encouraged by the CEQ NEPA-implementing regulations (40 CFR 1502.21). As required by the CEQ regulations, the incorporated material shall be cited in the statement and its content briefly described. No material may be incorporated by reference unless it is reasonably available for inspection by potentially interested persons within the time allowed for comment.

1.6 Lead Agency and Cooperating Agency Designations

For every federal action subject to NEPA, at least one federal agency must serve as the lead agency. A "lead agency" is the federal agency with primary responsibility for decision making and, therefore, complying with NEPA on a given proposal. If more than one federal agency is involved in a proposed action, then the lead agency is determined by considering the:

- Magnitude of the federal agency's involvement,
- Approval authority over the proposed action,
- Expertise with regard to environmental effects,
- Duration of the federal agency's involvement, and
- Sequence of the federal agency's involvement (40 CFR 1501.5(c)).

The Corps is designated as the lead agency for this proposed action.

Federal agencies demonstrating discretionary authority over a proposed action (i.e., the National Park Service for actions within the Missouri National Recreational River Reaches) or special expertise with respect to the environmental impact involved in the proposal (i.e., USFWS's expertise with respect to the Endangered Species Act) may be identified as Cooperating Agencies (40 CFR 1508.5; Forty Questions No. 14(a, b, c). The National Park Service (NPS) and the USFWS have agreed to participate as Cooperating Agencies for this PEIS.

A cooperating agency has the responsibility to assist the lead agency by participating in the NEPA process at the earliest possible time; by participating in the scoping process; in developing information and preparing environmental analyses, including portions of the environmental impact statement concerning in which the cooperating agency has special expertise; and in making available staff support at the lead agency's request to enhance the lead agency's interdisciplinary capabilities.

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[3] Agencies shall incorporate material into an environmental impact statement by reference when the effect will be to cut down on bulk without impeding agency and public review of the action.

Due to two of the segments being in the Missouri National Recreational River (MNRR) overseen by the NPS, a Memorandum of Understanding (MOU) between the Corps and NPS was signed in February 2006, and the roles and responsibilities in the development of this PEIS were detailed. The shared responsibilities include working together to "identify measures to avoid and/or minimize impacts to the natural, cultural, and recreational resources within the designated reaches of the MNRR." There are assigned roles that each agency will fulfill, to facilitate interagency cooperation and share information effectively. These roles are fully outlined in the MOU, dated February 2006; however, it is the responsibility of each agency to identify and characterize the significant resources within its jurisdiction and share that information with the other agency.

The USFWS did not formally sign the MOU but has been an active participant in the development of alternatives as well as providing valuable expertise. Beginning in March 2005, interagency meetings, conferences, and discussions have increased flow of knowledge and involvement between the Corps and USFWS. Refer to the attached letters and documentation to examine the interagency cooperation.

2 PURPOSE AND NEED FOR CORPS ACTION

2.1 PURPOSE AND NEED

The purpose of the ESH program is to support least tern and piping plover populations on the Missouri River by supplementing natural habitat through the mechanical creation and replacement of ESH in riverine segments.

In order to address the inherent uncertainties regarding biological response to management actions, the program will be implemented following an Adaptive Management strategy. The ESH program is needed to offset possible habitat deficiencies attributed to the U.S. Army Corps of Engineers' (Corps) operation of the Missouri River Main Stem Reservoir System. The interior population of the least tern was federally listed as endangered in 1985 and the northern Great Plains population of the piping plover was federally listed as threatened in 1986. The need for this action is to ensure that operation of the Missouri River Main Stem Reservoir System, as described in the Corps' revised Master Manual and Final Environmental Impact Statement (FEIS), will not result in jeopardy to these listed species.

The need for Corps action results from formal Section 7 consultation under the Endangered Species Act (ESA) and by a defined regulatory process. Throughout the formal process of revising the Master Manual (including the Master Manual Draft, Revised Draft, and Final EIS), the Corps has consulted with the U.S. Fish & Wildlife Service (USFWS). The USFWS has, through its' 2003 BiOp Amendment, expressed its opinion as to the actions the Corps might implement to avoid jeopardy to the least tern and piping plover.

Specifically, mechanical creation and replacement addresses RPA IV(b)3 of the 2003 BiOp Amendment that, when complied with, allows the Corps' operations, if necessary, to result in the levels of incidental take that are specified in the incidental take statement. The RPA includes habitat goals for the following segments along the Missouri River main stem:

Fort Peck River:	RM 1771.5 – RM 1568.0
Garrison River:	RM 1389.9 – RM 1304.0
Fort Randall River:	RM 880.0 – RM 845.0
Lewis & Clark Lake:	RM 845.0 – RM 828.1
Gavins Point River:	RM 811.1 – RM 753.0

The 2003 BiOp Amendment states that, when habitat goals (as measured in the acres of available emergent sandbar per river mile) are not met through flow regulation and least tern and/or piping plover fledge ratio goals have not been met for the 3-year running average, other means (e.g., mechanical creation of habitat) will be necessary to ensure the availability of habitat to meet fledge ratio goals. Typically, if an RPA is not strictly complied with, the Corps is to reinitiate Section 7 consultation with the USFWS under the Endangered Species Act. However, the 2003 BiOp Amendment recognizes the importance of Adaptive Management in implementing its RPA, stating:

> "The general management actions identified in this opinion as part of the current project descriptions and as the RPA, likely will be conducted, modified and continually improved upon through Adaptive Management."

The intention of the ESH program is to work with USFWS to incorporate new information through an Adaptive Management strategy while avoiding the need to reinitiate formal consultation on a regular basis. While there have been ongoing discussions between the Corps and USFWS regarding the interpretation and implementation strategy for the RPA, both agencies are committed to resolving this issue and ensuring that management actions support least tern and piping plover populations on the Missouri River.

The PEIS is needed to provide National Environmental Policy Act (NEPA) coverage for the mechanical construction of ESH. The purpose of the PEIS is to analyze the potential environmental consequences of implementing the ESH program on the Missouri River. For the purposes of the analysis presented in this document, the primary method that will be employed is assumed to involve the placement of material through dredges and other construction equipment, referred to in this document as "Mechanical Creation" (See Appendix C, construction assumptions). It is recognized that other construction methods (such as vegetation removal, overtopping and use of geotextiletubes) hold promise. Such methods may be incorporated through the Adaptive Management strategy (See Appendix H) if they prove effective at creating habitat, as demonstrated through pilot projects or as specific circumstances allow for other methods to be tried and monitored. However, the use of mechanical creation has been effective as shown in Appendix B, and is assumed to have greater impacts, both in terms of duration of construction and overall geographic extent disturbed, than any of the other methods discussed in Appendix H. This document assumes the primary use of mechanical creation of all habitat for purposes of analysis as it has been effective and discloses the maximum potential impacts of the program.

The PEIS allows the public, cooperating agencies (USFWS and National Park Service (NPS)), and Corps decision makers to compare impacts among a range of alternatives. The goal is to inform the selection of a preferred alternative that allows for the creation and replacement of sufficient habitat to support tern and plover populations on the Missouri River in a safe, efficient and cost-effective manner that minimizes negative environmental consequences.

2.2 SCOPE

In accordance with Council on Environmental Quality (CEQ) requirements, the Corps is integrating the NEPA analysis early in the planning process to ensure that environmental values are considered in decision making (40 CFR 1501.2). This draft PEIS describes the alternatives that the Corps is considering for programmatic implementation of the mechanical creation of ESH, as identified in RPA IV b (3), and estimates the beneficial and adverse environmental effects that would result from implementing such a program. The effects presented for each of the alternatives have been developed based on habitat creation and replacement assumptions developed specifically for the draft PEIS (see Appendix C, Emergent Sandbar Habitat Mechanical Creation and Replacement Assumptions).

In addition to the action alternatives, the draft PEIS describes the potential effects of a No Action Alternative, as required by NEPA. The impacts of the No Action Alternative provide a basis for comparison with the impacts of the action alternatives. Two "no action" alternatives are considered: 1) the implementation of the ESH Program at current levels of construction, approximately 150 acres per year (Existing Program), and 2) the environmental impacts of not implementing any construction program for ESH (No Program). The "no action" alternatives are consistent with the two definitions provided by the Council on Environmental Quality (CEQ) of "continuing with the present course of action" and "taking no action", respectively (46 Fed. Reg. 18026 (March 23, 1981), as amended).

As part of consultation with USFWS under the ESA, the Corps has made a commitment to work within its authorities to contribute to species recovery. Specifically addressed in this PEIS is the commitment to promote the recovery of the species in segments of the Missouri River identified in the 2003 BiOp Amendment. However, "recovery" in the sense of de-listing the species from endangered or threatened status is outside of the scope of this document because the action area is just one portion of each bird's ranges.

2.2.1 The Public & Agency Scoping Processes

The public scoping process for this document began in 2003 as a Public Notice for the ESH program. In 2004 the Programmatic EA Notice and Public Meetings occurred, and as part of this process, members of the public were invited to use a comment form to express their opinions. There were two broad categories on this form; methods for generating ESH, such as herbicide or dredging methods, and areas for construction such as Lake Sakakawea or Missouri River below Gavins Point Dam. These comments were then incorporated into Appendix E.

In 2004/2005 site-specific ESH EAs were begun, with the goal of adequately addressing all of the environmental concerns. The decision was made in 2005 to use a PEIS to address the intense planning, environmental and other concerns and cumulative impacts of the ongoing program implementation, from which project-specific NEPA compliance could be tiered. During this process all appropriate agencies such as USFWS, NPS and others were contacted for their comments, and their comments are incorporated into Appendix E. More information about these past efforts is in Chapter 12 (Public Involvement) and in Appendix E. Throughout the PEIS process, project-specific EAs were completed for projects in 2007, 2008, 2009, and 2010. After the Final PEIS is published, project-specific EAs would continue to be produced to discuss site-specific design, environmental and other issues, and to provide ongoing NEPA compliance, including the opportunity for public review and comment.

Specific comments from the 2004 scoping meetings were categorized by alternatives, erosion, bank stabilization, flows, impacts on flooding, cost, dam operation changes, EA vs. EIS, and effects on the surrounding environment. This PEIS addresses comments extensively throughout the document. Requirements for NEPA documentation are discussed in Chapter 1, and information on programmatic implementation and analysis are covered in Chapter 3. Issues related to land ownership and restrictions on land rights are addressed in the Real Estate Appendix F. Discussion of all alternatives, including those considered but eliminated such as reservoir and flow manipulations, is included in Chapter 4. Chapter 5 (Effected Environment) provides a detailed summary of "baseline" environmental conditions in each Segment. Chapter 6 (Environmental Consequences) addresses concerns raised in each category by segment and by alternative. Chapter 7 (Summary and Comparison of Environmental Effects) looks at environmental effects overall by alternative. Construction costs are detailed in Appendix C (Emergent Sandbar Habitat Creation and Replacement Assumptions), and total program costs, including construction and additional implementation costs, are discussed in the Executive Summary, Chapter 4, and Chapter 7. Measures to avoid and minimize impacts on sensitive resources are discussed in Chapter 8. Compliance with Environmental Laws and Regulations is in Chapter 9. A discussion on cumulative effects is covered in Chapter 10. Tribal consultation is outlined in Chapter 11. Specific concerns regarding the MNRR (raised by the NPS) and those raised by the USFWS are discussed throughout this document.

This document has undergone internal (Agency Technical Review) and external (Independent External Peer Review) review processes that are part of Corps regulations. This document has also undergone Cooperative Agency (CA) Review in early summer 2010. Public meetings regarding this Draft PEIS will be held in fall of 2010. The Final PEIS and published Record of Decision (ROD) are anticipated to be accomplished by spring 2011.

3 APPROACH TO PROGRAMMATIC IMPLEMENTATION AND ANALYSIS

The programmatic approach to this analysis was selected to address two primary issues:

1. To examine the alternatives and environmental consequences at a landscape-level considering the cumulative effects of the full extent of the program as opposed to many smaller projects assessed separately, and
2. To allow the Corps to be opportunistic, allowing managers to annually select and implement the most appropriate ESH manipulation methodologies or combination of methodologies. Where these actions are included in the PEIS, the actions may be implemented in a timely fashion while minimizing the negative environmental effects and maximizing the biological output.

Because this EIS is programmatic, specific projects for habitat creation or maintenance will not be selected. Rather, the PEIS will outline a framework of site-selection criteria; federal, state, and local coordination; permitting actions; pre- and post-construction surveys; and additional steps that will be taken before site-specific work is accomplished. These steps may vary by location, river segment (as applied in the 2000 Biological Opinion), and the site-specific actions to be taken. Appendix B (Sections 2.6 and 8.5.1) and the ESH Mechanical Creation and Replacement Assumptions Appendix (Appendix C) describe a process whereby known sensitive ecological and human resources were identified and avoided when sufficient area was available. Where insufficient area to create emergent sandbar habitat remained after avoiding the sensitive resources, the risks of significant environmental consequences increases and are characterized as such in Section 6, Environmental Consequences.

All additional federal and state environmental law remains in full force and must be addressed prior to carrying out site-specific ESH manipulation projects. Further NEPA compliance would entail documentation (checklists, memorandums, permits, EAs, etc.) for any site-specific actions in order to verify the evaluation of sites for future actions, implement policy articulated in the PEIS regarding construction methods and mitigation measures, and determine whether the environmental impacts of activities are within the range encompassed by the PEIS. Plans that include actions and potential effects that were not considered in the PEIS would require separate compliance with NEPA.

3.1 SPATIAL, TOPOGRAPHIC, HYDROLOGIC, SUBSTRATE, AND NESTING DATA

While the USFWS established the goals for avoiding jeopardy to the least tern and piping plover, the Corps is obligated to quantify the environmental effects of meeting the stated regulatory objective (i.e., take a “hard look” in NEPA parlance) in the PEIS. In order to predict both the adverse environmental consequences and the species-specific expected benefits of implementing a permanent and continuous program, many key variables needed to be established:

1. The extent of existing ESH within each segment to determine the segment-specific ESH deficit and establish the number of acres needed to first meet the 2015 2003 BiOp Amendment goals,
2. The rate at which ESH eroded within each segment to establish an estimate of the annual replacement that would be needed to maintain the acreage goals,

3. The rate of vegetation growth (natural succession) on ESH to establish a basis for the extent of vegetation management that would be needed to maintain the program,
4. A set of construction assumptions to quantify the intensity of actions necessary to mechanically build (and replace) ESH in accordance with the 2003 BiOp Amendment-established design criteria,
5. An expectation of the biological output (nests per acre and fledged birds per acre) that mechanically created habitat contributed to the fledge ratios to project the beneficial effects from implementing the program,
6. An understanding of the distribution of nesting and nesting success within each segment to identify locations that should be avoided or preferred for habitat creation,
7. Identification and mapping of riverine features conflicting with ESH creation and replacement to plan to avoid them, and
8. Characterization of the physical features of ESH to identify aspects that were correlated with nesting success to maximize the beneficial effects and to avoid mechanically creating poor habitat.

Appendix B presents the summary observations from data analysis, field data collection, and site investigations of the characteristics of riverine habitat conducted in the upper Missouri River to answer these questions. The document is organized into eight sections and six attachments. Appendix B, Section 1 is the introduction and organization of the document. Section 2 provides a detailed discussion of data sources, delineation procedures and data analysis methods used to conduct analyses that are common to all five study area segments. Some of the procedures used for analyses conducted are not included in Section 2. Procedures used for analyses conducted for only a single segment due to data limitations, are presented only in the discussion of that particular segment.

Sections 3 through 7 provide the results of the investigations for each of the five segments separately, beginning with the most downstream segment (Gavins Point River Segment) and ending with the most upstream segment (Fort Peck River Segment). Sections 3 through 7 present segment-specific:

- Discussions of delineation results in total acreages and acres per RM across 12 separate habitat types;
- analysis of ESH acres gained or lost between 1998/99 and 2005;
- discussion of the fluvial (riverine) processes that influence habitat distribution within the segment; and
- analyses of nests and nest habitat.

Habitat delineations were conducted using imagery collected at two separate points in time: 1998/1999[4] and 2005. Habitat delineations were used in concert with nesting data in a

[4] Imagery used to delineate the Fort Peck Segment was taken in 1999, imagery for all other segments was taken in 1998.

geographic information system (GIS) framework. Nest presence, nest success, nest failure, and the absence of nests were all analyzed against the background of delineated habitats.

While the acreage delineations for different years and segments were based on aerial photography captured at different flows (water levels) (Appendix B, Section 3.6), the conditions are believed to be representative of the habitat experienced by nesting birds on the system in the years they were taken indicating that they are still biologically relevant and useful for this analysis.

The flow differences between years, however, presents a problem for tracking absolute rates of change in ESH availability due to factors such as erosion and vegetation encroachment. This will be addressed through the Adaptive Management strategy (Appendix H). Initial flow correction curves were established for use in the adaptive management strategy based on analyses presented in Appendix B of this document and the technical appendices developed for the Master Manual. These curves will allow acreage to be adjusted to a particular flow so that acreages derived from two photo sets with different flows collected in different years will be directly comparable and allow for a more informed analysis of trends in rates of change in ESH acreage. The adaptive management strategy also recognizes that these curves represent the best available information at this time and specific monitoring efforts will be undertaken in order to improve understanding of the relationship between flow and acreage availability. Based on these monitoring efforts, the curves will be updated over time, allowing for better prediction of changes in ESH due to flow, erosion and vegetation encroachment.

Section 8 provides a comparison of the habitats delineated in all five segments in the study area, and a summary of findings from the investigation. In addition, Section 8 provides a comparison between habitat delineations described in this document, discusses comparisons with prior Missouri River habitat delineations and addresses the effects of stage change on low-lying habitat types. Section 8 concludes with a discussion under the heading of “Sensitive Features Assessment”, which defines the most suitable locations for ESH construction and maintenance on a segment-by-segment basis. The discussion focuses on an assessment of the relationships between nesting locations and various natural and anthropogenic features critical to species productivity and the continued protection of other important and legally protected features within the river corridor.

Appendix B, Attachments

Supplemental attachments also are part of this document. The six attachments provide additional details on important calculations, assumptions, and findings.

Attachment 1 provides a summary of constructed ESH efforts by the Corps since 2006, and additional findings from the Corps’ ongoing monitoring program.

Attachment 2 provides an analysis on the relationships among indices of production for the least tern and piping plover.

Attachment 3 discusses the high sustained flow hydrologic events of 1996 and 1997, the hydrologic patterns of these study area segments, the methods used for analyses of hydrologic data and the effects.

Attachment 4 provides detailed information on sandbar geometry and composition, and discusses the physical characteristics of nesting habitat. This attachment also includes a summary of findings from a 2006 field survey of nesting habitat and the mechanical sieve analysis of substrate materials.

Attachment 5 provides a thorough characterization of the plant communities, habitats, and associations found in the study area segments. Repetitive plant associations are described as they are distributed along gradients of frequency of inundation, flooding, and topography. Issues of vegetation succession and sandbar colonization are addressed.

Attachment 6 provides details on field data collected, locations of field data collection sites, and equipment used.

3.2 ESH Design and Construction Assumptions

NEPA and its implementing regulations require that federal agencies use an evaluative process before undertaking "major Federal actions significantly affecting the quality of the human environment." Among other things, agencies must analyze irreversible resource commitments involved in implementation of a proposed action, alternatives for the action under consideration, and alternatives' environmental impacts. To that end, Appendix C "Emergent Sandbar Habitat Creation and Replacement Assumptions" details the programmatic assumptions regarding the construction of ESH. These assumptions serve as the basis for establishing the magnitude of the actions necessary to create and replace ESH under each of the alternatives as well as the estimation of the environmental consequences.

This analysis of the ESH program and the techniques described are based on design requirements identified in the 2003 BiOp Amendment and the experience of construction contractors and Corps staff that have built and maintained ESH on the Missouri River. Estimates of materials necessary to construct the ESH were developed from actual projects completed on the river and interviews with the individuals responsible (see Appendix C). These numbers have been used to quantify the magnitude of the proposed actions, but not to prescribe any specific detailed designs or quantities at any specific location.

The combination of ESH creation and replacement projects recently completed by the Corps (2004-2006), newly-developed spatial habitat information, and productivity data from least tern and piping plover nest monitoring over that same time period have provided compelling data regarding the efficacy of various methods. Detailed evaluations of the 1999-2006 least tern and piping plover database and recent habitat manipulation activities (USACE, 2003; USACE, 2004) indicate that dredge- and/or heavy equipment-created sandbars have provided the only manipulated habitat extensively used for nesting. The assumptions for the creation of ESH for the establishment of this document rely exclusively on the use of dredge- and heavy equipment-created ESH (mechanical creation), as these methods are the only ones with data supporting successful nest and fledge production. Other techniques for creating ESH are described in Appendix H (Adaptive Management Strategy) and would likely be pursued as pilot projects. If these methods are shown to be effective over time, they would be incorporated into the overall program as appropriate with anticipated reductions in costs and impacts. However, because of the ongoing pilot vegetation removal actions (Section 4.11.4), the unique environmental consequences associated with vegetation removal are also considered specifically in Chapter 6 (Sections 6.3). The impacts associated with other potential techniques are assumed to be similar to or less than those disclosed for implementation of the program using mechanical creation and are covered within the range of impacts discussed in Chapter 6.

The ESH construction design methodologies described are based on programmatic assumptions. Future modifications and site-specific designs are expected to occur based on detailed engineering, cost evaluations, environmental considerations, public participation, and ongoing monitoring as it improves the scientific knowledge for the ESH program in an overall Adaptive Management context.

The programmatic construction assumptions have been developed to create a rational articulation of what implementing the entire ESH program under the different alternatives would require. This allows a consideration of the cumulative effects over the entire project area and the comparison of program alternatives. The assumptions regarding construction allow the PEIS to establish an envelope of estimated effects within which site-specific design modifications can be made without compromising the integrity of the assessment.

The description of the ESH creation and replacement within Appendix C does not represent any formal commitment to final design, equipment for use, vendors for supply of materials or services, or detailed methods of construction but gives an approximation of how the features could be constructed and the associated construction requirements thereof. It is intended to provide an example of how the work could be accomplished and serve as the basis for evaluating the potential environmental consequences of the ESH program alternatives.

3.3 Program Implementation within Missouri National Recreational River Segments

The Wild and Scenic Rivers Act (WSRA) of 1968 established a method of federal protection for the nation's remaining free-flowing rivers, and a policy of preserving these rivers and their immediate environments for the use and enjoyment of present and future generations. Section 1(b) contains a congressional declaration of policy:

"It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environment possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. The Congress declares that the established national policy of dam and other construction at appropriate sections of the rivers of the United States need to be completed by a policy that would preserve other selected rivers or sections thereof in their free-flowing condition to protect the water of such rivers and to fulfill other vital national conservation purposes."

Section 7 of the WSRA affords substantial protection to rivers included in the National Wild and Scenic Rivers System and Congressionally authorized study rivers. Section 7(a) states, in part:

"…no department or agency of the United States shall assist by loan, grant, license, or otherwise in the construction or any water resources project that would have a direct and adverse effect on the values for which such river was established, as determined by the Secretary charged with its administration."

A Section 7(a) evaluation is used to analyze impacts of a proposed water resources project and determine whether any impacts would have a direct and adverse effect on the values for which the river was established. The Corps expects that the NPS will not issue a programmatic determination pursuant to the WSRA on the effects of the proposed programmatic action as described in this PEIS. Each proposed project will undergo its own NEPA process, and those activities carried out within areas designated as Wild and Scenic Rivers will be reviewed by the NPS under the Section 7(a) process as they are developed for implementation. This PEIS will provide the NPS with a basis to consider the cumulative effects of the entire ESH program as well as a current baseline to compare potential future effects.

3.3.1 Meaning of the Wild and Scenic Designation

The MNRR comprises two segments of the Missouri River, separated by Lewis & Clark Lake, along the Nebraska-South Dakota boundary. The eastern portion (59-Mile District) starts about 1 mile downstream from Gavins Point Dam and continues downriver to Ponca, Nebraska. The western portion (39-Mile District) starts downstream from the Fort Randall Dam and continues downriver to Running Water, South Dakota. At the same time the 39-Mile District was established, the lower 20 miles of the Niobrara River and the lower 8 miles of Verdigre Creek were also designated as recreational rivers (the Niobrara National Recreational River and Verdigre Creek Recreational River) and are collectively known as the 1991-designated Missouri National Recreational Rivers (NPS, 1997).

Rivers in the National System are classified as wild, scenic, or recreational. This terminology has caused frequent confusion because wild rivers are not necessarily fast-moving whitewater rivers, scenic rivers may not be noted for scenic values, and recreational rivers may not receive heavy public use. The labels actually refer to the degree of development along the river at the time of listing in the national system. The definitions of wild, scenic, and recreational from the law are:

“Wild” river areas: Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

“Scenic” river areas: Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads, and

“Recreational” river areas: Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Both the 59-Mile District (Gavins Point River Segment) and the 39-mile district (Fort Randall River Segment) are designated as “recreational” river areas. Regardless of the classification, each designated river is administered with the goal of non-degradation and enhancement of the values that caused it to be designated. While some recreational use is encouraged, management to protect natural and cultural values is emphasized.

3.3.2 Establishment of the Missouri National Recreational River (MNRR)

The MNRR (both the 59-Mile and 39-Mile Districts) was established under the authority of the *Wild and Scenic Rivers Act* (October 2, 1968; 82 Stat. 906). The 59-Mile District was established in 1978 by P.L. 95-625 (92 Stat. 3529) and the 39-Mile District was established in 1991 by P.L. 102-50.

Both Districts were designated as a National Recreational River under the Wild and Scenic River Act because of the significant natural, recreational, and cultural values that warrant preservation. The Secretary of the Interior is mandated to administer the river in a manner that will protect and enhance these values for the benefit and enjoyment of present and future generations. Therefore, the recreational, fish and wildlife, aesthetic, historic and cultural values that qualified the segment for designation are to be protected and enhanced.

Both the 59-Mile and 39-Mile Districts are influenced by controlled dam releases from Fort Randall Dam and Gavins Point Dam. A mosaic of private homes, communities, tribal lands, federal, state and community parklands and recreational facilities borders the MNRR. The river currently supports irrigation, hydroelectric power production, flood control, and water supply throughout both districts; angling and recreation at the reservoirs and on the river; water for cattle; navigation from Sioux City to St. Louis; habitat management for fish and wildlife and their endangered species; and protection of Wild and Scenic segments.

The purposes of the MNRR include:

- Preserve the river in a free-flowing condition and protect it for the enjoyment of present and future generations,
- Preserve the significant recreational, fish and wildlife, historic, and cultural resources of the Missouri River corridor, and
- Provide for a level of recreation and recreational access that does not adversely impact the river's significant natural and cultural resources.

The Wild and Scenic Rivers Act provides that after establishment, boundaries must be set and a general management plan prepared. This task was given to the NPS (NPS, 1997). The MNRR collectively encompasses approximately 69,000 acres of which the NPS currently owns approximately 250 (NPS, 2005).

Section 10 of the act requires the managing agency (NPS) to emphasize the protection of recreational, scenic, historic, and scientific features and to provide for public use and enjoyment of these values. Management plans can establish varying degrees of intensity for protection and development, based on the special attributes of the area (NPS, 1997).

3.3.3 Identification of the Outstandingly Remarkable Values of the MNRR

By virtue of its inclusion in the Wild and Scenic River System, the MNRR was designated to preserve its free-flowing condition and its outstandingly remarkable values (ORVs). While not specifically defined in the law, the Interagency Wild and Scenic Rivers Coordinating Council (2000) defines the term ORVs as those unique, rare, or exemplary river values that, based on professional judgment, led to the designation of a river segment. The enabling legislation for the MNRR specifically referenced the Corps Umbrella Study (USACE, 1977) detailing the ORVs supporting the segment's eligibility for designation. The Umbrella Study defined the ORVs for the 59-mile District as recreational, fish and wildlife, historic and cultural. The Corps' Umbrella Study also pointed out specific river features that were recognized as having outstandingly remarkable natural value. These features include the river setting at Goat Island, including the entrance of the James River and Missouri chutes paralleling Goat Island; the general high bank shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs, particularly at river miles 763, 776, and 787 (USACE, 1977).

The enabling legislation for the MNRR stated this river segment was to be administered as a recreational river by the Secretary of the Interior. It directed the Secretary of the Interior to enter into a cooperative agreement with the Secretary of the Army for construction and maintenance of bank stabilization work and appropriate recreational development. In keeping with the legislation, both the Department of the Interior and the Department of the Army, have responsibility for the MNRR. The NPS retains overall administrative authority under the Wild and Scenic Rivers Act, including the responsibility for preparing determinations under Section 7(a) of the Act (NPS 1999).

3.3.4 National Park Service Non-Degradation and Enhancement Policy

The WSRA provides management mandates to agencies responsible for administering components of the System. Section 10(a) states that:

"Each component of the national wild and scenic rivers system shall be administered in such manner as to, protect and enhance the values which caused it to be included in said system without, insofar as is consistent herewith, limiting other uses that do not substantially interfere with public use and enjoyment of these values."

The Final Revised Guidelines for Eligibility, Classification, and Management of River Areas, promulgated by the Department of the Interior and the Department of Agriculture (NPS, 1982), interpret Section 10(a) as a non-degradation and enhancement policy for all designated rivers, regardless of their classification as wild, scenic, or recreational. Wild, scenic, and recreational classifications are based on the extent of development existing at the time of designation. The entire 59-Mile District of the MNRR was classified as "Recreational" at the time it was designated. The guidelines go on to state that although each classification permits certain existing development at the time of designation, the criteria for classification does not imply that additional inconsistent development is permitted in the future. Each component of the Wild and Scenic River system is managed to protect and enhance the values for which each river was designated while providing for public recreation and resource uses which do not adversely impact or degrade those values. This requires careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Impacts to the MNRR are specifically discussed by Alternative in Chapter 6 under the sub-sections for resources that are also ORVs.

3.3.5 Management Plan for the Missouri National Recreational River

Section 3(d) of the WSRA instructs each federal agency charged with administering components of the system to prepare a comprehensive management plan to provide for the protection of river values. In keeping with this requirement, the Heritage Conservation and Recreation Service (HCRS), working behalf of the NPS, prepared an initial General Management Plan (GMP) for the MNRR in 1980. Building upon the objectives outlined in that management plan, the Corps prepared a General Design Memorandum in 1980 (USACE, 1980) and a Supplement in 1988. An updated management plan was written in 1999 through a cooperative planning effort directed by the NPS and involving the Corps, the states of Nebraska and South Dakota, the counties bordering the MNRR, interested landowners, and aided by extensive public involvement. The update embraced and reflected the MNRR's legislative history, identified significant resources, and affirmed the purposes for designating the MNRR as a wild and scenic river. Purpose and significance statements from this effort became a foundation for management planning and subsequent actions (NPS, 1999).

The purposes of the MNRR as defined in the 1999 GMP are:

- Preserve the river in a free-flowing condition and protect it for the enjoyment of present and future generations,
- Provide streambank protection compatible with the river's significant natural and cultural resources,
- Preserve the significant recreational, fish and wildlife, and historic and cultural sites of the Missouri River corridor, and
- Provide for a level of recreation and recreational access that does not adversely impact the river's significant natural and cultural resources.

The GMP does not directly address creation of ESH but does acknowledge the need to protect and enhance habitat for endangered species (NPS, 1999).

3.3.6 Significance of the Missouri National Recreational River

Information in this section comes from the 1999 GMP for the MNRR and describes very briefly the ORVs of the MNRR. The 59-Mile District is one of the last representative parts of the un-dammed, un-channelized, middle Missouri River. It features a section of the river meandering in an older, wider, river valley not found on the other un-dammed, un-channelized, Missouri River sections. The large river environment found on the 59-Mile District is rare on the Great Plains (NPS, 1999).

The habitat within the 59-Mile District of the MNRR corridor supports at least 44 federal and state-listed sensitive species, including the federally listed endangered pallid sturgeon and least tern, and the federally listed threatened piping plover (NPS, 1999). The riverine and riparian habitats within the river corridor provide important wildlife habitat.

The 59-Mile District provides high quality outdoor recreation, including high quality fishing, hunting, trapping, and boating. Opportunities for bird watching and other wildlife observation abound (NPS, 1999). The 59-Mile District supports recreation on a large, relatively natural river (NPS, 1999).

In addition, the Missouri River was the principal highway to the northern plains used throughout prehistoric and early historic times. The 59-Mile District retains a historic landscape similar to that experienced by travelers over the centuries and captured in the writings and illustrations of early explorers (NPS, 1999). The number and variety of prehistoric and historic resources along the river attest to the long history of human use. Prehistoric villages, the route of Lewis and Clark, steamboat wrecks, the territorial capital of Yankton, and ethnic settlements have the potential for enriching visitors' understandings of past and present cultures (NPS, 1999).

3.4 HISTORIC PRESERVATION, CULTURAL RESOURCES, AND THE PROGRAMMATIC AGREEMENT

3.4.1 Cultural Resources Program

The Corps' Omaha District Cultural Resources Program has always been active in the preservation and protection of cultural sites within the Missouri River basin. The National Historic Preservation Act (NHPA) Section 106 responsibilities for inventory, testing and evaluation, impact assessment, and mitigation have been, and continue to be, the focus of the program. With the enactment of the Native American Graves Protection and Repatriation Act (NAGPRA) and the Archaeological Resources Protection Act (ARPA), the Cultural Resources Program now is responsible for the implementation of more than 20 federal laws, regulations, and Executive Orders, to include Executive Order 13007, Indian Sacred Sites. A Program Review and Peer Assessment was completed by a four-person group, consisting of Corps Headquarters, Division, and District personnel, in September 2000 to review performance and streamline operations. This group made recommendations in four areas: accountability, training, staffing, and contracting. The program quickly implemented many of the recommended changes that resulted in improved program performance. For example, the Corps currently has contracts with American Indian Tribes to survey and identify sacred sites. The changes have affected the program positively.

3.4.2 Bank Stabilization for the Protection of Cultural Resources Sites

The Corps, through the Operations and Maintenance (O&M) appropriations, has made progress in bank stabilization efforts for the protection of archaeological sites. In January 2001, the Corps asked for assistance from the American Indian Tribes in the Missouri River basin in prioritizing cultural resource sites that were in need of stabilization. Through the responses received from the Tribes and Corps Operations Managers, the Corps developed the Cultural Resource Site Stabilization List. The Corps committed at that time to update the list every 2 years. The Corps will continue to consult with American Indian Tribes, Tribal Historic Preservation Offices, and State Historic Preservation Offices to determine priority sites where bank stabilization efforts should be focused. Site-stabilization work is contingent upon available funds. Additional sites will be protected as funding becomes available.

3.4.3 Native American Graves Protection and Repatriation Act

On November 16, 1990, NAGPRA was signed into law. NAGPRA addresses the recovery, treatment, and repatriation of American Indian and Native Hawaiian cultural items by Federal agencies and museums. NAGPRA also addresses the inadvertent discovery of American Indian or Native Hawaiian cultural items. As defined by the Act, cultural items are human remains, associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony. It is the policy of the Corps' Omaha District to repatriate the remains of American Indians that are inadvertently uncovered by erosion or any other means in accordance with NAGPRA. Disposition of human remains, artifacts, and funerary objects is made to the Tribe whose cultural affiliation to the remains has been established. Within the State of North Dakota, transfer of custody of human remains, artifacts, and funerary objects of American Indians is made to the North Dakota Intertribal Reinternment Committee (NDIRC). A NAGPRA-based Memorandum of Agreement was signed in 1993 among the Devil's Lake Sioux Tribe, Standing Rock Sioux Tribe, Three Affiliated Tribes, and Turtle Mountain Band of Chippewa, as represented by the NDIRC, and the Corps' Omaha District concerning the protection, preservation, and disposition of unmarked human burials, burial mounds, and cemeteries.

3.5 SITE SELECTION, MONITORING, DATA MANAGEMENT, AND REPORTING

3.5.1 Real Estate

The Corps utilizes a variety of real estate tools to address real estate needs in implementation of the ESH program. These tools involve obtaining temporary site access or staging areas for construction as well as the potential of purchasing real estate interests from willing sellers. This section will also briefly address the Corps authority to utilize navigational servitude in order to perform work in the river.

3.5.1.1 Temporary Construction Site Access and Staging

In order to construct ESH projects, temporary staging areas are required to set up equipment, accommodate fueling, provide crews access and launch vessels into the river. Equipment may need to be transported to the sites via truck or other land vehicle. Lands can be owned by federal or state agencies, or private landowners. The Corps would review potential sites on a project-specific basis and contact the appropriate agencies or landowners to obtain temporary access and staging areas. These sites will be analyzed for the presence of cultural resources, wetlands and other sensitive resources. Best Management Practices (BMPs) would be used to avoid negative impacts to these areas. Modifications resulting from use of staging and access areas would be returned to the original state upon completion of construction activities. Project- and site-specific access and staging area considerations would be included in individual NEPA documentation (e.g. environmental assessments).

3.5.1.2 Real estate interests

As part of the ESH program, the Corps could pursue purchase of real estate interests from willing sellers on lands adjacent to the proposed projects. Real estate actions would be considered on a site-specific basis. Either fee title or easement interest may be purchased. Real Estate interests would be acquired within the authorities listed in Appendix F. If a real estate interest would be approved for purchase, a site-specific Real Estate Plan would be generated to establish the anticipated real estate requirements for the acquisition of land interests.

As these actions may involve the fee-title purchase of land and possibility of easement purchases along the river, some land may be transferred from private to federal holding resulting in limited development along the river in these areas. In order to avoid financial impacts to counties which would no longer receive taxes from land that is purchased in fee title, Payments in Lieu of Taxes (PILT) would be made in accordance with Public Law 97-258. In accordance with PL-97-258, these annual payments would be made by the Bureau of Land Management (BLM) to the state in which the land was purchased. The state would then distribute the funds to the county in which the land resides.

3.5.1.3 Navigational Servitude

For the Emergent Sandbar Habitat Complexes, the U.S. Army Corps of Engineers is exercising navigational servitude authority for work being done within the river bed [(Memorandum for Chief, CENWO-PM-C, Use of Navigation Servitude to Support Ecosystem Restoration (Emergent Sandbar Habitat) Missouri River Mainstem Dams, 3 April 2007)]. Navigational servitude applies to lands below the ordinary high water mark (ER 405-1-12 Change 6, Section 2-6).

As a general rule, the United States does not acquire interests in real estate that it already possesses or over which jurisdiction is or can be legally exercised. Irrespective of the ownership under state law of the banks and bed of a stream below ordinary high water mark, no further Federal interest is required for navigation projects in navigable streams below the ordinary high water limit. The navigational servitude is a public right of navigation for the use of the public at large. The proper exercise of this power is not an invasion of private property rights in the stream or the lands underlying it, but is the lawful exercise of a power to which the interests of riparian landowners have always been subject.

3.5.2 Segment-Specific ESH Site Selection Criteria

Appendix G outlines the Corps' procedures for selecting potential ESH construction sites. A strategy of "avoidance" is utilized by identifying "available areas" outside of identified sensitive resource sites (and buffers) to the extent possible. Some sensitive resources, such as unidentified cultural resource sites, would need to be evaluated on a site-by-site basis prior to construction. This would be done as part of the site-specific 404 (Clean Water Act) authorizations.

The site selection process is done as part of an interagency team effort, so issues related to specific sites can be raised and addressed as part of the process.

3.5.3 Segment-Specific Pre-Construction Site Evaluation

As described above, construction sites would need to be evaluated for certain sensitive resources that cannot be programmatically avoided, such as cultural resources. For those resources, site-specific literature review and/or pre-construction surveys would need to be done prior to construction. Each individual construction site (including the Area of Potential Effect) will be inventoried for cultural resources. Compliance with Section 106 (including the State Historic Preservation Officers, Tribal Historic Preservation Officers, and potentially the Advisory Council on Historic Preservation) and Tribal consultation will occur for each construction site under evaluation. Should significant cultural resources be found and not be able to be avoided, the construction site will be eliminated from any further consideration. A new construction site will be identified. With the number of Tribes and states involved, individual Section 106 compliance at each proposed construction site is the most efficient method of handling the compliance activities. With these procedures in place, adverse effects are not expected nor would a Memorandum of Agreement be appropriate.

3.5.4 Segment-Specific During Construction Monitoring

If a construction site is near a sensitive resource and there are uncertainties regarding the potential for impacts, then monitoring of the resource could be done during construction. This would be possible for such resources as steamboat wrecks for which exact locations are not apparent. Criteria would be established for which construction would be halted if a potential resource is unearthed until approval to construct is received from a Corps archeologist, who has coordinated with appropriate state and Tribal officials.

3.5.5 Segment-Specific Post-Construction Monitoring

Post-construction monitoring will be done for the purposes of determining if construction actions are resulting in the desired biological and physical outcome and to ensure avoidance and minimization of collateral impacts. Monitoring plans, based on scoping issues and biological outputs, can be found in Appendix H.

3.5.6 Segment-Specific Data Management, Data Accessibility, and Data Reporting

Data collected as part of ESH monitoring and Adaptive Management efforts will be housed by the Corps' Integrated Science Program (ISP) in Yankton, South Dakota. Data will be evaluated and decisions made in a transparent process inclusive of the interagency partners. Reports will be made available following any necessary reviews. Search under the "MRRP Documents" tab at http://www.moriverrecovery.org.

3.6 COMPLIANCE WITH SECTION 404(B)(1) OF THE CLEAN WATER ACT

Once a preferred alternative is selected and reviewed by the Cooperating Agencies, projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If impacts of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

The Section 404(b) (1) Guidelines (Guidelines) under the Clean Water Act (CWA) is the only requirement outside of NEPA that specifically requires the development of a purpose statement. How a purpose and need statement is scoped and written to meet statutory requirements, what the statement should include and whether the statement is described appropriately is always challenging. Under NEPA, the purpose and need statement is written broad enough to support a reasonable range of alternatives; under Section 404, a project purpose statement must support an evaluation of "practicable alternatives". In order to streamline the environmental review process, alternatives considered under NEPA would satisfy Section 404 requirements; issues may arise when the least environmentally damaging practicable alternative (LEDPA) to the aquatic environment, identified under Section 404 is not included in a NEPA evaluation of alternatives. It may be necessary to supplement the Corps' NEPA draft document with additional information to adequately respond to the requirements under the Guidelines.

The Corps' mitigation policy is defined by regulations 320.4/320.4 of the regulations preamble, mitigation MOA and compensatory mitigation rule. Currently, the Corps is working to identify impacts and ensure those impacts are avoided to the extent practicable. The Corps may further minimize impacts through implementation of best management practices. For remaining unavoidable impacts, mitigation measures to the extent determined to be appropriate and practicable may be necessary and required under the Clean Water Act. The Corps' regulation 33 CFR 320.4 states that mitigation includes a general description of the District Engineer's authority to require mitigation including that the District Engineer may "require minor project modifications" 33 CFR 320.4 (i) and that "for Section 404 applications, mitigation shall be required to ensure that the project complies with the 404(b)(1) Guidelines" 33 CFR 320.4 (ii) and that "Mitigation measures in addition to those under Paragraphs (i) and (ii) may be required as a result of the public interest review process" 33 CFR 320.4(iii).

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. The State of North Dakota denied Section 401 certification for NWP 27 for all activities located in the Missouri River. The State of Montana denied Section 401 certification for all activities authorized by NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

3.7 ADAPTIVE MANAGEMENT PLAN

In order to address uncertainties with regard to the amount and type of habitat needed to support the species, expected biological response to various construction methodologies and habitat types, interactions between dam releases and habitat availability, collateral damage to other resources, and other unknowns, an Adaptive Management strategy has been drafted. This strategy will allow for implementation of the program while incorporating new information, predicting and monitoring the outcomes of management actions, informing decision makers, and altering projects to track success in meeting the stated objectives (see Appendix H).

4 ALTERNATIVES

This Draft PEIS analyzes the potential environmental consequences of implementing the Emergent Sandbar Habitat (ESH) program on the upper Missouri River. The ESH program is a part of the Corps' Missouri River Recovery Program (MRRP). The PEIS is tiered from the Final EIS and Record of Decision (ROD) for the Master Water Control Manual Review and Update (March 2004). The ESH PEIS allows the public, cooperating agencies (USFWS and NPS), and Corps decision makers to make comparisons of the impacts of the range of alternatives for the ESH program.

As per the purpose and need (Section 2.1), the goal of the program is to supplement naturally available habitat. As such, the acre goals of the each Alternative are expressed as the total acres of habitat present (including mechanically created and any naturally occurring sandbars). The range of alternatives evaluated includes the USFWS 2003 Amended Biological Opinion 2015 Acreage Target (Alternative 1), as well as lesser acreage alternatives developed as a result of incorporation of latest analysis of physical and biological data and scoping comments related to minimizing or avoiding environmental impacts of program implementation. This approach is consistent with the CEQ's guidance on reasonable alternatives, agency discretion in implementing the RPA, and the adaptive management framework called for in the BiOp. The goal is to implement a program to mechanically create and maintain sufficient quantities of ESH to support tern and plover populations in a safe, responsible, and efficient manner that minimizes adverse environmental impacts. Because the Corp expects to make segment-specific choices among the alternatives and not select a single alternative to be applied uniformly to all segments, the alternatives discussion in Section 4-6 is organized by segment. The preferred alternative would be implemented using an Adaptive Management strategy (Appendix H) that would allow the Corps to analyze the effects of management actions and adjust the program over time in order to incorporate new information, address uncertainty, and track progress towards meeting the stated objectives.

This chapter is organized in the following sections:

Section 4.1	CEQ guidelines considered in formulating the alternatives in this PEIS
Section 4.2	Programmatic assumptions
Section 4.3	Spatial and temporal limits on construction or replacement
Section 4.4	Overview of alternatives considered
Section 4.5	Summary of available, restrictive and exclusionary areas
Section 4. 6	Actions to implement alternatives by segment
Section 4.7	Acreage summary and estimated costs of the alternatives
Section 4.8	Selection of the preferred alternative
Section 4.9	Environmentally preferred alternative
Section 4.10	Alternatives considered but eliminated from detailed consideration
Section 4.11	Other actions likely to be implemented (across all alternatives)

4.1 PEIS Alternatives and CEQ Guidance

The alternatives in this PEIS are featured because the CEQ's regulations implementing NEPA requires the Corps to rigorously explore and objectively evaluate reasonable alternatives to a proposed action (40 CFR 1502.14(a)). The regulations specifically require that the analysis include reasonable alternatives even when the alternatives are not within the jurisdiction of the agency (40 CFR 1502.14(c)).

Question 2(b) of the Forty Most Asked Questions Concerning CEQ's NEPA Regulations (46 FR 18026, March 23, 1981) further addresses the issue of alternatives beyond the agency's jurisdiction. If an alternative is outside the legal jurisdiction of the lead agency, it must still be analyzed in the EIS if it is reasonable. Discussions regarding specific alternatives that are beyond the Corps' jurisdiction to implement are extensively discussed in the Master Manual. In addition, alternatives considered but eliminated for detailed consideration are discussed in Section 4.10. A potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered (40 CFR 1506.2(d)). Alternatives that are outside the scope of what Congress has approved or funded must still be evaluated in the EIS if they are reasonable, because the EIS may serve as the basis for modifying the Congressional approval or funding in light of NEPA's goals and policies (40 CFR 1500.1(a)). Although the BiOp RPA IV.B.3 identified a target of 11,886 acres by 2015, the CEQ language, normal agency discretion in implementing RPA elements, and fact that the BiOp also called for the use of Adaptive Management, highlights the rationale for the inclusion of lesser acreage alternatives. In addition, if necessary, the Corps could reinitiate formal consultation to seek modification to the RPA to allow other alternatives that currently may not meet the ESH acreage requirements in the RPA, however such reinitiating of consultation is not required or within the scope of this PEIS, but would be tiered from the Master Manual.

The concept of reasonableness is not self-defining; that is, reasonable alternatives for an EIS must be determined on a case-by-case basis. To ensure flexibility in program decision making, the range of alternatives needs to consider the possibility of change not only in the context of the Corps' ongoing activities and compliance framework but also with an eye toward flexibility should implementation techniques advance or new compliance agreements be reached with the USFWS.

Five of the seven action alternatives examined in the PEIS (Alternatives 2-5) would not meet the specific acreage creation and maintenance recommendations for habitat goals as stated in the 2003 BiOp Amendment; however, it is anticipated that the range of alternatives considered are consistent with the adaptive management provisions in the PEIS and would address potential acreage targets that could still meet the biological needs of the species. While there have been ongoing discussions between the Corps and the USFWS regarding the interpretation and implementation strategy for the RPA, both agencies are in agreement that this issue can and will be resolved through the Adaptive Management process and through ongoing coordination.

CEQ regulations (40 CFR 1502.12 specify that areas of controversy and issues to be resolved are also discussed. All of the action alternatives require the creation of ESH within the MNRR, potentially threatening the ORVs for which these reaches were originally designated for protection. The NPS has formally and informally stated that implementing the ESH program within the MNRR may create unacceptably significant and permanent effects to the designated river reaches. The 2003 BiOp Amendment specifies habitat goals within the 59-Mile and 39-

Mile Districts that are two of the highest priority reaches identified in the 2003 BiOp Amendment. The NPS and the Corps manage the MNRR through a cooperative agreement. The NPS is represented on the ESH Project Delivery Team (PDT) and, therefore, is heavily involved in the selection of and design of potential sites. In working with the NPS, the Corps identified different scales of implementation through the various alternatives, discussed how to minimize impacts, and utilized GIS buffers to identify sensitive resources (see Section 4.2.1). The NPS is the overall administrator for the MNRR and has responsibility for WSRA Section 7A determination of effects in the MNRR.

In addition, there have been concerns raised regarding construction in the Fort Peck River Segment due to its designation as part of endangered pallid sturgeon Recovery-Priority Area 2 (RPA 2 also includes the lower Yellowstone River). Implementation of many of the larger alternatives risks permanent construction-related effects to the endangered pallid sturgeon. In addition, bird usage in this segment is low, as documented by the 2003 BiOp Amendment. Therefore, the Fort Peck River Segment is considered a lower priority reach for ESH construction. Future ESH needs would be identified through the Adaptive Management process. Local monitoring and consultation with state, Tribal, and federal experts knowledgeable of specific sites and habitats important to pallid sturgeon would be used to identify and avoid high risk areas. Finally, concerns expressed by North Dakota regarding the amount and locations of habitat constructed in the state have been recognized, and will involve further coordination among the agencies prior to any implementation.

4.2 Programmatic Assumptions for ESH Creation and Replacement

The ESH Mechanical Creation and Replacement Assumptions (Appendix C) detail programmatic assumptions necessary to quantify the intensity of actions under the various alternatives. The assumptions for design and construction of ESH are specific, consistent with the language of the 2003 BiOp Amendment, and applied to each of the river segments for all of the alternatives so that the effects of implementing the alternatives may be compared. Programmatic ESH creation and replacement assumptions have been developed to create a rational articulation of what implementing the entire ESH program under the different alternatives would require. This depiction allows an informed comparison of the environmental consequences associated with implementing each of the alternatives and enables the environmental consequences to be contrasted with the anticipated benefits.

The description of the ESH creation and replacement within Appendix C does not represent any formal commitment to final design, equipment for use, vendors for supply of materials or services, or detailed methods of construction, but it does give an approximation of features constructed and the associated construction requirements thereof. It is intended to provide an example of how the work would reasonably be accomplished and serve as the basis for evaluating the potential environmental consequences of the ESH program alternatives.

Estimates of the equipment and materials necessary to create and replace emergent sandbars have been developed from ESH projects completed by the Omaha District on the Missouri River over several years and interviews with contractors that have built ESH for the Corps. These completed projects and the experience gained serve as the basis for assumptions regarding how the work would be accomplished. This allows the Corps to quantify the magnitude of the habitat manipulation methods needed for the entire program while not prescribing the detailed quantities or exact designs for site-specific actions. As noted in previous sections, in order to disclose the maximum amount of potential impacts, mechanical creation is utilized as the primary construction methodology (see Sections 2.1 and 3.2).

4.3 SPATIAL AND TEMPORAL LIMITATIONS ON CONSTRUCTION AND REPLACEMENT

An important component of the implementing strategy for the ESH program is the avoidance of sensitive resources and features (special avoidance) and restriction of ESH construction and replacement activities during biologically important times of the year (temporal avoidance). Implementing the ESH program within these limitations can minimize the environmental consequences of program implementation. The effects of applying these limitations on the ESH program are identified in the segment-specific descriptions of Section 4.6. The following summarizes how river segments were examined to programmatically avoid sensitive resources and, therefore, minimize significant environmental effects. A more detailed explanation of spatial and temporal limits is provided in the ESH Mechanical Creation and Replacement Assumptions (Appendix C) and a description of how the spatial constraints were applied in GIS is in Appendix B, Sections 2.6 and 8.5.

4.3.1 Sensitive Resources and Spatial Limits

Various features, habitats, engineering considerations and activities in the Missouri River channel limit physical area of riverine habitat available for program implementation. In addition, minimizing the environmental consequences of the ESH program relies heavily on a presumption of avoiding the sensitive resources. Significant effort has been made to coordinate with state and federal resource agencies, Tribes, utilities and other stakeholders to identify sensitive riverine resources that should be avoided when implementing the ESH program. A detailed description is provided in Appendix B (Section 2.6) and Appendix C (Section 2.3 and Table 10).

Spatial avoidance measures were implemented to maximize habitat effectiveness and to minimize or eliminate potential environmental consequences by keeping ESH activities sufficiently isolated from known locations of sensitive resources. In discussion of each alternative, "high-bank to high-bank area" of each segment is defined in acres. "High-bank-to-high-bank area" was derived from 2005 aerial photos and ground-truthed and is, therefore, representative of the current flow regime (post-dam) in the segment (versus historic pre-dam high bank area).

Appendix B (Sections 2.6 and 8.5) details the GIS methods used to assign these spatial restrictions, but the restrictions collectively triage the riverine acreage into three practicable categories:

- Available Areas - Locations most suitable for and protective of nesting birds with minimal physical risk, where ESH could be constructed as long as other high interest features are given due consideration and appropriate protection (e.g., pre-construction surveys for significant mussels beds) during site reconnaissance, habitat design, and creation and replacement activities.
- Restrictive Areas - Locations where ESH could be created and replaced at relatively low physical risk, but would be within the buffer limits of some sensitive resources, such as forests (increasing predation risk) or boat ramps, recreation areas or domiciles (increasing risk from recreational encroachment). The decision to allow construction activities in these areas would require additional Federal and State coordination to address site-specific concerns.

- Exclusionary Areas - Locations where creation and replacement of ESH would generally be excluded. Intrusion into these locations, for example, within buffer limits of the thalweg, narrow river segments or intakes, could result in unsustainability of habitats, could cause significant geomorphic alterations to the river corridor or could risk physical and economic damages to major public and private infrastructure or land uses. High cost and high impact engineering solutions (e.g., hardened structures) would be necessary to overcome challenges. Therefore, these areas are generally excluded.

When these buffer area distances are applied to the segments, substantial areas become unavailable for the implementation of the ESH program. Reproducing figures displaying the application of these buffers in each river segment is not possible in this format because of the scale (117,000 acres; or approximately 180 square miles). In addition, some resources such as endangered species habitats, cultural resources or intakes should not be disclosed due to their sensitive nature. However, the net effect on the available area is summarized for each segment in section 4.5 and in more detail in Section 4.6. In addition, site-specific NEPA documentation will be performed for each project as the program is implemented, and the related analysis will include site specific details, including information on avoiding sensitive resources in the project area. Figure 4-1 is a screen capture of the GIS analyses performed to assess the environmental buffers and provides an example of what applying the buffers to a portion of the Garrison River Segment looks like when the restricted and exclusionary areas are shown.

Throughout this document, levels of potential impacts are defined according to utilization of the available, restrictive and exclusionary areas. The potential risk of incurring significant environmental effects is minimal (green) when constructing an alternative could be accomplished while avoiding the environmentally sensitive features, and entail construction activities only within the “available area.” When construction activities of an alternative would occur in “restrictive areas,” the risk of incurring significant impacts would be considered moderate (yellow). When construction activities of an alternative would occur within “exclusionary areas,” the risk of incurring significant impacts and unacceptable environmental, social, and cultural consequences would be considered high (red). The number of acres in the available, restrictive and exclusionary areas is identified in Sections 4.5 and is further broken down in the segment-specific discussion in Section 4.6. Impacts to specific resources are discussed in Chapter 6.

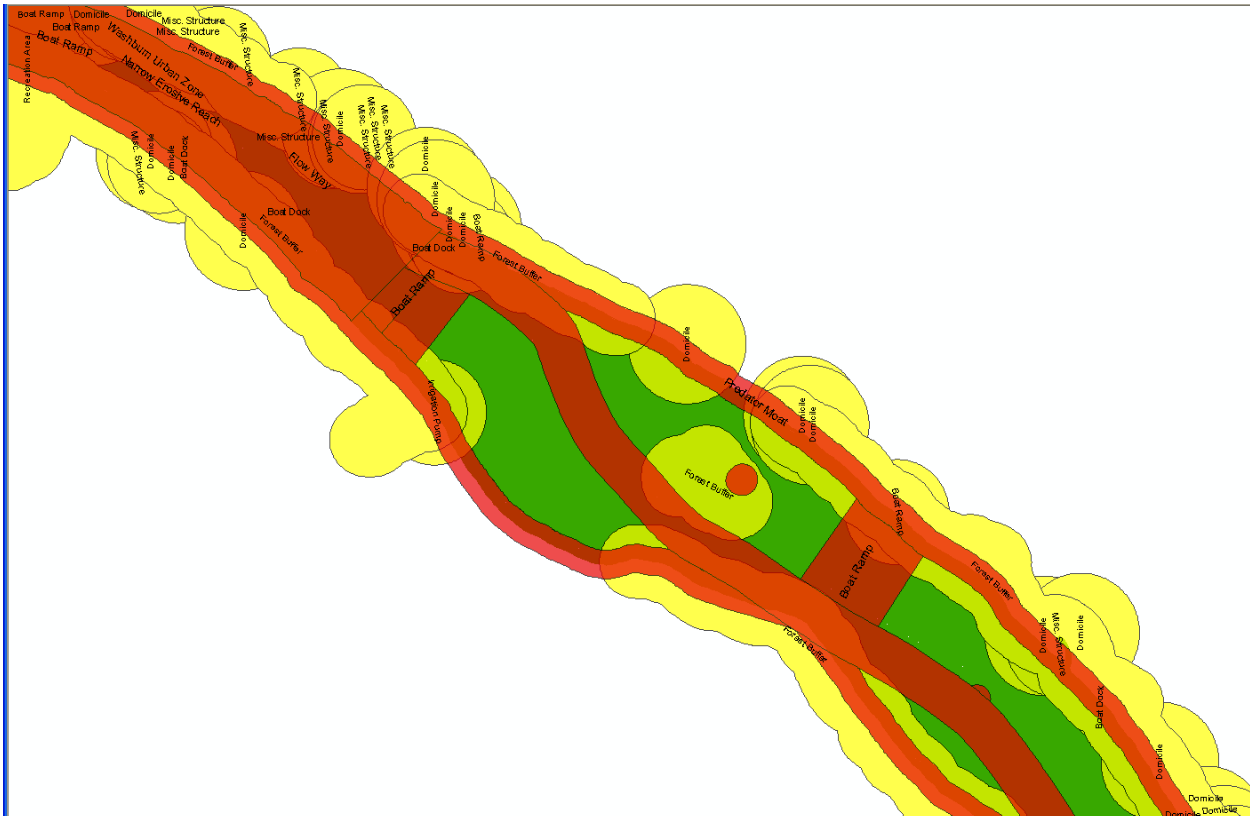

Figure 4-1: Example of Influence of Applying Sensitive Resource Buffers in the Garrison River Segment. Exclusionary (Red), Restrictive (Yellow) and Available (Green) Areas are shown.

4.3.2 Temporal Limits

A number of criteria and potential limitations have been proposed in regards to what dates during a year actual implementation activities can occur. While overall these are quite restrictive, their remains some flexibility as long as adequate coordination is completed. In general, there are four factors that limit timeframe in which ESH construction can take place. Specific criteria and limitations are listed below.

The first factor is related to the nesting season for terns and plovers. USFWS consultation with the Corps on ESH creation and replacement activities established an April 1 to September 15 restriction on these activities within 0.25 miles of an active least tern or piping plover nesting site and a similar April 1 to September 15 limit within 0.5 miles for the avoidance of bald eagle nest sites while they are "active." Correspondence from the Nebraska Game and Parks Commission (NGPC) specifies no activities February 1 through August 30 within 0.5 miles of bald eagle nests. In addition, regional Section 10/404 permit conditions in North Dakota do not allow work within the Missouri River from April 15 to June 1. A key point of these restrictions is that they are only in effect while "active," meaning that even in these areas, if nesting activities are completed earlier, additional days are available.

Experience at ESH construction projects has demonstrated that if construction is ongoing when migrating least terns and piping plovers return to these river segments, the birds could be assumed to initiate nesting (or re-nesting) on created ESH before construction is completed. As such, it may be extremely difficult to construct the sandbar without birds immediately trying to initiate nesting and before construction is completed. To avoid such conflicts, the entire breeding season was assumed unavailable for construction (ESH creation and replacement). From a practical standpoint, weather conditions prohibit the construction of ESH from approximately December through the end of February because of winter cold and ice-up.

In order to allow greater flexibility in construction (creation and replacement) timetables and bring down construction costs of ESH, it has been proposed that construction be allowed to continue past April 15 at the beginning of the nesting season and that construction be allowed to start before the birds leave the area in August. For the April window, with concurrence of the USFWS, a five-nest protocol was established where a contractor could work up to two weeks later than 15 April as long as no more than five least tern and/or piping plover nests were found in exposed sand. Regarding a July start, Corps data indicates very few nests are initiated or re-initiated after July15. USFWS construction constraints are still in place that state that construction cannot take place within ¼ mile of a least tern or piping plover-nesting site. Construction could begin on July 15 at sites greater than ¼ mile from active least tern and piping plover nests.

The second factor is weather. Construction activities must cease in the winter when the river freezes and cannot start again until the river thaws in the late winter/early spring. Typically this down period occurs sometime between December 1 and March 1.

The third factor is construction methodology. If the contractor chooses to use a dredge to collect borrow material, construction must be initiated when the river is high in order to be able to launch the dredge. The river is highest during the navigation season which typically occurs from mid-March to mid-October. If contractor chose to use bulldozers and scrapers to collect borrow material, construction would not begin until the end of the navigation season because the borrow material would likely be submerged until that time.

The fourth factor is recreational pursuits. NPS has raised concerns regarding the potential impacts to the recreation season on the MNRR. They asked that, until the NPS has the opportunity to complete studies regarding these impacts, the prime recreational season from Memorial Day to Labor Day be off limits for construction (creation and replacement). This could severely shorten the window of opportunity to dredge in the summer months and complete construction within one season, impacting the availability of constructed ESH to the birds. The Corps is addressing this issue with the NPS on a case by case basis, including timing of mobilization of equipment to staging areas, and could construct within this timeframe as necessary. The recreation appendix of this draft PEIS includes details of existing recreation in each segment for which the 2003 BiOp Amendment recommends ESH acreage targets. The possibility of a more detailed recreation study, ongoing restrictions, and flexibility regarding mobilization on staging areas during restricted times, are under discussion with the NPS.

Table 4-1 is a graphical representation of the construction period based on nesting activity and primary equipment. The primary months for ESH construction (March, April, September, October, November) are noted in green. Months noted in yellow represent the time when some construction activities could be conducted if conditions are adequate and there is no anticipated disturbance to nesting birds (July, August, December, February, May). The primary recreation season is noted in orange (End-May – Mid-September. Months during which work would generally not be conducted are noted in red (January, June). Primary equipment and recreation time frames are not as fixed as bird presence. Gray squares with an "X" denote those times when construction would not usually take place and blank squares represent times when work could be accomplished given the right circumstances.

Table 4-1: ESH Construction Windows*

		JUL		AUG		SEP		OCT		NOV		DEC		JAN		FEB		MAR		APR		MAY		JUN	
Nesting Activity	No Nearby Nests	X											X	X	X	X							X	X	X
	Nests on Bar or within 1/4 mile	X	X	X	X								X	X	X	X					X	X	X	X	X
Primary Equipment	Dredge	X											X	X	X	X	X	X					X	X	X
	Bulldozers	X	X	X	X	X	X	X					X	X	X	X							X	X	X
Recreation Activity		X	X	X	X	X																	X	X	X

** Blank squares represent times when work could be accomplished given the right circumstances. In time periods where nesting, primary equipment limitations or recreation activities overlap, the presence of birds would be give first consideration.*

The overall effect of these temporal constraints dictate that for the Gavins Point River, Lewis & Clark Lake, and Fort Randall River Segments ESH creation and replacement activities are limited to approximately 2.5 months (approximately 77 days) in any given year, from September 15 until December 1. Because of the more northern latitudes, the Garrison River Segment and Fort Peck River Segment are restricted to 62 days (September 1 - November 15) and 47 days (September 15 - November 1), respectively.

4.4 OVERVIEW OF ALTERNATIVES

Early in the process of the PEIS, the uncertainty between habitat availability and species response was recognized. Additionally, concerns over scale of the ESH program and the potential adverse impacts of program implementation were identified during the scoping phase. A suite of alternatives was developed in coordination with Cooperating Agencies that addressed potential acreage targets that may provide the potential to avoid and/or minimize adverse impacts to non-target resources while still meeting the biological needs of the species. The alternatives identify potential amounts of habitat that could support the species based on:

- Habitat estimates contained in the 2003 BiOp Amendment
- Habitat amounts present during discrete years bounding a period of positive biological response
- Estimates of nesting habitat amounts used by the species over a period of positive biological response

Alternative 1 in the PEIS (11,886 acres) is based on an estimate of the habitat availability as seen on the system in 1998 contained in the RPA. Alternative 2 was also contained in the 2003 BiOp Amendment and was stated as an interim goal in implementing the RPA, representing roughly half of Alternative 1. Based on analysis of monitoring and spatial data, presented primarily in Appendices B and C, the PEIS examines the potential for several lesser acreage alternatives to avoid jeopardy while minimizing negative environmental consequences. The years of 1998-

2005 represent the most productive and populous period on record for least terns and piping plovers (out of 25 years of data). These other alternatives were based on conducting measurements of the habitat availability during this period and developing alternatives that would replicate these conditions. Total acreage goals were determined for each alternative, and distributed among the river segments in a manner similar to the 2003 Amended BiOp. Alternative 3, to create and replace ESH area present in 1998/1999, represents the actual acreage of emergent sandbar habitat that existed within each of the segments after the 1997 high releases from Fort Peck, Garrison, Fort Randall, and Gavins Point Dams and offers a beginning point in a timeframe during which the birds were highly productive. Alternative 4 would seek to replace ESH as it erodes such to retain the number of acres as actually present in 2005, when both species were meeting, or approximating, the fledge ratio goals of the 2003 BiOp Amendment. Because there was such a large gap in the acres identified in Alternatives 3 and 4, Alternative 3.5 was included to represent an average between those alternatives and fill in the scale of the amount of acres analyzed. Alternative 5 was developed based on an analysis of nesting patterns from 1999-2006 and seeks to approximate the amount of habitat actually used by the species during these years. In addition, the effects of continuing the Existing Program and of No Program are discussed. Table 4-2 provides an alternative-by-alternative comparison of the acreage goal totals. As per the purpose and need (Section 2.1), the goal of the program is to supplement naturally available habitat. As such, the acre goals of the each Alternative are expressed as the total acres of habitat present (including mechanically created and any naturally occurring sandbars).

Table 4-2: Comparison of Acreage Totals for the Alternatives

River Segment	Alt 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Existing Program	No Program
Fort Peck River	883	-----	883	565	247	30	TBD	0
Garrison River	4,295	2,148	2,066	1,327	588	500	TBD	0
Fort Randall River	700	350	295	212	128	135	TBD	0
Lewis & Clark Lake	1,360	680	566	354	142	80	TBD	0
Gavins Point River	4,648	2,324	2,944	1,912	880	570	TBD	0
Total ESH Required	11,886	5,502	6,754	4,370	1,985	1,315	833[5]	0

As noted in the previous sections, for this analysis, all of these alternatives and impacts were analyzed based on implementation utilizing the primary construction methodology of mechanical creation. Other potential methodologies, such as vegetation removal, overtopping, or geotextile tubes, if proven effective at creating habitat, could be incorporated into the program. As pilot projects or specific circumstances allow, these methodologies will be tested and monitored. Alternative methods are discussed in the Adaptive Management Strategy (Appendix H). Impacts

[5] The total ESH required for the existing program was calculated by determining a break even point between building and losing sandbar habitat, assuming construction of an average of 150 acres per year (from Table 4-6) and a 15% loss rate due to erosion on Gavins Point River Segment and a 50% loss rate on the Lewis & Clark Lake Segment. This number was not extrapolated among the river segments as the existing program has only constructed ESH in the Lewis & Clark Lake and Gavins Point River Segments and will, upon conference with the ESH PDT, construct ESH where it is most needed and feasible each year.

of these other methodologies are considered to be similar to or less than those associated with mechanical creation discussed in Chapter 6.

4.4.1 Alternative 1: Create and Replace 2015 ESH Goals from the BiOp

For this alternative, the Corps would mechanically create and retain ESH to meet the goals established for 2015 in the 2003 BiOp Amendment. These goals represent the largest amount of habitat manipulation required by the RPAs. The 2003 BiOp Amendment, did not specify acreage goals for the Fort Peck River Segment (USFWS, 2003), but deferred establishing the goal until habitat delineation was completed using photo-interpretation. Completed in 2005, the evaluation established the Fort Peck River Segment goal for 2015 at 883 acres of ESH. Table 4-3 provides the acreage goals for the other segments.

Table 4-3: Alternative 1 – ESH Area based on BiOp Goals for 2015

Segment	ESH Goal Acres per Segment
Fort Peck River	883
Garrison River	4,295
Fort Randall River	700
Lewis & Clark Lake	1,360
Gavins Point River	4,648
TOTAL	11,886

4.4.2 Alternative 2: Create and Replace 2005 ESH Goals from the BiOp

For this alternative, the Corps would create and replace emergent sandbar habitat to meet the acreage goals established for 2005 in the 2003 BiOp Amendment. These goals represent one-half of the ESH goals established for 2015 (Alternative 1) but do not include any acres in the Fort Peck River Segment. The 2003 BiOp Amendment goals for 2005 did not include a requirement to maintain or create any ESH in the Fort Peck River Segment.

Table 4-4: Alternative 2 – ESH Acres based on BiOp Goals for 2005

Segment	ESH Goal Acres per Segment
Fort Peck River	None
Garrison River	2,148
Fort Randall River	350
Lewis & Clark Lake	680
Gavins Point River	2,324
TOTAL	5,502

4.4.3 Alternative 3: Create and Replace ESH Area as Present in 1998/1999

In 2005, the 1998 photoset was used to delineate the riverine habitat for the Gavins Point River, Lewis & Clark Lake, Fort Randall River, and Garrison River Segments. Because a 1998 photoset is not available for the Fort Peck River Segment, the segment was delineated using a 1999 photoset (see summary of Appendix B, Habitat Delineations, in Section 3.1 of this document). Using the same methods to delineate interchannel sandbars (ESH) that had been performed by the Corps to support the 2003 BiOp Amendments' preparation,[6] the areal extent of interchannel sandbar was measured for each of the segments. This delineation identified a substantial discrepancy between the 2003 BiOp Amendment acreage goals for 2015 and the actual number of acres of ESH that existed within each of the segments after the high releases of 1997. This alternative characterizes the environmental consequences of requiring the Corps to create and replace ESH based on that the number of acres actually present after the 1997 high releases. It also represents a beginning point in a timeframe during which the birds were highly productive. Both species were meeting the fledge ratio goals of the 2003 BiOp Amendment. In the four river and Lewis & Clark Lake segments, the 1996-1998 and 1997-1999 3-year fledge ratios for least terns were 1.03 and 1.44, respectively (goal 0.94), and for piping plovers were 1.37 and 1.34, respectively (goal 1.22). Table 4-5 identifies the acres of ESH actually measured in the lower four segments in the 1998 photoset and in the 1999 photoset for the Fort Peck River Segment.

Table 4-5: Alternative 3 – ESH Acres based on that Present in 1998/1999

Segment	ESH Goal Acres per Segment
Fort Peck River	883
Garrison River	2,066
Fort Randall River	295
Lewis & Clark Lake	566
Gavins Point River	2,944
TOTAL	6,754

4.4.4 Alternative 3.5: Average of Acreage between Actual 1998/1999 and 2005 Acreages

This alternative was not included in the Notice of Intent for this PEIS published in the Federal Register, but was added after the scoping phase in order to present impacts associated with a "mid-point" between two existing alternatives (Alternative 4, Section 4.4.3 and Alternative 3, Section 4.4.5). This alternative was added to ensure a full range of options was presented to decision-makers.

This alternative characterizes the environmental consequences of recommending that the Corps create and replace ESH to retain an average between the amount of ESH that was actually present after the 1997 high releases (when the birds were highly productive) and the amount

[6] For a detailed discussion of the techniques used to verify this assertion and the basis for establishing the number of acres of interchannel sandbar that were left exposed after the large releases of 1997, refer to Appendix B, Section 2, Habitat Mapping of the Upper Missouri River; 1998 and 2005.

actually present in 2005 (when the population and fledge ratios were just beginning to fall below target levels). Having 2005 as an endpoint in the timeframe is also important to consider because fledge ratios for both species have dropped below the fledge ratio goals prescribed in the 2003 BiOp Amendment since 2005 (see Section 4.7). Table 4-6 identifies the average of acres of ESH actually measured in the segments in the 1998/1999 photosets and in the 2005 photoset.

Table 4-6: Alternative 3.5 – ESH Acres as an Average between 1998/1999 and 2005 Actual Acreages

Segment	ESH Goal Acres per Segment
Fort Peck River	565
Garrison River	1,327
Fort Randall River	212
Lewis & Clark Lake	354
Gavins Point River	1,912
TOTAL	4,370

4.4.5 Alternative 4: Create and Replace ESH Area as Present in 2005

This alternative is based on Corps data indicating that biological metrics (measurements) for population and productivity (as expressed by fledge ratio goals identified in the 2003 BiOp Amendment) were met or approximated with the amount of ESH acreage existing during the 2005 field season. In 2005, fledge ratios for least terns were above the goal, but fledge ratio for piping plovers fell below the goal. After 2005 (2006 field season), fledge ratios for both species were declining and fell below goal levels. Table 4-7 summarizes the Alternative 4 segment-specific goals. Detailed aerial imagery collected during the 2005 breeding season for all segments was used to measure how much ESH was present (see summary of Appendix B, Habitat Delineations, in Section 3.1 of this document).

Table 4-7: Alternative 4 – ESH Acres based on that Present in 2005

Segment	ESH Goal Acres Per Segment
Fort Peck River	247
Garrison River	588
Fort Randall River	128
Lewis & Clark Lake	142
Gavins Point River	880
TOTAL	1,985

4.4.6 Alternative 5: Create and Replace ESH Area Derived from Nesting Patterns

During the formulation of alternatives, Alternative 5 was conceived to represent an amount of acreage used for nesting by terns and plovers during the period of analysis. The analysis used to develop this alternative, detailed in Section 3.4 of Appendix B, used nesting records and other

GIS data to approximate the number of acres of nesting habitat and used the BiOp design criteria for the amount of foraging and brood-rearing habitat that should accompany nesting habitat, to derive an estimate of the total acreage of ESH that was utilized by terns and plovers during the period of analysis. It is noted that this acreage does not capture any "diversionary", or unused, habitat that may have benefits in reducing predation. Still, similar to Alternatives 3, 3.5, and 4, this acreage represents a potential amount of habitat that could sustain the species based on an analysis of data from the highly productive period following the increased ESH acreage in 1998.

ESH creation projects in 2004 and 2005 in the Gavins Point River Segment demonstrated the utility and benefit to the species from mechanically created habitat (USACE, 2006; USACE, 2006a). The Corps' 2004 Annual Report (USACE, 2006a) states, "*The sandbar creation that occurred as a part of this project [Ponca Complex at River Mile 755] resulted in the creation of 3 emergent sandbars with a combined area of 37 acres. Successfully fledged from the constructed emergent sandbar complex were 23 piping plovers and 64 least terns. This made the Ponca sandbar complex the most productive least tern complex on the Missouri River in 2004.*" Additional sandbar complexes constructed on the Gavins Point River Segment (e.g., RM 770.0 and 761.3) demonstrated high productivity (See Appendix B).

Table 4-8: Alternative 5 – Create and Replace ESH Area Derived from Nesting Patterns

Segment	ESH Goal Acres per Segment
Fort Peck River	30
Garrison River	500
Fort Randall River	135
Lewis & Clark Lake	80
Gavins Point River	570
TOTAL	1,315

4.4.7 Continue Existing Program Alternative

This alternative is considered one of the "No Action" alternatives; essentially proposing "no change" by continuing existing low-level construction efforts as has been going on for the past several years. This alternative was added since the Notice of Intent, at which time there was no ongoing ESH program. Since then, annual ESH construction has been proceeding at levels that apparently do not seem to be meeting the needs of the species with regard to the retention of sufficient habitat to support bird population and productivity metrics (measurements). Acres per segment constructed through the ongoing ESH program are presented in Table 4-9. This alternative would not meet the Purpose and Need for the ESH program.

Table 4-9: Alternative Continue Existing Program – ESH Acres based on Existing Program (2004-2009)[7]

Segment	Average Acres Constructed Per Year
Fort Peck River	0
Garrison River	0
Fort Randall River	0
Lewis & Clark Lake	25
Gavins Point River	125
TOTAL	150

4.4.8 No Program Alternative

The No Program Alternative assumes no action by the Corps to implement any type of ESH creation or replacement in the upper Missouri River. The effects of implementing the No Program Alternative (as described in Section 6) reflects the continuation of existing economic, social, and environmental conditions and trends within the affected areas in the absence of Corps activities to create and manage ESH. This alternative would not meet the Purpose and Need for the ESH program.

4.5 SUMMARY OF AVAILABLE, RESTRICTIVE AND EXCLUSIONARY AREAS

As described in Section 4.3.1 (Sensitive Resources and Spatial Limits), throughout this document, levels of risk of impacts are defined according to utilization of the available areas (minimal/green), restrictive areas (moderate/yellow) and exclusionary areas (high/red) after environmental or sensitive resource buffers have been applied.

- Available Areas - Locations most suitable for and protective of nesting birds with minimal physical risk.
- Restrictive Areas - Locations where ESH could be created and replaced at relatively low physical risk, but construction activities could be within the buffer limits of some sensitive resources. Additional Federal and State coordination would be required.
- Exclusionary Areas - Locations where creation and replacement of ESH would generally be excluded. Intrusion into these locations (e.g. within buffer limits of the thalweg), could result in unsustainability of habitats, significant geomorphic alterations to the river or damages to major public and private infrastructure or land uses.

Table 4-10 is a summary of the number of acres in each of these areas, by segment.

[7] Acreages for the Existing Program Alternative are average annual construction amounts, rather than a cumulative goal.

Table 4-10: Summary of the Number of Acres by Area Type, By Segment

SEGMENT Area (Ac)	Area Type	Acres Within Buffers
Ft Peck 39,009	Exclusionary	>19,753
	Restrictive	3,825 – 19,753
	Available	0 – 3,825
Garrison 24,518	Exclusionary	>9,678
	Restrictive	4,361 – 9,678
	Available	0 – 4,361
Ft Randall 13,790	Exclusionary	> 8,065
	Restrictive	2,784 – 8,064
	Available	0 - 2,784
L&C Lake 17,157	Exclusionary	> 13,969
	Restrictive	4,711 – 13,969
	Available	0 – 4,711
Gavins Pt 23,228	Exclusionary	> 9,880
	Restrictive	3,881 – 9,880
	Available	0 – 3,881

The potential risk of incurring significant environmental effects is minimal (green) when constructing an alternative could be accomplished while avoiding the environmentally sensitive features, and entail construction activities only within the "available area." When construction activities of an alternative would occur in "restrictive areas," the risk of incurring significant impacts would be considered moderate (yellow). When construction activities of an alternative would occur within "exclusionary areas," the risk of incurring significant impacts and unacceptable environmental, social, and cultural consequences would be considered high (red).

The following tables demonstrate that acres from all alternatives, with the exception of Gavins Point Alternative 1, can be physically placed within the available area (Table 4-11). However, when considering impacts to environmental and other resources, the total area impacted includes the borrow areas for construction. For each acre of ESH constructed, an estimated 2.75 total acres are impacted. At certain levels, construction activities, including borrow areas, would require actions in the restrictive or exclusionary areas (Table 4-12).

Table 4-11: Summary of Available Area by # Acres of ESH (By Alternative, By Segment)

SEGMENT	# Acres in Available, Restrictive & Exclusion Areas By Segment	# Acres ESH Total (By Alternative, By Segment)						
		ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist
Ft Peck	Exclusion > 19,753	883	--	883	565	247	30	--
	Restrictive 3,825 - 19,753							
	Available 0 - 3,825							
Garrison	Exclusion > 9,678	4,295	2,148	2,066	1,327	588	500	--
	Restrictive 4,361 – 9,678							
	Available 0 – 4,361							
Ft Randall	Exclusion > 8,065	700	350	295	212	128	135	--
	Restrictive 2,784 – 8,064							
	Available 0 – 2,784							
L&C Lake	Exclusion > 13,969	1,360	680	566	354	142	80	25/yr
	Restrictive 4,711 – 13,969							
	Available 0 – 4,711							
Gavins Pt	Exclusion > 9,880	4,648	2,324	2,944	1,912	880	570	125/yr
	Restrictive 3,881 – 9,880							
	Available 0 - 3,881							
		11,886	5,502	6,754	4,370	1,985	1,315	150/yr

Table 4-12: Summary of Available Area by # Acres Required, Including Borrow (By Alternative, By Segment)

SEGMENT	# Acres in Available, Restrictive & Exclusion Areas By Segment	Area Impacted*: # Acres Required, Including Borrow Areas (By Alternative, By Segment)						
		ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist
Ft Peck	Exclusion > 19,753	2,623	--	2,623	1,681	737	89	--
	Restrictive 3,825 - 19,753							
	Available 0 - 3,825							
Garrison	Exclusion > 9,678	12,756	6,380	6,136	3,941	1,746	1,485	--
	Restrictive 4,361 – 9,678							
	Available 0 – 4,361							
Ft Randall	Exclusion > 8,065	2,079	1,040	876	630	380	401	--
	Restrictive 2,784 – 8,064							
	Available 0 – 2,784							
L&C Lake	Exclusion > 13,969	2,594	1,297	1,080	675	271	153	95
	Restrictive 4,711 – 13,969							
	Available 0 – 4,711							
Gavins Pt	Exclusion > 9,880	13,805	6,902	8,744	5,679	2,614	1,693	2,474
	Restrictive 3,881 – 9,880							
	Available 0 - 3,881							

For each acre of ESH constructed, an estimated 2.75 acres are impacted

Additional information regarding specific acreage requirements of each alternative by segment is included in Section 4.6, particularly in each "Area Disturbed Effects" table for each segment. This information is then utilized throughout Chapter 6 as a way to gauge the level of potential impacts to specific resources. Finally, the site selection process for ESH is defined in Appendix G, where considerations of potential construction activities in available, restrictive and exclusionary areas are summarized.

4.6 Actions to Implement Alternatives by Segment

Because the Corps expects to make segment-specific choices among the alternatives and not select a single alternative to be applied uniformly to all segments, the alternatives discussion in this section is organized by segment.

ESH construction includes mechanical creation and maintenance activities to achieve the quantity and quality of ESH habitat to meet the various alternative goals within approximately 10 years. This section quantifies the magnitude of material moving effects necessary to create and maintain ESH within each of the segments and for each of the alternatives according to the assumptions articulated in Section 2 of the ESH Mechanical Construction and Maintenance Assumptions (Appendix C). The total number of acres of ESH to be created under each alternative and the ultimate area of disturbance are presented.

In addition, the annual requirements for these same categories as well as the annual equipment requirements are presented in this section. The annual values are based on the assumption that it could take 10 years to reach the total number of acres specified for each alternative if fully implemented except for alternatives 4, 5, and Existing Program, which will initially have their acreage goals met as an assumption (acres measured in 2005). The primary variable affecting the amount of habitat to be constructed annually for the first 10 years (additional ESH is created and eroded acres are replaced each year) or to retain the ESH acreage goals to perpetuity by continued replacement of eroded ESH is the annual erosion rate for each alternative, which varies among the alternatives (Erosion rate increases as the acreage goal for each alternative is higher, except for Lewis & Clark Lake Segment where it is constant for all alternatives.) and is identified for each alternative in Section 2.2.5 of Appendix C.

For all of the charts regarding Area Disturbed in this section, the "Area Disturbed" is the number of acres disturbed by the gathering of material (by dredge and heavy equipment) to build the required area of ESH, as well as the footprint of the ESH to be constructed. Avoiding sensitive resources, or staying within the "Available Area," (described in Section 4.3.1 and Appendices B and C) forms the basis for discussions of impact significance in Chapter 6. The number of acres in the total Available Area are listed, as well as the number of acres required in the available, restrictive and exclusionary areas (defined in Section 4.3.1; Tables 4-10 – 4-12).

For all of the charts regarding Annual Creation and Replacement amounts in this section, the "CY of Material Moved" row is the volume of material needed annually to create and replace the acres of ESH needed under each alternative. The "Days of Mechanical Work" is the number of days that each team of mechanical operators would work to move and place 70-percent of the necessary material and the "Days of Dredge Work" is the number of days each dredge would work to place the remaining 30-percent of the needed material.[8] The number of "Teams of Mechanical Operators" and "Number of Dredges" are the number of each category assumed to be working simultaneously in a given year to annually complete the necessary "Days of Mechanical Work" and "Days of Dredge Work" within the number of days available for maintenance construction (varies per segment). The number of "Teams of Mechanical Operators" and the "Number of Dredges" presented are rounded up to the next whole integer.

[8] Refer to the ESH Creation and Replacement Assumptions in Appendix C, Sections 2.2.6, Mechanical Excavation and Placement and 2.2.7, Removal and Placement With Dredge for details of the fundamental assumptions supporting the hours of daily operation, rates of material movement, and the type of equipment used to achieve the assumed production rates.

A comprehensive summary table of the risk of adverse effects by alternative is provided in Chapter 7.

4.6.1 Fort Peck River Segment

This section identifies the alternative-specific ESH goals for the Fort Peck River Segment and summarizes the magnitude of the construction (combination of ESH creation and replacement) actions necessary to implement each of the alternatives. Table 4-13summarizes the alternative-specific ESH creation goals and the total area of disturbance required to reach these goals (by approximately year 10) for the Fort Peck River Segment.

The Fort Peck River Segment has a measured high-bank to high-bank area of approximately 39,009 acres. After application of the environmental buffers to the segment, 3,825 acres remain as potentially "available" while avoiding sensitive environmental resources. Construction activities for each of the alternatives are within the available (green) area remaining after applying the environmental buffers (See tables 4-12 and 4-13).

There are no ESH creation goals for Alternative 2 for the Fort Peck River Segment because there were no 2005-habitat requirements in the 2003 BiOp Amendment for the Fort Peck River Segment. The quantities for Alternatives 1 and 3 are the same because 2003 BiOp Amendment did not assign an acreage goal for the segment but deferred the goal based on an actual delineation of the habitat visible in the remotely sensed photography from 1999. Therefore, for this segment only, the acreage goals for Alternatives 1 and 3 are the same.

Table 4-13: Area Disturbed Effects for ESH Creation for the Fort Peck River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres for Goal	883	--	883	565	248	30	0[9]
Area Disturbed (AC)	2,623	--	2,623	1,681	737	89	--
% of Total Riverine Habitat Disturbed to Construct	7	--	7	4	1.9	0.2	--
Available Area (AC) After Environmental Buffers Applied	3,825	--	3,825	3,825	3,825	3,825	--
# Acres in ***Available Area***	2,623	--	2,623	1,681	737	89	--
# Acres in ***Restrictive Area***	0	0	0	0	0	0	--
# Acres in ***Exclusionary Area***	0	0	0	0	0	0	0

[9] The Existing Program does not include construction of ESH in Fort Peck River Segment.

Calculation of the annual ESH creation and replacement amount (creation diminishes and replacement increases in each successive year until the goal is reached in year 10) is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total ESH creation goal but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 4-14 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year for the Fort Peck River Segment.

Table 4-15 summarizes the annual quantities and effort necessary to create and replace the requisite number of acres under each of these alternatives for the Fort Peck River Segment. The temporal limits on construction discussed in the ESH Creation and Replacement Assumptions (Appendix C, Section 2.3.3) identify 47 days annually when ESH construction could be accomplished in the Fort Peck River Segment.

Table 4-14: Fort Peck River Segment Annual Creation and Replacement Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	247						247		
Create Goal Ac.	883						883		
Ann. Loss Rate	0.3	**Create**	**Replace**		**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	270	**New**	**Lost**		**New**	**Lost**	270	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	247						247		
1	443	196	74				443	196	74
2	580	137	133				580	137	133
3	676	96	174				676	96	174
4	743	67	203				743	67	203
5	790	47	223				790	47	223
6	823	33	237				823	33	237
7	846	23	247				846	23	247
8	862	16	254				862	16	254
9	874	11	259				874	11	259
10	882	8	262				882	8	262

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	247			247			247		
Create Goal Ac.	566			248			30		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	146	**New**	**Lost**	37	**New**	**Lost**	3	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	247			247			247		
1	331	84	62	247	0	37	225	0	3
2	394	63	83	247	0	37	206	0	3
3	442	47	99	247	0	37	188	0	3
4	477	36	110	247	0	37	172	0	3
5	504	27	119	247	0	37	158	0	3
6	524	20	126	247	0	37	145	0	3
7	539	15	131	247	0	37	134	0	3
8	550	11	135	247	0	37	123	0	3
9	559	8	138	247	0	37	114	0	3
10	565	6	140	247	0	37	106	0	3

Table 4-15: Summary of Annual Construction to Create and Replace ESH for the Fort Peck River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres to Create/Replace	265	--	265	142	37	3	N/A
CY of Material Moved	1,552,370	--	1,552,370	831,836	216,746	17,574	--
Area Disturbed (AC)	787	--	787	422	110	9	--
Days of Mechanical Work	178	--	178	95	25	2	--
Days of Dredge Work	153	--	153	82	21	2	--
Teams of Mechanical Operators	4	--	4	3	1	1	--
Number of Dredges	4	--	4	2	1	1	--

4.6.2 Garrison River Segment

Table 4-16 summarizes the alternative-specific ESH goals and the total area of disturbance required to reach these goals (by approximately year 10) for the Garrison River Segment. The Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 acres remain as potentially "available" while avoiding sensitive environmental resources.

Alternative 1 would require construction activities in exclusionary (red) areas and Alternatives 2, and 3 would require construction activities within restrictive (yellow) areas after applying environmental buffers. All construction activities required for Alternatives 3.5, 4 and 5 could occur within the available (green) areas after applying the environmental buffers (See tables 4-12 and 4-16).

Table 4-16: Area Disturbed Effects for ESH Creation for the Garrison River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres for Goal	4,295	2,148	2,066	1,327	588	500	N/A
Area Disturbed (AC)	12,756	6,380	6,136	3,941	1,746	1,485	--
% of Total Riverine Habitat Disturbed to Construct	52	26	25	16	7	6	--
Available Area (AC) After Environmental Buffers Applied	4,361	4,361	4,361	4,361	4,361	4,361	--
# Acres in Available Area	4,361	4,361	4,361	3,941	1,746	1,485	--
# Acres in Restrictive Area	5,317	2,019	1,775	0	0	0	--
# Acres in Exclusionary Area	3,078	0	0	0	0	0	0

Calculation of the annual ESH creation and replacement amount (Creation diminishes and replacement increases in each successive year until the goal is reached in year 10.) is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total ESH creation goal but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 4-17 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year for the Garrison River Segment.

Table 4-18 summarizes the annual quantities and effort necessary to create and replace the requisite number of acres under each of these alternatives for the Garrison River Segment. The temporal limits on construction discussed in the ESH Creation and Replacement Assumptions (Appendix C, Section 2.3.3) identify 62 days annually when ESH construction could be accomplished in the Garrison River Segment.

Table 4-17: Garrison River Segment Annual Creation and Replacement Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	588			588			588		
Create Goal Ac.	4295			2148			2066		
Ann. Loss Rate	0.4	**Create**	**Replace**	0.3	**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	1727	**New**	**Lost**	658	**New**	**Lost**	633	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	588			588			588		
1	2080	1492	235	1069.6	482	176	1045	457	176
2	2975	895	832	1407	337	321	1364	320	313
3	3512	537	1190	1643	236	422	1588	224	409
4	3834	322	1405	1808	165	493	1745	157	476
5	4027	193	1534	1924	116	542	1854	110	523
6	4143	116	1611	2004	81	577	1931	77	556
7	4213	70	1657	2061	57	601	1985	54	579
8	4255	42	1685	2101	40	618	2022	38	595
9	4280	25	1702	2129	28	630	2049	26	607
10	4295	15	1712	2148	19	639	2067	18	615

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	588			588			588		
Create Goal Ac.	1327			588			500		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	343	**New**	**Lost**	88	**New**	**Lost**	45	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	588			588			588		
1	784	196	147	588	0	88	574.2	0	45
2	931	147	196	588	0	88	562	0	45
3	1041	110	233	587	0	88	551	0	45
4	1124	83	260	587	0	88	541	0	45
5	1186	62	281	587	0	88	531	0	45
6	1232	47	296	587	0	88	523	0	45
7	1267	35	308	587	0	88	516	0	45
8	1294	26	317	587	0	88	509	0	45
9	1313	20	323	587	0	88	503	0	45
10	1328	15	328	587	0	88	498	0	45

Table 4-18: Summary of Annual Construction to Create and Replace ESH for the Garrison River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres to Create/Replace	1,718	644	620	332	88	50	N/A
CY of Material Moved	10,064,044	3,772,552	3,631,960	1,944,856	515,504	292,900	--
Area Disturbed (AC)	5,102	1,913	1,841	986	261	149	--
Days of Mechanical Work	873	327	315	169	45	25	--
Days of Dredge Work	750	281	271	145	38	22	--
Teams of Mechanical Operators	15	6	6	3	1	1	--
Number of Dredges	13	5	5	3	1	1	--

4.6.3 Fort Randall River Segment

Table 4-19 summarizes the alternative-specific ESH creation goals and the total area of disturbance required to reach these goals (by approximately year 10) for the Fort Randall River Segment. The Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres. After application of the environmental buffers to the Fort Randall River Segment, 2,784 acres remain as potentially "available" while avoiding sensitive environmental resources. All acres required for construction activities needed for each of the alternatives are within the available area (see Tables 4-12 and 4-19).

Table 4-19: Area Disturbed Effects for ESH Creation for the Fort Randall River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres for Goal	700	350	295	212	128	135	0[10]
Area Disturbed (AC)	2,079	1,040	876	630	380	401	--
% of Total Riverine Habitat Disturbed to Construct	15	8	6	5	3	3	--
Available Area (AC) After Environmental Buffers Applied	2,784	2,784	2,784	2,784	2,784	2,784	--
# Acres in Available Area	2079	1,040	876	630	380	401	--
# Acres in Restrictive Area	0	0	0	0	0	0	--
# Acres in Exclusionary Area	0	0	0	0	0	0	--

Calculation of the annual ESH creation and replacement amount (Creation diminishes and replacement increases in each successive year until the goal is reached in year 10.) is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total ESH creation goal but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 4-20 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year for the Fort Randall River Segment.

Table 4-21 summarizes the annual quantities and effort necessary to create and replace the requisite number of acres under each of these alternatives for the Fort Randall River Segment. The temporal limits on construction discussed in the ESH Creation and Replacement Assumptions (Appendix C, Section 2.3.3) identify 77 days annually when ESH construction could be accomplished in the Fort Randall River Segment

[10] The Existing Program does not include construction of ESH in the Fort Randall Segment.

Table 4-20: Fort Randall River Segment Annual Creation and Replacement Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	128			128			128		
Create Goal Ac.	700			350			295		
Ann. Loss Rate	0.4	**Create**	**Replace**	0.3	**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	281	**New**	**Lost**	107	**New**	**Lost**	90	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	128			128			128		
1	358	230	51	196.6	69	38	180	52	38
2	496	138	143	245	48	59	216	36	54
3	578	83	198	278	34	73	241	25	65
4	628	50	231	302	24	83	259	18	72
5	658	30	251	318	16	91	271	12	78
6	676	18	263	330	12	95	280	9	81
7	686	11	270	338	8	99	286	6	84
8	693	6	275	343	6	101	290	4	86
9	697	4	277	347	4	103	293	3	87
10	699	2	279	350	3	104	295	2	88

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	128			128			128		
Create Goal Ac.	212			128			135		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	54	**New**	**Lost**	19	**New**	**Lost**	14	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	128			128			128		
1	150	22	32	128	0	19	129.2	0	14
2	167	17	38	128	0	19	130	0	14
3	179	12	42	127	0	19	131	0	14
4	188	9	45	127	0	19	132	0	14
5	195	7	47	127	0	19	133	0	14
6	200	5	49	127	0	19	134	0	14
7	204	4	50	127	0	19	134	0	14
8	207	3	51	127	0	19	135	0	14
9	209	2	52	127	0	19	135	0	14
10	211	2	52	127	0	19	136	0	14

Table 4-21: Summary of Annual Construction to Create and Replace ESH for Fort Randall River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres to Create/Replace	280	105	89	53	19	14	N/A
CY of Material Moved	1,640,240	615,090	521,362	310,474	111,302	82,012	--
Area Disturbed (AC)	832	312	264	157	56	42	--
Days of Mechanical Work	115	43	36	22	8	6	--
Days of Dredge Work	98	37	31	19	7	5	--
Teams of Mechanical Operators	2	1	1	1	1	1	--
Number of Dredges	2	1	1	1	1	1	--

4.6.4 Lewis & Clark Lake Segment

Table 4-22 summarizes the alternative-specific ESH creation goals and the total area of disturbance required to reach these goals (by approximately year 10) for the Lewis & Clark Lake Segment. The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers, 4,711 acres remain as potentially “available” while avoiding the sensitive resources within the segment. All acres needed for construction activities for each of the alternatives are within available (green) areas (see Tables 4-12 and 4-22). ESH actions in the delta area should result in no net gain of sediment (cutting and filling from same flood plain area) in accordance with construction guidelines.

Table 4-22: Area Disturbed Effects for ESH Creation for the Lewis & Clark Lake Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres for Goal	1,360	680	566	354	142	80	25 annually
Area Disturbed (AC)	2,594	1,297	1,080	675	271	153	95
% of Total Riverine Habitat Disturbed to Construct	15	8	6	4	1.6	0.9	0.6
Available Area (AC) After Environmental Buffers Applied	4,711	4,711	4,711	4,711	4,711	4,711	4,711
# Acres in the Available Area	2,594	1,297	1,080	675	271	153	95
# Acres in the Restrictive Area	0	0	0	0	0	0	0
# Acres in the Exclusionary Area	0	0	0	0	0	0	0

Calculation of the annual ESH creation and replacement amount (Creation diminishes and replacement increases in each successive year until the goal is reached in year 10.) is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total ESH creation goal but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 4-23 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year for the Lewis & Clark Lake Segment.

Table 4-24 summarizes the quantities and effort necessary to create and replace the requisite number of acres under each of these alternatives for the Lewis & Clark Lake Segment. The temporal limits on construction discussed in the ESH Creation and Replacement Assumptions (Appendix C, Section 2.3.3) identify 77 days annually when ESH construction could be accomplished in the Lewis & Clark Lake Segment. There are no "Days of Mechanical Work" or "Teams of Mechanical Operators" to construct ESH in the Lewis & Clark Lake Segment because the static water levels in the segment do not permit the use of pan scrapers to gather material to construct ESH. All ESH creation and replacement for this segment would perforce be performed by dredge.

Table 4-23: Lewis & Clark Lake Segment Annual Creation and Replacement Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	142			142			142		
Create Goal Ac.	1360			680			566		
Ann. Loss Rate	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**
Ann. Const. Ac.	680	**New**	**Lost**	340	**New**	**Lost**	283	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	142			142			142		
1	751	609	71	411	269	71	354	212	71
2	1056	305	376	546	135	206	460	106	177
3	1208	152	528	613	67	273	513	53	230
4	1284	76	604	646	34	306	540	27	257
5	1322	38	642	663	17	323	553	13	270
6	1341	19	661	672	8	332	559	7	276
7	1350	10	670	676	4	336	563	3	280
8	1355	5	675	678	2	338	564	2	281
9	1358	2	678	679	1	339	565	1	282
10	1359	1	679	679	1	339	566	0	283

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	142			142			142		
Create Goal Ac.	354			142			80		
Ann. Loss Rate	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**
Ann. Const. Ac.	177	**New**	**Lost**	71	**New**	**Lost**	40	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	142			142			142		
1	248	106	71	142	0	71	111	0	40
2	301	53	124	142	0	71	96	0	40
3	328	27	151	142	0	71	88	0	40
4	341	13	164	142	0	71	84	0	40
5	347	7	170	142	0	71	82	0	40
6	351	3	174	142	0	71	81	0	40
7	352	2	175	142	0	71	80	0	40
8	353	1	176	142	0	71	80	0	40
9	354	0	177	142	0	71	80	0	40
10	354	0	177	142	0	71	80	0	40

Table 4-24: Summary of Annual Construction to Create and Replace ESH for Lewis & Clark Lake Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres to Create/Replace	680	340	283	177	71	40	25
CY of Material Moved	3,983,440	1,991,720	1,657,814	1,036,866	415,918	234,320	146,450
Area Disturbed (AC)	1,297	649	540	338	135	76	48
Days of Mechanical Work	0	0	0	0	0	0	0
Days of Dredge Work	797	398	332	207	83	47	29
Teams of Mechanical Operators	0	0	0	0	0	0	0
Number of Dredges	11	6	5	3	2	1	1

4.6.5 Gavins Point River Segment

Table 4-25 summarizes the alternative-specific ESH creation goals and the total area of disturbance required to reach these goals (by approximately year 10) for the Gavins Point River Segment.

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres. The "% of Total Riverine Habitat Disturbed to Construct" is the "Area Disturbed" under each alternative divided by the total high-bank to high-bank area (23,228 acres) of the segment. This number reflects the percent of the entire segment that would be affected by ESH activities under each alternative.

After application of the environmental buffers to exclude portions of the segment for ESH construction, 3,881 acres remain in the available area. Alternative 1 would require construction activities in the exclusionary area, and Alternatives 2, 3, and 3.5 would require construction activities in the restrictive areas. Construction activities for Alternatives 4 and 5 could occur in the available area (Tables 4-12 and 4-25).

Table 4-25: Area Disturbed Effects for ESH Creation and Replacement for the Gavins Point River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres for Goal	4,648	2,324	2,944	1,912	880	570	125 annually
Area Disturbed (AC)	13,805	6,902	8,744	5,679	2,614	1,693	2,474
% of Total Riverine Habitat Disturbed to Construct	59	30	38	24	11	7	11
Available Area (AC) After Environmental Buffers Applied	3,881	3,881	3,881	3,881	3,881	3,881	3,881
# Acres in the Available Area	3,881	3,881	3,881	3,881	2,614	1,693	2,474
# Acres in the Restrictive Area	5,999	3,021	4,863	1,798	0	0	0
# Acres in the Exclusionary Area	3,925	0	0	0	0	0	0

Calculation of the annual ESH creation and replacement amount (Creation diminishes and replacement increases in each successive year until the goal is reached in year 10.) is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total ESH creation goal but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 4-26 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year for the Gavins Point River Segment.

Table 4-27 summarizes the annual quantities and effort necessary to create and replace the requisite number of acres under each of these alternatives for the Gavins Point River Segment. The temporal limits on construction discussed in Section 2.3.3 identify 77 days annually when ESH construction could be accomplished in the Gavins Point River Segment.

Table 4-26: Gavins Point River Segment Annual Creation and Replacement Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	880			880			880		
Create Goal Ac.	4648			2324			2944		
Ann. Loss Rate	0.4	**Create**	**Replace**	0.3	**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	1868	**New**	**Lost**	710	**New**	**Lost**	901	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	880			880			880		
1	2396	1516	352	1326	446	264	1517	637	264
2	3306	910	958	1638	312	398	1963	446	455
3	3851	546	1322	1857	219	491	2275	312	589
4	4179	327	1541	2010	153	557	2494	218	683
5	4375	196	1672	2117	107	603	2646	153	748
6	4493	118	1750	2192	75	635	2754	107	794
7	4564	71	1797	2244	52	658	2828	75	826
8	4606	42	1826	2281	37	673	2881	52	849
9	4632	25	1843	2307	26	684	2918	37	864
10	4647	15	1853	2325	18	692	2943	26	875

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	880			880			880		
Create Goal Ac.	1912			880			570		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	493	**New**	**Lost**	132	**New**	**Lost**	40	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	880			880			880		
1	1153	273	220	880	0	132	832	0	40
2	1358	205	288	880	0	132	789	0	40
3	1511	154	339	880	0	132	750	0	40
4	1626	115	378	880	0	132	715	0	40
5	1713	86	407	880	0	132	683	0	40
6	1778	65	428	880	0	132	655	0	40
7	1826	49	444	880	0	132	630	0	40
8	1863	36	457	880	0	132	607	0	40
9	1890	27	466	880	0	132	586	0	40
10	1911	20	473	880	0	132	567	0	40

Table 4-27: Summary of Annual Construction to Create and Replace ESH for Gavins Point River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5 Nesting Patterns	Existing Program
ESH Acres to Create/Replace	1,859	697	883	478	132	57	125
CY of Material Moved	10,890,022	4,083,026	5,172,614	2,800,124	773,256	333,906	732,250
Area (AC) Disturbed	5,521	2,070	2,623	1,420	392	169	371
Days of Mechanical Work	761	285	361	196	54	23	51
Days of Dredge Work	653	245	310	168	46	20	44
Teams of Mechanical Operators	10	4	5	3	1	1	1
Number of Dredges	9	4	5	3	1	1	1

4.7 SUMMARY OF ESTIMATED CONSTRUCTION COSTS & TIMEFRAMES

Table 4-28 provides an alternative-by-alternative comparison of the estimated total ESH program annual costs, followed by a discussion of potential timeframes. Because the program would be implemented in an Adaptive Management framework, costs and timeframes are estimates. To provide a basis of comparison, it is assumed the program is fully implemented using mechanical creation. However, it is recognized that during implementation, costs could be affected by the following:

- If opportunities arise for the Corps to utilize more cost effective methods of creation (e.g. vegetation removal or geotextile tubes), cost efficiencies could be gained
- Full implementation may not be necessary if species metrics or measurements (e.g. population and productivity) are met at lower acreage levels (see Adaptive Management, Appendix H).
- Acreage goals are expressed as the total habitat present, including created and naturally occurring sandbars. The number of acres required to supplement naturally available habitat would likely fluctuate each year.

Table 4-28: Comparison of Estimated Acreages and Costs for Alternatives if Fully Implemented

	Alt 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Existing Program	No Program
Total ESH Acres	11,886	5,502	6,754	4,370	1,986	1,315	883	0
Estimated Annual Construction (Acres)	4,802	1,786	2,140	1,182	347	164	150	0
Const. Cost/Year ($ M)	$147.7	$54.9	$65.8	$36.4	$10.7	$5.0	$4.6	$0
Engineering & Design/ Year (9%) ($M)	$13.3	$4.9	$5.9	$3.3	$1.0	$0.5	$0.4	$0
Field Supervision & Admin/Year(6%) ($M)	$9.7	$3.6	$4.3	$2.4	$0.7	$0.3	$0.3	$0
Program Management, Planning & NEPA/Year (5%) ($M)	$8.5	$3.2	$3.8	$2.1	$0.6	$0.3	$0.3	$0
Contingency/Year (10%) ($M) *	$17.9	$6.7	$8.0	$4.4	$1.3	$0.6	$0.6	$0
Total Cost/Year ($M) **	$197.1	$73.3	$87.8	$48.6	$14.3	$6.7	$6.1	$0

** Construction cost is calculated in Appendix C. Cost estimations are based on actual historical costs from past ESH projects over a number of years. Therefore, factors such as contractor inefficiency/unavailability or weather are accounted for in the calculations. These estimates were prepared based on an estimated annual level of effort to construct and replace habitat.*

*** Total cost is calculated with estimated costs for engineering and design, field supervision and administration, program management, planning, NEPA compliance and contingency (10%).*

Annual costs are projected to remain constant over time to maintain a given acreage of habitat, but construction activities would shift from new creation to replacement of lost (eroded or vegetated) ESH. The goal levels would be attained over an approximate 10-year period during which the goal level would be approached gradually until construction amounts would level off, or adjusted based on biological performance (see Appendix H). After that initial construction period, the acreage goal would be retained with a constant annual acreage replacement-only program for these four alternatives (annual construction acreage is essentially the same as the subsequent replacement acreage). Alternatives 1, 2, 3, and 3.5 would require an initial construction (combination of ESH creation and replacement) period during which the habitat goal of these alternatives would be met. Although the actual rate of construction will follow an adaptive management framework, for comparison purposes the table shows the annual construction acres/costs to reaching target acreage over ten years and sustaining them. Alternatives 4, 5, and Existing Program do not show an initial period with increasing creation acres because the acreage goal was exceeded with the amount of habitat available in 2005 (assumed to exist for all of the alternatives, when implemented). Under these three alternatives, a constant annual replacement program would be implemented in the first year, and the 2005 acreage amount would be maintained (Alternative 4) or allowed to deteriorate to a reduced amount of habitat (Alternatives 5 and Existing Program). Figure 4-2 depicts the amount of created ESH that would exist assuming that the starting point is the 2005 acreage and the creation and replacement (whichever is the case) period begins the first year (as early as 2012).

Note the diminishing amount of new ESH that is created as the construction seasons increase for Alternatives 1, 2, 3, and 3.5.

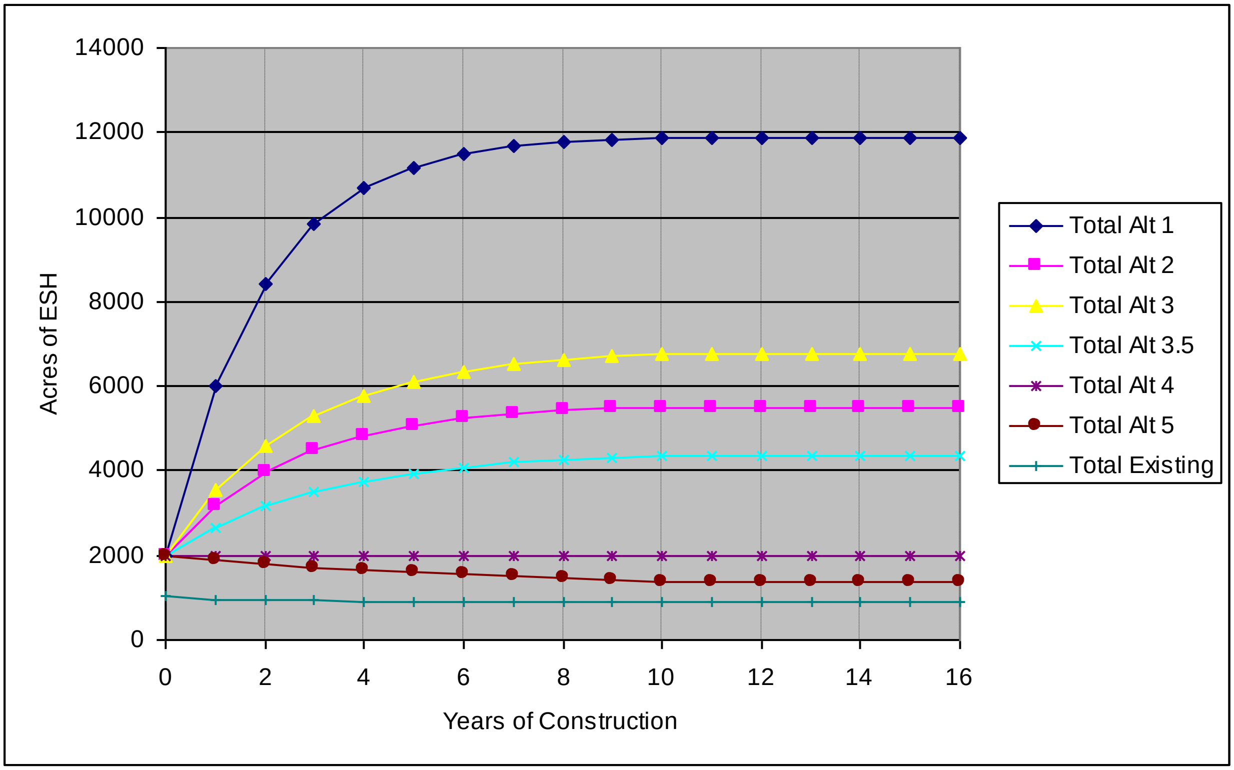

Figure 4-2: Estimated Amount of Habitat that Could Exist within Various Construction Timeframes

Figure 4-2 demonstrates how acreage goals could be approached gradually until the amount of created acres would level off; however, it does not account for adjustments due to biological response of initial actions based on an Adaptive Management approach (see Appendix H). If the funding levels specified in Table 4-28 are not provided when the ESH program is initiated, the construction period to reach the specified acreage goal (Alts. 1, 2, 3, and 3.5) would be longer or the assumed acreage to exist (2005 levels) would be somewhat less due to continuing erosion and vegetation encroachment. Construction levels would be subject to available funding and other Missouri River Recovery Program priorities.

Figure 4-2 also does not account for episodic events such as the extremely high flows that occurred in 1997 that created the large ESH acreages that existed in 1998. Figure 4-3 shows and example of what would happen if an episodic event were to occur in year 5 under Alternative 3.5 that increased the ESH acreage by 0 to 75 percent in the Gavins Point River Segment. As the effect of the episodic event on ESH acres is greater, the impact on ESH in year 5 becomes more noticeable. The figure also demonstrates what would happen if the construction rate were cut by 50 percent over the next 2 years. By year 10, the ESH acres are relatively near the ESH goal for Alternative 3.5. Other reductions in the construction rate would have somewhat difference effects; however, the acreage goal would eventually be approached.

Large amounts of ESH have not been created except during the 1997 high releases from the dams. These releases were in response to the largest inflow into the upper Missouri River since inflow data were first recorded in 1898. In fact, the 1997 inflows exceeded the second highest inflows recorded in 1978 by 8.403 million acre-feet (MAF) (49.037 MAF in 1997 versus 40.634 MAF in1978, a reduction of 17.1 percent). The magnitude and duration of high-flow events large enough to create ESH are relatively unknown except that considerable new ESH occurred after the 1997 high inflow episodic event. The utilization of flows to specifically create ESH to meet the ESH acreage goals is beyond the scope of this study, as discussed in Section 4.10, Alternatives Considered but Eliminated.

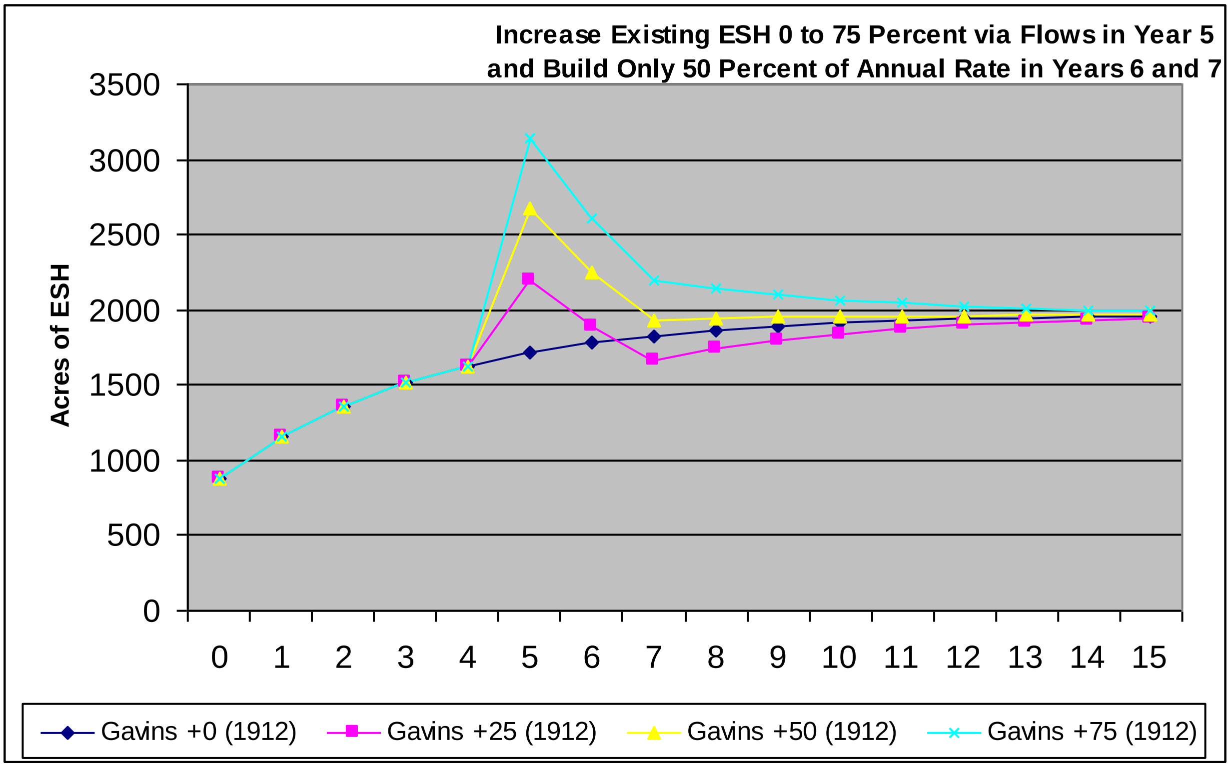

Figure 4-3: Example Effects of an Episodic High-Flow Event on ESH and the Annual Construction-Rate Decision

4.8 THE PREFERRED ALTERNATIVE

After detailed consideration of the environmental and social impacts, and cumulative effects, of the Alternatives, the Corps has identified an Adaptive Management Implementation Process (AMIP) as the preferred alternative. The key aspect of the AMIP is that, rather than selecting a specific acreage alternative and then implementing it, actions would be progressively implemented with the focus on monitoring a combination of biological and physical metrics (measurements). Implementation of progressively larger acreage amounts of habitat would continue until the desired biological response is attained and sustained. While the exact number of acres needed to be constructed and maintained is uncertain at this time, this document discloses the impacts associated with constructing and replacing up to the acreage of Alternative 3.5 (4,370 acres). The AMIP strategy recognizes that, during implementation, lesser acreage alternatives (Alternative 5, 1,315 acres; Alternative 4, 1,985 acres) would be reached prior to achieving the acreage of Alternative 3.5. As the level of habitats created reach these lesser alternative acreages (used as benchmarks), an assessment of the biological response will be completed to determine if it indicates that adequate habitat is in place to support the species (Figure 4-4). If the desired tern and plover population and productivity levels are being met and sustained at lower acreage levels, these acreages would be maintained and biological metrics (measurements) would continue to be monitored to ensure project success.

The preferred AMIP alternative provides a flexible approach to meeting the biological metrics (measurements) for the least tern and piping plover identified in the 2003 BiOp Amendment. Through monitoring and analysis, the success of management actions in meeting the needs of the species will be evaluated annually and every third year with more detailed assessments using an Adaptive Management process. The Corps will be coordinating with the Cooperating Agencies (USFWS and NPS) on an ongoing basis to establish and refine the timeline to meet benchmark acres. If the acreage associated with Alternative 3.5 is eventually determined to be inadequate to maintain bird biological performance, further analysis will be performed as necessary to disclose the impacts of larger acreage alternatives and/or other potential management actions.

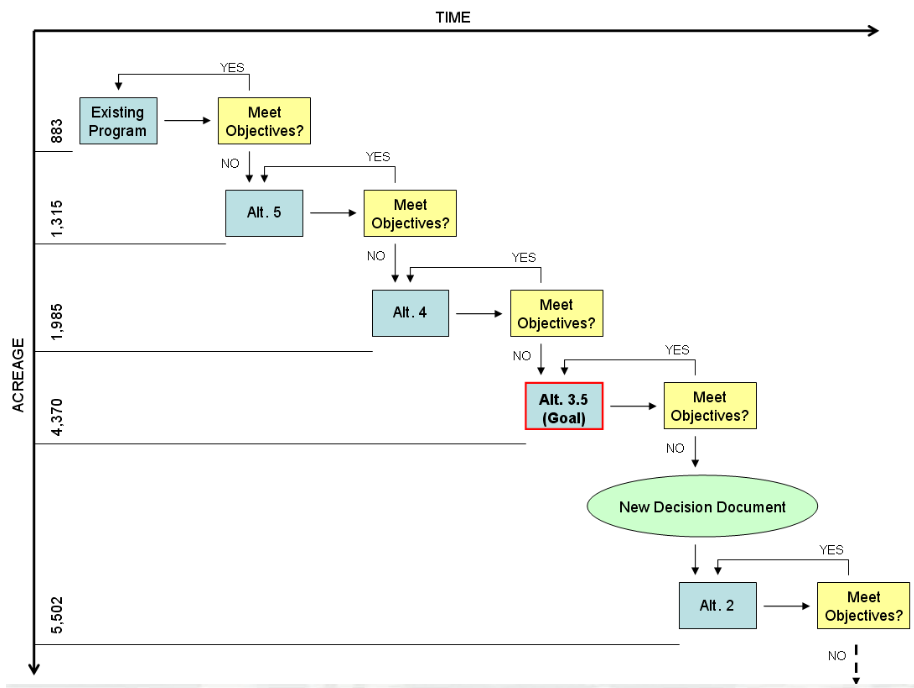

Figure 4-4: Progressive Implementation of ESH PEIS Alternatives

Alternative 3.5 is one of the six alternatives examined in this PEIS that was anticipated to meet the biological needs of the species. Of those alternatives, the reasoning for selecting Alternative 3.5 as the upper limit of potential construction follows:

- Alternative 3.5 would create and replace ESH area that is believed to represent an average acreage between acres present in 1998/1999 (a beginning timeframe during which the birds were highly productive after the 1997 high releases from the 4 dams) and those acres present in 2005 (a time when the population and fledge ratios were just beginning to fall below target levels). This alternative is anticipated to meet the purpose and need of this program by achieving bird metrics (measurements) prescribed in the 2003 BiOp Amendment.

- Alternative 3.5 represents a midrange of habitat available during a timeframe when the birds were highly productive. Both species were meeting, or approximating, the fledge ratio goals of the 2003 BiOp Amendment until 2005.
- If replicated, this quantity of habitat acres may be sufficient to meet the biological need of the species.
- It provides up to 4,370 acres of ESH, representing an anticipated amount of habitat needed to ensure the birds success. In years where acres of ESH have dropped below that present in 2005, there has been a corresponding drop off in productivity.
- A downward trend in fledge ratios began in 2006. This is reflected by the 2004-2006 3-year fledge ratio approaching the goal set by the 2003 BiOp Amendment (2006 fledge ratios bringing the 3-year average down), and the 2005-2007 3- year fledge ratio dropping below the goal set by the 2003 BiOp Amendment. Fledge ratios have continued to generally drop each year. This has raised concerns regarding long-term success associated with acreage levels of Alternatives 4 and 5.
- For lower acreage alternatives (Alternatives 4 and 5), identification of impacts at this upper limit allows flexibility to re-distribute acres amongst different river segments as needed to meet biological metrics (measurements).

The implementation of an AMIP up to acre amounts in Alternative 3.5 is consistent with the Adaptive Management framework called for in the BiOp. It would entail first identifying management actions that are anticipated to offer substantial ecological improvements with lesser effects, and to move on to additional actions if needed to meet the biological needs of the birds.

For example, the area available after applying environmental buffers is exceeded with Alternative 3.5 in one segment, the Gavins Point River Segment. In the context of Adaptive Management, if performance metrics demonstrate success with a lesser amount of acres in the Gavins Point River Segment or any of the segments, the flexibility remains to reevaluate construction efforts and create a lesser amount of acres. However, if biological metrics are not being met, under the AM framework the decision could be made to borrow from or construct in an area that is "restrictive," or where ESH could be constructed at relatively low physical risk, but may have increased uncertainty regarding bird response (see Table 6-1 and discussion).

Another example of flexibility within the Adaptive Management framework, relative to Alternative 3.5, is that in one segment, the Garrison River Segment, estimates indicate that this could be a large amount of material relative to annual sediment load. This could lead to eventual effects on aggradation, degradation and erosion within the segment. The Adaptive Management framework would allow for evaluation of sediment placement and availability, and the ability to make segment-specific choices or adjustments as the program is progressively implemented.

The Corps believes that the preferred alternative will be protective of human health and the environment, comply with all applicable laws and requirements, and will be cost effective.

4.9 ENVIRONMENTALLY PREFERRED ALTERNATIVE

CEQ regulations for implementing NEPA require that a Record of Decision (ROD) specify "the alternative or alternatives that were considered to be environmentally preferable" (40 CFR 1505.2(b)). This alternative has generally been interpreted to be the alternative that will promote the national environmental policy as expressed in NEPA's Section 101 (CEQ's "Forty Most-Asked Questions," 46 Federal Register, 18026, March 23, 1981).

In addition, discharges of fill into waters of the United States must comply with the Clean Water Act, Section 404(b)(1) Guidelines. Ordinarily, this means that the alternative that causes the least damage to the biological and physical environment; however, it also means that the alternative that best protects, preserves, and enhances historic, cultural, and natural resources. On the basis of the assessment of potential environmental impacts presented in this draft PEIS, the Corps selects the preferred alternative (Adaptive Management Implementation Process, with Alternative 3.5 (4,370 acres) as the upper limit of construction – see Section 4.8) as the environmentally preferred alternative.

4.10 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED CONSIDERATION

4.10.1 Flow and Reservoir Methods to Create ESH

Methods of creating and replacing ESH include flow management from the mainstem dams, reservoir management and habitat enhancement, and mechanical creation in riverine reaches. Figure 4-5 provides a visual representation of the various methods of creating habitats. This PEIS focuses exclusively on implementation of the RPA for the mechanical maintenance and creation of habitat in riverine segments (A in Figure 4-5), as described previously.

Flow alternative B_1 in Figure 4-5 was evaluated in the Master Manual EIS (2004), from which this document is tiered, and not selected as part of the preferred alternative. The Master Manual EIS stated (on page 7-242), "Flow changes alone are not adequate for the pallid sturgeon, least tern, and piping plover. Additional shallow water habitat and emergent sandbar habitat are currently being constructed or formed naturally as the result of floods. Considerably more habitat will have to be constructed to meet minimal needs, as identified in the BiOp." The Corps' Biological Assessment provided to the USFWS in 2003 identified potential high-flow tests to determine the merit of purposely concentrating excess water in storage during this extended period in the fall months to determine the potential for high flows to create additional ESH, which would fall under the category of flow alternative B_2. A separate RPA calls for reservoir habitat creation (C in Figure 4-5) through intrasystem regulation and habitat enhancements. Such actions are also outside of the scope of the document, and a separate scope and study is being initiated. However, a brief discussion follows regarding flow modifications and why these methods were eliminated from detailed consideration in the Master Manual and reservoir management,

It is recognized, in general, that any ESH formed or made available through flow management on the riverine reaches would reduce the amount of ESH that needs to be created mechanically. However, revisiting the flow manipulations within the limits of the Master Manual (B_1) would provide limited potential as only the most extreme runoff years would require the need to potentially provide flows high enough for a long enough duration to create ESH, such as occurred in 1997 (highest inflow year on record dating back to 1898, or the most extreme runoff year). Considering flow manipulations outside of the limits of the Master Manual (B_2) would potentially require additional analysis and NEPA documentation. Future opportunities to consider flow alterations specifically for the purpose of providing additional ESH exist through the Missouri River Ecosystem Restoration Plan (MRERP - see Section 1.2) or through the Missouri River Authorized Purposes Study (MRAPS).

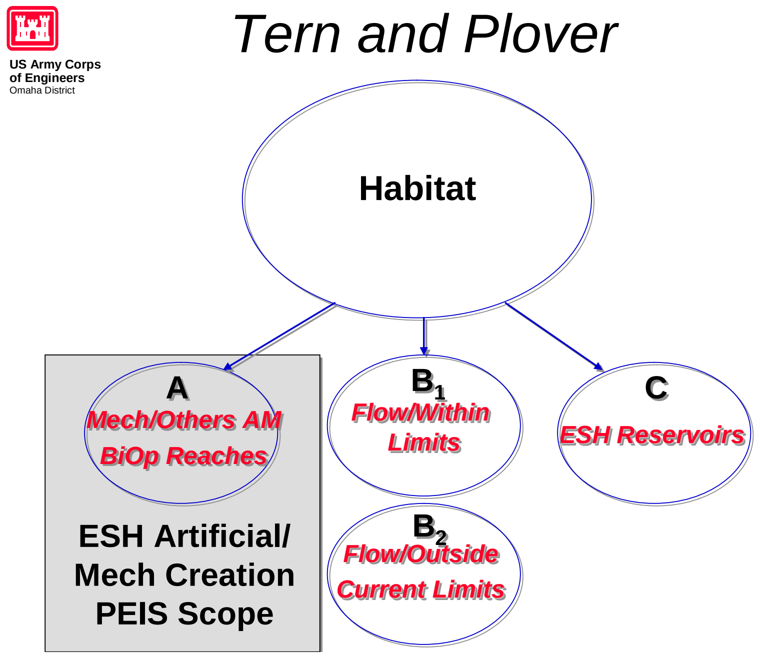

Figure 4-5: Methods of Creating Piping Plover and Least Tern Habitat

4.10.1.1 Habitat Creation through High Flow Releases

In general, the process of creating sandbars through dam releases starts when current velocity and flow increase to a sufficient amount to mobilize or transport riverbed sediment. In areas of lower velocity sediments are deposited (typically in wide reaches over low elevation sandbars), raising elevations. Later, when river stages drop, higher elevation sandbars are exposed.

Sandbar habitat was formed in this manner following the high releases of 1997. During this event, average daily releases from Gavins Point Dam were above 60,000 cubic feet per second (cfs) for all or parts of 8 months (May to December) with a maximum daily release of 70,100 cfs during the month of November (USACE, 1999). As a point of reference, average May through November releases from Gavins Point Dam are 32,611 cfs for the period 1967 through 2007. While 1997 was the most dramatic year, it was preceded by a period of increased runoff and releases from Gavins Point Dam with daily averages of 50,000 cfs or greater for extended periods of time in 1995, and 1996 (USACE, 1999). No notable changes in ESH occurred following those earlier years. In comparison, releases from Gavins Point Dam were greater than or equal to 60,000 for a total of 206 days, and considerable ESH was created when these high flows occurred for an extremely long period. The 1997 event represented near period of record flows, and these releases are not expected to occur very often in the future under the current criteria in the Master Manual (B_1), including flood control and navigation criteria.

Following the high flow event in 1997, USFWS included recommendations to form ESH via similar, smaller scale events in its 2000 BiOp. The USFWS suggested a spring release from Gavins Point Dam with a target of 48,500 cfs, as measured at Sioux City, Iowa. This flow increase was to occur over a period of 30 days, ramping up to the target flow over a period of 1 week, held there for 2 weeks and then ramped back down during the final week. This was to be followed by minimum service navigation flows of 25,000 cfs. These flow increases were to take place one out of every 3 years on average.

The 2003 BiOp Amendment also allowed the Corps to develop its own criteria for what the Corps has labeled as the spring pulse release from Gavins Point Dam. Criteria were incorporated into the Missouri River Master Water Control Manual in March 2006. Criteria for downstream flow limits would likely limit releases from Gavins Point Dam to less than 10,000 cfs over full service navigation releases. This would likely be no more than 40,000 cfs from Gavins Point Dam, (actually a combination of the Gavins Point Dam release plus James River inflows entering the Missouri River several miles downstream from the dam) under the current criteria. These downstream flow limits for the spring pulse would likely make the fall months as the period that high releases could be made from Gavins Point Dam. Providing some reasonable frequency of events of greater than 60,000 cfs for an extended period would require retention of water in the system for such purpose. Releases for navigation under the current Missouri River Master Water Control Manual in most years would preclude this retention of water in almost every year, with extremely high system inflows, such as occurred in 1997 and 2010, being the only types of situations when the necessary volumes of water would accumulate.

A number of flow-related test projects were included in the Corps' biological assessment submitted to the USFWS prior to its preparation of the 2003 BiOp Amendment, which also included this as part of the Corps' actions. These test projects would require adequate water in the system storage to provide the water for the releases from Gavins Point Dam. One objective of the tests would be to identify the volume and duration the releases required to create additional ESH.

ESH was not created at flows of less than 55,000 cfs for 14 to 20 days or 50,000 cfs for 109 to 127 days (1995 and 1996, respectively) but was created at flows greater than 60,000 cfs for 206 days or 70,000 cfs for 34 days (1997). To the extent that these flow manipulations provide additional ESH, they cannot be counted on as a reliable method of habitat creation. Instead, these occurrences will be limited to the period of evacuation of reservoir water following extremely wet periods.. Erosion of the ESH created by flows will begin to take place immediately, requiring replacement of the lost ESH. Based on these findings, this method of ESH creation was eliminated from detailed consideration in the Master Manual (and as discussed in the Purpose and Need for this document).

4.10.1.2 Creation of Habitat through Low Flow Releases

Another form of flow modification, lower summer releases, could potentially provide ESH. Flow curves from the Adaptive Management Plan (Appendix H) were used, along with habitat availability and system outflows from 2005, to provide an example of potential increases and decreases in habitat availability due to changes in flow (Table 4-26). In the Gavins Point River Segment, where the flow curve is likely the most accurate as it was developed from LiDAR (Light Detection and Ranging; remote-sensing technology) data collected in the fall of 2005, the maximum outflow during the 2005 nesting season (May – August) was 24.5 kcfs and the minimum was 17.0 kcfs. Using the measured habitat (880 acres at 21.0 kcfs) and the flow curve, the estimated maximum amount of habitat available would have been 1,118 acres (at 17.0 kcfs) and the estimated minimum would have been 775 acres (at 24.5 kcfs). This range represents a potential 1.4 fold increase in habitat availability due to changes in flows in a single year. If flows were at raised to provide full service navigation (35.0 kcfs), only 464 acres would have been available according to the flow curve.

The flows curves for the Fort Randall and Garrison River Segments are likely much less accurate as they were developed as part of the Missouri River Master Water Control Manual, and therefore did not incorporate LiDAR data. However, as a start to understanding the amount of additional sandbar acreage lower flows can provide in these segments, system conditions during 2005 and these Master Manual curves were used to project changes during the 2005 nesting season. At Fort Randall, the maximum outflow during the 2005 nesting season was 24.9 kcfs and the minimum was 9.8 kcfs. Using the Master Manual curve and the 2005 habitat measurement (128 acres at 14.7 kcfs), this represents an estimated range of acreage between 34.4 and 195 acres. This is a potential 5.7 fold increase in habitat acreage due to changes in flow. In the Garrison River Segment, the maximum flow during the 2005 nesting season was 18.7 kcfs and the minimum was 14.4 kcfs. Using the Master Manual curve and the 2005 habitat measurement (588 acres at 15.2 kcfs) this flow difference represents an estimated range of acreage between 291 and 691 acres, or a potential 2.4 fold increase in habitat availability due to changes in flow.

There is no available flow curve for the Fort Peck River Segment, but it is anticipated that there would be somewhat similar results.

Table 4-29: Example Potential Acres Created with Low Flows

2005 Nesting Season (May-August)

River Segment	Measured (kcfs)	Acres	Min 2005 Kcfs	Est Acres	Max 2005 Kcfs	Est Acres	Full Service Kcfs	Est Acres	Min-Max Gap Acres
Gavins Point	21	880	17	1118	24.5	775	35	464	654
Ft. Randall	14.7	128	9.8	195	24.9	34.4	-	-	160.6
Garrison	15.2	588	14.4	691	18.7	291	-	-	400

While there is the potential to affect the amount of habitat acreage through flow management, currently the system flow/releases are set by the criteria established in the Master Manual (e.g. Navigation Flow Releases, Hydropower Production). The low flows are typically below the minimum service levels required for navigation on the lower Missouri River, which the Corps is mandated by Congress to provide. Other concerns regarding lower summer releases include possible effects on water intakes, summer recreation, and power generation.

A very important consideration is the elevation of sandbars made available in this manner. Elevation is an important characteristic of ESH as higher elevation nest sites offer greater protection from localized flooding events and allow for increased flexibility in dam releases to meet downstream flow targets. During the 2008 nesting season, a low-flow situation occurred below Gavins Point Dam from reduced releases due to flooding on the lower Missouri River. While there was an increase in exposed sandbars, nesting remained concentrated on the mechanically created sites, indicating that even at low flows, high elevation, bare sandbars may still be preferred for nesting. In addition, creating habitat at low flow elevations presents potential for increased take if tributary runoff or system conditions later require higher releases that could inundate nests.

Based on these findings, the low-flow method of ESH creation was eliminated from detailed consideration in the Master Manual (and therefore this document).

4.10.2 Captive Rearing

When the captive rearing program operated in the late 1990s, the Corps collected 456 least tern eggs and 575 piping plover eggs for captive rearing. Of these, 83% of the least tern eggs and 82% of the piping plover eggs successfully hatched. During the same period, 7,072 least tern eggs and 9,275 piping plover eggs were laid and attended in the wild, and of the wild eggs, 60.5% of least tern eggs and 61.7% of piping plover eggs hatched. Of the chicks hatched in the captive facility, 81.2% least tern and 87.6% piping plover chicks fledged and were released back onto the Missouri River or its tributaries. This compares with wild fledge rates of 58.8% for least terns and 58.7% for piping plovers during the same period.

The University of Wisconsin-Madison conducted "An Evaluation of Captive Rearing as a Management Tool for Piping Plovers in the Great Plains" from 1998-2000. This research project showed that pre-migratory post-release survival of captive reared birds was the same as wild reared birds. However, research on the Great Lakes found that captive reared birds have lower survival and produce significantly fewer offspring than their wild-reared cohorts (Roche et al. 2008).

Finally, the USFWS does not approve of captive rearing programs unless a species is at great risk throughout the range. Because these conditions do not exist for either of these species in the upper Missouri, the USFWS will not approve of captive rearing as an acceptable means to meet reproductive goals. On this basis, this alternative was eliminated from detailed consideration.

4.10.3 Kensler's Bend ESH Creation

Downstream of Ponca, NE, the Missouri has been extensively modified by the construction of dikes and revetments and is heavily channelized. Dike structures were built nearly perpendicular to flow and vary in length from several meters to several thousand meters. Alluvium (deposit of sand/mud formed by water) has been deposited behind the long dikes, filling the original flood plain and reducing the cross-sectional area of the river. To ensure a self-scouring channel, L-shaped dikes have been installed in numerous locations to channel the river's flow. Revetments are used to protect the riverbanks and maintain the channel alignment, and the channel has thus been modified from an offset V-shape to a trapezoidal configuration (USACE, 1994). The current character of this segment is gently curving and highly constrained with no interchannel sandbars.

At the request of the NPS, the Corps is separately examining the feasibility of creating ESH in the Kensler's Bend Segment (between Ponca, NE and Sioux City, IA). The USFWS has provided written confirmation that, "*creation of biologically functional ESH in the upper portion of Segment 11* [Kensler's Bend] *could be credited towards ESH goals in Segment 10* [Gavins Point River Segment]" (USFWS, 2005). However, as summarized above, this segment is significantly different from the upstream segments, as shoreline revetments and groins confine the river flow for bank stabilization, altering the planform of the river. The channel width is significantly less (< 1,300 feet) compared to the Gavins Point River Segment where the river width is greater than 3,300 feet at more than five separate locations and averages more than 2,600 feet. Throughout the upper Missouri, interchannel sandbars persist and nesting colonies are found where the channel width is greatest. In the Kensler's Bend reach, there are no wide bends to the river, and the channel supports no interchannel ESH or nesting least terns or piping plovers.

The opportunities to create ESH within this segment are limited because the modified geomorphology prevents the formation of interchannel sandbars. Creating ESH in this reach would require widening the top-width of the river channel by 650-1,600 feet. Increasing the channel width would spread the river out across a much wider area, decreasing the velocity, and permitting a depositional environment conducive to creating and retaining interchannel sandbars. Implementing such an action would require the identification of a landowner willing to sell hundreds (or more) of acres of property, removal of all shoreline protection (dikes, revetments, etc.) and the excavation and removal of millions of cubic yards of earthen material to a sufficient depth to be completely inundated, thus creating a large meandering river bend.

While creation of ESH in the Kensler's Bend reach represents an opportunity for the Corps to manipulate habitat outside of the MNRR, the real estate and other issues prevent this method of ESH creation from being assessed within this programmatic document. The Corps could continue to examine the opportunities to create ESH in the Kensler's Bend reach under separate study scope, site-specific analysis and NEPA review.

4.10.4 Off-Channel ESH Creation

In preliminary scoping discussions with the NPS and the USFWS, a suggestion was made to consider the creation of "off-channel" ESH as a method to create least tern and piping plover habitat. While attractive from the standpoint of not having any potential effects to the MNRR, the USFWS recommended that the approach not be formally considered because of observations on the Platte River in Nebraska. Similar to the Missouri River, riverine nesting habitat has been so severely reduced in the central and upper Platte River that sand and gravel pits adjacent to the river now provide the majority of nesting habitat (Nebraska Game and Parks Commission, 2006). However, least terns nesting at sand and gravel pits have low reproductive success because of predation and human disturbance (Nebraska Game and Parks Commission, 2006). On this basis, this method of ESH creation was eliminated from detailed consideration.

However, in recent years the discussion of off-channel habitat within the floodplain, such as in backwaters or on areas of land acquisition on the river floodplain adjacent to the main channel, has increased. Because this method of off-channel habitat creation has not been tested, any efforts would be considered pilot projects. In addition, because these efforts would not be within the in-channel footprint area for which the analysis for this document was completed, separate site- or project-specific analysis and NEPA review would be required.

4.11 Other Likely Actions to be Implemented (All Alternatives)

4.11.1 Land Acquisition

A supplement to the existing Real Estate Design Memorandum (REDM) No. 1, dated 22 March 1990, will be generated and submitted for approval to Headquarters as the overall Real Estate Design Memorandum for the MRRP. The supplement will encompass all authorities for land acquisition from past Water Resources Development Acts (WRDAs). Until the supplement is approved, the ESH program will rely on existing real estate authorities and vehicles as described in the REDM No. 1.

4.11.2 Restrictions to Public Access

The Corps may allow the use of public river access areas as staging areas by construction contractors after the appropriate coordination with partnering agencies and the public is conducted. These public access areas would be open for public use as much as possible during construction. However, due to space limitations and safety concerns at certain public access areas, public access may need to be temporarily stopped during construction.

Where public river access does not exist, the Corps would develop a safe and stable location for landside equipment access to and egress from the river as well as a staging area for equipment, materials, and temporary field offices. Access to the river and use of the property would be with the cooperation of willing landowners. All public and private access sites would be restored to their previous condition when ESH construction is completed.

4.11.3 Alternative Methods of Construction

As mentioned in previous sections, while the primary construction method considered in analysis for this document is mechanical creation, other methodologies are and could be tested and considered if proven to provide suitable habitat and to support the tern and plover populations. Examples include vegetation removal or overtopping (see Appendix H.)

In addition, it is important to note that low and high flow years or periods are typical of the system. In those years, as flows are stored or evacuated as per the Master Manual, opportunities may exist to try various methods to provide habitat. One example is the use of geotextile tubing (see Appendix H) or constructing in aggradation areas (headwaters/deltas) or reservoirs during low flows.

Again, because this document discloses the impacts associated with mechanical creation, which is believed to represent the largest geographic and potential extent of impacts, any efforts to create habitat that would have a smaller footprint and/or a lesser degree of similar impacts, would be considered in compliance with NEPA coverage.

4.11.4 Vegetation Modification Study

Beginning in the fall of 2008, the Corps initiated tests of vegetation removal techniques including use of pre- and post-emergent herbicides, mowing, raking, and overtopping. As previously mentioned, vegetation removal efforts thus far have had mixed success. The study was designed cooperatively with USFWS, NPS, U.S. Geological Survey (USGS), and representatives from numerous state agencies. It involves testing combinations of methods on 25 m^2 test plots on 15 sandbars on the Missouri River from the Gavins Point River Segment to the Garrison River Segment. Once the most successful combination of treatments is identified, broad use of the treatment(s) will be analyzed and may be incorporated into the program. It is believed that vegetation removal, if viable, would be more cost effective and require a shorter construction period than mechanical creation. A copy of the vegetation removal study plan, “Evaluation of Vegetation Removal and Control Methods to Create Emergent Sandbar Habitat on the Upper Missouri River” is available at http://www.moriverrecovery.org/mrrp/f?p=136:132. Results of the study are expected in the fall of 2010.

4.11.5 Reservoir Management Study and Pilot Projects

The 2003 BiOp Amendment (RPA IVB.2) calls for the Corps to maintain reservoir habitats through intra-system regulation as well as habitat enhancements (C in Figure 4-2). In 2009, the Corps of Engineers, Omaha District began to examine potential methods and locations within the reservoirs of the Missouri River for potential opportunities for habitat creation. The following methods are within the current study scope: replenishment or nourishment of existing sandbars and islands within the reservoirs, creation of habitat within the reservoirs depositional zones, off channel chutes and flats as foraging area, removal of vegetation from existing habitat areas, peninsular cutoffs or island creation s in reservoir side bays, reservoirs water level management, and dike construction to dewater reservoir side bays for nesting and foraging habitat. It is anticipated that the study team could recommend several demonstration reservoir habitat projects for construction by fall of 2011 which would enable the study team the opportunity to evaluate creation methods within the reservoirs. The Reservoir Habitat Study for Piping Plovers and Interior Least Terns is anticipated to be completed 2013.

4.11.6 Spring Pulse

Subsequent to the Master Manual, additional coordination and NEPA compliance was performed to allow for spring pulses below Gavins Point Dam. Desired biological outcomes of such actions were tied to spawning cues for the pallid sturgeon, habitat conditioning for pallid sturgeon and terns and plovers, and floodplain connectivity. It was determined in the Master Manual EIS that the flows associated with a spring pulse would not result in high-elevation sandbars (nesting habitat). However, such flows could produce additional productivity for terns and plovers through the availability of wet sand for foraging area. Because the spring pulse is highly constrained by downstream flow limits, this is not a method to be relied upon for habitat creation, but could be an action that could benefit the populations.

4.11.7 Predation Management

In 2009, the Corps created a plan for managing predation of least terns and piping plovers on the Missouri River. Numerous incidents of predation on the two species by a variety of predators are documented annually by the Corps' Tern and Plover Monitoring Program crews as well as by other agencies and organizations conducting research on behalf of the Corps. Because predation impacts the productivity (reproductive success) and adult survival of the least tern and piping plover (USACE 2008), predation management is an important strategy to aid in the recovery and conservation of these listed species (USFWS 2003).

Proposed management actions in the plan include the use of exclusion cages and exclusion fencing to protect nests and hazing of predators with audio or visual frightening devices to deter predators away from nesting sites. Lethal and non-lethal removal of individual target predators that have the greatest impact on least tern and piping plover nests and chicks, particularly raccoons (*Procyon lotor*), coyotes (*Canis latrans*), mink (*Mustela vison*), and great horned owls (*Bubo virginianus*), would also occur. Mammals would be lethally removed while great horned owls would be non-lethally removed by relocation to a new area except in North Dakota, where avian predators are required to be euthanized rather than relocated. Individual predators belonging to non-target avian and mammal species may occasionally be lethally or non-lethally removed as a special case if they are determined to pose a threat to a least tern or piping plover colony. The plan is a programmatic document that will be modified as needed to improve the effectiveness of predation management actions.

Areas for predation management include emergent sandbars and Corps reservoir shorelines within the lower portion of Fort Peck Lake, the Missouri River below Fort Peck Dam to Lake Sakakawea, Lake Sakakawea, the Missouri River below Garrison Dam, Lake Oahe, Lake Francis Case, the Missouri River below Fort Randall Dam, Lewis and Clark Lake, and the Missouri River below Gavins Point Dam to Ponca State Park in Nebraska. Predation management activities could occur any time during the nesting season, which runs from May 1 through August 15, but because predation pressure is greatest in July and August, most actions would occur during those months.

The environmental assessment for the predation management plan determined that the plan would have no significant impact on the environment. Copies of the predation management plan and the environmental assessment can be found on this website: https://www.nwo.usace.army.mil/html/pd-e/NEPA.html

4.11.8 Maintenance

Maintenance activities are different from original construction in that they are intended to retain the original "as built" conditions to the extent possible, for which NEPA compliance, 404 compliance and WSRA compliance will be attained. Maintenance of ESH habitat created each year or in recent years would be done on an "as needed" basis for the lifespan of the bars, and would be fully coordinated with the interagency ESH PDT. Maintenance activities would be prioritized based on evidence of declining bird usage, bird agonism (survivalist animal behavior that includes aggression, defense, and avoidance), degradation of nesting habitat, changes in water surface elevations due to degradation/aggradation of the river bed at the site, and excessive vegetation encroachment on nesting and foraging habitats. The goal would be the restoration of nesting and foraging habitats as originally designed to the extent possible.

Efforts could include removal of early successional vegetation from nesting areas as well as repair of intended slope ratios and channels. If foraging habitats were found to be insufficient at a site following construction, manipulation of the contours could also be performed to increase the ratio of wetted sand to nesting area at a given complex. An accounting of maintenance activities will be included each year in the Emergent Sandbar Habitat Annual Work Plan reports as well as the Annual Reports for the Biological Opinion implementation activities.

Maintenance activities may include:

- Use of glyphosate-based and/or imazapyr-based aquatic herbicide (such as RODEO and HABITAT) on leafed-out vegetation by ATV with boom or backpack spray application methods
- Mowing of vegetation with rotary mower or sickle mower
- Hand pulling/cutting woody saplings (<4 inches)
- Removal of woody vegetation with a mulching cutter (e.g.-TimberAx)
- Removal of large driftwood and other non-living potential predator perch sites
- Disposal of vegetative and woody debris into the river• Reshaping of island perimeter for the elimination of cut banks to increase forage area.

- Deepening of channels within complex to augment forage areas.
- Overtopping of nesting areas to restore design elevations and discourage growth of vegetation.

Vegetation would be removed as described in the Vegetation Modification Study (Section 4.9.4). The use of contractors or the need for staging areas for maintenance is not anticipated, but would be determined on a case by case basis. All actions would take place after terns and plovers have left the area.

5 AFFECTED ENVIRONMENT

The environmental resources within the ESH project area have received extensive study and have been summarized in a number of comprehensive documents prepared by the Corps, NPS, National Research Council, and other federal and state agencies. The Corps' Master Water Control Manual and update as well as the Master Water Control Manual Final EIS (USACE, 1994; USACE 1998; USACE, 2004) contain extensive information on the existing conditions of the upper Missouri River. In addition, the reaches within the MNRR segments have been the subjects of environmental analyses and characterization summarized in the NPS's General Management Plans for each of these respective river segments (NPS, 1997; NPS, 1999). The emphasis of the following sections will be on those existing resources that have changed or require an update because of changes. Existing conditions that have remained substantially the same will receive only a brief description of the existing resources and be incorporated by reference. The above-cited references and the supporting appendices are the basis of the detailed information incorporated by reference.

5.1 MISSOURI RIVER BASIN GENERAL CHARACTERISTICS

5.1.1 Topographical and Cultural History

5.1.1.1 Regional Topographical History

About two million years ago, before North America was first glaciated during the Pleistocene Ice Age, all of the rivers in North and South Dakota and eastern Montana drained northeastward into Canada to Hudson Bay. The presence of glaciers in the eastern part of Nebraska also had a profound effect on rivers that had been flowing generally eastward for millions of years. New drainage ways were cut around the glaciated areas. The Missouri River valley was formed along the edge of continental glaciers as the advancing ice blocked east and north flowing streams, forcing the waters to flow in a southerly direction along the glacier margin. Many different configurations of the Missouri River existed during the Pleistocene, but most were subsequently buried beneath thick deposits of glacial sediment (Biedenharn, 2001).

5.1.1.2 Cultural Resources

5.1.1.2.1 Historic Properties

Historic properties include historic and prehistoric archaeological sites, historic architectural and engineering features and structures, and resources having traditional cultural or heritage significance to American Indians and other social or cultural groups. Paleontological resources are fossils of prehistoric plants and animals. The National Historic Preservation Act (NHPA) and its implementing regulations (36 CFR 800) define responsibilities for managing cultural resources when a federal agency considers an undertaking. Any undertaking that would affect sites, structures, or objects eligible for nomination to the National Register of Historic Places (NRHP) according to the criteria set forth in 36 CFR 800 merits an analysis of the significance of the effect and potential avoidance or mitigation measures under the NHPA. The Antiquities Act of 1906 mandates that the federal government protect significant fossil discoveries. Although "Historic Properties" is a legal definition pertaining to a specific field of science, in terms of American Indian cultural resources, it is not a reflective term from the American Indian viewpoint and is often a point of disagreement. In general, American Indians view cultural resources from a spiritual viewpoint and disagree with the premise adopted by the field of archaeology.

5.1.1.2.2 Archeological and Historic Resources

Historic and archaeological resources are the physical remains of human occupation and activity that extend back in time for approximately 11,500 years in North America. Written historical records tell the story of the past 200 years for the Missouri River basin. Archaeologists have reconstructed the general trends of prehistory from analyses of archaeological remains. The significance of historic and archaeological resources lies in their heritage and scientific value. Important historical sites or historic architectural or engineering structures embody technological and historical heritage. Archaeological sites are the raw material from which specific events and general trends of prehistory, and generalizations about human social and cultural evolution can be constructed.

The Mainstem Reservoir System spans two subregions of the Great Plains region. These are the Northwest Plains and the Middle Missouri subregions. Fort Peck Lake is located within the Northwest Plains subregion, and the remaining mainstem facilities are located within the Middle Missouri subregion. Prehistoric and historic trends in these two subregions are parallel and similar, but also exhibit major differences, particularly after A.D. 1. Gregg (1986) compares and contrasts the chronological sequences for the Northwest Plains and Middle Missouri subregions.

Prehistory begins in both subregions with a Paleoindian period followed by the Archaic period. The final prehistoric period is called Late Prehistoric in the Northwest Plains. The Middle Missouri subregion, in contrast, adopts horticultural economic practices and diverges in cultural development from the Northwest Plains subregion. The final two prehistoric temporal periods in this region are called Plains Woodland and Plains Village. The Paleoindian period in both subregions extends between 9,500 and 6,500 B.C. (Frison, 1991).

Paleoindian is generally thought to represent the remains of the earliest human occupants of North America, who entered the continent by crossing the Beringian land bridge between Asia and North America. Paleoindian remains are sometimes associated with bones of extinct large game species such as mammoth, mastodon, camel, horse, and giant bison. The Plains Archaic period extended from 6,500 B.C. to A.D. 500 in the Northwest Plains and until A.D. 1 in the Middle Missouri. This period is generally divided into Early, Middle, and Late subperiods. The beginning of this period is marked by a change from the lance-shaped projectile points of the Paleoindian period to smaller points with basal “ears” or large notches on their sides near the base, used to assist in tying them to a lance or spear. It is also possible that there was a shift at this time from the use of lance weapons to the atlatl, or spear thrower.

Other significant innovations first appeared during this period, including pit houses, stone circles, and the beginnings of bone boiling and bone grease extraction, which was significant in the later development of pemmican food storage technology (Reeves, 1990). An increase in grinding stones and platforms points to more efficient plant food processing, possibly to make use of a wider variety of food sources. After 1,000 B.C., the number and complexity of communal bison kill sites detected in the archaeological record increased dramatically in the northern Plains. Possibly, a new form of socio-political organization, the pan-tribal society (overlapping and mixing of tribal cultures), developed during this period, influenced by the economic surpluses derived from the preparation of pemmican on a large scale (Reeves, 1990). Pemmican, a mixture of dried meat, berries, fat, and liquid bone grease, was compact, highly nutritious, and preserved well, allowing the Plains people to store a secure winter food supply. After A.D. 1, a cultural pattern began to develop in the Middle Missouri subregion that emphasized exploitation of food resources in river valleys and wooded bottomlands and showed many cultural affinities with archaeological cultures of the eastern United States at this time (Lehmer, 1971). This manifestation is called Plains Woodland.

As in the Mississippi and Illinois River valleys and elsewhere, Woodland peoples on the Plains may have begun experimenting with small-scale horticulture through the husbanding of native seed crops such as lamb's quarter, goosefoot, and sumpweed and imported plants such as maize, beans, and squash. Horticultural foods did not make up a significant percentage of the diet until much later, however. This period also marks the advent of pottery making on the Plains. The Late Prehistoric period began in the Northwest Plains subregion with the advent of the bow and arrow, sometime after A.D. 500. With its greater range, accuracy, and rapid-fire capability, this weapon enabled more efficient bison procurement/obtainment. This may have led to increasing population densities and more complex forms of social organization. In the Middle Missouri subregion, the Plains Woodland culture gave way to the Plains Village culture with the advent of full-scale maize horticulture by around A.D. 1000. Two major traditions, the Middle Missouri characterized by intense horticulture and sedentary life) and the Coalescent (emphasis on horticulture, earth lodges and pottery), and the influence of numerous other groups made up the Middle Missouri subregion of the Plains Village Tradition. Plains Village is marked by continued exploitation of bison resources from large and permanent earth lodge villages located mostly on the mainstem and by the intensification of a horticultural subsistence subsystem based on maize, beans, and squash. Maize horticulture did not penetrate upstream of the Yellowstone River mouth.

At the time of the earliest European American contact in the early 18th century, the horticultural Mandan, Hidatsa, and Arikara Tribes occupied earth lodge villages along the Middle Missouri, and semi-nomadic bison hunting tribes such as the Blackfoot, Crow, and Assiniboine occupied the Northwest Plains. The introduction of horses, guns, and diseases dramatically altered Tribal economies as well as political relationships between the Tribes. Woodland Tribes such as the Dakota and Cheyenne moved onto the Plains and took up bison hunting. Waves of epidemic diseases such as smallpox dramatically reduced the strength of the Plains Village Tribes, who began a process of consolidation and aggregation, combining Tribal communities.

5.1.1.2.3 European History

The earliest recorded European American penetration of the Middle Missouri region was the 1738 trading expedition of Pierre Gaultier de Varennes, Sieur de la Verendrye, to the Mandan villages (Lehmer, 1971). French traders entered and resided in the area intermittently for the remainder of the century. After America gained control of the region from the Louisiana Purchase in 1803, organized trading parties and established trading posts became more common on the Middle Missouri and beyond. Lewis & Clark explored the region between 1804 and 1806, and the Missouri River Fur Company, based in St. Louis, established several trading posts under the direction of Manuel Lisa until the company's demise in 1814 (Oglesby, 1963). The period between 1820 and 1860, however, was the most important for the fur trade, and numerous trading forts were constructed on the Missouri during that period. The period between 1850 and 1880 was marked by the establishment of United States military forts, principally to protect navigation on the river. The Treaty of Fort Laramie in 1868 established several Reservations, but most forts were in operation until the 1880s. Farmers increasingly arrived in the Great Plains to settle after the completion of the earliest railroads in the 1880s. The railroad was completed to Bismarck, North Dakota in 1873 and to Pierre, South Dakota in 1880.

5.1.1.2.4 Archeological Resources

The archeological resources along the Missouri River contain a wealth of information about the prehistoric and historic lifestyles of the Great Plains. Many of these resources are either eligible for the National Register of Historic Places or have been listed on the National Register. All known National Register or eligible sites will be avoided. Impacts to these sites will be avoided. While many prehistoric earthlodge village sites have been recorded and their locations can be avoided, the locations of steamboat wrecks are not always known. Should unrecorded sites be discovered during the ESH site-selection process, the sites will be evaluated for their significance. If they are suspected to be of a caliber for listing on the National Register of Historic Places, the design for the habitat creation will be revised to avoid these sites.

5.1.2 General Physical and Biological Resources

5.1.2.1 Soils

Riverbed materials are predominately sand while outcrops of gravel, cobbles, and dense clay are occasionally observed. Bed material tends to be coarser in the portion immediately downstream of the dams (Biedenharn, 2001). Material used for the construction of ESH habitat is composed entirely of riverbed materials; typically unconsolidated sands, gravels, and cobbles.

Sandbars are composed of sand that has been freed by physical rock degradation processes, captured by erosion and transported by flowing water in suspension (wash load) or as bed load to some point of deposition. Sandbars exist whether or not observed above an ambient water surface elevation during any visit to a sand-channel river. Emergent sandbar is that portion of a sandbar above the water surface if river stage is sufficiently low during an incident visit.

Sand is a particle size classification for chiefly quartzite rock fragments in the size range of 0.062 to 2 millimeters in diameter. Sand occurs in all rivers as result of the degradation of rocks and the winnowing (loosening/separating) and sorting of particle sizes under fluvial (riverine) conditions, accounting for between 85 and 99 percent of the sedimentary material carried in rivers supporting least tern and piping plover nesting. More than 90% of particle size classes found in the Missouri River channel area are fine sand (>0.125 mm) or larger in diameter (see Table 5-1). While this size material is representative of the channel bed, bank material and tributaries are also a component of river sediment transport.

Soils of the Missouri flood plain consist almost exclusively of alluvium (deposit of sand/mud formed by water) on the nearly level flood plains and low terraces (USACE, 1992). The primary soils are of the Vanda Havre type, developed entirely from alluvial deposits (USACE, 1992). These soils have the highest potential for vegetation production but are subject to frequent flooding. Fertility is fairly high where the salinity is low and textures range from coarse to very fine. The parent material depends on the source of alluvial outwash from surrounding terraces and benches. Soils are stratified but structureless and depths are highly variable (USACE, 1992).

Table 5-1: Bed and Habitat Bar D10 Gradation Values for Each Study River Segment[11]

River Segment	Habitat Bar Average D_{10} (mm)	Bed Average D_{10} (mm)	Representative Bed Material Size (mm)
Fort Peck River	0.16	0.21	0.16
Garrison River	0.14	0.18	0.14
Fort Randall River	0.16	0.21	0.16
Gavins Point River	0.20	0.23	0.20

Nesting habitat is primarily composed of clean, cohesionless (unbounded), abundant sand and fine to medium gravel. All sandbar habitat and particularly nesting habitat, relies on the qualities and the quantities of sand available in the great rivers of central North America such as the Missouri and upon the energetic ability of these rivers to move sand around, stack it in some locations, and free it from others.

Attachment 4 of Appendix B provides detailed information on sandbar geometry and composition and discusses the physical characteristics of nesting habitat. This attachment also includes a summary of findings from a 2006 field survey of nesting habitat and the mechanical sieve analysis assessing particle size distribution of substrate materials.

5.1.2.2 Vegetation

Vegetation occurs in repetitive associations or communities distributed along environmental gradients. Plants respond to all effective environmental influences simultaneously. However, the most compelling influence within a major riparian zone is the characteristics of the hydrologic regime (precipitation, runoff, infiltration and evaporation), both during and outside of the growing season. During the growing season the frequency of inundation or saturation within the root zone and the duration of oxygen-free soil conditions, or conversely, the rapidity of desiccation and the persistence of drought, are powerful segregators of plant species.

Throughout the year and over periods of years, changes in water level associated with inundation (particularly infrequent higher energy flood events) select for and segregate among species for those tolerant of, or benefited by, the damaging, habitat-changing effects of flooding. Flooding also deposits, removes, winnows, and segregates soil materials by particle size and specific gravity. Soil particle size distributions affect water retention, nutrient availability, and resistance or availability to water and wind erosion, reinforcing repetitive patterns.

Both the presence of water near the surface and the frequency and magnitude of effects of flooding operate along a topographic gradient. Lower relative elevations in a channel experience more frequent and more persistent inundation or saturation within the rooting zone. Lower relative elevations in the river channel experience more frequent, lower-energy inundation events and are most susceptible to drastic substrate modification (sediment moving) during high-energy

[11] Table excerpted from Chapter 4, Biedenharn et al 2001. The particle size classification for fine sand is 0.125-0.25 mm.

events. These elevation-mediated conditions result in separate and distinctive vegetation zones that support repetitive species groupings.

A number of species common throughout the project area are sufficiently dominant to define the zones they typically inhabit. Many of the species making up the zones or associations change along climatic and latitudinal gradients[12] along the Missouri River. Often the replacement is by a species within the same genus or plant family. Sometimes replacement is by another group altogether; however, structure and form may be similar due to similarities in tolerance to flooding, root anoxia (oxygen deficiency), or drought tolerance.

The repetitive distributions of plant groupings, forced into association by physical forces and processes, result in identifiable patterns that can be used as indicators of the importance and effectiveness of physical phenomena within a particular cross section of the riverine corridor. Local, relative elevation above a fluctuating river stage, rather than absolute elevation, serves as the primary plant association-segregating factor. Plant associations (classifications by type) assemble and form over growing seasons and over years between flood events. Those dominated by annual herbaceous plants demonstrate a much shorter period of stability than a gallery forest. As a result, the presence of particular vegetation associations expresses the frequency and importance of water stage, without regard to the stage at an instant observation. Local cross-sectional river stage changes in absolute elevation as the river falls in elevation, while the vegetation association patterns follow the falling river. The vegetation associations found within the Missouri River riparian corridor[13] are summarized by position (relative elevation) and the dominant species in Table 5-2.

Table 5-2: Vegetation Associations of the Missouri River Riparian Corridor Distributed by Relative Elevation in the Channel Cross-Section

Association	Position, Elevation Comments	Dominant Species
High Bank Gallery Cotton Wood Forest	Top of high bank, highest elevations in riparian corridor, level to moderately sloping, rarely flooded. Perennial, woody and semi-persistent. Mapped as Riverine Forest.	Eastern or Plains Cottonwood Eastern Red Cedar Green Ash Box elder Common Juniper
Late Successional Flood Plain Forest	Climatic climax forest. Ultimately replaces cottonwood forest with time and fire. Longest period since disturbance. Perennial, woody and persistent. Top of Bank and beyond. Mapped as Riverine Forest.	Northern Hackberry Basswood Burr oak Red Cedar Post Oak Box elder Green ash
Low Flood plain Mixed-Mesic Forest	Forest in frequently flooded to mesic conditions on slopes to the river, along low flood benches and side channel benches and upper deltas. Perennial,	American Sycamore Black Willow American Elm

[12] Between Sioux Falls, Iowa, and Fort Peck in Montana, the Missouri River passes through three distinct climates (Critchfield, 1974) and up to five plant hardiness zones (USDA, 1990).

[13] This list includes all associations in Fort Peck River, Garrison River, Fort Randall River, Lewis & Clark Lake, and Gavins Point River Segments.

Association	Position, Elevation Comments	Dominant Species
	woody and persistent. Mapped as Riverine Forest.	Silver Maple Box elder Mulberry Wild Plum Cottonwood
Xeric (Moist to Very Dry) Sandbar Crest Early Succession	Sparsely vegetated elevated sandbar and shoreline. Few species, often monocultures of drought tolerant (often succulent) plants. Mapped as ESH, Non-ESH Sand and Herb-Shrub-Sapling, depending on time of year.	Red Goosefoot Kochia Cockle-bur Evening Primrose Witch Grass Yellow-sweet Clover White Sweet Clover Winged Pigweed
Mixed Perennial Upland Herbs	Perennial herbs and grasses in mesic to xeric conditions on sandbar and recently disturbed banks and shallow slopes. Long persistent but will transition to woody species with time. Occurs 2 to 10 feet above mean water elevation during the growing season. Mapped as Herb-Shrub-Sapling in late summer, but may be mapped as ESH in spring.	Yarrow Buffalo Grass Partridge Pea Flat-topped Aster Motherwort Indian-hemp Stiff Sunflower Big Bluestem Ragweed White sage Silverweed
Woody Shrubs and Saplings	This type supplants mixed perennial upland herbs and precedes various upland flood plain forest types. Stand 4 to 10 feet in height are mapped as Herb-Shrub-Sapling types.	Cottonwood Red Cedar Lead Plant False Indigo-bush Shining Willow Peach-leaf Willow White Sage Red-osier Dogwood Wild Plum
Cattail Marsh	Strongly dominated by two species of cattail. Perennial and persistent. From 1.5 feet above to 1-foot below mean water level. Found in lacustrine backwaters, filled-in sloughs, ponds and protected shoals. Often eutrophic (high in nutrients). Mapped as Wetland Matrix.	Broad-leaf Cattail Narrow-leaf Cattail Wool grass Soft-stem Bulrush Green Bulrush Soft Rush
Fringe Willow Clonal Beds	One-foot above to one-foot below mean water level during the growing season. Perennial, woody, persistent, often monocultures. Often clonal (genetic colony). Mapped as Herd-Shrub-Sapling and Wetland Matrix depending on apparent height of stand.	Narrow-leaf Willow Sandbar Willow Peach-leaf Willow
Mixed Marsh	Found on low pool fringes, lower banks, filled-in backwater chutes, filled-ponds, depressions	Soft-stem Bulrush Green Bulrush

Association	Position, Elevation Comments	Dominant Species
	underlain by fine materials on sandbars. Can be persistent but may be replaced by cattail marsh. Mixed perennials and annual herbs and graminoids (grasses). Mapped as Wetland Matrix.	Wool grass Monkey-flower Swamp Milkweed Least Spike-rush Willow-herb Soft Rush Boneset Western Horehound Bugle-weed Red Ammannia
Early-Successional Rush and Sedge Fringes	Successional sandbar association found at 0.5 below to 1.5 feet above mean water level during the growing season. Perennial and annual, replaced by mixed marsh or cattail marsh with time and substrate stability.	Common Three-square Inland Rush Water Horehound Green Bulrush Soft Rush Common Spikerush
Wrack Line Seedlings	Annual colonial association forming at the wrack line along sandbars and shorelines. Mixed annual and perennial woody and herbaceous species with mid-summer water-borne seeds. Elevated 0.5 feet above to 0.1 feet below mean late summer water elevation. Mapped as ESH.	Least Spike-rush Stink-Grass Ditch Stonecrop Slender Flat-sedge Sandbar Willow Cottonwood
Frequently Inundated Mud Flat	Inundated most of year and growing season. Exposed mudflat at low water. Colonized by mostly annual and tuberous perennial species. Mapped as Open Water, Shallow Water, Lacustrine Fine Sediments and Wetland Matrix, depending on river stage.	Ditch Stone-crop Water Speedwell Arrow-head Clammy Hedge-hyssop American Water-plantain
Backwater Sloughs and Still water Habitats	Fringes of backwater sloughs and shallow persistently inundated pools. Rarely communicate by surface flow with river but contiguous through shallow inlets or through groundwater.	Arrow-head American Water-plantain American waterweed Common pondweed Soft-stem Bulrush American Slough Grass Cattail Clammy Hedge-hyssop
Submersed Aquatic Vegetation Beds	Lowest vegetated habitat. Perennially inundated. Persistent between scouring floods. Along low energy shorelines, back channel sloughs. Mapped as Shallow Water and Wetland Matrix.	American waterweed Curly Pondweed Common pondweed

Appendix B includes detailed results of reach-specific fieldwork characterizing the species composition, wetland indicator status, nativity index, and the relative importance rating for over 180 species of plants identified in the subject segments of the upper Missouri River.

The vegetation assemblages describing the communities, associations, and habitat types are also characterized. Detailed explanation of the process of natural succession on interchannel sandbars--including the important role played by cottonwood and willow in establishing vegetation on barren sandbars--is provided in the appendix. The details are not reproduced in the body of the EIS, but are incorporated by reference.

5.1.2.3 General Hazardous, Toxic, and Radioactive Waste (HTRW)

A preliminary HTRW investigation was conducted to identify areas that could affect construction activities due to the presence of environmental contamination (EDR, 2006). EDR searched federal and state government records to produce an EDR Corridor Study for the 400-plus mile project area of the upper Missouri River. The EDR Corridor Study was split into four separate reports (EDR, 2006; 2006a; 2006b; and 2006c) and included the latitude and longitude for each toxic site in their GIS deliverable and site detail in the report. Federal, state, local, and Tribal databases were searched from the high-bank to high-bank riverine polygon to the minimum distances required by the American Society for Testing and Materials (ASTM) Standard for Phase I site assessments.

5.1.3 Socioeconomic and Historic Resources

The Master Manual FEIS (USACE, 2004) defined the area of analysis for socioeconomic considerations to be "first tier" counties defined as those counties that the Missouri River intersected. The same convention is used for this PEIS.

5.1.3.1 Recreation

Major recreational activities engaged in along all segments of the Missouri River for which ESH construction is proposed include: boat and shore fishing; hunting; trapping; pleasure boating, canoeing, kayaking, and rafting; swimming; sunbathing and other beach activities; camping; picnicking; hiking; birdwatching and other nature observation and interpretive activities; outdoor photography; and enjoying scenic views. Water-skiing and jet-skiing are prohibited in the MNRR but are engaged in on the other Missouri River segments. Recreation is an important consideration because of the relatively high levels of visitor use, interest expressed by the general public, and inclusion of ESH construction within the two districts of the MNRR. Expenditures by recreational visitors also contribute to the regional economy, and changes in visitation and/or visitor spending have the potential to affect the local/regional economy. Changes in spending may also affect incomes of individuals and businesses and business sales, which could affect tax revenues to governmental entities. Several scoping comments (Appendix E) concerned potential effects of ESH construction and maintenance activities on recreational activities. Major characteristics of existing recreational activities in each segment are included in this chapter. Appendix D contains more detailed qualitative characteristics and sites of recreational activities and available visitation data. Where possible, the visitation data is tabulated by time periods relevant to the tern and plover nesting period and to the September 15-December 1 ESH construction period (which was based on consultation between USFWS and the Corps).

The Master Manual Final EIS recreation baseline was based on a recreation analysis conducted in 1992 for the Missouri River Master Water Control Manual Review and Update (USACE, 1994). That recreation use analysis was based on extensive surveying, user interviews, and mathematical modeling and was largely focused on characterizing the recreation within the mainstem reservoirs (e.g., Fort Peck Lake, Lake Sakakawea, Lake Oahe, and Lewis & Clark Lake) and recreation use by anglers in the river segments. This section includes relevant information from the Corps' 1994 report and updates the information based on more recently published data gathered from analyses conducted at the federal, state, and local level and personal communications in 2009 with representatives of Tribal, federal, and state agencies. This updated report is included as Appendix D of this PEIS and supplements the previous extensive research effort.

5.1.3.2 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations* (Executive Order, 1994), directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority population and low-income populations. When conducting NEPA evaluations, the Corps incorporates environmental justice considerations into both the technical analyses and the public involvement in accordance with Environmental Protection Agency (EPA) and Council on Environmental Quality (CEQ) guidance (CEQ, 1997). The CEQ guidance defines "minority" as individuals who are members of the following population groups: American Indian or Alaskan native, Asian or Pacific Islander, Black, not of Hispanic origin, and Hispanic (CEQ, 1997). The CEQ defines these groups as minority populations when either the minority population of the affected area exceeds 50 percent of the total population, or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

5.2 GEOMORPHIC SETTING

Evaluation was performed of the ESH segments to provide information regarding the geomorphic setting. Missouri River dam construction has had a significant impact on the geomorphic character of the ESH segments and is a critical factor to consider when evaluating existing and future conditions.

5.2.1 Effect of Dams

Dam construction has a direct impact on the downstream peak flow and sediment regime. Channel adjustments to the altered flow duration and sediment loads include changes in the bed material size (armoring), bed elevation, channel width planform (alignment), and vegetation. Missouri River dam construction dramatically reduced the historic flood flows. Secondly, the dams also captured sediment, eliminating it from the channel morphology downstream of the dams. The reduction in the peak flows and sediment load downstream of a dam tend to produce counter-acting results. Bed degradation would normally be the result of decreased sediment supply while flow reduction creates an aggradational (sediment deposition) tendency. Consequently, the response of a channel system to dam construction is extremely complex (Biedenharn, 2001).

5.2.1.1 Channel Parameter Evaluation

Although it is not feasible to precisely predict how the Missouri River system will respond to dam construction, a considerable number of reports detailing the changes that have occurred have been completed. These reports have examined changing trends in downstream channel variables such as bed material grain size distribution, average bed elevations, thalweg (deepest/fastest moving part of channel) elevations, water surface profiles, stage trends, and channel geometry. Previous studies have evaluated channel changes within both the degradation reach, located downstream of each dam, and the aggradation reach, located in the headwaters of each reservoir pool. A few of the more recent of these studies include the *Missouri River – Fort Peck Dam to Ponca State Park Geomorphological Assessment Related to Bank Stabilization* (Biedenharn, 2001), the *Bank Stabilization Cumulative Impact Analysis Final Technical Report, Fort Peck, Garrison, Fort Randall, and Gavins Point Study Reaches*, (USACE, 2008), and the *Missouri River Gavins Point Degradation Trends Study* (West, 2002). Notable conclusions from the referenced reports pertaining to the degradation reaches include:

- Water surface profile plots indicate general decreases in elevation over time throughout the degradation reaches. The Gavins to Ponca reach has declined at a rate of 0.16 ft/yr from 1956 to 2001. Stage decreases from 1956 to 2001 vary in the reach from Gavins to Ponca with a decrease of 11 feet downstream of the dam (West, 2002).
- Immediately downstream of each dam, a significant progress trend of bed material coarsening with time is observed. The coarsening appears to have stabilized in the 1980's in each degradation reach (Biedenharn, 2001).
- Evaluation of hydraulic parameter changes with time show increases in cross section area, small increases in top width, a progressive drop in the average bed elevation, and thalweg decrease (West, 2002).
- Within the degradation reaches downstream of each dam, the rate of bank erosion relative to the average discharge was higher in the initial period after dam closure than in the more recent periods (West, 2002).
- The higher flow period from 1995 to 1997 formed a large extent of habitat features. The Gavins Point average daily outflow rates of 52,300 cfs in 1997 and 40,000 in 1996 rank as the two highest annual rates since system operation initiated in 1967. A detailed study has not been performed to compare habitat extent to that formed following high releases of other high flow periods. However, aerial photo analysis determined that the reach average sandbar density from Gavins Point Dam to Ponca in 1997 of 30.7 ha/km nearly doubled the value from 1976 of 16.5 (Biedenharn, 2001, pg. 108).

5.2.1.2 Meandering Evaluation

Dam construction effects typically result in downstream bed degradation with subsequent lateral erosion (Shields et al., 2000) because the sediment supply is deficient relative to the sediment transport capacity of the river. This effect diminishes with distance from the dam and is offset by the flow reduction. For the Garrison Study Reach, previous analysis (Shields et al., 2000) included the following consequences:

- The mean erosion rate has decreased more than fourfold since the closure of Garrison Dam.
- Much of the reach has experienced net channel widening.
- Deposition rates of alluvial material to form islands and bars have decreased from 408 to 3.2 acres/year.

Shields et al. (2000) further state that changes in meandering rates, which were the object of their study, were associated with the effects of the dam on high flows. Missouri River high flows within the study reach have been reduced in magnitude, and their timing has changed with the natural spring flood peaks reduced. The mechanisms linking high-flow events and accelerations in channel activity were not examined by Shields et al. (2000) but were assumed to be reflective of higher levels of stream power and sediment transport capacity associated with higher flows. The control, or reduction, of higher flows similarly reduces overbank flows. This implies that channel changes must occur as a result of processes acting only on the banks, including a loss of sedimentation by mass wasting due to a lack of prolonged periods of high-stage saturated banks.

5.2.2 Dynamic Equilibrium

Previous studies examined the Missouri River ESH segments in the geomorphic context for evaluating dynamic equilibrium (USACE, 2008, pg. 1-9), (Biedenharn, 2001). A commonly used definition of dynamic equilibrium (Biedenharn, 1997) is:

> … a stable river, from a geomorphic perspective, is one that has adjusted its width, depth, and slope such that there is no significant aggradation or degradation of the stream bed or significant plan form changes (meandering to braided, etc.) within the engineering time frame (generally less than about 50 years). By this definition, a stable river is not in a static condition, but rather is in a state of dynamic equilibrium where it is free to adjust laterally through bank erosion and bar building.

The Missouri River that exists today is still classified as a meandering stream; however, it is not the same as it was before the dams were constructed. Today’s floodplain is, for all practical purposes, confined to the historic channel, which is several thousand feet wide compared to the pre-dam channel that was active within a one to two mile wide historic floodplain. Hydraulic analysis conducted with the revised hydrology regulated by the dams identified that in excess of a 500-year discharge is required to initiate significant historic floodplain flows in the study reaches where degradation has occurred (USACE, 2008).

The new river appears to be approaching dynamic equilibrium as defined above in some locations. This means that the planform and slope of the river are nearing a dynamically stable condition and there is a decreasing rate of degradation. However, within each reach, there will be two areas that will be in transition for a much longer time period. One is immediately downstream of the dams, where the absence of sediment will result in some continued degradation, especially during high flows. Armoring, or an increase in bed sediment size, has occurred in the immediate vicinity downstream of each dam. The other exception is at the upper end of the reservoirs, where the delta will continue to build up as sediment is continuously deposited where the river enters the pool and slower velocity reduces the river sediment transport capacity.

Specific gage analysis has been conducted for a number of gages within the ESH segments (USACE, 2008). Results vary widely with location. Within the degradation reaches, impacts decline as distance increases from each dam. Specific gage analysis also shows that the rate of change has decreased significantly since dam closure. This decline leads to the consideration that portions of each degradation reach appear to be approaching dynamic equilibrium. The nearest gage downstream of each dam generally shows degradation of over 10 feet since dam closure. Within the Lewis and Clark Lake aggradation segment, the Missouri River gage downstream of Niobrara has recorded a stage increase of over 8 feet since 1956.

5.2.3 Bar Formation

Previous evaluation of bar formation dynamics (Biedenharn, 2001) concluded that multiple factors affect bar morphology, the most important being a supply of suitably sized sediment, local channel geometry, and a stability status that allows and promotes bar existence. Since dam construction, the major source of sediment for each reach has been eliminated with the exception of large tributaries such as the Yellowstone and Niobrara Rivers. The loss of sediment to the system and flow regulation has affected bar morphology.

A previous study determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Study results are summarized as:

- The threshold channel width values for the Fort Peck, Garrison, and Gavins Point reaches are about 250 m, 630 m, and 500 m, respectively. Below these channel widths, bars are not likely.
- Using the 70% value for the presence of bars (bars were present 70% of the time for that channel width), the channel widths for the Fort Peck, Garrison, and Gavins Point reaches are about 350 m, 800 m, and 1000 m, respectively.
- Within the variable character of the Fort Randall reach, no threshold value could be established.
- This type of analysis is not meaningful within the Lewis and Clark lake aggradation reach.

The channel width values are useful in evaluating the likely success of creating new sandbar habitat within each ESH segment.

5.2.4 Future Channel Geometry

An evaluation of future channel geometry has been previously examined to predict the existence of habitat features (USACE, 2008b). Although each dam captures all upstream sediments, the bed and banks provide a source of sediment such that supply is not limiting (Biedenharn, 2001). Previous studies (USACE, 2008b) have also examined the effect of bank stabilization on sediment and the existence of habitat features. With the exception of the Fort Peck segment which has nearly 0% bank stabilization, the remaining segments vary between 30 and 40% bank stabilization (USACE, 2008b, pg. 8-6). Evaluation of habitat features indicates that the extent of bar and island features is generally declining while the extent of bank attached habitat features is increasing (USACE, 2008b, pg. 8-6).

A channel evolution analysis was not performed for this study. However, general guidance regarding channel evolution downstream of dams combined with information from previous studies can be used to form general guidelines regarding future Missouri River channel evolution trends.

- The trend toward approaching dynamic equilibrium indicates that the river's response to dam construction and operations is declining.
- The new river planform is likely to have increased meandering and a reduced sediment load compared to the immediate post dam condition.
- Regulated flow releases are a significant factor in the downstream channel geometry and the extent of habitat features. This is demonstrated by the habitat observed following the high releases from 1995 to 1997.
- Bank stabilization may affect the dynamic equilibrium process and the extent of habitat features although a detailed study was unable to find a correlation between bank stabilization activities and the extent of habitat features.

Within the context of the new equilibrium channel geometry, the potential future planform is indicated by the declining trend of bar and island habitat features, reduced degradation rates, and the corresponding lower sediment transport rate. Relative to the ESH program, significant conclusions are:

- The habitat extent naturally created by sustained high release flows will likely have a declining trend with each repeated flow release cycle of similar peak flow and volume.
- In the long term, the stability of ESH created bars is likely to increase as the bed degradation and sediment transport rates continue to decline. Expanding channel top width will also tend to increase future bar stability although vegetation impacts may be detrimental to habitat value.
- In the short term, the stability of ESH created bars will continue to be heavily correlated to the annual flow release volume, flow peak, and site specific effects like ice jams and ice scouring.
- The abundance of sediment supply in both the bed and banks indicates material will be available to replace ESH constructed habitat.
- Increasing top width indicates that more suitable sites for ESH activities may occur in the future.
- The ESH program segments are not in sediment balance as demonstrated by numerous reports tracking stage trends. The general trends within these reaches are driven by dam construction and flow regulation.

5.3 EXISTING CONDITIONS BY RIVER SEGMENTS

5.3.1 Fort Peck River - Segment 2

The Fort Peck River Segment extends nearly 200 river miles flowing unchannelized from west to east from just downstream of the Fort Peck Dam in Fort Peck, MT, to Williston, ND, near the confluence with the Yellowstone River. Richland, Roosevelt, and one-half of McCone Counties in northeastern Montana border the segment. Major tributaries include the Milk, Poplar, and Yellowstone Rivers, although the latter enters the Missouri River just upstream of the Lake Sakakawea delta and influences only a short portion of the Fort Peck River Segment. The largest communities in the segment are Wolf Point in Roosevelt County and Sidney in Richland County. Wolf Point is located on U.S. Highway 2, and Sidney is at the intersection of State Routes 16 and 200.

Abandoned channels and several oxbow lakes remain in the flood plain. Upstream of Brockton, MT (RM 1660), the flood plain is about 4 miles wide and is bordered by rolling grasslands, dry land crops, and rangelands. Downstream from this point, the flood plain narrows to a 1-mile-wide valley surrounded by badlands (USACE, 2004).

5.3.1.1 Physical Resources (Fort Peck River Segment)

5.3.1.1.1 Climate/Meteorology (Fort Peck River Segment)

The climate of this part of Montana is typical of the North American high plains with moderately cold winters that have average January minimums near zero degrees Fahrenheit (F) and have occasional cold periods exceeding –20 degrees F. Summers are generally pleasant (averaging in the 80s during afternoon hours) with occasional hot periods exceeding 100 degrees F. Low humidity, high temperatures, and moderate to strong winds cause rapid loss of soil moisture. Mean annual precipitation is 12-13 inches with about 70 percent occurring from April-September. Due to the dominantly heavy-textured soils, runoff is rapid, often exceeding 50 percent of the total precipitation. The average frost-free period is about 120 days. The area is also subject to intense lightning storms from July into September, often resulting in wildfires (USFWS, 1985).

5.3.1.1.2 Aesthetics (Fort Peck River Segment)

Away from the obvious man-made features (e.g., roads, bridges, water withdrawal structures), the Missouri River bottom and surrounding lands generally present a wild, undeveloped perspective to the viewer. With sweeping vistas, rugged breaks, open plains, and minimal sign of man, the lands possess a wild land visual quality (USACE, 1992). The lands on the glaciated north side of the river consist mainly of grassy rolling plains dissected by coulees and gullies and isolated buttes; lands on the unglaciated south side include similar rolling plains but there are also many hills, gullies, and rough breaks. These natural vistas are valuable, rare, and provide a desirable aesthetic resource.

5.3.1.1.3 Geology (Fort Peck River Segment)

The Fort Peck River Segment is within the northern Great Plains province, with the glaciated portions of the area exhibiting level to rolling uplands dissected by coulees and gullies. Unglaciated areas are characterized by low hills, rugged breaks, and badlands (USACE, 1992). The Missouri River marks the southernmost advance of the Pleistocene glaciers, leaving the north side of the Missouri River relatively smooth; but the unglaciated south side often has rugged terrain reflecting the advanced erosion of ancient grasslands and sedimentary deposits (USACE, 1992).

The Bearpaw Shale Formation (Upper Cretaceous age) underlies more of the Fort Peck River Segment area than any other formation. Bearpaw Shale is composed almost entirely of dark gray clay shale and includes beds of bentonite. The predominant particle of this formation is clay. As a result, this unit swells when exposed on steep slopes and erodes rapidly at many locations. In general, Bearpaw Shale does not yield water (USACE, 1992). Any measurable precipitation, together with motorized use of roads built on Bearpaw shale quickly turns them into an impassible quagmire.

5.3.1.1.4 Air Quality (Fort Peck River Segment)

The EPA Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for six principal pollutants, called “criteria” pollutants. They are carbon monoxide, nitrogen dioxide, ozone, lead, particulate material (PM) of 10 microns or less in size (PM-10 and PM-2.5), and sulfur dioxide. Ozone is the only parameter not directly emitted into the air but forms in the atmosphere when three atoms of oxygen (0_3) are combined by a chemical reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Motor vehicle exhaust and industrial emissions, diesel and gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC, also known as ozone precursors. Strong sunlight and hot weather can cause ground-level ozone to form in harmful concentrations in the air. For the Fort Peck River Segment (Montana and North Dakota) including all counties within which actions could take place, all parameters are in attainment for all of the air quality standards (USEPA, 2006).

5.3.1.1.5 Hazardous, Toxic, and Radioactive Waste (HTRW) (Fort Peck River Segment)

The scope of investigation was not designed to delineate the extent of contamination from any particular site, but strictly to identify known areas of contamination in a database search. Findings for the Fort Peck River Segment were very limited and included in the project GIS, enabling the Corps to avoid known areas of contamination in the subsequent phases of the planning site-specific projects. The results of these investigations are available upon request, but not included as technical appendices to the PEIS because the data and maps are hundreds of pages long. The data in the GIS deliverable data were included in the Programmatic Limitations on Construction and Maintenance as discussed in Section 4.2 and Appendices B and C.

5.3.1.2 Water Resources (Fort Peck River Segment)

5.3.1.2.1 Surface Water Hydrology and Hydraulics (Fort Peck River Segment)

The Fort Peck Dam regulates this segment, with a mean daily flow at the Culbertson gauge of about 12,000 cfs (Biedenharn, 2001). The channel in this segment exhibits a meandering pattern with occasional straight reaches. The channel width ranges from about 450 feet to 2,800 feet with an average width of about 1,150 feet. The energy slope for the Fort Peck River Segment, calculated from a HEC-RAS analysis, ranges from about 0.0003 to 0.0005. The most important tributary in this segment is the Yellowstone River, which enters at the downstream boundary of the study area. There are several minor tributaries in this segment such as the Milk River, Poplar River, and Redwater River, but taken together their contribution to the discharge in this segment is generally less than five percent. Bank heights in this segment generally range from about 10 to 40 feet with an average bank height of about 18 feet.

Releases of water from Fort Peck Dam into the Missouri River average about 10,000 cubic feet per second (cfs) (7 million acre feet per year), with slightly more in wet years and slightly less in drought years. Channel capacity below Fort Peck Dam is approximately 35,000 cfs. Maximum Fort Peck Dam releases occur during the summer flood evacuation period or in the winter to support winter power demands. Daily winter release rates are generally 10,000 to 13,000 cfs when water supply is near normal and about 7,000 to 8,000 cfs during Fort Peck Dam generally are not greater than those needed for full hydropower capacity, which is 15,000 cfs. Releases are higher during large runoff years and lower during droughts. Spring through fall releases are generally lower than winter releases, except during significant reservoir evacuation years such as 1975, when releases averaged 35,000 cfs in July. During the 1987 to 1993 drought, releases in spring and early summer were in the 6,000- to 8,000-cfs range, while late summer and fall releases varied between 3,000 and 10,000 cfs. Releases during the tern and plover spring and summer nesting season are generally kept at below 9,000 cfs.

Minimum hourly releases are about 4,000 cfs to maintain trout habitat below the dam. When tributary inflows cause flooding in the segment, daily average releases are reduced to as low as 4,000 cfs. Maximum hourly releases for power generation purposes (generally in winter) are 16,000 cfs. The maximum release to evacuate the exclusive and annual flood control zones is near 35,000 cfs, which is the channel capacity (USACE, 2004).

5.3.1.2.2 Degradation, Aggradation, and Erosion (Fort Peck River Segment)

The river immediately below the Fort Peck Dam has a very low sediment load contributing to erosion of the streambed and is responsible for the gravel substrate throughout the area (USACE, 1994). Although most of the bed degradation below Fort Peck Dam occurred before 1966, some degradation continues in the upper and center portions of the segment. Degradation below the dam occurs to varying degrees to about RM 1650; below RM 1650, no significant degradation has occurred since 1966 (USACE, 1994).

There has been little increase in the width of the river channel due to streambank erosion, except in isolated stretches between RM 1612 and RM 1746. Streambank erosion rates for the 204-mile segment were about 97 acres per year from 1975 to 1983. Based on the survey performed by the Mni Sose Intertribal Water Rights Coalition (February 1994), the Fort Peck Reservation identifies erosion as "moderate." Bed materials have become coarser over time below Fort Peck Dam, with finer material deposited in the lower portion of the segment above Lake Sakakawea. The silty (i.e., muck) deposits begin near the mouth of the Yellowstone River and extend downstream to Lake Sakakawea.

Much of the channel is narrow (under 1,000 feet) and designated by Biedenharn (2005) as erosional, as indicated in Table 5-3. The downstream 12 miles of the segment near the confluence with the Yellowstone is in backwater from Lake Sakakawea, and the lowest 4 miles may be in the pool.

There is little interchannel sandbar formation and no suitable nesting habitat in the upper 69 miles of the river (which correlates with Biedenharn's Geomorphic Reaches 1 and 2) to RM 1712 at a bend near Wolf Point. Downstream of the island formation at RM 1712, the next suitable nest site does not occur until RM 1692, 20 miles downstream. Proceeding downstream, sandbar formation is discontinuous, with nesting habitat occurring at wide intervals. There are only six suitable sandbar sites (at RMs 1689.7, 1682.9, 1679.6, 1664.0, 1659.0, and 1636.0) until RM 1615, a distance of 77 additional miles. Each of these sites, single islands or bars representing short deposition zones, are located in major bends. The longest reach supporting suitable ESH occurs between RM 1615.5 and RM 1616.5 (one mile). Two additional suitable ESH nesting areas occur at RM 1598.5 and RM 1606.3. The extent of depositional area within the Fort Peck River Segment is less than 10 miles. The remainder of the segment is erosional and most likely unsuitable for the construction and maintenance of ESH.

Table 5-3: Geomorphic Erosive and Depositional Reaches for Fort Peck River Segment*

Geomorphic Reaches	Erosion		Deposition		Balance	
	Bank	Bed	Bank	Bed	Bank	Bed
(RM)	(1980-1998) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)		
GR 1 1768-1750	-13,831	-142,964	21,761	42,929	7,930	-100,035
GR 2 1749-1753	-108,329	-238,976	93,122	30,438	-15,207	-208,538
GR 3 1712-1700	-64,803	-34,104	1,209	24,255	-63,594	-9,849
GR 4 1699 1686	-46,945	-251,561	42,889	0	-4,056	-251,561
GR 5 1685-1654	-182,203	-170,633	100,791	54,650	-81,412	-115,983
GR 6 1653-1621	-101,863	-97,388	184,369	0	82,506	-97,388
GRs 7 & 8 1620-1599	-131,167	-50,447	65,815	240,488	-65,352	190,041

* (Data excerpted from Biedenharn 2001)

5.3.1.2.3 Water Quality (Fort Peck River Segment)

As the river progresses downstream from the hypolimnotic (characteristically cold, clear, and virtually sediment-free) discharge from the dam, the water gradually changes in character. Ten miles below Fort Peck Dam, the Milk River contributes warm turbid water more characteristic of natural Missouri River conditions. Farther downstream, the Poplar and Redwater Rivers contribute additional sediment and warm water, causing the river to take on a more natural character with a sandy-silty bottom and warmer turbid water.

There are two Missouri River reaches downstream of Fort Peck Dam that are on the State of Montana's 303(d) List of Impaired Waterbodies: reach MT40S001_010, from Fort Peck Dam to the Poplar River; and reach MT40S003_010, from the Poplar River to the North Dakota border (USACE, 2004). Metals and habitat alteration resulting from the modified stream flows affect these reaches.

Stream reach MT40S001_010 is rated as a high "severity" on the 303(d) list and a TMDL study has already been initiated by the State of Montana. Under the 303(d) listing process, mercury has also been mentioned as a parameter of concern that is directly related to dam operations (USACE, 2004). Dissolved oxygen in the releases from Fort Peck Dam at times is slightly below saturation levels. The Yellowstone River is on the State of North Dakota's 303(d) List of Impaired Waterbodies due to metals and pathogens (USACE, 2004).

5.3.1.2.4 Water Use (Fort Peck River Segment)

There are 455 water supply intakes and intake facilities located on the Missouri River in this segment between Wolf Point, MT and Williston, ND (USACE, 2004). These include 5 municipal water supply facilities, 4 industrial intakes, 283 irrigation intakes, 162 domestic intakes, and 1 public intake. The municipal water supply facilities serve a population of approximately 28,020 persons, 80 percent of whom live in the Williston area. Of the total 455 water supply intakes and intake facilities, there are 109 water supply intakes and intake facilities located on the Missouri River serving the Fort Peck Reservation. These include 1 municipal water supply facility, 94 irrigation intakes, and 14 domestic intakes. The municipal water supply facilities serve a population of approximately 200 persons (USACE, 2004).

The Assiniboine and Sioux Tribes of the Fort Peck Reservation exercise water rights downstream from Fort Peck Dam. These Tribes are in the process of using the Missouri River for domestic water. In cooperation with EPA, the Tribes are developing a treatment system based upon existing water quality conditions in the river (USACE, 2004).

5.3.1.3 Biological Resources (Fort Peck River Segment)

5.3.1.3.1 Results of Habitat Delineation (Land Cover/Vegetation Classifications) (Fort Peck River Segment)

The Fort Peck River Segment begins in the upper end of the Lake Sakakawea at RM 1568.0 near Trenton, North Dakota and ends 203 miles upstream at Fort Peck Dam. There are approximately 37,000 acres in the riverine corridor, for an average of 192.2 acres per river mile and an average corridor width of 1,586 feet. Fort Peck Dam uses daily power-peaking, to offset daily peak loads on the national electrical power grid. Mean daily variation at Fort Peck Dam gage is approximately 0.6 feet, which declines to 0.2 feet at Wolf Point gage, and becomes negligible at Culbertson gage.

Tables 5-4 and 5-5 present the findings and comparisons between habitat delineations for the Fort Peck River Segment for 1999 and 2005. [14] It was necessary to use 1999 aerial imagery for the Fort Peck River Segment delineation because the 1998 orthophotographs[15] were complete for only the Bainville SW quadrangle. It is noteworthy that the drought has made river stage a major measurement problem between the available imagery. The 1999 imagery was obtained at a flow of 10,100 cfs while the 2005 imagery split in time between June and July flights at flows of 5,600 cfs and 5,200 cfs, respectively. Using the Wolf Point USGS gage as a difference surrogate, the stage for photo collection in 1999 was 3.7 feet, the river stage for the June 2005 flight was at 2.55 feet and the river stage for the July flight was at 1.97 feet. This variation in stage (1.15 to 1.73) foot is significant in this segment and makes habitat comparisons between 1999 and 2005 very problematic (see summary of Appendix B, Habitat Delineations, in Section 3.1 of this document).

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[14] As described in Section 3.1 and detailed in Appendix B, the riverine habitat for each of the subject segments of the Upper Missouri River have been delineated in GIS for two separate years (1998/1999 and 2005). Each Segment-specific section will summarize the results of that river segment's delineation. Factors controlling the distribution of different habitats across a landscape are those factors that cause measurable differences in soil and its occupation by plants and animals. These factors include parent material of the substrate, time since egregious disturbance or deposition of the substrate, climate (thermic and moisture regimes), surficial form (topography) and the composition of available inhabitating organisms. The factors affecting the ability to represent realistic divisions between habitat types of interest from remotely sensed data (aircraft-based aerial photographs and aerial imagery, LiDAR, satellite imagery, etc.) include the precision and accuracy of the remotely sensed data, the importance of incidental and seasonal environmental variation at the moment of data capture, and the degree to which the habitat divisions of interest represent realistic divisions of the landscape.

The objective for comparing changes in habitat over time requires segregating these groupings into relatively homogeneous polygons that depict important bio-physical characteristics for the species or group of organisms of interest. These factors were considered in the selection of methods, the selection of relevant habitat types, and the conduct of this habitat delineation of portions of the Missouri River channel. This Fort Peck River Segment summary contains only the results of the habitat delineation. Refer to Appendix B for the details of the delineation for all segments.

River stage differences in aerial imagery used to delineate habitat strongly restricts direct year-to-year areal comparability. Previous habitat delineations did not appear to correct for stage differences between photosets; in power pulsed reaches the daily differences can be profound. When comparing habitat quantities at differing stages, only the highest bars and islands would be visible in all years for all reaches, but general trends in erosion or deposition can be credibly accounted for only if a subsequent measurement is at a similar or lower flow, and may not be at all meaningful if a subsequent photograph was collected at a higher flow. This analysis has attempted to correct for stage fluctuation, as these factors are essential when attempting to compare changes over time.

[15] Comparison delineations were conducted for the 7-mile reach from RM 1599.3 to RM 1606.3 of the coincident 1998 imagery and the 1999 imagery. The comparison shows that the water surface elevation was higher in the 1998 photoset than in 1999; the 1998 Open Water polygon was only 104% of the 1999 Open Water polygon. However, the area of ESH mapped in this test for 1998 was 45% of the area mapped using the 1999 photography. This test suggests that use of the 1999 imagery greatly over estimated the acreage of ESH relative to the area visible in 1998. The measurement problem caused by stage differences between aerial photographs cannot be minimized, particularly with the acreage–sensitive recommendation imposed by the BiOp RPA.

Table 5-4: Habitat Acreage Summary for Fort Peck River Segment, 1999 and 2005.

Habitat Type	2005 Acres	1999 Acres	Change in Acres	2005 % of Total	1999 % of Total
Open Water	17,135	17,714	(578)	45.7%	47.1%
ESH	247	883	(635.6)	0.7%	2.3%
Herb/ Shrub/ Sapling	8,093	7,122	970.3	21.6%	19.0%
Non- ESH Sand	399	676	(277.4)	1.1%	1.8%
Forest	2,954	3,204	(250)	7.9%	8.5%
Agriculture	190	93	97.8	0.5%	0.2%
Wetland Matrix	4,102	3,791	311.3	10.9%	10.1%
Shallow Water	2,405	2,474	(69.4)	6.4%	6.6%
Daily Inundated Sand	7	16	(8.8)	0.0%	0.0%
Grand Total	37,487	37,573			

Comparisons of habitat type that typically occur above river stage fluctuation levels (e.g., Forest, Agriculture, Herb/Shrub/Sapling) are meaningful. Habitat types that occur near or within river stage fluctuation levels (e.g., Shallow Water, Wetland Matrix, Daily Inundated Sand, ESH) have probably declined much more than indicated, due to the below normal stage at the time of 2005 photograph acquisition. Delineations performed using imagery collected under more representative release conditions would further reduce acreage estimates for any residual ESH, No-ESH Sand, and Wetland Matrix habitats (see summary of Appendix B, Habitat Delineations, in Section 3.1 of this document). The decrease in the area of ESH between 1999 and 2005 are however, approximately equally divided between erosion loss and vegetation encroachment (Table 5-5).

Table 5-5: Disposition of Original ESH Lost from 1999 to 2005: Fort Peck River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	262.9	30%	ESH lost to erosion and carried down river
ESH	96.5	11%	ESH retained from original 1999 area
Herb/Shrub/Sapling	250.2	28%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	44.3	5%	Became terrestrialized or surrounded by forest
Forest	0.0	0%	Natural growth of shrubs into forest-sized trees
Wetland Matrix	131.6	15%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	29.9	3%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand	64.5	7%	ESH redistributed to low plateaus by daily high flows from power peaking at Fort Peck Dam
Lacustrine Sediments	3.0	0%	ESH eroded; resulting high point coved by silt and clay
Grand Total	883		

5.3.1.3.2 Wildlife (Fort Peck River Segment)

The wetland and riparian forests provide habitat for white-tailed and mule deer, waterfowl, bald eagles, aquatic furbearers, and other wildlife. White-tailed deer typically congregate in densely vegetated scrub-shrub and emergent wetlands and riparian forests on islands and the flood plain (USACE, 2004). The wood duck and common merganser nest in wetland/riparian-forested areas, while Canada geese rely on vegetated islands for nest sites. Other species of waterfowl, such as mallard, blue-winged teal, and gadwall, nest in uplands in proximity to water or in emergent wetlands.

Islands and sandbars provide waterfowl with secure loafing and roosting areas during spring and fall migration. During spring migration, typical flows near 10,000 cfs yield about 30 acres of suitable sandbar roosting/resting habitat; there is slightly less of this habitat during fall migration due to higher releases (USACE, 2004). The acreage of sandbar habitat varies from 85 acres at 15,000 cfs to 635 acres at 6,000 cfs. Between 25 and 50 bald eagles wintered (November to February) along the ice-free segment between Fort Peck Dam and Lake Sakakawea in 1998 (USACE, 2004). These birds foraged primarily on mutilated fish (primarily cisco, *Coregonus* sp.) in the 2 to 3 miles immediately downstream of the dam within the Charles M. Russell NWR. Peregrine falcons and whooping cranes also occur occasionally along this segment during spring and fall migration (USACE, 2004).

5.3.1.3.3 Fish and Invertebrates (Fort Peck River Segment)

Although Missouri River flows are regulated in the Fort Peck River Segment, the segment remains in a semi-natural state, partly because of the influence of unregulated tributaries. Backwaters, oxbows, and side channels are abundant, except in the 10-mile section below Fort Peck Dam, where the steep banks are eroded and the streambed is degraded. The river immediately below Fort Peck Dam is cold and clear and has little cover. The low sediment load in this section contributes to the presence of the gravel substrate throughout the area. The tailrace area supports a large population of shovelnose sturgeon in the winter. In the tailrace area, a 2-mile-long side channel developed during dam construction provides good spawning and rearing habitat for rainbow trout. The quality of the spawning habitat has been enhanced by the placement of gravel in this side channel. Two dredge cuts in the same area provide 860 acres of lake-like habitat that is used by paddlefish and numerous other species as refuge from the main currents of the river (USACE, 2004).

Downstream of the tailrace area, the river becomes gradually warmer and more turbid and the characteristics of the river approach conditions that are more natural. The inflow of the Milk and Yellowstone Rivers and other large tributary streams contributes to these changes. Some of the largest paddlefish and sauger populations left in the Missouri River are present in this segment (USACE, 2004). Paddlefish migrate out of Lake Sakakawea in spring to spawn in the Milk and Yellowstone Rivers. Today, native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e., turbidity). The lower Yellowstone River can exhibit Nephalometric Turbidity Unit (NTU) readings greater than 1,000 or secchi disk depths of only ½” in main channel habitats—this is extremely turbid water. Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

The substrate of sandbars is home to a number of invertebrate species, the primary food source for the piping plover. In general shoreline habitat provides more diverse invertebrate assemblages that are more adaptable to stochastic events (Angradi, Schweiger and Bolgrien 2006). In one study, Plovers foraged for invertebrates in all available habitats including dry sand, on vegetation, and in both moist and saturated sand, but spent the majority of their time foraging in moist sand. While Diptera (flies) were the most abundant invertebrates collected during sampling, Coleoptera (beetles) were most numerous in plover fecal samples. This finding is aligned with prior study results, suggesting that beetles are typically the main food source for plovers. Other taxa captured in this study included Hemiptera, Homoptera, Hymenoptera, Odonata, Orthoptera, and Araneae (Le Fer, 2006). A study analyzing macroinvertebrate diversity, density, and composition finds that the current communities are in general both diverse and densely populated within the project area (Angradi et. Al 2009).

5.3.1.3.4 Threatened and Endangered Species and Habitats (Fort Peck River Segment)

Five different species are listed as threatened or endangered near the Fort Peck River Segment in eastern Montana. The detailed life histories for these species are incorporated by reference from the original Master Water Control Manual Review and Update Final EIS (USACE, 2004).

Black Footed Ferret (*Mustela nigripes*)

Due to losses of prairie dog colonies over North America, few suitable ferret reintroduction areas remain today. The reintroduction of black-footed ferrets into the wild began in 1991 with releases in Wyoming and additional releases were initiated in 1994 at the Charles M. Russell National Wildlife Refuge in Montana. These releases in Montana were adjacent to the Fort Peck Reservoir and above the Fort Peck Dam at the head of the Fort Peck River Segment. No critical habitat has been designated for the black-footed ferret within the Fort Peck River Segment.

Piping Plover (*Charadrius melodus*)

Approximately 125 miles of the Fort Peck River Segment has been designated critical habitat for the piping plover (http://www.fws.gov/mountain-prairie/species/birds/pipingplover/mtunit2.pdf). The designated area is from approximately RM 1712 near Wolf Point, MT to RM 1586.6 downstream of Nohly, MT. Appendix B summarizes relevant life history and protected status of the piping plover.

Least tern (*Sternula antillarum*)

No critical habitat has been designated for the least tern within the Fort Peck River Segment. Appendix B summarizes relevant life history and protected status of the least tern.

Whooping crane (*Grus americana*)

Wild populations of whooping cranes utilize the Texas Gulf coast, and migration and staging areas through northeastern Montana, the western half of North Dakota, central South Dakota, Nebraska, Oklahoma, and east-central Texas. There are five areas of Critical Habitat designated for the whooping crane and none of them are in Montana. (They are located in Idaho, Kansas, Nebraska, Oklahoma, and Texas).

Pallid Sturgeon (*Scaphirhynchus albus*)

Recovery-Priority Area 2 includes the Missouri River from the Fort Peck Dam discharge to the headwaters of Lake Sakakawea in North Dakota. Recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some reaches still exhibit a natural channel configuration of sandbars, side channels, and varied depths.

5.3.1.4 Socio-Economics (Fort Peck River Segment)

5.3.1.4.1 Land Use (Fort Peck River Segment)

Communities within the study area are rural in nature, with a long-standing economic base in agriculture and ranching. The largest communities in the segment are Wolf Point in Roosevelt County and Sidney in Richland County (USACE, 2004). The socioeconomic character of these communities reflects this agricultural and ranching lifestyle and land use.

5.3.1.4.2 Population (Fort Peck River Segment)

The 2000 Census (U.S. Bureau of the Census, 2000) reports the population for the four first tier Montana counties--Valley, Richland, Roosevelt, and McCone--combined was 29,939. The 2004 update estimated the population at 28,817 (U.S. Bureau of the Census, 2006), representing a decrease of nearly 12 percent since the 1990 census. The population density of Valley, McCone, Richland, and Roosevelt Counties is typical of rural counties, with 2, 0.75, 4.6, and 4.5 persons per square mile, respectively.

The Fort Peck River Segment also intersects two North Dakota Counties (Williams and McKenzie) before entering Lake Sakakawea. The combined population for these two counties as of the 2000 Census was 25,498 (U.S. Bureau of the Census, 2000). The 2004 update estimated the population at 24,777 (U.S. Bureau of the Census, 2006), representing a decrease of more than 11 percent since the 1990 census. The population density of Williams and McKenzie counties in North Dakota is typical of predominantly rural counties, at 10 and 2 persons per square mile, respectively.

5.3.1.4.3 Transportation (Fort Peck River Segment)

The Fort Peck River Segment is in a sparsely populated area of the United States, with associated low levels of traffic. The largest road in the area is U.S. Route 2 that runs east-west on the north side of the Missouri River through the entire Fort Peck River Segment. Smaller state and local roads provide access to homes, ranches, and communities in the area. The Montana Department of Transportation's most recent published automatic traffic counter data provides data at two locations within the entire project area (MTDOT, 2004). Average daily traffic (number of vehicles per day) on U.S. Route 2, counted 2 miles east of Wolf Point, MT, Sunday through Saturday was 2,255 vehicles; weekday traffic (Monday-Thursday) was 2,459 vehicles (MTDOT, 2004). Average daily traffic on Montana State Route 16 near Culbertson on Sunday through Saturday was 851 vehicles; weekday traffic was 877 vehicles (MTDOT, 2004). No separate data was reported to segregate the number of trucks from the total number of vehicles.

5.3.1.4.4 Employment and Income (Fort Peck River Segment)

The primary 2000 employment sectors in the first tier counties for this segment were agriculture (21 percent); education, health and social services (22 percent); and retail trade (11 percent) (U.S. Bureau of the Census, 2000). The public administration (8 percent) sector was slightly higher, proportionally, than other segments. The 1990 unemployment rate was 7.6 percent, the highest of the river segments and reservoirs, and significantly more than the 5.5 percent for the United States and the 4.8 percent for the Missouri River States (USACE, 2004).

The most recent economic survey published by the Census Bureau (1999) estimated the median household income for McCone, Richland, Roosevelt, and Valley Counties to be $29,718, $32,110, $24,834, and $30,979 respectively (U.S. Bureau of the Census, 2006). Statewide median household income for Montana (1999) was $33,024 (U.S. Bureau of the Census, 2006). The most recent Poverty Status figures (2003) estimated that 12.7, 13.1, and 14.6 percent of individuals in McCone, Richland, and Valley Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). An estimated 26.2 percent of individuals in Roosevelt County were considered below the poverty level (U.S. Bureau of the Census, 2006).

Based on the most recent economic survey published by the Census Bureau (1999), median household income in Williams and McKenzie Counties (ND) was $31,491 and $29,342 respectively. An estimated 11.2 and 13.7 percent of the individuals in Williams and McKenzie Counties were below the poverty level (U.S. Bureau of the Census, 2006), compared with 14.2 percent in North Dakota as a whole (USDA, 2006).

5.3.1.4.5 Recreation (Fort Peck River Segment)

The Fort Peck River Segment is in a sparsely populated area of the United States, with associated low levels of recreation. Table 5-6 lists the recreation facilities along this segment. The prominent water-related activities along this segment are boating and fishing. Designated swimming areas exist at only two sites along this segment (the Fort Peck Flood plain Recreation Area and the Culbertson Bridge Fishing Access Site).

Table 5-6: Missouri River Recreation Sites: Fort Peck Dam to Lake Sakakawea

Site Name	Boat Ramps	Boat Trailer Parking	Camp Sites (RV, Camper, Tent)	Swimming Beach
Fort Peck Flood plain R.A. (1)	2	20	6	Yes
Roundhouse Point R.A. (1)	1	20	4	No
Boy Scout R.A. (1)	1	15	None	No
Nelson Dredge R.A. (1)	1	3	None	No
School Trust Access Site (1)	1	6	None	No
Lewis & Clark (Wolf Point/Rt. 13 Bridge) Fishing Access Site (1)	1	7 + overflow	None	No
Poplar River Access Point (1)	1	3 + overflow	None	No
Culbertson Bridge Fishing Access Site (1)	1	5	None	No
Snowden Bridge Fishing Access Site (1)	Canoe	5	3 + tent	No
Confluence R.A. (2)	1	60	None	No
Pumphouse Pedestrian Access (2)	None	None	None	No
Lewis and Clark WMA Fishing Access(2)	1	Some	None	N0

R.A = Recreation Area, WMA = Wildlife Management Area, (1) Montana, (2) North Dakota

Each recreation site along this segment included a boat ramp and parking facilities for boat trailers, although some ramps were unimproved dirt or gravel and some sites had no facilities for picnicking or other activities. Drought conditions in 2006 also made the extensive boating facilities at Lewis and Clark State Park (ND) (including boat ramps, docks, gas dock, and a protected marina) inoperable because they were no longer inundated. Prolonged drought may positively impact riverine recreation if boaters who would typically use the facilities at Lewis and Clark State Park use access points on the river instead because water levels in the Fort Peck River Segment are more stable and boat ramp/recreation facilities remain accessible.

This segment of the Missouri River has less recreational use then other segments assessed in this analysis. The low volume of recreation on the Missouri River from the Fort Peck Dam to Lake Sakakawea is very likely due to the low population and population density in this area of Montana and North Dakota. The short warm season (120 frost-free days) and cold winters also contribute to the reduced days of recreational use on this segment. The characteristics, amount, and locations of various recreational activities in this segment, including fishing, hunting, pleasure boating, swimming, picnicking, and camping, are provided in Appendix D. In 2006, among person at last 16 years old (adults) recreating in Montana, residents of Montana accounted for approximately 81 percent of fishing days, 83 percent of hunting days, and 51 percent of wildlife watching days away from home. In 2006, expenditures in Montana related to recreational trips were approximately $51.18 per day for fishing, $62.00 per day for hunting, and $98.22 per day for wildlife watching. Trip-related expenditures in Montana for these three activities totaled over $585 million (USFWS/USCB, 2008).

5.3.1.4.6 Noise (Fort Peck River Segment)

This segment of the Missouri River includes very limited residential and recreational areas, with the majority of the segment being natural or agricultural. As such, ambient noise levels are very low and characteristic of a natural setting where the intrusion of man-made noise is infrequent and typically of short duration.

5.3.1.5 Environmental Justice (Fort Peck River Segment)

According to the 2000 Census, the ethnic mix of residents in Richland, Roosevelt, McCone, and Valley Counties, Montana and McKenzie and Williams Counties, North Dakota is presented in Table 5-7. The contrasting percentage of Native Americans in Roosevelt County relative to the other two counties is a result of the Fort Peck Reservation encompassing approximately three-fourths of Roosevelt County (USACE, 2004). The Reservation had a 1990 population of 10,595. The ethnic distribution of the residents was approximately 55 percent American Indian, 45 percent Caucasian, and less than 1 percent of other ethnic heritage (USACE, 2004).

Table 5-7:Race in Fort Peck River Segment First Tier Counties

County	African American	Asian	Hispanic	Native American	White
Richland - MT	0.1 %	0.20 %	2.2 %	1.5 %	96.6 %
Roosevelt - MT	0.0 %	0.04 %	1.2 %	55.8 %	40.9 %
McCone - MT	0.3 %	0.30 %	1.0 %	1.1 %	97.0 %
Valley - MT	0.1 %	0.20 %	0.8 %	9.4 %	88.1 %
McKenzie - ND	0.1 %	0.10%	1.0 %	21.2 %	77.4 %
Williams - ND	0.1 %	0.20 %	0.9 %	4.4 %	92.9%

Source: http://factfinder.census.gov

Low-income populations are identified using statistical poverty thresholds from the Bureau of the Census Current Population Reports, Series P-60 on Income and Poverty (U. S. Bureau of the Census, 2000a). In identifying low-income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The threshold for the 2000 census was an income of $17,761 for a family of four (U.S. Bureau of the Census, 2000a). This threshold is a weighted average based on family size and ages of the family members. As stated previously in Section 5.2.4.4, the most recent Poverty Status figures (2003) estimated that 12.7, 13.1, and 14.6 percent of individuals in McCone, Richland, and Valley Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). An estimated 26.2 percent of the families in Roosevelt County were considered below the poverty level (U.S. Bureau of the Census, 2006).

5.3.1.6 Cultural and Paleontological Resources (Fort Peck River Segment)

The Fort Peck project lands have a full range of these types of properties. Early, middle, and late Native American sites, steamboat wrecks, early homesteads and ranches, trading posts, and New Deal properties are all a part of the cultural landscape. Many of the municipal buildings in the town of Fort Peck, as well as 12 residences along East Kansas Avenue are listed on the National Register of Historic Places. The Fort Peck Powerhouse and Dam are also eligible for the National Register of Historic Places. Since Fort Peck Lake was constructed prior to cultural resources protection legislation (other than the Antiquities Act of 1906) and prior to the River Basin Surveys; little archaeological work was done there until recently. A sample survey of 4,000 acres located both on and off Corps lands at Fort Peck Lake (Ebasco Environmental, 1992). The Fort Peck survey recorded 49 archaeological sites, including 12 historic and 37 prehistoric sites. These sites ranged from historic-era homesteads to lithic (stone artifact) debris scatters, stone circle sites, and rock cairn (pile) sites to a large communal bison kill and processing site. Other recorded sites at Fort Peck number 110, for a total of 159 recorded sites.

Significant paleontological resources along the Mainstem Reservoir System are found in the Fort Peck region. The first Tyrannosaurus Rex skeleton with the forearms intact was found near Nelson Creek, south of the town of Fort Peck. Many triceratops skeletons have been found in the general area around the reservoir. Ammonites (marine fossils) and laccolites (igneous/volcanic rock) are also found in abundance. Downstream of Fort Peck, the river flows through thick deposits of glacial till and loess and does not cut through the deeper fossil-bearing bedrock (USACE, 2004).

Archeologists divide the cultural chronology for the eastern Montana area into several different eras or periods. These include the Early Prehistoric Period, Middle Prehistoric Period, late Prehistoric, the Protohistoric Period, and the Historic Period.

The Early Prehistoric Period (similar to the Paleoindian Period in regions further east) is the time between 11,000 Before Present (BP) to 7,700 BP. The archeological record indicates that these people were big game hunters during the earlier parts of this period and bison hunters during the later parts. Included within this time are the Clovis, Goshen, Agate Basin, Hell Gap, Alberta, and Cody complexes. Spear or dart points are part of the archeological record from this period.

The Middle Prehistoric Period is described as the time from 8,000 to 1,300 BP. This is synonymous with the Early, Middle, and Late Archaic and early Woodland periods along the Missouri River farther to the east. This period includes Mummy Cave, Oxbow, McKean, Pelican Lake, Yonkee, Sandy Creek, and Besant type projectile points. During this time, people hunted bison and many other species of animals. Late in this period, pottery becomes part of the archeological record at some sites. The bow and arrow were also invented late in this period.

The Late Prehistoric Period runs from 100 AD to Historic times. Bison hunting was the main means of procurement and communal hunting was practiced. This period is similar to the Late Prehistoric and Protohistoric periods described for the Central Plains.

The Historic Period is marked by written records. The eastern Montana area is inhabited by Gros Ventres (or Atsina), Piegan (or Blackfoot) and Assiniboine. Much later, the Chippewa and Cree people arrived at the Rocky Boys Reservation.

The Historic Period is also marked by the travels of Lewis & Clark up the Missouri River. Much has been written about this expedition in both popular and scholarly journals. The Historic Period also includes the fur trade, ranching, railroads, the homestead era, and the Great Depression. The fur trade is highlighted by the construction of many fur trade posts and forts. Fort Galpin was constructed about 12 miles above the confluence with the Milk River in 1862. Fort Copeland was constructed in 1865 at the confluence of the Milk River and the Missouri. Fort Peck was built in 1866, near the current site of the town of Fort Peck. Fort Peck also served as an Indian Agency from 1873 to 1879. Fort Kaiser was constructed in 1885, immediately downstream from the confluence of the Milk and Missouri Rivers (near the site of the defunct Fort Copeland).

All of these fur trade posts were in commission for at least one or two years and a few continued for several decades. Ranching was also part of the historic era. Cattle and sheep ranchers settled in eastern Montana in the late nineteenth and early twentieth centuries. The construction of the Great Northern railroad in 1887 and the Chicago, Milwaukee, St. Paul, and Pacific railroad in 1905 further emphasized ranching. The railroad companies provided the means for European immigrants to settle much of the land on either side of the route. These companies also encouraged settlement with somewhat exaggerated descriptions of the land in the eastern part of the state. Homesteading began around 1900 and continued with periods of plentiful rainfall until 1916. At that point, in time, rainfall amounts declined on the northeastern part of the state and many homesteaders gave up farming for other occupations.

In more recent times, the state was hit with the effects of the Great Depression. To counter unemployment, Roosevelt initiated the New Deal plan. His first big project was Fort Peck Dam that began in 1933. This project provided jobs for many of the unemployed. Workers brought their families, since it was impossible to earn enough money to maintain themselves at the dam site and their family at another location. As a result, many boomtowns sprang up around the dam site. More people arrived than the government had anticipated. Up to 10,000 people were employed, either directly or indirectly, at the height of the construction season. Almost all of these boomtowns are gone and the town site of Fort Peck has decreased to just a few hundred people. Today, the eastern Montana-Fort Peck area is working hard to maintain a viable economy with ranching, farming, and tourism as a basis for economic health.

The segment of the Missouri River downstream from the Fort Peck spillway to the Highway 85 bridge in North Dakota has the potential to contain many types of cultural sites. These could include prehistoric campsites, procurement areas, sacred areas, stone effigies, early fur trading forts, historic homesteads, sites associated with railroads (bridges, abutments, graded lines), and sites associated with farming and ranching.

Although most of the Corps' land surrounding Fort Peck Lake has not been surveyed for cultural sites, known sites consist of lithic (stone artifact) scatters, campsites, tipi rings, and historic structures. The town site of Fort Peck has many buildings that are listed on the National Register of Historic Places (NRHP). As mentioned earlier, Fort Peck Dam and powerhouse are listed on the NRHP. The Fort Peck Dam is under consideration for National Historic Landmark status.

The Corps funded a cultural site inventory within the project vicinity, approximately 200 miles of the Missouri River below Fort Peck Dam. The contractor surveyed lands within 150 feet of the Missouri River along both banks in order to identify cultural "features." The "features" of a site help to determine a site's significance with regard to the Natural Historic Preservation Act of 1966. "Features" are specific activity areas that have become part of the historic or prehistoric record. Features include such things as hearths, ash lenses, post molds, cache pits, root cellars, or cairns (a pile of rocks to mark a special area or part of a trail). Many other aspects of a site would qualify as a feature as well: a grain bin, a pump house, a stone or brick walkway, a windmill, a stone circle, or a tipi ring.

5.3.2 Garrison River Segment – Segment 4

Below Garrison Dam, the Missouri River flows approximately 87 miles in a south-southeasterly direction, passing the cities of Bismarck and Mandan, North Dakota before entering Lake Oahe. Significant tributaries include the Knife River near Stanton, North Dakota and the Heart River just upstream of the Lake Oahe delta and downstream of Mandan.

Within the Garrison River Segment, the flood plain terraces form a complex of different low-lying landforms, many at an elevation within three feet above the river. This segment is also restricted to one main channel with very few side channels, old channels, or oxbow lakes.

5.3.2.1 Physical Resources (Garrison River Segment)

5.3.2.1.1 Climate/Meteorology (Garrison River Segment)

The region has a high latitude continental climate where there is little natural shelter from the climatic extremes. Winters are often long and cold with occasionally severe blizzards. Cold spells with temperatures below zero for several days are not unusual (USACE, 1978). Summer temperatures near or above 100 degrees F are not uncommon and clear to partly cloudy conditions prevail with 80-percent frequency during this season (USACE, 1978). The frost-free growing season averages 140 days per year and due to the northern latitude, long hours of sunlight occur in the summer months.

During the summer season, thunderstorms bring a large share of the area’s annual precipitation with 75-percent of the area’s precipitation occurring between April and September. The total annual rainfall averages between 14 and 15 inches per year (USACE, 1978).

5.3.2.1.2 Geology (Garrison River Segment)

The following summary is taken from Appendix B of Biedenharn (2001) quoting the *Geologic Map of Southwest North Dakota* (Blueme, 1980). The surface geology in the Garrison River Segment is often incongruent with the bedrock formations since more recent sediments overlap and conceal the bedrock in many places. The bed load of the river (alluvium/mud, sand, and silt) extends generally over the entire riverbed, changing in thickness and coverage with the weather and the seasons. The glacial deposits overlying the Fox Hill Formation (shale and sandstone) is observed mainly within the first 10 mi. downstream from Garrison Dam and then occasionally throughout the segment. The Bullion Formation occurs in the next 40 mi. (RM 1380 to 1340), replaced at the surface occasionally by glacial deposits, and the Tongue River Formation around RM 1379. The Tongue River Formation (sandstone, shale, and lignite) extends for the next five miles downstream and then sporadically until the end of the segment. The Tongue River Formation is replaced at the surface by the Cannonball Formation around RM 1344, which is interrupted occasionally by the Bullion and the Tongue, Formations. The Hell Creek Formation can be observed from RM 1312 until RM 1305 at Bismarck, which marks the end of the segment.

5.3.2.1.3 Soils (Garrison River Segment)

Channel materials are primarily sands with occasional outcrops of gravel. Gradation analysis in the reach indicates bed materials in the Garrison reach are essentially devoid of fines (less than 0.063 mm). The average bed D_{10} (diameter) for the entire reach is about 0.20 mm (Biedenharn, 2001).

As would be expected in a region with a semiarid climate, the surrounding soils generally have developed some alkalinity and zones of sulfate and or carbonate deposition. Calcite and salt leaching are soils phenomena familiar to residents in the area (USACE, 1978). The region’s glacial history has left large expanses of soils derived from glacial till, lakes, and morainal (stone/rock) material as well as glacial meltwater and fluvial (riverine) sediments. The consistently high winds of the region lead to the development of soils on wind modified and/or derived materials. This is especially true of soils from the Pleistocene Loess deposits (USGS, 1978).

The flood plain environment of the Missouri River in this segment can be divided into three terraces ascending upward from the river. Havre-Banks and Lohmiller-Havre soils occur on the flood plain with the sandier, less fertile soils closest to the river. As distance from the Missouri River increases, the soils become more fertile and river related disturbances are less evident. These conditions are responsible for the diversity of species and the montage of communities represented on the flood plain (USACE, 1978).

5.3.2.1.4 Air Quality (Garrison River Segment)

The EPA Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards for six principal pollutants, called “criteria” pollutants. They include carbon monoxide, nitrogen dioxide, ozone, lead, particulates, and sulfur dioxide. For North Dakota, including all counties within which actions could take place, all parameters are in attainment of the air quality standards (USEPA, 2006).

5.3.2.1.5 Aesthetics (Garrison River Segment)

The initial visual impression of the prairie landscape surrounding the Missouri River below the Garrison Dam is one of open rolling plains and undulating rises. The horizon, horizontal line, and the expansive sky are dominant landscape elements (USACE, 1978). The areas of remaining river flood plain are very pleasing scenically in North Dakota. Heavily wooded, the flood plain is unique visually because horizontal lines do not dominate it and because some canopied relief from the surrounding "wide open spaces" is afforded (USACE, 1978). The river below Garrison Dam has remained in a near natural state, except for some bank stabilization, and flows through forested bottomland typical of the land before the impoundment of Lake Sakakawea (USACE, 1994).

5.3.2.1.6 Hazardous, Toxic, and Radioactive Waste (HTRW) (Garrison River Segment)

The scope of investigation was not designed to delineate the extent of contamination from any particular site, but strictly to identify known areas of contamination in a database search. Findings for the Garrison River Segment were very limited and included in the project GIS, enabling the Corps to avoid known areas of contamination in the subsequent phases of the planning site-specific projects.

5.3.2.2 Water Resources (Garrison River Segment)

5.3.2.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment)

Releases from Garrison Dam are generally lowest in the spring and fall and highest in the winter and summer. The channel capacity below Garrison Dam is approximately 60,000 cfs. Maximum daily winter releases from Garrison Dam necessary to limit downstream flooding are just over 30,000 cfs. Winter releases are usually cut back to near 18,000 cfs when the river first freezes in December. Releases are normally reduced to about 20,000 cfs by mid-March as the demand for power declines. During non-drought periods, spring and fall average monthly releases range from 20,000 to 30,000 cfs, or higher during flood evacuation periods. Flows are lowest in late summer and early fall, but normally exceed 10,000 cfs. Water releases from Garrison Dam are highly variable on a daily basis because of the fluctuations in power demand. Known as "power peaking," these daily variations in flow cause daily water surface level fluctuations.

Daily variations in this segment are much higher than in the Fort Randall River Segment, ranging from nearly 2 feet at the Stanton USGS gage, to approximately 0.6 feet at Bismarck. Peak timing appears to occur from 11:00 AM to 5:00 PM, but may require several additional hours to subside. The energy gradient of the daily surge is more erosive than observed in the Fort Randall Segment, possibly due to the relative narrowness of the channel. Bars in the upper portion observed at low water are chiefly composed of clean cobbles 2 to 12 inches in diameter, showing strong evidence of frequent violent scouring of the streambed. The distance affected by channel scouring below Garrison Dam appears to be approximately 25 miles, which approximates the length of Biedenharn's upper two geomorphic reaches.

Biedenharn (2005) divides Garrison into six geomorphic reaches, which differ in local geology, plan form, and balance between erosion and deposition. Three reaches, totaling approximately 31 river miles, are highly erosional and unsuited to construction and maintenance of ESH. Islands and bars forming in these reaches rarely persist.

Table 5-8: Geomorphic Erosive and Depositional Reaches for Garrison River Segment*

Geomorphic Reaches	Erosion		Deposition		Balance	
	Bank	Bed	Bank	Bed		
(RM)	(1980-1998) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)	Bank	Bed
GR 1 1390-1376	-140,353	-142,828	7,486	34,762	-132,867	-108,066
GR 2 1375-1363	-85,192	-411,339	28,852	142,302	-56,340	-269,037
GR 3 1362-1363	-53,114	-72,115	104,450	114,648	51,336	42,533
GR 4 1352-1349	-59,943	-434,067	204,528	28,510	144,585	-405,557
GR 5 1339-1324	-62,131	-92,694	3,226	97,328	-58,905	4,634
GR 6 1323-1315	-64,399	-92,694	3,226	97,328	-61,173	4,634

* (Data excerpted from Biedenharn 2005)

To discourage terns and plovers from nesting too near the water during the mid-May through August nesting period, daily releases are usually fixed at a constant rate in the 19,000- to 26,000-cfs range with hourly peaking limited to 6 hours a day near 30,000 cfs. During prolonged droughts, daily average releases for the birds may be in the 10,000- to 15,000-cfs range with power peaking restricted even further. During large system inflow years, large flood control evacuation release rates are necessary and nesting flow restrictions are lifted.

5.3.2.2.2 Degradation, Aggradation, and Erosion (Garrison River Segment)

Degradation of the riverbed below Garrison Dam (RM 1390) occurs primarily in the first 35 miles below the dam. Erosion was greatest before the beginning of power generation in 1956 and began to level off in about 1983 (USACE, 2004c). Grain size has increased over the years in the 25 miles below Garrison Dam, thus indicating a gradual armoring of the channel. The riverbed 25 to 50 miles below the dam continues to degrade, but the rate of degradation decreased after the mid 1970s. Since 1960, erosion of the streambed in this area totals about 4 feet.

The channel widths for the first 20 miles below Garrison Dam have remained fairly constant. Only near the mouth of the Knife River (RM 1378) is the channel width decreasing. This decrease is due to a buildup of Knife River deposits resulting from a reduction in flood flow currents. Farther downstream, the channel is widening. Stream bank erosion rates were 48 acres per year from 1978 to 1982 for the 87-mile segment and have declined steadily since (USACE, 2004c). Bank erosion continues in the segment, but has actually declined since dam closure in 1953, probably due to the reduction in high spring and early summer flows. Before 1953, bank erosion averaged 200 to 250 acres per year (USACE, 2004c). Since 1953, the loss has been about 60 acres per year. A study of erosion rates during the 1990s showed the rates to be highly variable, ranging from 35.1 to 86.5 acres per year (USACE, 2004c). In this segment, the Corps constructed some bank protection in the 1980s, which has limited the erosion in most reaches of this segment (USACE, 2004c).

5.3.2.2.3 Water Quality (Garrison River Segment)

This segment of the Missouri River has remained in a near-natural state, except for some bank stabilization programs. The river below Garrison Dam flows through forested bottomland typical of the land before impoundment. The segment is dominated by cold, clear water releases from Lake Sakakawea that can support trout and salmon year round (Corps, 1994l). There are, however, fish consumption advisories relating to mercury contamination within this river segment (USACE, 2004).

5.3.2.2.4 Water Use (Garrison River Segment)

There are 123 water supply intakes located in the Garrison River Segment. These include 6 power plants, 3 municipal water supply facilities, 6 industrial intakes, 77 irrigation intakes, 28 domestic intakes, and 3 public intakes. The 6 power plants have a gross generating capacity of 3,147 MW. The municipal water supply facilities serve a population of approximately 70,000 persons (USACE, 2004).

5.3.2.3 Biological Resources (Garrison River Segment)

5.3.2.3.1 Habitat Delineation Results (Land Cover/Vegetation Classification) (Garrison River Segment)

The Garrison River Segment begins at Lake Oahe at RM 1303.8 and continues to Garrison Dam at RM 1389.9, a navigation distance of 86.1 river miles. Riverine habitat area within the high banks is approximately 24,500 acres, translating to 266 acres per river mile with an average width of 2,194 feet. This average is only slightly above the lower channel width threshold for formation and retention of sandbars (Biedenharn 2005). Riverine habitat area increased by 72 acres between 1998 and 2005, which could be accounted as part of the bank erosion that is likely complicit in the nearly 800-acre loss of Non-ESH Sand. The lower 13 miles (beginning at approximately RM 1315.0) of the segment appears to be backwatered by the Lake Oahe pool. Measured acreage values for the habitat types delineated from the 2005 and 1998 aerial photography, as described in Appendix B, are listed in Table 5-9 (see summary of Appendix B, Habitat Delineations, in Section 3.1 of this document).

All lower elevation bar and bank habitat types (e.g., ESH, Non-ESH Sand and Wetland Matrix) have greatly declined since 1998 (particularly in the upstream reaches of the segment), while habitats representing deposition have increased (e.g., Shallow Water and DSP) in reaches 3, 5 and 6 of the segment. A 50% increase in forest type suggests that bed erosion may have been more important than bank erosion during the period in some areas because the bank-edge forest was retained while herb/shrub/sapling stands succeeded sufficiently to be classified as forest in the 2005 photos.

ESH declined by 72% for the Garrison River Segment between 1998 and 2005. While erosion played a part, upland vegetation encroachment accounts for most losses in the evidenced by the 20% increase in Herb/Shrub/Sapling habitat primarily in the depositional reaches. Overlay of the interchannel sandbars shows high positional coincidence between the two years, although the portions sufficiently elevated to support nesting have drastically declined. Table 5-10 presents the disposition of the 2,066 acres of ESH delineated in the 1998 photos.

Table 5-9: Habitat Acreage Summary and Comparison for Garrison River Segment: 1998 and 2005

Habitat Type	2005 Acres	1998 Acres	Change in Acres	2005 % of Total	1998 % of Total
Open Water	12,237	12,951	(715)	49.9%	53.0%
ESH	588	2,066	(1,478)	2.4%	8.5%
Herb/ Shrub/ Sapling	4,977	2,798	2,179	20.3%	11.5%
Non- ESH Sand	480	1,306	(826)	2.0%	5.3%
Forest	927	650	276	3.8%	2.7%
Agriculture	94	29	65	0.4%	0.1%
Wetland Matrix	822	1,058	(236)	3.4%	4.3%
Shallow Water	2,137	1,856	281	8.7%	7.6%
Daily Inundated Sand	2,257	1,711	546	9.2%	7.0%
Grand Total	24,518	24,427			

Table 5-10: Disposition of Original ESH Lost from 1998 to 2005: Garrison River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	585	28%	ESH lost to erosion and carried down river
ESH	360	17%	ESH retained from original 1998 area
Herb/ Shrub/ Sapling	535	26%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	96	5%	Became terrestrialized or surrounded by forest
Forest	11	1%	Natural growth of shrubs into forest-sized trees
Wetland Matrix	60	3%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	173	8%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand Plain	247	12%	ESH redistributed to low plateaus by daily high flows from power peaking at Garrison Dam
Grand Total	2,066		

5.3.2.3.2 Wildlife (Garrison River Segment)

The 90-mile segment between Garrison Dam and Lake Oahe lies at the transition zone of eastern and western bird species and therefore supports a relatively diverse bird community. More than 50 species of breeding birds depend on the wetland riparian habitat in the corridor, along with 17 species of reptiles and amphibians (USACE, 2004). The extensive riparian cottonwood forests that historically bordered the river have diminished since dam closure, largely because of the conversion of land for agricultural uses. In addition to land use impacts, cottonwood acreage will continue to diminish as mature stands age and convert to stands of mixed species. Canada geese (more than 2 pairs per mile of river) rely on stable flows in this segment during mid-March to mid-May for successful nesting. From late-October to December, several hundred thousand migrating waterfowl, including over 180,000 Canada geese, use sandbars, wetlands, and croplands (USACE, 2004). Waterfowl often remain in the area until the river freezes (typically between November and December), and some continue to utilize the open water below the dam all winter.

Sandbar habitat for migratory waterfowl varies from 18 acres at 30,000 cfs to 3,237 acres at 10,300 cfs, with flows in most years producing between 135 and 765 acres (USACE, 2004). Shallow water areas provide night roosting for as many as 30,000 migrating sandhill cranes during September and October. There were eight bald eagle nests between Garrison Dam and Upper Lake Oahe in 1998 (USACE, 2004). The current nests are located in a stand of riparian cottonwoods that is 12 to 20 feet above the normal river level. Bald eagles also winter along this segment, with total numbers exceeding 100 birds (USACE, 2004).

5.3.2.3.3 Fish and Invertebrates (Garrison River Segment)

The Missouri River channel downstream of Garrison Dam has remained in a near-natural state, except for some bank stabilization. Backwater and side channel habitat is common, and numerous sand bars and deep pools are present. The segment is dominated by releases of cold and clear (sediment free) releases from Garrison Dam. In the tailwaters, water temperatures are cold enough to support stocked populations of trout and salmon. Walleye, sauger, white bass, and channel catfish are also common in the tailrace. Temperature and turbidity increase progressively downstream because of local runoff and bank erosion. In the downstream sections of the segment, carp, white bass, yellow perch, and river carpsucker dominate the species composition. The lower portion of the segment also supports substantial populations of shovelnose sturgeon, blue sucker, sauger, walleye, shorthead redhorse, and channel catfish. Pallid sturgeon may occur in this segment (USACE, 2004).

The substrate of sandbars is home to a number of invertebrate species, the primary food source for the piping plover. In general shoreline habitat provides more diverse invertebrate assemblages that are more adaptable to stochastic events (Angradi, Schweiger and Bolgrien 2006). In one study, Plovers foraged for invertebrates in all available habitats including dry sand, on vegetation, and in both moist and saturated sand, but spent the majority of their time foraging in moist sand. While Diptera (flies) were the most abundant invertebrates collected during sampling, Coleoptera (beetles) were most numerous in plover fecal samples. This finding is aligned with prior study results, suggesting that beetles are typically the main food source for plovers. Other taxa captured in this study included Hemiptera, Homoptera, Hymenoptera, Odonata, Orthoptera, and Araneae (Le Fer, 2006). A study analyzing macroinvertebrate diversity, density, and composition finds that the current communities are in general both diverse and densely populated within the project area (Angradi et. Al 2009).

5.3.2.3.4 Federally Listed Species and Habitats (Garrison River Segment)

Four different species are listed as threatened or endangered near the Garrison River Segment in North Dakota. The detailed life histories for these species are incorporated by reference from the original Master Water Control Manual Review and Update Final EIS (USACE, 2004).

Piping Plover (*Charadrius melodus*)

The entire Garrison River Segment has been designated critical habitat for the piping plover http://www.fws.gov/mountain-prairie/species/birds/pipingplover/ndunit11.pdf). The designated area is from approximately RM 1389 near Garrison Dam to RM 1302 downstream of Bismarck, ND. Appendix B summarizes relevant life history and protected status of the piping plover.

Least tern (*Sternula antillarum*)

No critical habitat has been designated for the least tern within the Garrison River Segment. Appendix B summarizes relevant life history and protected status of the least tern.

Whooping crane (*Grus americana*)

Migrating whooping cranes have been observed to roost in this section of the river in recent years (USACE, 2004).

Pallid Sturgeon (*Scaphirhynchus albus*)

None of these Recovery-Priority Areas include the Garrison River Segment.

5.3.2.4 Socioeconomic and Historic Resources (Garrison River Segment)

5.3.2.4.1 Land Use (Garrison River Segment)

Land uses on the flood plain include farming, grazing, residential home sites, industrial, and feedlot complexes (USACE, 1978). Burleigh, Morton, Oliver, McLean, and Mercer Counties border the Garrison River Segment. The land use is predominantly agricultural with a total of 1,020,900 acres of cropland in these first-tier counties along this segment (USACE, 2004). There are 123 water supply intakes in the segment, providing water for irrigation (77), municipal (3 intakes serving 69,960 people), domestic (28), industrial (6), and public (3) uses (USACE, 2004). This segment includes Bismarck, the capital of North Dakota and North Dakota's second-largest city, which had over 55,000 residents as of the 2000 census. It is directly across the Missouri River from Mandan, North Dakota with approximately 17,000 residents.

5.3.2.4.2 Population (Garrison River Segment)

Counties comprising the Garrison River Segment (Burleigh, Morton, Oliver, McLean, and Mercer Counties) have had a population increase since 1970, the only portion of the upper Missouri River area to do so. A significant 30 percent increase from 1970 to 1980 (69,246 to 90,281) was followed by a 4 percent increase from 1980 to 1990. The 2000 Census (U.S. Bureau of the Census, 2000) reports the population for these five counties continued to increase to 114,739. The 2004 update estimated the population at 117,048 (U.S. Bureau of the Census, 2006) representing an increase of about 9 percent since the 1990 census. Burleigh County includes the City of Bismarck, accounting for the much higher population density there (42 persons per square mile) than for the other counties (13 persons per square mile for Morton, 8 for Mercer, 4 for McLean, and 3 for Oliver County).

5.3.2.4.3 Transportation (Garrison River Segment)

This region of North Dakota, including Bismarck, is served by one U.S. highway, U.S. 83, and one interstate highway, Interstate 94, which runs through the northern part of Bismarck. Some of the largest North Dakota cities included in this area are Underwood, Washburn, Stanton, Hazen, Beulah, Wilton, Bismarck, Mandan, and New Salem. The Bismarck Municipal Airport is the main airport of western North Dakota. The North Dakota Department of Transportation’s most recent published automatic traffic recorder (ATR) data provides data at a number of locations within the Garrison River Segment (NDDOT, 2005). Table 5-11 provides a summary of average daily traffic (ADT, number of vehicles per day) on surrounding roads with permanent traffic counters. Data was reported segregating the number of trucks from the total number of vehicles.

Table 5-11: ND DOT Automatic Traffic Recorder (ATR) Data

ATR Location Numbers	Route No	County	Location	2004 ADT	% Change 2003-2004	2004 Commercial Trucks	% Change 2003-2004
249	SR 1804	McLean	Garrison	1178	-2.5	110	6.8
307	US 83	McLean	Washburn	3984	1.9	550	0.7
271	SR 200	Mercer	Golden Valley	373	2.6	-	-
275	SR 31	Oliver	Hannover	500	-0.6	63	3.3
283	US 94	Morton	Bismarck	18782	6.8	1951	3.9
225	US 94	Burleigh	Sterling	491	-5.4	45	-
605	US 94	Morton	Mandan	20158	0.0	-	-
601	US 83	Burleigh	Bismarck	11961	0.9	-	-

Source: North Dakota Department of Transportation (NDDOT). 2005. North Dakota 2004 Traffic Report.

5.3.2.4.4 Employment and Income (Garrison River Segment)

The primary 2000 employment sectors in the first-tier counties for this segment were educational, health, and social services (21 percent); agriculture (16 percent); and retail trade (11 percent) (U.S. Bureau of the Census, 2000). Transportation, warehousing, and utilities (10 percent) employed a greater proportion of the population than the other first-tier counties (U.S. Bureau of the Census, 2000).

The most recent economic survey published by the Census Bureau (1999) estimated the median household income for Burleigh, Morton, Oliver, McLean, and Mercer Counties to be $41,309, $37,208, $36,650, $32,337, and $42,269 respectively (U.S. Bureau of the Census, 2006). Statewide median household income for North Dakota (1999) was $34,604 (U.S. Bureau of the Census, 2006).

The most recent Poverty Status figures (2003) estimated that 8.5, 9.5, 8.9, 11.6, and 7.4 percent of individuals in Burleigh, Morton, Oliver, McLean, and Mercer Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). Statewide, 10.5 percent of residents of North Dakota were considered below the poverty level (USDA, 2006).

5.3.2.4.5 Recreation (Garrison River Segment)

This region of North Dakota, including Bismarck, is bisected by one U.S. highway, U.S. 83, and one interstate highway, Interstate 94, which runs through the northern part of the city. Access to the Missouri River along the segment is mostly limited to a small number of public access points, with the exception of the area surrounding Bismarck, ND. As the river approaches and proceeds through Bismarck, there is a major increase in accessibility, both public and private. Table 5-12 lists the recreation facilities along this segment.

Table 5-12: Missouri River Recreation Sites: Garrison River Segment

Site Name	Boat Ramps	Boat Trailer Parking +(Slips)	Camp Sites (RV, Camper, Tent)	Swimming Beach
Garrison Dam Downstream R.A.	2	100+	114	Yes
Riverdale WMA *	None	None	14	No
Stanton (UPA) Boat Ramp**	1	30	None	No
Washburn Boat Ramp	2	40	None	No
Don Steckel Boat Landing	1	10	None	No
Eagle Park	Canoe	None	None	No
Hoge Island Park **	1	100	None	No
Misty Waters Marina	1	60+(204)	None	No
Kneifel Boat Landing	1	30	None	No
Sanger Boat Ramp	1	15	15	No
Little Heart Bottom R.A.	1	100	None	No
Graner Bottom/Graner Park R.A. (1)	2	50+	45	No
The Desert (Kimball Bottom R.A.)	1+Beach	Hundreds	Yes	Yes
General Sibley Park	1	50	120	No
Fox Island Boat Area	1	75	None	No
Grant Marsh Boat Launch	1	75	None	No
South Port Marina	1	(376)	None	No

RA = Recreation Area, WMA = Wildlife Management Area. Note: Entire segment is within North Dakota.

(1) One boat ramp inaccessible due to low water level

* Updated 2009. Sources for updated information: Bailey, personal communication, 2009; Halstead, personal communication, 2009.

** Updated 2010. Sources for updated information: Gangl, personal communication, 2010; Smith, personal communication, 2010; Thompson, personal communication, 2010; Weixel, personal communication, 2010; NDGFD, Missouri River Boating/Fishing Access Sites, accessed April 19, 2020 at http://www.gf.nd.gov/.

Note: Entire segment is within North Dakota.

The upper reach of the segment--just downstream of Garrison Dam--provides camping opportunities at two very large campgrounds. These campgrounds also include boat ramps and other facilities. The reach that occupies most of the segment and lies between the campgrounds and the northern outskirts of Bismarck has limited access, which consists mostly of boat ramps with limited parking. In the downstream reach, located near Bismarck and Mandan, there are numerous boat ramps and marinas, and an area south of Bismarck known as "the Desert," which is a focal point for beach- and water-based recreation and off-road vehicle use and is discussed below.

Signage educating the public on the protected least terns and piping plovers was observed at only three locations in the segment: the Garrison Dam Downstream Recreation Area, the Garrison Dam Downstream Campground, and the Washburn Boat Ramp. Discussions with local boaters confirmed that sandbars are commonly used as beach areas and swimming access. The boaters were also aware that least terns and piping plovers use the sandbars for nesting.

One activity observed in this segment not observed elsewhere, is a canoe drop off and pick-up service (canoe livery service). The proprietor indicated that she operated the only such service on the river for the past six years, but that another outfitter may have recently started in Pick City, ND. The proprietor indicated that the volume of canoe trips using this service averages less than one trip per week.

In addition to the public boat ramps along this segment, there are a number of private marinas. For example, one new marina on the northern (upstream) end of Bismarck's left descending bank was recently built as a component of a residential complex and has dock space for more than 300 boats. Other newly constructed waterfront residential complexes, not quite as extensive, have also incorporated docks and a private marina in the area south of Bismarck with dock space for approximately 200 boats.

There are also many private docks adjacent to homes along the river north and south of Bismarck, and the incidence of private docks increases as the river approaches Bismarck. Overall, the concentration of marinas, private docks, and boat access occurring in and around Bismarck is the greatest concentration of boating activity observed along the riverine segments.

Kimball Bottom Recreation Area, locally known as the Desert, is approximately a 10-minute drive south of central Bismarck. The inland section of the park is a combination of woods, sand dunes, and trails that are used for camping, all-terrain vehicle use, and dirt biking. There is also a concrete ramp with boat trailer parking area. The riverfront at the Desert is a unique sandy beach, often more than 100 feet wide and approximately one-half mile long. The beach is easily accessible. Visitors are able to drive their cars, trucks, and boat trailers up to the water's edge, and hundreds of vehicles may be on the beach on summer weekends. The Desert's sandy beach is the largest recreation attraction in Bismarck and the surrounding area. Discussions with users indicate that on summer weekends, the entire stretch may be lined with cars and trucks and the water filled with jet skis and other watercraft. The beach is used for swimming, beach activities such as sunbathing and volleyball, and access to sandbars.

Discussions with Bismarck Department of Parks and Recreation personnel indicate that campers come from as far away as Jamestown, ND (100 miles) to enjoy the unique recreation opportunities at the Desert. These discussions also indicate that visitation at the Desert has been increasing over the years. On summer weekends when water conditions make sandbars accessible, as many as 4,000 people have been estimated using the beach and adjacent sandbars at the Desert (City of Bismarck Department of Parks and Recreation, personal communication, 2007).

Bismarck is also home to four colleges, which influences the level of recreational use of the river, especially at the Desert. Observations and discussions with local Parks and Recreation Department personnel indicate that the unique river-recreation opportunities at the Desert draw users from across the state and make this location the single most intensively used recreation area among the segments assessed in this analysis.

At the upper end of the segment, water temperatures are cool enough to support a year-round trout and salmon fishery and the location is popular with anglers. Other species frequently caught along the segment include channel catfish, walleye, sauger, and white bass. Because of lower Lake Oahe levels and the drought-induced change from a lake environment to a river-like environment downstream from Bismarck, river fishermen adjusted their fishing patterns by moving farther downstream into the upper reaches of Lake Oahe (USACE, 2004). White-tailed deer is the most sought after big game species. Characteristics, amount, timing, and locations of various recreational activities in this segment, including fishing, hunting, pleasure boating, picnicking, camping, and bird watching, are provided in Appendix D. In 2006, among person at last 16 years old (adults) recreating in North Dakota, residents of North Dakota accounted for approximately 95 percent of fishing days, 80 percent of hunting days, and 64 percent of wildlife watching days away from home. In 2006, expenditures in North Dakota related to recreational trips were approximately $41.00 per day for fishing, $53.90 per day for hunting, and $18.76 per day for wildlife watching. Trip-related expenditures in Montana for these three activities totaled over $116 million (USFWS/USCB, 2008).

5.3.2.4.6 Noise (Garrison River Segment)

The project area includes very isolated areas where ambient noise levels are typical of a natural/undisturbed setting as well as residential, industrial, and agricultural areas with varying degrees of associated noise. The primary sources of noise include everyday vehicular traffic along nearby roadways and associated with agriculture (typically between 50 and 60 dBA at 100 feet) and maintenance of roadways, bridges, and the other structures (typically between 80 and 100 dBA at 50 feet).

Noise sources affecting the public in a residential area such as Bismarck/Mandan are dominated by transportation sources such as buses, delivery and construction trucks, private vehicles, and emergency vehicles. Seasonally, noise associated with water-based recreational activities (i.e., powerboat as well as personal watercraft) can be a noticeable source of ambient noise. Noise from occasional commercial aircraft crossing at high altitudes is indistinguishable from the natural background noise of the city. Noise ranging from about 10 dBA (A-weighted sound level measured in decibels) for the rustling of leaves to as much as 115 dBA (the upper limit for unprotected hearing exposure established by the Occupational Safety and Health Administration) is common in areas where there are sources of industrial operations, construction activities, and vehicular traffic.

5.3.2.5 Environmental Justice (Garrison River Segment)

According to the 2000 Census, the ethnic mix of residents in Burleigh, Morton, Oliver, McLean, and Mercer Counties, North Dakota is presented in Table 5-13. The contrasting percentage of Native Americans in Roosevelt County relative to the other two counties is a result of the Fort Peck Reservation encompassing approximately three-fourths of Roosevelt County (USACE, 2004).

Table 5-13:Race in Garrison River Segment: First Tier North Dakota Counties

County	African American	Asian	Hispanic	Native American	White
Burleigh	0.3 %	0.4 %	0.7 %	3.3 %	95 %
McLean	0.0 %	0.1 %	0.9 %	5.9 %	92.5 %
Mercer	0.0 %	0.3 %	0.4 %	2.0 %	96 %
Morton	0.2 %	0.3 %	0.6 %	2.4 %	95.8 %
Oliver	0.1 %	0.1%	0.6 %	1.3 %	97.6 %

Source: http://factfinder.census.gov

Low-income populations are identified using statistical poverty thresholds from the Bureau of the Census Current Population Reports, Series P-60 on Income and Poverty (U. S. Bureau of the Census, 2000a). In identifying low-income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The threshold for the 2000 census was an income of $17,761 for a family of four (U.S. Bureau of the Census, 2000a). This threshold is a weighted average based on family size and ages of the family members. As stated previously in Section 5.2.4.4, the most recent Poverty Status figures (2003) estimated that 12.7, 13.1, and 14.6 percent of individuals in McCone, Richland, and Valley Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). An estimated 26.2 percent of the families in Roosevelt County were considered below the poverty level (U.S. Bureau of the Census, 2006).

5.3.2.6 Cultural and Paleontological Resources (Garrison River Segment)

According to the Master Water Control Manual Final Environmental Impact Statement, archaeological surveys have resulted in the discovery of 1,402 archaeological sites in and adjacent to Lake Sakakawea. These include 85 historic sites and 1,317 prehistoric sites. The historic sites include steamboat wrecks, 60 homesteads and cabins, 7 historic towns, 2 trading posts, and other historic sites such as churches. The prehistoric sites include 7 earthlodge villages; 2 Plains Woodland burial mounds; 225 rock alignment sites (rock cairns and stone circles); 200 lithic (stone artifact) debris sites; 27 eagle-trapping pits; and hearth, cache pit, and bison jump sites. Only 120 of these sites are located in the reservoir pool. Lake Sakakawea project lands also contain Traditional Cultural Properties.

Paleontological resources are also found in this vicinity. Petrified sequoias, mammoth, extinct bison species, and leaf fossils are amongst the many types of paleontological specimens preserved within the Lake Sakakawea project lands. The North Dakota National Guard assisted the Corps and the State Paleontologist transport an entire sequoia tree trunk to the State Capital grounds in Bismarck, North Dakota, to be a part of the State fossil exhibit.

5.3.3 Fort Randall River Segment - Segment 8

The 2003 BiOp Amendment segregates this continuous reach into two separate segments (Fort Randall River Segment and Lewis & Clark Lake Segment) with separate ESH goals. However, most resource agencies and reference materials do not segregate these segments, but describe and quantify resources in the Fort Randall River and Lewis & Clark Lake Segments as if the two segments were one contiguous segment. Consequently, some of the affected environment discussion for the Fort Randall River Segment will be limited to exactly that segment as defined in the 2003 BiOp Amendment and some of the disciplines will be combined to eliminate redundant discussions. When combined, the information will be presented in Section 5.2.3 and referenced where appropriate in Section 5.2.4 for the Lewis & Clark Lake Segment. This segregation in the outline form is also carried through to allow segment-specific consideration of environmental consequences in Section 6.

The Fort Randall River Segment extends from Fort Randall Dam (RM 880) to just upstream of the Niobrara River confluence (RM 845) and so is included in the 39-mile District of the MNRR (RM 880 to Running Water, RM 841). This segment is managed by the NPS as a primitive recreational area to protect its wildlife habitat, natural landscapes of the Lewis & Clark National Historic Trail, and cultural resources. It also provides a primitive recreational experience.

The following description of the general setting of the segment is derived from the NPS's 1997 General Management Plan and Final Environmental Impact Statement for the MNRR (NPS, 1997). This river segment is approximately 2,000-3,000 feet wide above the confluence with the Niobrara River, meandering through a valley that varies in width from 5,000-9,000 feet. The banks along this segment tend to restrict flow to one main channel; there are only a few side channels and backwaters (USACE, 2004). Much of the shoreline along the Nebraska banks is composed of forested chalkstone bluffs adjacent to gently rolling to flat agricultural crop and range bottomland. The shore is occasionally bordered by cottonwood forests interspersed with several concentrated seasonal cabin developments. On the South Dakota side, the valley bottom is up to one mile wide and is bordered by forested chalkstone bluffs and rolling hillsides. Agriculture and grazing of the bottomland are the most common land uses, and this segment receives no significant inflow from tributaries.

5.3.3.1 Physical Resources (Fort Randall River Segment)

5.3.3.1.1 Climate/Meteorology (Fort Randall River Segment)

The summers are hot with temperatures typically vary from highs in the 90s to lows in the 50s and 60s. Strong thunderstorms with gusty winds, hail, and lightning are common at any time of day or night. In winter, temperatures vary widely--as low as -15 F but more typically between 0 F and 30 F.

5.3.3.1.2 Geology (Fort Randall River Segment)

Quaternary river-deposited (alluvial) sand and gravel are the uppermost geologic components beneath the flood plain of the Missouri River throughout the Fort Randall River Segment. These deposits are generally less than 100 feet thick and consist primarily of fine- to medium-grained sand and fine-grained gravel interlayered with lesser amounts of silt and clay. Clay-rich glacial till and fine- to coarse-grained sediments washed out of glaciers and/or alluvium (deposit of sand/mud formed by water) occur in some areas beneath the more recent river deposits. This is more common in ancient valleys (paleovalleys) that cut into bedrock under the Missouri River valley (Biedenharn, 2001). The river's course marks the southern/western terminus of glaciation (NPS, 1997) leaving the South Dakota side of the Missouri River a characteristically glacially smoothed landscape.

Quaternary deposits have been washed away leaving the Cretaceous Pierre Shale as the main outcrop on the South Dakota side. This shale can be found from RM 880 to RM 862, and again from RM 864 to the end of the segment at RM 844. Tertiary deposits (silt, sandstone, and clay) linger and are present farther to the southwest (Biedenharn, 2001).

Wisconsin aged glacial till and loess over Cretaceous Pierre Shale cover the northeast flood plain along the Fort Randall River Segment. Glacial till is present near the riverbank at the beginning of Fort Randall River Segment (RM 880), at RM 862, and again at the end of the segment at RM 844 (Biedenharn, 2001).

The geologic formations of the Nebraska side of the river include (from older to younger): Pierre shale, the White River Group (tertiary mudstones, siltstones, and volcanic ash beds), the Arikaree Group (Miocene soft sandstone, composed mainly of siltstone), the Ogallala Group (interbedded sandstone, siltstone, silt, and sand, which is often cemented by lime). Closest to the river, all Tertiary deposits have been eroded, leaving the Pierre shale either exposed or mantled by Quaternary deposits (Biedenharn, 2001). The dominant Quaternary deposits are stream-deposited (alluvial) clay, silt, sand, and gravel. Quaternary wind-blown silt (loess) and fine sand are also present. Tertiary deposits (silt, sandstone, and clay) overlying Cretaceous Pierre Shale are present from RM 880 to RM 844. Niobrara Formation sandstone outcrops at several places and is present throughout the Nebraska side (Biedenharn, 2001).

5.3.3.1.3 Soils (Fort Randall River Segment)

Channel materials are primarily sands with occasional outcrops of gravel. Gradation analysis of particle in the reach indicates bed materials in the Fort Randall River Segment are essentially devoid of fines (less than 0.063 mm). The average bed D_{10} for the entire reach is about 0.21 mm (Biedenharn, 2001).

As stated in the NPS General Management Plan for this segment of the Missouri River (NPS, 1997), the soils in the area vary from level and nearly level silty and clayey soils on flood plains of the Missouri River and its terraces to undulating to steep loamy and clayey soils on uplands. Most soil types are moderately to well-drained. The Sansarc soil series consists of shallow, well-drained soils formed in residual material from clayey shale on the breaks of the Missouri River. The Inavale soil series consists of deep, somewhat excessively drained soil formed in sandy riverwash material on the Missouri and Niobrara rivers. Silty clay soils on the Missouri River flood plain are deep and poorly drained. Most of these areas support native vegetation and provide wildlife habitat.

Field studies were undertaken in August 2006 to gather physical data (including soil and substrate data) from some of the most productive nesting sites in the Fort Randall River Segment. The objectives of the field survey included the collection of accurate soil data at least tern and piping plover nesting clusters that were used most frequently, particularly those used for nesting and rearing during the 2006 breeding season. Data was also collected from locations that never supported nests, both on separate sandbar islands and on the portions of nesting site islands that had not been used for nesting. These data and the details of the collection are in Appendix B.

The findings for grain size distributions for the Fort Randall River Segment was compared to the Biedenharn et al 2001 dataset. Biedenharn had collected and performed similar mechanical sieve analyses on 631 sediment samples from all segments of the Missouri River. Using the generated data samples (Appendix A in Biedenharn), the particle diameter that represents more than 90% of the substrate material (D_{90}) is medium sand (0.25-0.5mm). The D_{50} (50% of particles finer) was found to be very fine sand. Only 2% of particles were found be larger than 2mm (coarse sand). Based on these data, a finding of particle size distributions with greater than 2% coarse sand or greater would indicate the operation of a concentrating process: the mean percentage of coarse sand and larger particles for samples from locations used for nesting in 2006 was found to be nearly 49%, indicating a concentrating process was at work.

The grain size distributions for nesting sites strongly differ from the non-nesting sites in all grain size categories (49% to 4% coarse fraction), except for medium sand size particles (approximately 27% of each sample). The Biedenharn data indicate that medium sand comprises an average of 25.6% of substrate composition. This difference suggests that materials immediately at and under the surface layer consistent with the most common distributions throughout the river corridor. Also, this finding would be consistent with a finding for the nesting areas that the upper layer had been sifted and the finer fractions removed (as by wind deflation).

The findings indicate that the substrate where most nests occurred is created by wind and surface desiccation. Wind is nearly constant in the river corridor. The desiccation of the surface in well-drained and wind-exposed areas eliminates moisture adhesion between substrate particles, allowing particles to be available for transport. Finer particles are eroded and transported downwind, leaving a pavement-like surface composed of particles sufficiently large to resist wind transport covering a compacted matrix of finer particles.

There were two substrate conditions where nests never occurred: 1) dominantly fine (sugar) sands in well-drained but higher density vegetation areas, and 2) fine sands to silts, found in perennially saturated wetlands. Both of these conditions resist wind erosion and never supported nesting in the data set.

There was no significant visual difference in nesting substrates between naturally occurring nesting islands and the Corps' mechanically created nesting islands. Any substrate differences were due to local differences in drainage, frequency of substrate saturation, and incident wind exposure. This suggests that the source of substrate material may not matter to the development of suitable nesting substrate. If true, this reinforces the importance of the role of wind in creating quality nesting habitat.

5.3.3.1.4 Air Quality (Fort Randall River Segment)

The EPA Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards for six principal pollutants, called "criteria" pollutants. They include carbon monoxide, nitrogen dioxide, ozone, lead, particulates, and sulfur dioxide. Air quality within this segment is generally considered good (NPS, 1997). For South Dakota, including all first tier counties within which actions could take place, all parameters are in attainment of the air quality standards (USEPA, 2006).

5.3.3.1.5 Aesthetics (Fort Randall River Segment)

Visual resources of the MNRR include several scenic vistas of a variety of natural landscapes such as bottomlands, cottonwood forests, wooded draws, forested hills, sand dunes, high-bank islands, tall grass prairie, wetlands, and chalk rock bluffs. These vistas include the Spirit Mound Historic Prairie, Old Baldy, Ionia Volcano, Calumet Bluff, and the Mulberry Bend Overlook (NPS, 2005). There are developed areas in the MNRR ranging from the City of Yankton, South Dakota to seasonal cabins. In addition, while much of the land inside the park boundary is in a somewhat natural state, agricultural practices and influence from the Fort Randall Dam discharges have altered the landscape in the historic flood plain (NPS, 2005).

The terrain surrounding Lewis & Clark Lake offers a wide variety of scenic vistas. The dramatic effect of the chalk bluffs intersected by heavily wooded ravines and the rolling hills of the prairie form an ever-changing background (USACE, 2003). The lake extends upstream from the dam about 25 miles, then changes to a meandering river much as Lewis and Clark knew it. Where the Niobrara River enters the lake, a delta (sediment depositional area) has formed and a marsh/wetland environment has developed (USACE, 2003). In many places, the lake appears to be a sea of wetland grasses and hydrophilic (water-thriving) vegetation.

5.3.3.1.6 Hazardous, Toxic, and Radioactive Waste (HTRW) (Fort Randall River Segment)

A preliminary HTRW investigation was conducted to identify areas within the Fort Randall River Segment that could affect construction activities due to the presence of environmental contamination (EDR, 2006). The scope of investigation was not designed to delineate the extent of contamination from any particular site, but strictly to identify known areas of contamination in a database search. Findings for the Fort Randall River Segment were included in the project GIS enabling the Corps to avoid known areas of contamination in the subsequent phases of the planning site-specific projects.

5.3.3.2 Water Resources (Fort Randall River Segment)

5.3.3.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment)

Releases from Fort Randall Dam vary considerably during the year. Maximum hourly releases for hydropower generation are 45,000 cfs. The minimum hourly release is zero cfs, except during the spring game fish spawning season, when the desired minimum hourly release is 15,000 to 20,000 cfs (USACE, 2004). Spring through fall monthly average releases are usually 20,000 to 36,000 cfs to meet navigation targets downstream. During the mid-May to mid-August nesting season, hourly releases are increased to 36,000 cfs for 6 hours to encourage the birds to nest at higher island elevations where the nests are less vulnerable to inundation from late summer higher daily average navigation releases. This peak release permits average daily releases to be increased as needed to continue to meet the navigation requirements when the inflows from tributaries to the Lower River decrease.

The Fort Randall River Segment is subject to significant daily discharge variation from Fort Randall Dam, due to the practice of power-peaking. Power-peaking begins in the late morning each day.[16] The stage change is noticeable in the river from early to late afternoon to early evening, reducing in stage change as a function of distance below the dam. The effect results in hundreds of acres of sandbar visible above the water surface in the morning becoming fully inundated in the afternoon. The magnitude of the effect on stage generally declines from up to downstream.

The Verdel USGS stream gage, near the lower end of Fort Randall River Segment, indicates a daily fluctuation of approximately 0.75 feet. While no gage data are available to confirm, the daily stage change near the dam may approach 2 feet, based on field observations of upper island shorelines.

5.3.3.2.2 Degradation, Aggradation, and Erosion (Fort Randall River Segment)

The tailwater area of Fort Randall Dam from RM 880 to 860 has experienced up to 6 feet of degradation of the bed and widening of the channel from 1953 to 1986. The rate of erosion has decreased over this period. Streambank erosion since closure of the dam in 1953 has averaged about 40 acres per year compared to a pre-dam rate of 135 acres per year. The river has coarser bed material above than below RM 870, indicating some armoring of the channel below the dam. Less erosion of the bed and streambanks occurs downstream from the tailwater area (USACE,

[16] The 2006 power production schedule included a daily flow increase for Fort Randall Dam from 25,000 cfs to 41,000 cfs from 11:00 AM to 4:00 PM (B. Doan, USACE pers com 2007).

2004). At the mouth of the Niobrara River (RM 843.5), a delta of sediment has built up near Ponca Tribal Lands. The Ponca Tribal Lands are located at the confluence of the Niobrara River and the Missouri River.

Based on the 2006 LiDAR, the segment is in backwater from Lewis & Clark Lake to approximately RM 854.0 (the lower 9 miles of the segment). This point correlates with a reduction in average riverine corridor width to less than 2,200 feet, which is the approximate lower threshold channel width for sandbar formation and retention (Biedenharn et al, 2001).

This "daily-inundated sand plain" (DSP) habitat is unique to the power pulsed segments and is the result of re-deposition of elevated sandbar and bedload. This habitat type has increased throughout the segment between 1998 and 2005, but is most widely distributed in the upper portion of the segment. Sandbars are continually modified by flow. The Fort Randall River Segment has a very low channel gradient (approximately 0.000073 ft/ft[17]), resulting in a low river velocity that may be less effective in moving sediment than the daily peak flow spike and decline.

Each day during power-peaking, volume, stage, and velocity increase to re-mobilize fine sediments. Later, as discharges are reduced, entrained sediments carried by the flow are re-deposited, with coarse sediments carried only a short distance, if at all. Comparison of the 1998 and 2005 sandbar polygons suggest that much of this deposition is occurring on the upstream end of bars formed in 1998. The enlarging upstream bars protect the original materials, allowing for the observed increase in ESH polygon size. The source of this sediment may be channel erosion immediately downstream of the dam (Biedenharn, 2005) and bank erosion, as might be suggested by the decline in Non-ESH Sand and forest habitat. Bars tend toward simple round to oval forms as would be expected when water level rises and lowers frequently.

The same process is notable in the lower part of the segment, but a second surge-related effect has apparently occurred therein. Bars and ESH lower in the segment have decreased in area due to significant erosion of upstream protrusions, which are notably ragged. The backwater effect that begins in the lower section may participate in allowing surge waters to pile up against and dissolve sandbar faces. The DSP deposits are smaller and lower in relative elevation, allowing rising, higher-energy waters to soften and erode materials. DSP and shallow-water habitats occur more frequently on the trailing than the leading end of bars in the lower portion of the segment.

5.3.3.2.3 Water Quality (Fort Randall River Segment)

Water quality in this segment is considered generally good (NPS, 1997). Results of Corps sampling in the early 1990s, in Niobrara, Nebraska and Running Water, South Dakota concluded that concentrations of selenium (a naturally occurring heavy metal) in the surface water was within state water quality standards and EPA criteria (NPS, 1997). Warm water dominates this segment because Lake Sharpe and Lake Francis Case (immediately upstream) rarely stratify in the summer and therefore the tailwaters are relatively warm water when compared to the three upper river segments (USACE, 1994).

[17] Based on LiDAR data.

The State of Nebraska has designated the Fort Randall River Segment as a Class A water. The State of South Dakota has not listed this segment of the Missouri River on the 303(d) List of Impaired Waterbodies. The water quality parameters of concern include ammonia, pathogens, dissolved oxygen, nutrients, and accumulated sediment. Tailwaters are turbid due to the sediment accumulation in the upstream lakes (USACE, 2004).

5.3.3.2.4 Water Use(Fort Randall River Segment)

There are eight irrigation intakes located on the river segment downstream of Fort Randall Dam; four of them are located on the Yankton Sioux Reservation (USACE, 2004).

There are 37 water supply intakes located on Lewis and Clark Lake. These include 2 municipal water supply facilities, 27 irrigation intakes, 6 domestic intakes, and 2 public intakes. The municipal water supply facilities serve a population of approximately 4,380 persons. Of the 37 water supply intakes, there are 7 water supply intakes located on Lewis and Clark Lake serving the Santee Reservation. These include five irrigation intakes and two public intakes (USACE, 2004).

5.3.3.3 Biological Resources (Fort Randall River Segment)

5.3.3.3.1 Habitat Delineation Results (Land Cover/Vegetation Classification) (Fort Randall River Segment)

The Fort Randall River Segment begins at the upstream end of the Lewis & Clark Lake Segment at RM 845.0, and extends to Fort Randall Dam at RM 880.0, a navigation distance of 35.0 river miles. The riverine habitat area within the high banks is approximately 13,790 acres, translating to 384 acres per river mile and an average width of 3,168 feet. Riverine habitat area increased by 175 acres between 1998 and 2005, which overlay of the respective riverine corridors suggests is from bank erosion.[18] Power-peaking creates the DSP habitat type defined and described previously and in detail in Appendix B. This habitat type comprised nearly 10% of the total riverine habitat in 2005, tripling the area observed in 1998. Tables 5-14 and 5-15 summarize habitat changes observed for the Fort Randall River Segment between 1998 and 2005.

ESH habitat has declined by 57% in the Fort Randall River Segment. The majority (44%) has been lost to natural succession of lower areas into wetlands and, on better-drained sites, to herb and shrub communities. Approximately 20% has become DSP, which has also occupied approximately 700 acres of formerly open water. The loss of open water suggests that the Fort Randal Segment may not be sediment deficient, which would follow from the shallow slope and low energy gradient. The sum of Non-ESH sand, Shallow Water (visible submersed sand) and DSP for 2005 exceeds the same combination for 1998 by 225 acres. Source materials for construction of ESH may be ample in this segment. Those sediments, occurring in elevated positions and observed during August 2006, appear to contain a suitable coarse material fraction.

[18] This is also suggested by the loss of 155 acres of forest, which, lacking evidence of harvest could only result from bank erosion.

Table 5-14: Habitat Acreage Summary: Fort Randall River Segment 1998 and 2005

Habitat Name	2005 Acres	1998 Acres	Change Acres	2005 % of Total	1998 % of Total
Open Water	4,926	5,639	(713)	35.7%	41.4%
ESH	128	295	(168)	0.9%	2.2%
Herb/ Shrub/ Sapling	2,164	1,405	758	15.7%	10.3%
Non-ESH Sand	120	327	(207)	0.9%	2.4%
Forest	859	1,014	(155)	6.2%	7.4%
Agriculture	60	20	39	0.4%	0.1%
Wetland Matrix	1,684	1,505	179	12.2%	11.1%
Shallow Water	2,470	2,931	(461)	17.9%	21.5%
Anthropogenic	10	0	10	0.1%	0.0%
Daily Inundated Sand Plain	1,370	478	893	9.9%	3.5%
Grand Total	13,790	13,790			

Table 5-15: Disposition of Original ESH Lost from 1998 to 2005: Fort Randall River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	36.7	12%	ESH lost to erosion and carried down river
ESH	56.2	19%	ESH retained from original 1998 area
Herb/Shrub/Sapling	96.2	33%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	0.9	0%	Became terrestrialized or surrounded by forest
Forest	0.6	0%	Natural growth of shrubs into forest-sized trees
Wetland Matrix	33.2	11%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	23.3	8%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand	48.2	16%	ESH redistributed to low plateaus by daily high flows from power peaking at Garrison Dam
Total	295.2		

5.3.3.3.2 Wildlife (Fort Randall River Segment)

Wildlife is plentiful in and along the 39-mile District of the MNRR, and recent surveys have identified 48 species of mammals (NPS, 2005). Small mammals, including mice, voles, bats, moles, rats, and ground squirrels, made up roughly 60 percent of represented species. White-tailed deer and mule deer are the only large mammals in the segment. Coyote, red fox, and badger are common and other small, fur-bearing animals such as raccoon, mink, muskrat, opossum, striped skunk, plains spotted skunk, beaver, eastern cottontail, whitetail jackrabbit, and bobcat. For mammals as well as reptiles, this species composition has not changed significantly from early historic times, except for the loss of the grizzly bear and large herbivores like buffalo and elk (NPS, 2005).

The number of species of birds that occur in the 39-mile District of the MNRR varies seasonally. The river's bottomland serves as wintering, feeding, breeding, and staging grounds. The river corridor is home year-round to 25 species. An additional 58 species commonly nest in the areas, while another 15 species are common winter residents. The Missouri River is a significant pathway for migratory birds during spring and fall migration (NPS, 2005).

This segment supports migrating and breeding waterfowl and contains two great-blue heron and double-crested cormorant rookeries (nesting sites). Of particular importance for migratory waterfowl are the loafing (rest) areas provided by the 10 to 70 acres of sandbar habitat exposed by releases of between 35,000 and 18,000 cfs (USACE, 2004).

The bald eagle (*Haliaeetus leucocephalus)* was de-listed as a "threatened species" under the Endangered Species Act on June 28, 2007 (effective August 8, 2007). This species is still protected under the Bald and Golden Eagle Protection Act as well as the Migratory Bird Treaty Act. These birds tend to construct their nests in mature trees near the river's edge--especially in cottonwood trees--and the Fort Randall River Segment is particularly heavily used by wintering bald eagles (USACE, 2004).

5.3.3.3.3 Fish and Invertebrates (Fort Randall River Segment)

Fish habitat in the Fort Randall River Segment is more similar to natural river conditions than segments downstream. The channel, including banks of the Yankton Sioux Reservation, is wide and meandering and contains numerous shifting sandbars and side channels. Because neither Lake Sharpe nor Lake Francis Case stratify strongly, release water temperatures do not support coldwater species and the segment is dominated by coolwater and warmwater species. The segment is subject to considerable bank erosion because of variable flows released from the dams and the natural meandering of the river. Native fish populations in the area are relatively productive. A naturally reproducing population of paddlefish occurs in the segment.

Sauger is the most sought after sport species in Lewis & Clark Lake. Walleye, freshwater drum, and channel catfish are also common in catches, and smallmouth bass are becoming more common. Smallmouth bass were stocked below Fort Randall Dam and have since become established in Lewis & Clark Lake. A small population of adult paddlefish is also present in the lake and is believed to be spawning naturally upstream of the lake near the Santee Reservation banks. High water levels during the spring spawning period increase the reproductive potential of most fish species in the lake. As in Lake Sharpe, fish production appears negatively related to the rate of water flow through the lake.

The substrate of sandbars is home to a number of invertebrate species, the primary food source for the piping plover. In general shoreline habitat provides more diverse invertebrate assemblages that are more adaptable to stochastic events (Angradi, Schweiger and Bolgrien 2006). In one study, Plovers foraged for invertebrates in all available habitats including dry sand, on vegetation, and in both moist and saturated sand, but spent the majority of their time foraging in moist sand. While Diptera (flies) were the most abundant invertebrates collected during sampling, Coleoptera (beetles) were most numerous in plover fecal samples. This finding is aligned with prior study results, suggesting that beetles are typically the main food source for plovers. Other taxa captured in this study included Hemiptera, Homoptera, Hymenoptera, Odonata, Orthoptera, and Araneae (Le Fer, 2006). A study analyzing macroinvertebrate diversity, density, and composition finds that the current communities are in general both diverse and densely populated within the project area (Angradi et. Al 2009).

As summarized in the South Dakota Game Fish and Parks Report 2005-08 (SDGFP, 2005), freshwater mussel surveys were conducted on the 39-mile District of the MNRR between Ft. Randall Dam, South Dakota and Running Water, South Dakota from October 2004 to September 2005. The objective of the study was to provide baseline survey information on the mussel communities of this segment. Prior to the 2004-2005 survey, no investigations of the mussel community had been conducted. During the fieldwork, 49 locations were inspected for the presence of mussel populations. Mussels (live individuals or dead shells) were collected at only 37% (18 of 49) of the sites. The majority of sites (37 of 49) only contained one or two individual shells or were devoid of mussels altogether. No adult zebra mussels *Dreissena polymorpha (aquatic nuisance species)* were observed during this study.

Of the seven mussel species collected during this survey, the fragile papershell *Leptodea fragilis* and pink papershell *Potamilus ohiensis* were the most common. The paper pondshell *Utterbackia imbecillis* and mapleleaf *Quadrula quadrula* were rare and only represented by a few individuals. Most sample locations in the upper half of the 39-mile District of the MNRR (from Ft. Randall Dam downstream to Verdel, Nebraska) were largely devoid of mussels. Similarly, areas with an unstable, shifting sand substrate, such as the Niobrara River delta, were devoid of mussels. Overall, mussel abundance and diversity was low compared to mussel populations found downstream in the Gavins Point River Segment (SDGFP, 2005).

5.3.3.3.4 Federally Listed Species and Habitats (Fort Randall River Segment)

Four different species are listed as threatened or endangered within the Fort Randall River Segment in South Dakota and Nebraska. The detailed life histories for these species are incorporated by reference from the original Master Water Control Manual Review and Update Final EIS (USACE, 2004).

Piping Plover (*Charadrius melodus*)

The entire Fort Randall River Segment has been designated critical habitat for the piping plover http://www.fws.gov/mountain-prairie/species/birds/pipingplover/sdunit2.pdf). The designated area is from approximately RM 880 near the Fort Randall Dam to approximately RM 752.2 near Ponca, NE. Appendix B summarizes relevant life history and protected status of the piping plover.

Least tern (*Sternula antillarum*)

No critical habitat has been designated for the least tern within the Fort Randall River Segment. Appendix B summarizes relevant life history and protected status of the least tern.

Whooping crane (*Grus americana*)

Migrating whooping cranes have been observed foraging in adjacent wetlands and in this river corridor in recent years (USACE, 2004).

Pallid Sturgeon (*Scaphirhynchus albus*)

The Missouri River from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake is designated as recovery-priority area 3 for the pallid sturgeon; this includes the Fort Randall River and Lewis & Clark Lake segments.

5.3.3.3.5 State Listed Species and Habitats (Fort Randall River Segment)

The South Dakota Game, Fish and Parks (SDGFP) have identified a state-listed threatened species, the false-map turtle (*Graptemys pseudogeographica*), as occurring within the South Dakota portion of the Missouri River. These turtles are active during the period of April-September with nesting taking place during the late spring and summer months. Nests in the Missouri River are typically established in sandy banks or on sandbars. Basking is typically restricted to inter-channel snags, rocks, and sandbars. False-map turtles are typically dormant in soft river bottom sediments from October to April.

The Nebraska Game and Parks Commission (NGPC) has identified four fish species that are of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and “At-Risk” species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*).

5.3.3.4 Socioeconomic and Historic Resources (Fort Randall River Segment)

5.3.3.4.1 Land Use (Fort Randall River Segment)

A total of 244,800 acres of cropland exists in the first-tier counties along the Fort Randall River and Lewis & Clark Lake segments (USACE, 2004). The area is primarily a rural area where agriculture plays a major role in the overall economy of the area (NPS, 1997).

5.3.3.4.2 Population (Fort Randall River Segment)

The first tier counties for the Fort Randall River and Lewis & Clark Lake segments are Boyd and Knox Counties in Nebraska and Gregory, Charles Mix, and Bon Homme Counties in South Dakota. The regional population has been declining for more than 65 years (NPS, 1997).

The 2000 Census (U.S. Bureau of the Census, 2000) reports the population for the three first tier South Dakota counties-- Gregory, Charles Mix, and Bon Homme --combined was 21,402. The 2004 update estimated the population at 20,502 (U.S. Bureau of the Census, 2006). The present estimated population is a decrease of over 5 percent since the 1990 census. The population density of Gregory, Charles Mix, and Bon Homme Counties is typical of rural counties, with 5.25, 8, and 13 persons per square mile, respectively.

The combined population for the two first tier Nebraska counties (Boyd and Knox) as of the 2000 Census was 11,812 (U.S. Bureau of the Census, 2000). The 2004 update estimated the population at 11,262 (U.S. Bureau of the Census, 2006). The two-county population has decreased more than 10 percent since the 1990 census. The population density of Boyd and Knox counties in South Dakota is typical of rural counties, at 4 and 8 persons per square mile, respectively.

There are no interstate routes providing access to the Fort Randall River and Lewis & Clark Lake segments from either the South Dakota or the Nebraska sides of the river, and the only U.S. route providing access to the segments is U.S. Route 18/281 at the Fort Randall Dam. All other roads providing access to the segments from the Nebraska or South Dakota side are State roads (SR 12 in Nebraska and SR 46/50 and 37 in South Dakota) and local roads. These state and local roads provide access to the homes, farms, and communities in the area. The South Dakota Department of Transportation’s most recently published automatic traffic counter data provides no data on the roads within these segments (SDDOT, 2006). Average daily traffic (number of vehicles per day) is not available for roads within the project area.

On the Nebraska side of the Missouri River, State Route 12 traverses the segments in an east-west orientation, and average daily traffic data are available (NDOR, 2005). In the vicinity of Bristol, Lynch, Monowi, and Verdel, State Route 12 averages slightly fewer than 600 vehicles per day, of which up to 60 are trucks (NDOR, 2005). Further to the east, near Niobrara, NE State Route 12 averages between 1,200 and 1,500 vehicles per day, of which 100 to 125 are trucks (NDOR, 2005).

5.3.3.4.3 Employment and Income (Fort Randall River Segment)

The primary 2000 employment sectors in the first-tier South Dakota counties (Bon Homme, Charles Mix, and Gregory) for the Fort Randall River and Lewis & Clark Lake segments were educational, health, and social services (23 percent); agriculture (20 percent); and retail trade (11 percent) (U.S. Bureau of the Census, 2000). Employment for the first tier Nebraska counties (Boyd and Knox) were educational, health, and social services (24 percent); agriculture (23 percent); and retail trade (10 percent) (U.S. Bureau of the Census, 2000).

The most recent economic survey published by the Census Bureau (1999) estimated the median household income for Bon Homme, Charles Mix, and Gregory counties to be $30,644, $26,060, and $22,732 respectively (U.S. Bureau of the Census, 2006). Statewide median household income for South Dakota (1999) was $35,282 (U.S. Bureau of the Census, 2006). The same economic survey (U.S. Bureau of the Census, 1999) estimated the median household income for Boyd and Knox counties at $26,075 and $27,564 respectively. Statewide median household income for Nebraska (1999) was $38,834 (U.S. Bureau of the Census, 2006).

The most recent Poverty Status figures (2003) estimated that 13, 21.3, and 12.3 percent of individuals in Bon Homme, Charles Mix, and Gregory Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). Statewide, 13.2 percent of residents of South Dakota and 9.7 percent of the residents of Nebraska were considered below the poverty level (USDA, 2006).

5.3.3.4.4 Recreation (Fort Randall River Segment)

The Fort Randall River Segment extends from Fort Randall Dam (RM 880) to the Niobrara River confluence (RM 845). The Yankton Sioux Reservation borders a portion of this segment on the north (SD) bank. Ponca Tribal Land is located south of the Yankton Sioux Reservation at the confluence of the Niobrara River and the Missouri River. This segment and the upstream reach (Niobrara River to Running Water, RM 841) of the adjacent Lewis & Clark Lake Segment are collectively designated as the 39-mile District of the MNRR. This MNRR District is managed by the NPS as a primitive recreational area to protect its wildlife habitat, natural landscapes of the Lewis & Clark National Historic Trail, and cultural resources. Because much of the recreational activities in the Lewis & Clark Lake Segment occur within the 39-mile District of the MNRR, recreation occurring in both segments will be discussed in this section, and will not be repeated within Section 5.2.4.

Numerous permanent duck blinds were observed nestled in the wetlands and low vegetated sandbars along these two segments of the river. These segments appear to have more vegetated islands and wetland areas used for waterfowl hunting than the two upstream segments. Discussions with local Corps personnel at the Fort Randall Project Office indicate that waterfowl hunting is a popular activity along these segments. There are also a number of outfitters that provide blinds and transportation to preferred hunting areas along the river. Targeted species include Canada goose, snow goose, mallard, and other migrating waterfowl.

In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River and Lewis & Clark Lake segments. All of these trips took place between mid-September and early December. Most (93 percent) of the hunting conducted on these segments took place below the Fort Randall Dam tail waters (Mestl et al., 2001).

Summer use of permanent and seasonal cabins and trailers is high, with over 300 private buildings in these segments (NPS, 1997). Water access to this 39-mile District of the MNRR is primarily limited to individuals with private boats, rafts, or canoes. Traditional uses of the rivers by local residents include power boating, fishing, camping, waterfowl hunting, trapping, and watching wildlife throughout the year (NPS, 1997). Sandbars are popular for volleyball, picnicking, and other leisure activities. Canoeing and float trips originating at Fort Randall Dam and ending at Niobrara State Park are popular. Visitation is estimated at 130,000 recreation days annually (USACE, 2004). Recreation sites in these two segments are listed in Table 5-16.

Table 5-16: Recreation Sites: Fort Randall River and Lewis & Clark Lake Segments

Site Name	Boat Ramps	Boat Trailer Parking	Camp Sites (RV, Camper, Tent)	Swimming Beach
Fort Randall Dam Spillway R.A.[(1)]	1	50	None	No
Randall Creek R.A.[(1)]	1	20	130	No
Yankton Sioux Tribe/Woods Beach R.A.[(1)]	None	None	None	Yes
Buffalo Run Park [(1)]	Proposed	None	None	No
Standing Bear Bridge [(1)]	1	4	None	No
Running Water Public Access Site[(1)]	1	30	None	No
Springfield R.A.[(1)]	1	50+	40	No
Sunshine Bottom [(2)]	1	15	None	No
Verdel Landing [(2)]	1	100	None	No
Niobrara Village Boat Launch [(2)]	1	30	None	No
Ferry Landing Boat Ramp [(2)]	1	Some	None	No
Bazile Creek Boat Ramp [(2)]	1	20	None	No

R.A. = Recreation Area, [(1)] South Dakota, [(2)] Nebraska

Fishing is an important recreational activity along these segments. The SDGFP conducted an analysis of angler use along the Missouri River from Fort Randall Dam to Gavins Point Dam in 2005 (Wickstrom and Schuckman, 2006). The angler use study collected and reported data for two reaches: a 2-mile-long reach at the Fort Randall Dam tail waters and a 40-mile-long reach from the tail waters downstream to Bazile Creek (RM 838). The analysis separately looked at fishing on Lewis and Clark Lake between Bazile Creek and Gavins Point Dam.

Many riverside cabin owners have boat docks, and public boat access sites are located along these segments (see Table 5-16). Some boat ramps are located downstream of Fort Randall Dam and are designed to operate under the fluctuating dam releases for power production and navigation. Currently, none of the ramps located downstream of Fort Randall Dam are located on either the Yankton Sioux Reservation or the Ponca Tribal Land (USACE, 2004), but the Yankton Sioux Tribe desires to install a ramp at Buffalo Run Park in Greenwood, SD. There are some commercial boat rental services available. In Pickstown, SD, people can rent boats, paddleboats, and canoes (NPS, 1997). Jet skiing is not allowed within the MNRR.

These segments of the river are heavily used as a recreation resource. The 2000 Survey indicates that more than 96 percent of users will visit the river more than once, and 67 percent indicated that they would access the river more than eight times that year. Total recreation use in 2000 was estimated at approximately 187,000 hours between April 1 and December 31. More than 16 percent of river recreation took place between mid-September and the end of December (30,441 hours); much of that is believed to be associated with waterfowl hunting.

The Lewis & Clark Lake Segment, which extends to the downstream end of the accretion islands at RM 828.1, is an extremely important recreational resource for waterfowl hunting. This segment contains extensive wetlands, vegetated islands, and protected areas of open water essential for migrating waterfowl. As such, this area attracts many thousands of migrating birds and waterfowl hunters throughout the fall. The 39-mile District of the MNRR also attracts many sightseers, the number of whom may have been underestimated by previous surveys. During 2006-2008, the Niobrara State Park Overlook and the Standing Bear Bridge Overlook near Springfield, SD were used by an average of over 4,600 and 6,500 vehicles, respectively, each year between April 1 and November 30 (NPS, 2009). This high visitation rate, about 19 percent of which occurs in the fall, indicates the importance of scenic views of the downstream end of the 39-mile District of the MNRR in attracting visitors.

The characteristics, amount, timing, and locations of various recreational activities in the three reaches surveyed (Fort Randall Dam tail waters, Upper River, and Islands) in these two segments, including fishing, hunting, pleasure boating, picnicking, camping, bird watching, trail hiking, outdoor photography, and sightseeing, are provided in Appendix D. In 2006, among person at last 16 years old (adults) recreating in South Dakota, residents of South Dakota accounted for approximately 83 percent of fishing days, 69 percent of hunting days, and 50 percent of wildlife watching days away from home. In 2006, expenditures in South Dakota related to recreational trips were approximately $34.55 per day for fishing, $68.10 per day for hunting, and $94.02 per day for wildlife watching. Trip-related expenditures in South Dakota for these three activities totaled over $305 million (USFWS/USCB, 2008).

5.3.3.4.5 Noise (Fort Randall River Segment)

Noise levels in the Fort Randall River and Lewis & Clark Lake segments are varied seasonally and geographically. Relative tranquility is common in some inaccessible areas while sounds typical of more developed areas persist near towns (e.g., traffic) or recreation areas (e.g., confluence with Niobrara River, headwaters of Lewis & Clark Lake). Seasonal water-based recreation-related sounds (e.g., outboard motors, waterfowl hunting) are common in some areas (NPS, 1997).

5.3.3.5 Environmental Justice (Fort Randall River Segment)

According to the 2000 Census, the ethnic mix of residents in the first-tier South Dakota counties (Bon Homme, Charles Mix, and Gregory) and the Nebraska counties (Boyd and Knox) for the Fort Randall River Segment is presented in Table 5-17. This table also addresses the first tier counties for the Lewis & Clark Lake Segment; this data will not be repeated in Section 5.3.4.

Table 5-17: Race in South Dakota and Nebraska First Tier Counties

County	African American	Asian	Hispanic	Native American	White
Bon Homme	0.1 %	0.10 %	0.60 %	3 %	95.5 %
Charles Mix	0.1 %	0.10 %	2 %	28 %	69.7 %
Gregory	0.1 %	0.20 %	1 %	6.9 %	91.7 %
Boyd	0.0 %	0.01 %	0.01 %	1 %	99 %
Knox	0.1 %	0.10%	1 %	7 %	92 %

Source: http://factfinder.census.gov

5.3.3.6 Cultural and Paleontological Resources (Fort Randall River Segment)

Fort Randall has a similar assortment of cultural resources, prehistoric Native American sites, protohistoric village sites, and historic sites. Approximately 78 sites have been recorded at Fort Randall. In addition to these sites, there are also Traditional Cultural properties located within these project lands. These sites are important to the Tribes who have used and continue to use these lands. With Fort Randall project lands, as with all federal lands considered for the proposed ESH creation areas, care should be taken to avoid impacts to significant sites. Steamboat wrecks, some yet unrecorded, could be discovered during construction. Fort Randall project lands also contain paleontological remains. A plesiosaur (marine reptile) was recently excavated from project lands. Mosasaurs (marine lizards) have also been located nearby.

This description of cultural resources for this reach is taken directly from the NPS Northern Great Plains Exotic Plant Management Plan and Environmental Assessment (NPS, 2005). A number of archeological projects have been conducted in or near this reach and have been summarized by the NPS. Surveys varied in coverage, resource direction, reporting, analysis of data, and terminology. Most of the sites have been defined by the presence of surface materials and only limited excavations have been conducted in the area. Of the 285 sites within or adjacent to the riverway, only three are Euroamerican (two mills and a cemetery). However, several of the sites are multi-component (i.e., these sites contain evidence of occupation or use by several different groups, often over a long period, and may include historic features). The rest of the sites can be defined only as prehistoric or protohistoric (generally, protohistoric sites were created during the time of Euroamerican exploration and early settlement). The prehistoric and protohistoric sites include burials and burial mounds, villages, and campsites with scattered lithics (stone tools) and ceramics. These archeological sites fall into the Paleo-Indian, Archaic, and Woodland periods, and the Great Oasis and Coalescent

Tradition Cultural Affiliations

Historic Indian tribes, including the Omaha, Ponca, Santee Dakota, Pawnee, Arikara, Ioway and the Brule and Oglala Divisions of the Lakota, are also believed to have used the area. Euroamerican exploration of the area began in the early 1700s when the Mallet brothers ascended the Missouri in search of trade routes. Spanish traders soon followed and trading posts were built along the Missouri River in association with the fur trade. Several of these forts were situated along the 59-mile stretch of the Missouri River, including Fort Vermillion I, McClellans Trading Post, and a Columbia Fur Company Post. Acquisition of these areas as part of the Louisiana Purchase (1803) led to the 1804-1806 Lewis & Clark Expedition.

During the mid-1800s, a series of military expeditions explored the Missouri River Valley seeking transportation routes across the Great Plains. When tribes were removed to reservations, land in the area opened for settlement. Immigration into the area was encouraged, and during the late 1870s and early 1880s, immigrants from France, Ireland, Scandinavia, Czechoslovakia, Germany and German-Russia settled in the area and established farms and ranches, small market villages, and crossroad communities. During the late 19th and early 20^{th} centuries, immigrants built a number of local communities. Historic Euroamerican structures and features from the late 1800s and early 1900s include general stores, postal facilities, mills, farms, churches, school buildings, granaries, railroad depots, and cemeteries. Fifty-seven cultural sites have been documented in or adjacent to the river, including farmsteads, historic houses and barns, cemeteries, and sites associated with early settlement.

Several of the river's other historic resources are related to transportation themes. The river was the primary highway to the northern Plains until the late 1800s. Historic wrecks of steamboats are part of the historical record, but exact locations of wrecks are not known. Railroads facilitated the development of communities and the Meridian Bridge spanning the Missouri River at Yankton was a significant engineering accomplishment. Ponca State Park demonstrates the growth of 20th century tourism and recreation along the Missouri River. Extensive flooding prompted the implementation of many flood control measures during the mid-1900s.

The pastoral qualities of the landscapes are widely appealing. The river valley contains a series of cultural landscapes that were created through the interaction of people with natural forms and forces. The landscapes include residences and farms buildings (many of them historic), bridges, roads and trails, fences and corrals, orchards and gardens, cultivated fields, grazing land, and forested areas. The arrangement of these features on the land and the spatial relationships among them combine to create these rural landscapes. The States of South Dakota and Nebraska have identified numerous historic resources that contribute to agrarian and ethnic landscapes. For example, settlers constructed residences and farm buildings of native chalkstone. Often the design and arrangement of these buildings was guided by the availability of local materials, the topography, and cultural traditions.

The Fort Randall River Segment does not contain many Federal lands. As a result, very few of the cultural resources that have been rigorously studied have been evaluated to determine their eligibility for the National Register of Historic Places, National Historic Landmark status, or level of significance in a national context. In Nebraska, within or immediately adjacent to the recreational river boundaries, six historic properties are listed on the National Register: the Bow Valley Mills, the Meridian Bridge at Yankton, Schulte Archeological Site, Wiseman Archeological Site, Ponca Historic District, and the Indian Hill Archeological Districts. Most South Dakota National Register sites are within the Yankton and Vermillion Historic Districts.

Some South Dakota farms are included in a noncontiguous thematic nomination for Czech folk architecture in southern South Dakota close to, but not within, the boundaries of the river. In recognition of its importance to American history, the route of the Lewis & Clark Expedition was designated as a National Historic Trail in 1978. Prehistoric and historic resources have been identified for potential further evaluation for National Register eligibility. Specific recommendations include further study of Gavins Point Dam, the powerhouse(s), and other features related to the Pick-Sloan plan to determine their national significance related to technology, engineering, and invention. Ethnographic resources associated with traditional farming and ranching and with ethnic settlements are included in the area's cultural resource base. Researchers have consulted with Indian tribes to identify tribal concerns, traditional uses, and sensitive areas. This information would not be made public unless tribes so requested.

Other detailed accounts of the cultural resources of these reaches are incorporated by reference from:

National Park Service. 1999. Final General Management Plan Environmental Impact Statement. Missouri National Recreational River, Nebraska, South Dakota. p. 86-91. NPS D-0A/Aug 1999.

National Park Service. 1997. Final General Management Plan Environmental Impact Statement. Missouri/Niobrara/Verdigre Creek. National Recreational Rivers, Nebraska South Dakota. p. 119-127. NPS D-3A/June 1997.

As with the Fort Peck project lands, an inventory of the construction site and Area of Potential Effect will be conducted on an individual basis. The appropriate Tribes will be notified and invited, through government to government consultation, to provide their comments and concerns. Should a potentially National Register eligible site be discovered, the construction site will be removed from further consideration and an alternate construction site will be located. The inventory results will be coordinated with the State Historic Preservation Officer(s), the appropriate Tribe(s) and/or Tribal Historic Preservation Officer, and the Advisory Council on Historic Preservation, should they choose to participate. The goal of the proposed Emergent Sandbar Habitat project is to create habitat to mitigate the loss of this habitat along the Missouri River. In keeping with this goal, causing an adverse effect to a National Register-eligible site would be counterproductive (having to provide mitigation for mitigation) and will be avoided. There is the possibility that deeply buried sites will be encountered. An archaeological monitor will be on-site during construction. Criteria will be established to maintain a buffer zone should intact cultural deposits be encountered.

5.3.4 Lewis & Clark Lake Segment - Part of Segment 9

5.3.4.1 Physical Resources (Lewis & Clark Lake Segment)

Refer to Section 5.3.3.1 for the discussion of the Fort Randall River Segment, which also discusses the Lewis & Clark Lake Segment.

5.3.4.2 Water Resources (Lewis & Clark Lake Segment)

Refer to Section 5.3.3.2 for the discussion of the Water Resources of the Fort Randall River Segment, which also discusses the Lewis & Clark Lake Segment.

5.3.4.3 Biological Resources (Lewis & Clark Lake Segment)

5.3.4.3.1 Habitat Delineation Results (Land Cover/Vegetation Classification) (Lewis & Clark Lake Segment)

As illustrated by the Habitat Acreage Summary in Table 5-18, the habitat of the Lewis & Clark Lake Segment is demonstrably different from all other segments as it extends from well into the pool of Lewis and Clark Lake at RM 828.1, to just upstream of the Niobrara River confluence at RM 845.0. The entire reach is within the pool or in lake-backwatering effect, strongly influencing the habitat. Segment total acreage is approximately 17,000 acres between high banks. Average total acres of habitat per river mile are 1,000 acres, resulting in an average width of 8,250 feet. An approximately 450-acre difference is noted between the 1998 area and the

2005 area of the segment. As compiled in Table 5-19, the explanation for the difference is not an increase in habitat area, but the result of missing imagery for the 1998 orthophotographs in the Springville Quadrangle. Considering location of the absent imagery, the difference is primarily accounted by the open water and wetlands habitat types. Pool elevation in Lewis and Clark Lake is maintained at approximately 1,207 feet, however power-peaking discharges at Fort Randall Dam resulting in daily elevation changes in the upper part of the segment of approximately 0.5 feet, notable at the Niobrara USGS gage.

Not surprisingly, the dominant habitats of this segment are open water, emergent wetlands (strongly dominated by cattail (*Typha* spp.)), and shallow water, which together comprise more than 85% of the segment for both delineation years. Daily inundated (flooded) sand plain and low-lying Non-ESH Sand account for another 7% for both years. ESH accounts for less than 3.5% of the habitat for the period since the 1997 high releases. The majority of ESH usable for bird habitat seems to have been created in the delta just downstream of the Niobrara confluence during the 1997 high releases, a location most likely comprised of coarse sediments deposited as flow energy was dissipated at the lake pool. Downstream, substrate materials distribute themselves by declining grain size, offering declining suitability for use in creation of sandbars. Figure 5-1 is an example of the habitat delineation for the Lewis and Clark Lake Segment showing both the prevalence of emergent wetlands and the natural paucity or infrequency of barren sandbar habitat.

Table 5-18: Habitat Acreage Summary: Lewis & Clark Lake Segment 1998 and 2005

Habitat Name	2005 Acres	1998 Acres	Change Acres	2005 % of Total	1998 % of Total
Open Water	3,684	3,270	414	21.5%	19.6%
ESH	142	566	(424)	0.8%	3.4%
Herb/Shrub/Sapling	919	599	320	5.4%	3.6%
Non-ESH Sand	20	259	(239)	0.1%	1.6%
Forest	247	254	(7)	1.4%	1.5%
Agriculture	147	91	56	0.9%	0.5%
Wetland Matrix	8,397	7,570	827	48.9%	45.3%
Shallow Water	3,222	3,666	(444)	18.8%	21.9%
Daily Inundated Sand Plain	380	431	(51)	2.2%	2.6%
Grand Total	17,157	16,705			

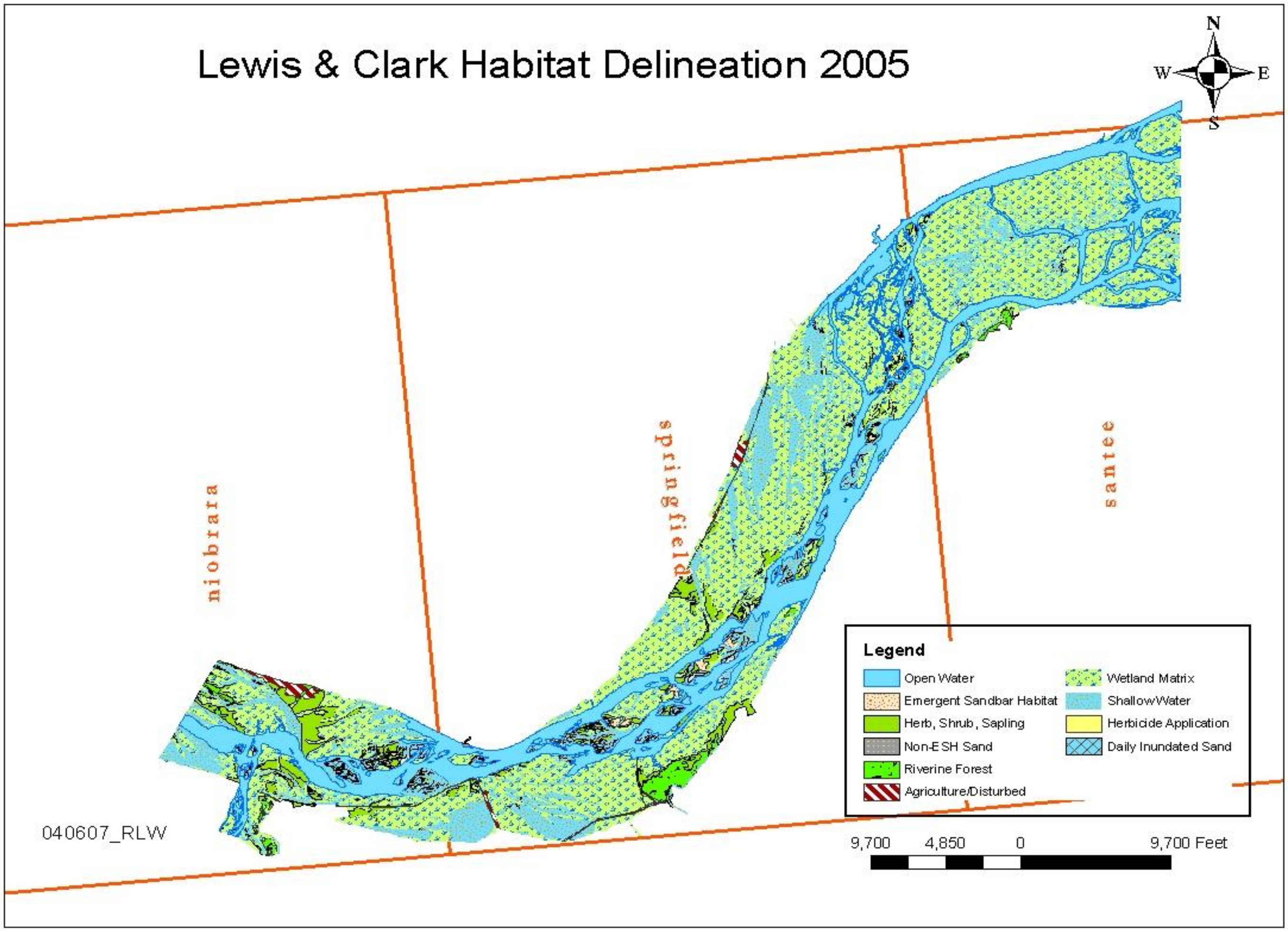

Figure 5-1: Example of Habitat Delineation for Lewis and Clark Lake Segment

Table 5-19: Disposition of Original ESH Lost from 1998 to 2005: Lewis & Clark Lake Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	100.2	18%	ESH lost to erosion and carried down river
ESH	46.1	8%	ESH retained from original 1998 area
Herb/Shrub/Sapling	118.8	21%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	1.6	0%	Became terrestrialized or surrounded by forest
Forest	5.7	1%	Forest canopy growth into/around ESH
Wetland Matrix	231.2	41%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	37.9	7%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand	23.9	4%	ESH redistributed to low plateaus by daily high flows from power peaking at Fort Randall Dam
Grand Total	565.5		

The Lewis & Clark Lake Segment is primarily composed of emergent wetlands (Wetlands Matrix), because it is principally in the lake pool. The occurrence of ESH, as evidenced by past nesting use, was directly related to the formation of deltaic deposits at the mouth of the Niobrara River and within a mile or two downstream of it. Brief ESH occurrences farther down river and into the lake pool were fortuitous events involving lowering of the lake pool elevation during the breeding season. Neither event has persisted due to sandbar erosion, sandbar dissolution from daily power peaking, from natural succession, and from normal, operational variation of the lake pool elevation. Change between the two delineation years is relatively minimal, with no real shifts to indicate change in this highly depositional ecosystem.

Approximately 25% of the ESH mapped for 1998 remained in 2005. The majority of former ESH (more than 60%) in the Lewis & Clark Lake Segment have succumbed to natural succession of both wetlands and upland habitats. Taken together these successional types increased by more than 1,100 acres. Erosion and redistribution to shallow water and DSP makes up another 39% of the loss. The few sandy openings comprising the 141 acres remaining in May 2005 were poorly used for nesting.[19] Field observations in August 2006 found windrows or concentrations of base sprouting cottonwood stems resulting from efforts to suppress woody vegetation with herbicides. These areas were highly effective in trapping and nursing annual weed seed, which had, by August 2006, fully invested the former sandy openings with rank growth.

The last row of Table 5.19 includes acreage for DSP, a habitat type resulting from power generation peaking surges. This habitat type is not in the Gavins Point River Segment, but is important in all of the other upriver segments.

[19] Out of 23 nest initiations, only two piping plover nests were successful. In 2006 there were only 4 plover nest initiations (with two successful).

5.3.4.3.2 Wildlife (Lewis & Clark Lake Segment)

This segment extends from the Niobrara River to just downstream of Springfield, and it includes extensive emergent wetland and riparian forest. Purple loosestrife has infested most of the emergent wetland. This has reduced wetland productivity as wildlife breeding habitat but still provides shelter for migratory waterfowl. The Bazile Creek Wildlife Management Area (WMA) in the lake's delta and over 3,000 acres in the Springfield and Running Water Bottoms (approximately RM 840) are managed for waterfowl. The open-water areas of the lake provide loafing habitat for Canada geese and ducks, especially diving ducks (e.g., scaup, canvasback).

5.3.4.3.3 Fish and Invertebrates (Lewis & Clark Lake Segment)

See Section 5.2.3.3.3.

5.3.4.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment)

See Section 5.2.3.3.4 and 5.2.3.3.5.

5.3.4.4 Socioeconomic and Historic Resources (Lewis & Clark Lake Segment)

See Section 5.2.3.4.

5.3.4.5 Environmental Justice (Lewis & Clark Lake Segment)

See Section 5.2.3.5.

5.3.4.6 Cultural and Paleontological Resources (Lewis & Clark Lake Segment)

The Lewis and Clark Lake Segment has an assortment of cultural resources, prehistoric Native American sites, protohistoric village sites, and historic sites. Approximately 69 sites have been recorded on project lands. Traditional Cultural Properties are also found on Lewis and Clark Lake project lands. Any of the federal lands considered for the proposed ESH creation areas will be screened to avoid impacts to significant sites. Steamboat wrecks, some yet unrecorded, could be discovered during construction. Paleontological remains have been found on Lewis and Clark Lake project lands. Vertebrate and invertebrate fossils have been found in the limestone cliffs.

As with the other reaches, a number of archeological projects have been conducted for the Corps within this reach. Most of the sites have been defined by the presence of surface materials and only limited excavations have been conducted in the area. Some of the historic sites are Euroamerican (two mills and a cemetery). Several of the sites are multi-component (i.e., these sites contain evidence of occupation or use by several different groups, often over a long period, and may also include historic features). The rest of the sites can be defined only as prehistoric or protohistoric (generally, protohistoric sites were created during the time of Euroamerican exploration and early settlement). The prehistoric and protohistoric sites include burials and burial mounds, villages, and campsites with scattered lithics (stone artifacts) and ceramics. These archeological sites fall into the Paleo-Indian, Archaic, and Woodland periods, Plains Village period, and the Equestrian period.

<u>Tradition Cultural Affiliations</u>

Historic Indian tribes, including the Omaha, Ponca, Santee Dakota, Yanktonais have used the area. Euroamerican exploration of the area began in the early 1700s when the Mallet brothers ascended the Missouri in search of trade routes. Spanish traders soon followed and trading posts were built along the Missouri River in association with the fur trade. Several of these forts were situated along the 59-mile stretch of the Missouri River, including Fort Vermillion I, McClellans Trading Post, and a Columbia Fur Company Post. Acquisition of these areas as part of the Louisiana Purchase (1803) led to the 1804-1806 Lewis & Clark Expedition.

During the mid-1800s, a series of military expeditions explored the Missouri River Valley seeking transportation routes across the Great Plains. When tribes were removed to reservations, land in the area opened for settlement. Immigration into the area was encouraged, and during the late 1870s and early 1880s, immigrants from France, Ireland, Scandinavia, Czechoslovakia, Germany and German-Russia settled in the area and established farms and ranches, small market villages, and crossroad communities. During the late 19th and early 20th centuries, immigrants built a number of local communities. Historic Euroamerican structures and features from the late 1800s and early 1900s include general stores, postal facilities, mills, farms, churches, school buildings, granaries, railroad depots, and cemeteries. Fifty-seven cultural sites have been documented in or adjacent to the river, including farmsteads, historic houses and barns, cemeteries, and sites associated with early settlement.

Several of the river's other historic resources are related to transportation themes. The river was the primary highway to the northern Plains until the late 1800s. Historic wrecks of steamboats are part of the historical record, but exact locations of wrecks are not known. Railroads facilitated the development of communities and the Meridian Bridge spanning the Missouri River at Yankton was a significant engineering accomplishment. Ponca State Park demonstrates the growth of 20th century tourism and recreation along the Missouri River. Extensive flooding prompted the implementation of many flood control measures during the mid-1900s.

The pastoral or rural/rustic qualities of the landscapes are widely appealing. The river valley contains a series of cultural landscapes that were created through the interaction of people with natural forms and forces. The landscapes include residences and farms buildings (many of them historic), bridges, roads and trails, fences and corrals, orchards and gardens, cultivated fields, grazing land, and forested areas. The arrangement of these features on the land and the spatial relationships among them combine to create these rural landscapes. The States of South Dakota and Nebraska have identified numerous historic resources that contribute to agricultural and ethnic landscapes. For example, settlers constructed residences and farm buildings of native chalkstone. Often the design and arrangement of these buildings was guided by the availability of local materials, the topography, and cultural traditions.

Very few of the cultural resources that have been rigorously studied have been evaluated to determine their eligibility for the National Register of Historic Places, National Historic Landmark status, or level of significance in a national context. In Nebraska, within or immediately adjacent to the recreational river boundaries, six historic properties are listed on the National Register: the Bow Valley Mills, the Meridian Bridge at Yankton, Schulte Archeological Site, Wiseman Archeological Site, Ponca Historic District, and the Indian Hill Archeological Districts. Most South Dakota National Register sites are within the Yankton and Vermillion Historic Districts.

The 1804-1806 Lewis & Clark Expedition was designated as a National Historic Trail in 1978. Prehistoric and historic resources have been identified for potential further evaluation for National Register eligibility. Specific recommendations include further study of Gavins Point Dam, the powerhouse(s), and other features related to the Pick-Sloan plan to determine their national significance related to technology, engineering, and invention. Ethnographic resources associated with traditional farming and ranching and with ethnic settlements are included in the area's cultural resource base. Researchers have consulted with Indian tribes to identify tribal concerns, traditional uses, and sensitive areas. This information would not be made public unless tribes so requested.

Other detailed accounts of the cultural resources of these reaches are incorporated by reference from:

National Park Service. 1999. Final General Management Plan Environmental Impact Statement. Missouri National Recreational River, Nebraska, South Dakota. p. 86-91. NPS D-0A/Aug 1999.

National Park Service. 1997. Final General Management Plan Environmental Impact Statement. Missouri/Niobrara/Verdigre Creek. National Recreational Rivers, Nebraska South Dakota. p. 119-127. NPS D-3A/June 1997.

5.3.5 Gavins Point River Segment - Segment 10

The 58-mile stretch of river between Gavins Point Dam (RM 811) and Ponca State Park (NE) (RM 753) is known as the Gavins Point River Segment. This segment is a meandering channel with many chutes, backwater marshes, sandbars, islands, changing shorelines, and variable current velocities. On average, this segment is about one half mile wide and six feet deep, with maximum depths rarely exceeding 20 feet (USACE, 1994). The Gavins Point River Segment resembles the natural river more than any other segment, and, compared to the other segments, displays the greatest density of wetlands, approximately 90 acres per mile (USACE, 2004). It is also the only river segment downstream of Gavins Point Dam that has not been channelized by dikes and revetments. Major tributaries in the Gavins Point River Segment are the James and Vermillion Rivers. This segment is also designated as the 59-mile District of the MNRR under the Wild and Scenic Rivers Act.

5.3.5.1 Physical Resources (Gavins Point River Segment)

5.3.5.1.1 Climate/Meteorology (Gavins Point River Segment)

South Dakota and Nebraska experience a continental interior climate with great variation in seasonal temperatures. Summers are typically very hot and winters are cold averaging approximately 155 days in the frost-free period (USACE, 2004a). Prolonged droughts of several years' duration and frequent shorter periods of deficient moisture, interspersed with periods of abundant precipitation are typical (USACE, 2004a). Temperatures range from in excess of 100 degrees F in summer to –20 degrees F during winter. Wintertime temperatures average 24 degrees with an average daily low of 14 degrees F. The average summer temperature is 72 degrees F with an average daily maximum of 85 degrees F (USACE, 2004a).

Annual precipitation is approximately 25 inches with 80 percent of this falling from April through September (USACE, 2004a). Thunderstorms occur on approximately 45 days each year with tornadoes and severe thunderstorms occurring on more rare occasions. Average seasonal snowfall is 34 inches (USACE, 2004a).

5.3.5.1.2 Geology (Gavins Point River Segment)

Bedrock in the area consists principally of flat-lying Cretaceous and Tertiary strata, with some exposures of early Quaternary formations. In ascending order, they are the Cretaceous Carlisle

Shale, Niobrara Chalk, and Pierre Shale formations; the Tertiary Ogallala Formation; and the Quaternary Grand Island Formation. The Carlisle Shale is the bedrock in the lowest portions of the river valley with a few surficial exposures of this formation downstream of the Gavins Point Dam (USACE, 2004a). Most of the region is covered by glacially derived deposits from the many episodes of glaciation that encroached upon the area. Wind-blown silt and sand cover most of the older deposits (USACE, 2004a).

5.3.5.1.3 Soils (Gavins Point River Segment)

Channel materials are primarily sands with occasional outcrops of gravel. Gradation analysis in the reach indicates bed materials in the Gavins reach are essentially devoid of fines (less than 0.063 mm). The average bed D_{10} for the entire reach is about 0.23 mm (Biedenharn, 2001).

The soil resources for this 59-mile District of the MNRR are described in NPS references (NPS, 1999; NPS, 2005) and read as follows. The recreation river boundary contains land in Cedar and Dixon Counties, Nebraska, and Yankton, Clay, and Union Counties, South Dakota.

The soils vary from level and nearly level silty and clayey soils on the flood plains of the Missouri River and its terraces to undulating to steep loamy and clayey soils on uplands. Most soil types are moderately- to well-drained. The Sansarc soil series consists of shallow, well-drained soils formed in residual material from clayey shale on the breaks of the Missouri River. The Inavale soil series consists of deep, excessively drained soil formed in sandy riverwash materials on the Missouri River. The silty clay soils on the Missouri River flood plain are deep and poorly drained, such as those in old oxbows.

5.3.5.1.4 Air Quality (Gavins Point River Segment)

The EPA Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards for six principal pollutants, called “criteria” pollutants. They include carbon monoxide, nitrogen dioxide, ozone, lead, particulates, and sulfur dioxide. For the Gavins Point River Segment (Nebraska and South Dakota), including all counties within which actions could take place, all parameters are in attainment of the air quality standards (USEPA, 2006). The NPS asserts that the air quality of this segment is generally good and the clean air and good visibility for scenic views are important values for the MNRR (NPS, 1999).

5.3.5.1.5 Aesthetics (Gavins Point River Segment)

This segment of the Missouri River is the lowermost unchannelized segment and remains in a relatively natural state. The appearance is representative of the original “Middle Missouri” (NPS, 1999). Characterized by a wide meandering channel with shifting sandbars, this segment is a pronounced contrast to the channelized river (dikes and revetments) downstream. The terrain surrounding this segment offers a wide variety of scenic vistas.

Natural features along the corridor include two large wooded islands, wooded Nebraska bluffs, and views of wide expanses of water with sandbars and steep or gentle riverbanks. The two large high-bank islands (James River Island and Goat Island) are covered by dense cottonwood and dogwood stands and are rare for the present day Missouri River (NPS, 1999). The 300- to 400- foot high Nebraska bluffs are outstanding because they are an uncommon topographic feature in the surrounding landscape (NPS, 1999). Due to the river’s action, some of the bluffs have eroded into sheer cliffs where the soil and subsoil show up clearly in brown, yellow, and gray horizontal layers (NPS, 1999).

The Gavins Point Dam itself and the dramatic effect of the chalk bluffs intersected by heavily wooded ravines and the rolling hills of the prairie form an ever-changing background. Woodlands occur in narrow bands and clumps along the river and small tributaries, on steep side slopes, and adjacent uncultivated uplands. Nearby agricultural areas are a mix of cropland and rangeland.

5.3.5.1.6 Hazardous, Toxic, and Radioactive Waste (HTRW) (Gavins Point River Segment)

A preliminary HTRW investigation was conducted to identify areas within the Gavins Point River Segment that could affect construction activities due to the presence of environmental contamination (EDR, 2006). The scope of investigation was not designed to delineate the extent of contamination from any particular site, but strictly to identify known areas of contamination in a database search. Findings for the Gavins Point River Segment were included in the project GIS, enabling the Corps to avoid known areas of contamination in the subsequent phases of the planning site-specific projects.

5.3.5.2 Water Resources (Gavins Point River Segment)

5.3.5.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment)

Releases from Gavins Point Dam follow the same pattern as those from Fort Randall Dam because there is little active storage in Lewis and Clark Lake. Releases from both dams are based on the amount of water in system storage, which governs how much water will be released to meet service demands in the portion of the Lower River from Sioux City to St. Louis. Constraints for flood control, threatened and endangered bird nesting, and fish spawning requirements are factors governing releases. In the navigation season, (April 1-December 1) releases from Gavins Point Dam are generally 25,000 to 35,000 cfs. In the winter, releases are in the 10,000- to 20,000-cfs range. In wet years with above-normal upstream inflows, releases are higher to evacuate flood control storage space in upstream reservoirs. Maximum winter releases are generally kept below 24,000 cfs to minimize downstream flooding problems caused by ice jams in the Lower River. Navigation releases are provided through November if July 1 system storage is at least 41million acre-feet (MAF). Navigation releases cease in mid-September if July 1 system storage is 25 MAF or lower. Full-service navigation releases vary, depending on the demand for water at downstream navigation target points at Sioux City, Omaha, Nebraska City, and Kansas City.

Generally, an average navigation season release of 35,000 cfs at Gavins Point Dam will provide downstream flows necessary for full service. If downstream tributary inflow above Kansas City is abnormally low, then additional water must be released from Gavins Point Dam to meet the 41,000 cfs target at Kansas City. If downstream tributary inflows are high, then the flow target at Sioux City will determine the system release rate. When system storage is low, less than full service is provided by lowering target flows by up to 6,000 cfs (minimum service). In extended droughts when navigation has ended or during floods, releases may be reduced to 9,000 cfs or less. Usually, navigation flow target requirements result in increasing summer releases to meet target flows as tributary inflows decline. Releases as high as 39,000 cfs from Gavins Point Dam have been necessary to provide full service at Kansas City.

Operation constraints dictate that releases from Gavins Point Dam not be increased between mid-May and mid-August because islands with nesting terns and plovers could be flooded. This constraint necessitates higher-than-needed late spring and early summer releases to anticipate the demand for late-summer navigation releases. The forecasted maximum late-summer navigation release requirement is established in mid-May, prior to nest initiation. This commitment dictates releases at least through early summer. During the 1987 to 1993 drought, summer release restrictions at Gavins Point Dam for the protection of terns and plovers resulted in not always meeting Nebraska City and Kansas City targets during August. A portion of the shortfall for the Kansas City target was met by water released from the Corps' Kansas River projects. Conversely, when the system water supply is unusually large, as in 1996 and 1997, service levels for the orderly evacuation of stored floodwaters take precedence over nesting birds. Consequently, release rates from Gavins Point Dam may have to be increased to as much as 25,000 cfs over and above full-service navigation flows during nesting (USACE, 2004).

5.3.5.2.2 Degradation, Aggradation, and Erosion (Gavins Point River Segment)

There has been a gradual erosion of the riverbed below Gavins Point Dam to Ponca, Nebraska, since 1955. The extent of erosion is highest (about 10 feet) in the reach immediately below the dam. The bed material in this reach has also become progressively coarser than in the lower reach of the segment, thus indicating gradual armoring of the channel bed over time. The rate of riverbed erosion has diminished since 1980. Stream bank erosion has also occurred below Gavins Point Dam. The rate of erosion declined after 1955. Rates of erosion since closure in 1956 have averaged 157 acres per year between Gavins Point Dam and Ponca State Park, compared to a pre-dam rate of 202 acres per year. Rates of erosion have declined somewhat since 1975. Stream bank erosion problems are generally confined to the river above Ponca because the banks are stabilized below Ponca (USACE, 2004).

Below Ponca, there are only a few sandbars connected to the shore (i.e., no interchannel sandbars) and side channels. The channel from Ponca to the Missouri River mouth is 754 miles long. Flood plain levees along much of this reach have reduced overbank flooding, thereby decreasing water flows to old sloughs and chutes (USACE, 2004).

5.3.5.2.3 Water Quality (Gavins Point River Segment)

Water quality management from Gavins Point Dam to Ponca, NE, is under the jurisdiction of two States (South Dakota and Nebraska). Nebraska has designated this segment of the river as a Class A State Resource Water that infers Tier 3 protection under the state's water quality standards and the Federal Clean Water Act's anti-degradation provisions (USACE, 2004a).

The Federal Clean Water Act requires water quality to be maintained and protected in Tier 3 waters. The USEPA has interpreted this provision to mean no new or increased discharges to Tier 3 waters and no new or increased discharges to tributaries of Tier 3 waters that could affect the Tier 3 waterbody (USACE, 2004a). The only exception to this prohibition, as discussed in the preamble to the Water Quality Standards Regulation, permits some limited activities that result in temporary and short-term changes in the water quality of Tier 3 waters. Such activities must not permanently degrade water quality or result in water quality lower than that necessary to protect the existing uses in the Tier 3 waterbody (USACE, 2004a).

The Missouri River below Gavins Point Dam is not listed on South Dakota's current 303(d) list, but is listed on Nebraska's 303(d) List of Impaired Waterbodies (USACE, 2004a). The impaired use identified by Nebraska is Primary Contact Recreation, the pollutant identified is pathogens, and the identified probable source is agriculture (USACE, 2004a). The quality of the water released from Gavins Point Dam gradually deteriorates downstream due to inflows from tributaries and point and non-point sources. At the Gavins Point Dam, the summer water temperature is 24 to 26°C, with saturated levels of dissolved oxygen and low nutrient and sediment levels. With increasing distance from the dam, the water temperature, nutrient levels, and biological oxygen-demanding materials increase, peaking near Kansas City (USACE, 2004).

Section 2.6.9 of the Corps' Master Plan for the Gavins Point Dam/Lewis and Clark Lake (USACE, 2004a) identifies a water quality management concern for the entire segment below Gavins Point Dam. The following summary is excerpted from that text.

A water quality management concern is the seemingly contradictory water quality management goals identified for the MNRR under the ESA, CWA, and WSRA. The 2000 Biological Opinion, as amended (2003) directs the Corps to increase turbidity and suspended solids in the MNRR. The 2003 BiOp Amendment states that sediment transport and turbidity need to be restored to functional levels in the MNRR to improve habitat conditions for the jeopardized species inhabiting the MNRR. State water quality standards (i.e., South Dakota and Nebraska) adopted pursuant to the CWA require that suspended solids and turbidity levels be maintained at "reduced" levels in the segment, and imply that increasing turbidity and suspended solids levels could represent a degradation of water quality conditions and a possible impairment of a designated beneficial use.

South Dakota has specifically adopted water quality standards criteria to manage total suspended solids levels in this segment consistent with its MNRR designation. One of the beneficial uses South Dakota designates is "warm water permanent fish life propagation." Protection of this use requires that total suspended solids levels are to be less than or equal to 158 mg/l as a daily maximum, and less than or equal to 90 mg/l as a 30-day average. Management of this segment as an MNRR under the provisions of the Wild and Scenic Rivers Act requires that the values for which it was designated as a recreational river (i.e., its outstanding remarkable recreational, fish and wildlife, aesthetic, historical and cultural values) be protected and enhanced.

Increasing suspended solids and turbidity levels in the MNRR segment may degrade the habitat for recreationally important fish species that were present when it was designated. The existing water quality literature suggests that elevated levels of turbidity adversely impact the recreational and aesthetic values of a water body. EPA's "Red Book" states, "Turbid water interferes with recreational use and aesthetic enjoyment of water."

5.3.5.2.4 Water Use (Gavins Point River Segment)

There are 42 water supply intakes located on the Gavins Point River Segment. These include 1 municipal water supply facility, 33 irrigation intakes, 7 domestic intakes, and 1 public intake. The municipal water supply facility serves a population of approximately 15,000 persons (USACE, 2004).

5.3.5.3 Biological Resources(Gavins Point River Segment)

5.3.5.3.1 Habitat Delineation Results (Land Cover/Vegetation Classification) (Gavins Point River Segment)

The Gavins Point River Segment extends from approximately the Ponca State Park at RM 753.0 to the tailrace of Gavins Point Dam at RM 811.1. This segment is the farthest down river, lowest in elevation and most southern of the designated segments. The total area within the up and down stream limits and between the high stream banks is approximately 23,228 acres. The average total habitat area is 402 acres per river mile, which when divided by feet per mile, results in an average riverine habitat area width of 3,316 feet. Approximately 50% of the total area, at flows of between 20,000 and 30,000 cfs from Gavins Point Dam, is open water. There are a few large forested islands that, given their elevated positions and dominance of large old trees, are most likely carved-off slivers of the ancient high bank flood plain, rather than sandbar created by recent fluvial (riverine) processes. The remaining area is occupied by sandbar deposits at various elevations that range in vegetative cover from barren sand to heavily vegetated. Table 5-20 summarizes the acreages of delineated habitats for 1998-2005 in the Gavins Point River Segment.

Table 5-20: Habitat Acreage Summary and Comparison for Gavins Point River Segment

Habitat Name	2005 Acres	1998 Acres	Change Acres	2005 % of Total	1998 % of Total
Open Water	12,678	11,893	785	54.6%	50.7%
ESH	880	2,944	(2,063)	3.8%	12.6%
Herb/ Shrub/ Sapling	2,391	1,498	893	10.3%	6.4%
Non-ESH Sand	256	2,208	(1,952)	1.1%	9.4%
Forest	4,325	3,425	900	18.6%	14.6%
Agriculture	77	54	23	0.3%	0.2%
Wetland Matrix	688	144	544	3.0%	0.6%
Shallow Water	1,932	1,290	642	8.3%	5.5%
Grand Total	23,228	23,455			

The 1998 delineation of the Gavins Point River Segment area by Vander Lee (2002) seems to have been used to establish 2003 BiOp Amendment RPA acreage objectives for Gavins Point and for all other segments. The 2003 BiOp Amendment ESH acreage goal for this segment (2015 goal) is 4,648 acres, yet when delineated and measured, only 2,944 acres could be delineated as interchannel ESH from the 1998 photoset. The area of ESH mapped in 1998, representing the first post-flood breeding season, declined 70% by 2005 to 880 acres. That majority of this acreage was lost to erosion, the sediment of which were either swept from or redistributed throughout the segment. Natural succession to vegetated upland or wetland habitats claimed 491 acres of former ESH. There were 476 acres of original ESH retained during the delineation period. Table 5-21 summarizes ESH fate and habitat type change.

Table 5-21: Disposition of Original ESH Lost from 1998 to 2005: Gavins Point River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	1551.0	53%	ESH lost to erosion and carried down river
ESH	476.5	16%	ESH retained from original 1998 area
Herb/Shrub/Sapling	345.3	12%	Natural succession of well-drained sand bar to upland shrubs and herbs
Shallow Water	354.9	12%	ESH lost to erosion and redistributed in local backwater shallows
Wetland Matrix	145.7	5%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Non-ESH Sand	41.6	1%	Became terrestrialized or surrounded by forest
Forest	28.0	1%	Natural growth of shrubs into forest-sized trees
Grand Total	2943.1		

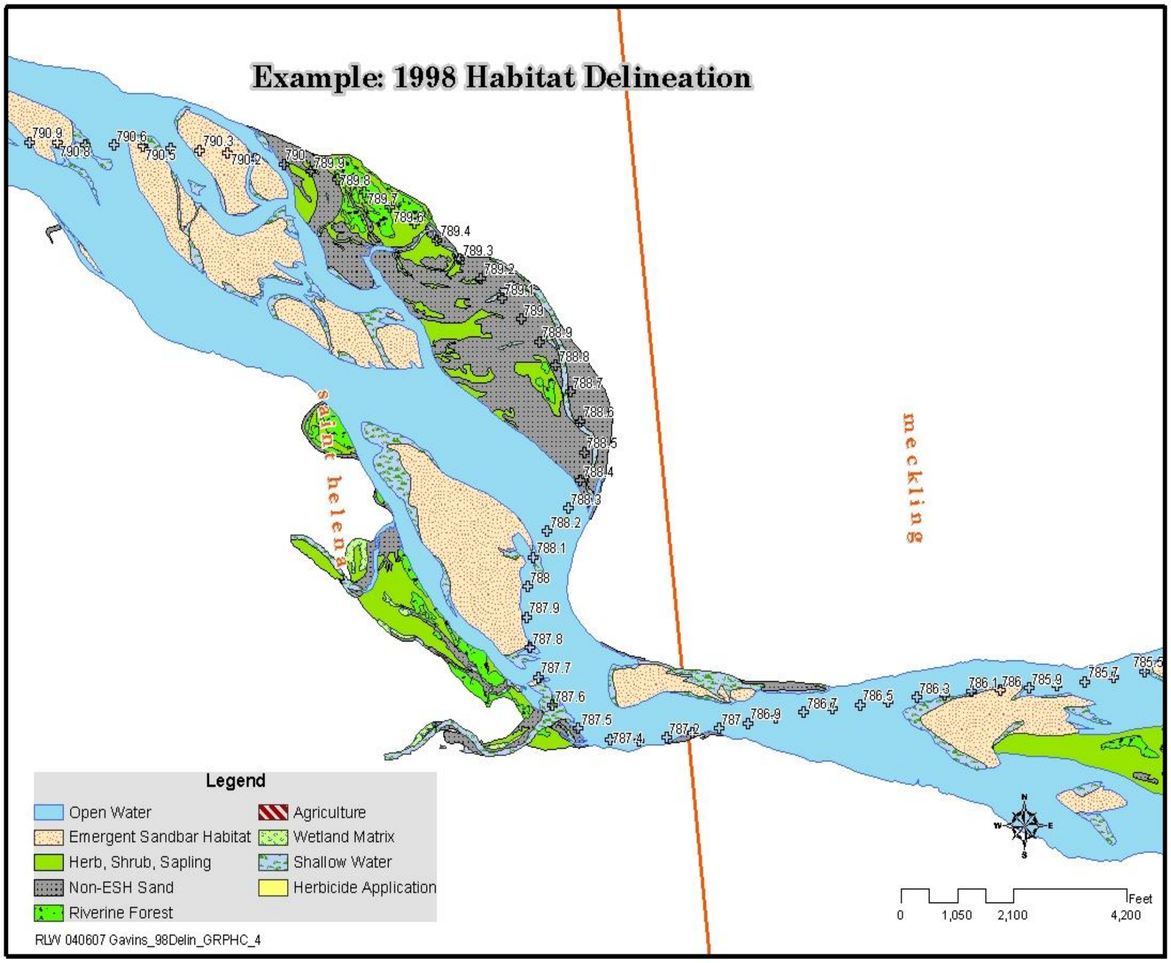

Figure 5-2: Example of Gavins Point River Segment Habitat Delineation for 1998

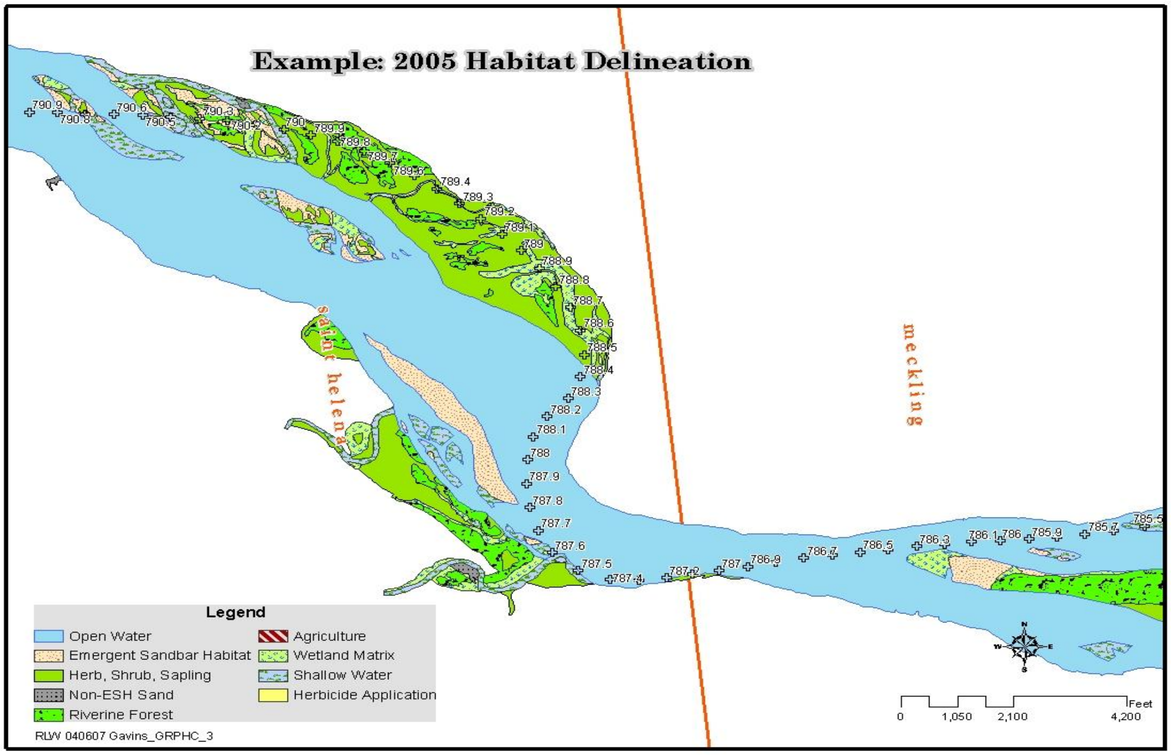

Figure 5-3: Example of Gavins Point River Segment Habitat Delineation for 2005

5.3.5.3.2 Wildlife (Gavins Point River Segment)

In this segment, the emergent, scrub-shrub, and forested wetlands and riparian forest support a wide variety of waterfowl, furbearers, upland game birds, raptors, big game, threatened and endangered species, and other wildlife. Snow geese and wild turkey are important game species in this segment. Agricultural conversion of wetlands and riparian forest has eliminated over 60 percent of these habitats within 0.6 mile of the river (USACE, 2004). Vegetation encroachment limits the use of numerous sandbars and islands by shorebirds and waterfowl. In most years, between 70 and 300 acres of sandbar are exposed during the fall migration at flows of 20,000 cfs and 35,000 cfs, respectively (USACE, 2004).There were at least two active bald eagle nests in Nebraska in 1998. Nineteen areas in this segment provide habitat for wintering bald eagles, especially areas downstream of Gavins Point Dam and near the mouth of the James River. These areas have large stands of riparian forests and are near waterfowl concentration sites along the river. From Gavins Point Dam to Rulo, Nebraska, over 200 bald eagles were observed wintering in 1997, many of which were in this segment (USACE, 2004).

5.3.5.3.3 Fish and Invertebrates (Gavins Point River Segment)

Downstream of Gavins Point Dam, the Missouri River flows unimpounded to its mouth. The 57- to 59-mile section of the unchannelized river downstream of Gavins Point Dam is a meandering channel with many chutes, backwater marshes, sandbars, islands, and variable current velocities.

Snags and deep pools are also common. Although this portion of the river includes bank stabilization structures, the river remains wide. Because river sediment settles in Lewis and Clark Lake (above Gavins Point Dam), extensive bed degradation has occurred in the river below the dam. Gradual armoring of the riverbed has reduced the rate of channel degradation. Approximately 27 percent of the banks have been stabilized to curtail erosion. Channel degradation and siltation of shallow areas have contributed to the loss of marshes, backwaters, and chute habitats.

Principal fish species include emerald shiner, river carpsucker, channel catfish, gizzard shad, red shiner (Notropis lutrensis), shorthead redhorse, carp, and goldeye. Pallid and shovelnose sturgeon and paddlefish are also found in this segment. Studies of the benthic fishes within the Missouri River were conducted between 1995 and 1999. Results from the 1996 and 1997 field seasons indicate that the overall diversity of species in the unchannelized river segments is increasing, which reflects the greater number of microhabitats and available niches (resources for the species). The largest number of species (40) was collected in the segment downstream from Gavins Point Dam (USACE, 2004).

In general, depth and velocity parameters for most taxa of fish were generally skewed to shallow depths (<2 meters [m]) and slower velocities (<0.6 m/s). Species requiring deeper water (2 to 6 m) and faster flows (0.6 to 1.2 m/s) included shovelnose sturgeon, sturgeon chub, sicklefin chub, blue sucker, blue catfish, and stonecat (USACE, 2004). Fish use all habitats in the unchannelized river but are most abundant in connected backwater areas.

This description of fisheries and aquatic resources is taken directly from the NPS' Final General Management Plan (NPS, 1999). Habitat on the Missouri River between Gavins Point Dam and Ponca State Park is more typical of an unchannelized, natural river condition than segments farther downstream. Native fish in this Missouri River segment are relatively abundant and include sauger (*Stizostedion canadense*), channel catfish, shovelnose sturgeon (*Scaphirhynchus platorynchus*), gizzard shad (*Dorosoma* spp.), river carpsucker (*Carpiodes carpio*), and a naturally reproducing population of paddlefish (Polyodon spathula). This segment is one of the recovery-priority areas for the pallid sturgeon (*Scaphirhynchus albus*). Other common species include shorthead redhorse, freshwater drum (*Aplodinotus grunniens*), and gar.

The substrate of sandbars is home to a number of invertebrate species, the primary food source for the piping plover. One study found that invertebrate populations within this reach were typically higher along protected shoreline as opposed to exposed shoreline (Le Fer, 2006). Plovers foraged for invertebrates in all available habitats including dry sand, on vegetation, and in both moist and saturated sand, but spent the majority of their time foraging in moist sand. While Diptera (flies) were the most abundant invertebrates collected during sampling, Coleoptera (beetles) were most numerous in plover fecal samples. This finding is aligned with prior study results, suggesting that beetles are typically the main food source for plovers. Other taxa captured in this reach included Hemiptera, Homoptera, Hymenoptera, Odonata, Orthoptera, and Araneae. A study analyzing macroinvertebrate diversity, density, and composition finds that the current communities are in general, both diverse and densely populated within the project area (Angradi et. Al 2009).

In 1999 the Corps contracted with the South Dakota Department of Game, Fish and Parks (SDGFP) to conduct a presence/absence survey for freshwater mussels below Gavins Point Dam, South Dakota and Ponca, Nebraska. Subsequently, SDGFP contracted Keith Perkins III, a malacological (mollusk) expert at the University of Sioux Falls, to take charge of the inventory with the assistance of Doug Backlund, SDGFP, Pierre, S.D. (SDGFP, 2000).

Forty-seven sites were examined for live or dead clams. A total of 1,709 dead shells (a dead shell is considered a matching pair of valves or a single valve) and 355 live clams were found. Live specimens of eight species of freshwater mussels were collected. Sixteen species were identified in the 1,709 dead specimens collected. These findings indicate that the study area supports a thriving population of unionids (freshwater mussels). At least six species are thriving: Lasmigona complanata, Leptodea fragilis, Potamilus alatus, Potamilus ohiensis, Pyganodon grandis and Truncilla truncate. Another nine species and one subspecies (Pyganodon grandis corpulenta) are present (SDGFP, 2000).

Unionid diversity was highest at the mouth of the James River, while total abundance was highest in the stretch immediately below Gavins Point Dam. Largely old, dead shells that probably washed downstream from the James River represented the high species diversity at the mouth of the James River. Highest species diversity of fresh dead shells and lives was in the river segment below Gavins Point Dam (SDGFP, 2000).

When the Corps proposed its first major ESH creation projects in the 59-mile MNRR in 2004, this prompted a number of other surveys within the footprint of the proposed islands. This survey indicated that mussels on the river may be using some habitat types, namely inter-channel submerged sandbars, where they were previously thought only to occur in small numbers. Just days after this survey was completed, Backlund discovered a weathered shell at the Bubble that was later determined to potentially be the endangered Higgin's Eye (*Lampsillis higginsii*) mussel (Backlund, 2004). These findings prompted a third survey in 2004 to determine the presence/absence of federally listed mussel species at the proposed construction sites RM 810-809, RM 770, and RM 761) (Ecological Specialists, Inc., 2005).

While completing mussel surveys for the NPS in October 2005, Perkins discovered a fresh-dead scaleshell mussel, the only other in the 59-mile MNRR since Hoke's discovery 22 years earlier. This event, along with the previously reported discovery of a Higgin's eye, prompted the Corps and NPS to assemble a group of malacologists from the area to discuss these findings at a Mussel Roundtable held in June 2006. The general consensus was that it was unlikely that there was a population of Higgin's eye in the river, but that it was possible that the scaleshell may have a small population in the 59-mile MNRR. The Corps hired Ecological Specialists, Inc. to complete a targeted survey of the 59-mile MNRR for the scaleshell mussel. The survey concluded that, in contrast to other large rivers of the Midwest, both mussel density and species richness of the Missouri river were low. No evidence of *L. Leptodon* or *L. Higginsi* was found during this survey. The report stated that while it was possible that *L. Leptodon* was in this reach, the probability of the species' occurrence is extremely low.

In general, the upstream portion of this reach (between RM 810 - 795) seemed to have higher densities and more diverse species than the downstream portion, presumably linked to coarser substrate in the upstream portion of the reach. Within the entire reach, mussels were found in higher concentrations in hydraulically protected areas where gravel was present. These areas were typically near the bank or shoreward of sandbars in water less than two feet deep during sampling times (at approximately 10,000 cfs). The survey identified high density mussel areas and defined what is considered, in this reach, a mussel bed and a mussel pocket. Beds were classified as large areas (> 8 acres) with a Catch Per Unit Effort (CPUE) greater than 35 unionids/hour. Pockets were identified as smaller areas (<8 acres) with CPUE >15 unionids/hour.

The report identified a mussel pocket located riverward of a sandbar located at river mile 790 in the area known as Audubon Bend. In addition, during a 2009 survey by Perkins, twelve species of unionids (freshwater mussels) were collected near river mile 790 in the Audubon Bend area. Three of the species collected have not previously been reported in the 59-mile segment of the MNRR. Perkins (2009) reports approximately 27% of all live specimens in the MNRR (~450 individuals) exist in the Audubon Bend area.

While the above mentioned mussel species are believed to be beneficial to the overall ecosystem, two invasive mussel species are threats to the existing community: the zebra mussel (*Dreissena polymorpha*) and the Asian clam (*Corbicula fluminea*). Neither species requires a fish host so larvae can spread much more rapidly than other freshwater species. Asian clams were first introduced to the U.S. in the 1930's and have spread throughout the country. They were first documented in the Missouri River below Gavins Point in 2003 and are now common in this reach. Zebra Mussels were first introduced to Lake St. Clair in 1988 and have been extremely destructive to the ecosystems of the Great Lakes. While zebra mussels have been found in the Missouri River near Sioux City Nebraska, their population in this system is not yet widespread. Zebra mussel "veligers" or reproducers were recently found in the MNRR near the St. Helena boat ramp, some indication that there may be reproducing adults in the reach. Although neither of these species were collected during the most recent mussel survey in the Missouri river, the threat of their spread via boats and other aquatic equipment remains.

5.3.5.4 Federally Listed Species and Habitats (Gavins Point River Segment)

Five different species are listed as threatened or endangered near the Gavins Point River Segment in South Dakota and Nebraska. The detailed life histories for these species are incorporated by reference from the original Master Water Control Manual Review and Update Final EIS (USACE, 2004).

5.3.5.4.1 Piping Plover (Charadrius melodus)

The entire Gavins Point River Segment has been designated critical habitat for the piping plover http://www.fws.gov/mountain-prairie/species/birds/pipingplover/sdunit2.pdf) The designated area is from approximately RM 880 near Fort Randall Dam to approximately RM 752.2 near Ponca, NE. Appendix B summarizes relevant life history and protected status of the piping plover.

5.3.5.4.2 Least tern (Sternula antillarum)

No critical habitat has been designated for the least tern within the Gavins Point River Segment. Appendix B summarizes relevant life history and protected status of the least tern.

5.3.5.4.3 American Burying Beetle (*Nicrophorus americanus*)

Listed as an endangered species in 1989, the American burying beetle is found in only six states: Nebraska, Rhode Island, Oklahoma, South Dakota, Kansas, and Arkansas. Habitats in Nebraska where these beetles have been recently found consist of grassland prairie, forest edge and scrubland. Specific habitat requirements are unknown but they may occur on the older, wooded islands in the segment, but none have been confirmed. The American burying beetle seems to be largely restricted to areas most undisturbed by human influence with an availability of carrion/carcass (appropriate in size as well as numbers). None have been confirmed on existing sandbars or interchannel islands.

5.3.5.4.4 Whooping crane (*Grus americana*)

Migrating whooping cranes have been observed foraging in adjacent wetlands and in this river corridor in recent years (USACE, 2004).

5.3.5.4.5 Pallid Sturgeon (Scaphirhynchus albus)

The Gavins Point River Segment is designated as recovery-priority area 3 for the pallid sturgeon.

5.3.5.5 State Listed Species and Habitats (Gavins Point River Segment)

The SDGFP has identified a state-listed threatened species, the false-map turtle (Graptemys pseudogeographica), as occurring within the South Dakota portion of the Missouri River. These turtles are active during the period of April-September with nesting taking place during the late spring and summer months. Nests in the Missouri River are typically established in sandy banks or on sandbars. Basking is typically restricted to inter-channel snags, rocks, and sandbars. False-map turtles are typically dormant in soft river bottom sediments from October to April.

The Nebraska Game and Parks Commission (NGPC) has identified four fish species that are of state concern: the state-endangered sturgeon chub (Macrhybopsis gelida), state-threatened lake sturgeon (Acipenser fulvescens), and "At-Risk" species blue sucker (Cycleptus elongates) and sicklefin chub (Macrhybopsis meeki). The American burying beetle may occur on the older, wooded islands in the segment, but none have been confirmed. The beetles appear to require forested islands with an accumulation of humus (decomposing organic matter) sufficient to bury carrion.

Incidental to their mussel survey in the Gavins Point River Segment, Backlund and Perkins (SDGFP, 2000) noted several turtle nesting areas on sandbars and habitats that appear important as nurseries for hatchling turtles. The two turtle species positively identified were the false-map turtle (Graptemys pseudogeographica) and the smooth softshell turtle (Trionyx mutica). Both the false-map turtle and the smooth softshell are species of concern in South Dakota. Many of the nests found were located only because of predation, the nests having been dug out and the eggs destroyed. Even though it appeared that there was a high rate of predation, it is unknown how many nests survived and there was evidence of successful reproduction of both species (SDGFP, 2000).

The shallows around the edges of sandbars near nesting areas are important as nurseries for young of year (YOY) smooth softshells. Here the young turtles are protected from large fish and larger turtles. By burrowing into the sand the turtles are hidden from predatory birds and mammals. While surveying for clams near the Gavins Point Dam, Keith Perkins discovered a large number (>100) smooth softshell turtles in the clam bed on March 19. The turtles were densely packed together and hibernating communally in association with the clam bed. All of the turtles in this communal wintering site were large, older turtles. Such a number of large, sexually mature turtles may represent a significant portion of the breeding population in a study area. This communal site was discovered during low water but the turtles and the clam bed were still in water one foot or more in depth (SDGFP, 2000).

5.3.5.6 Socioeconomic and Historic Resources (Gavins Point River Segment)

5.3.5.6.1 Land Use (Gavins Point River Segment)

According to the NPS General Management Plan for the MNRR (1999), the current land use includes a mix of private property and local, federal, and state jurisdiction. The USACE's management includes some recreational development in partnership with local agencies, and monitoring of private actions. Management varies under federal, state, and local laws, and by existing property owners. Agencies currently work together and consult on specific actions. The NPS is responsible for overall administration under the Wild and Scenic Rivers Act. The USACE, under cooperative agreement, manages bank stabilization, land acquisition, and recreational facility development. The Gavins Point project manager is part of the planning team. Individual property owners manage ranching and farming. Agriculture dominates the landscape.

The 1980 Missouri National Recreational River Management Plan recognized that protection of the river is dependent on the agreement of landowners to use the land in the river corridor in a manner compatible with the recreational river designation. Easement interests could be acquired, however none have been acquired. In 1980, 55 of 66 owners contacted signed a right-of-entry form for stream bank protection and gave the NPS scenic easements. Land has been acquired along the river by counties and by both states (SD and NE) for several recreational sites and access on both sides of the river.

There are residential and other private developments. Proposed developments could be built within the MNRR boundary. Union and Clay Counties, South Dakota, have zoning guidelines for development. There are no zoning controls for Yankton County, South Dakota or Cedar and Dixon Counties, Nebraska. There are more than 15 public and private access areas on the Missouri River from Gavins Point Dam to Ponca State Park.

5.3.5.6.2 Population (Gavins Point River Segment)

The first tier counties for this segment are Cedar and Dixon Counties in Nebraska and Yankton, Clay, and Union Counties in South Dakota. The regional population has been declining for more than 65 years (NPS, 1997).

The 2000 Census (U.S. Bureau of the Census, 2000) reports the population for the three first tier South Dakota counties—Yankton, Clay and Union--combined was 47,773. The 2004 update estimated the population at 47,937 (U.S. Bureau of the Census, 2006). The present estimated population is an increase of over 11 percent since the 1990 census and represents one of the few areas of the upper Missouri River with a growing population. The population density of Yankton, Clay, and Union Counties is 42, 33, and 27 persons per square mile, respectively, reflecting the greater regional population density.

The Gavins Point River Segment also intersects two Nebraska Counties (Cedar and Dixon) on the right descending bank. The combined population for these two counties as of the 2000 Census was 15,954 (U.S. Bureau of the Census, 2000). The 2004 update estimated the population at 15,169 (U.S. Bureau of the Census, 2006). The two-county population has decreased more than 7 percent since the 1990 census. The population density of Cedar and Dixon counties in Nebraska is typical of relatively rural counties, at 13 people per square mile for both counties.

5.3.5.6.3 Transportation (Gavins Point River Segment)

Interstate access to the downstream end of the Gavins Point River Segment is provided by the north-south running I-29 where it is within a few miles of the Missouri River at Elk Point, SD. Two important U.S. routes also provide access to the Gavins Point River Segment. U.S. Route 81 runs north-south through Yankton and connects South Dakota and Nebraska via the new Discovery Bridge (Route 81 bridge). U.S. Route 20 trends east-west within Nebraska, providing access to the Nebraska side of the river and connecting to Sioux City, IA. All other roads providing access to the segment from the Nebraska or South Dakota side are State or county roads (SR 12 in Nebraska and SR 50 and CR 10 in South Dakota) and local roads. These state and local roads provide access to homes, farms, and communities in the area.

The South Dakota Department of Transportation's most recently published automatic traffic counter data reports total vehicles per day for SR 52 west of Yankton, I-29 south of Junction City, and U.S. 50 in Vermillion, SD. State Route 52 averages approximately 5,800 vehicles per day, I-29 averages approximately 10,200 vehicles per day, and U.S. 50 averages approximately 700 vehicles per day (SDDOT, 2006). South Dakota does not report the portion of the vehicle count that is made up by trucks at these locations.

On the Nebraska side of the Missouri River, State Route 12 traverses the segment in an east-west orientation and average daily traffic data are available (NDOR, 2005). Nebraska Department of Roads reports that at the intersection with U.S. 81, SR 12 averages 1,910 vehicles, of which 150 are heavy vehicles (i.e., large trucks) (NDOR, 2005). Further to the east, near Newcastle, NE, SR 12 averages 1,275 vehicles per day, of which 120 are trucks (NDOR, 2005). Towards the eastern edge of the Gavins Point River Segment (east of Ponca, NE), SR 12 averages 2,470 vehicles per day, of which 155 are trucks (NDOR, 2005). Coming west from Sioux City, IA, U.S. 20 averages 4,725 total vehicles per day, of which 710 are trucks (NDOR, 2005).

5.3.5.6.4 Employment and Income (Gavins Point River Segment)

The primary 2000 employment sectors in the first-tier South Dakota counties (Yankton, Clay, and Union) for this segment were educational, health, and social services (26 percent); retail trade (12 percent); and arts, entertainment, recreation, accommodation, and food services (8 percent) (U.S. Bureau of the Census, 2000). Employment for the first tier Nebraska counties (Cedar and Dixon) were educational, health, and social services (19 percent); manufacturing (18 percent); and agriculture (15 percent) (U.S. Bureau of the Census, 2000).

The most recent economic survey published by the Census Bureau (1999) estimated the median household income for Yankton, Clay, and Union Counties to be $35,374, $27,535, and $44,790 respectively (U.S. Bureau of the Census, 2006). Statewide median household income for South Dakota (1999) was $35,282 (U.S. Bureau of the Census, 2006).

Similar data published for Nebraska estimated the median household income for Cedar and Dixon counties at $33,435 and $34,201 respectively (U.S. Bureau of the Census, 2006). Statewide median household income for Nebraska (1999) was $39,250 (U.S. Bureau of the Census, 2006).

The most recent Poverty Status figures (2003) estimated that 11.6, 17.7, and 6.3 percent of individuals in Yankton, Clay, and Union Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). Statewide, 13.2 percent of residents of South Dakota were considered below the poverty level (USDA, 2006).

The same data set estimated that 8.4 and 8.9 percent of the residents of Cedar and Dixon Counties were considered below the poverty level (U.S. Bureau of the Census, 2006). Statewide, 9.7 percent of the residents of Nebraska were considered below the poverty level (USDA, 2006).

5.3.5.6.5 Recreation (Gavins Point River Segment)

The 58-mile Gavins Point River Segment extends from Gavins Point Dam (RM 811, located on the Nebraska and South Dakota state line), to Ponca State Park, NE (RM 753). It is a component of the National Wild and Scenic Rivers System and has been designated the 59-mile District of the MNRR under the Wild and Scenic Rivers Act. Recreational use of the area is similar to that associated with other river stretches of the Missouri River Mainstem Reservoir System. The recreational activity on this segment of the river is estimated at 744,000 recreation days annually (USACE, 2004). Boating, jet skiing, water-skiing, canoeing, fishing, sightseeing, and swimming are popular activities. Waterfowl hunting is also popular.

Recreation areas along this segment of the river are somewhat more developed than recreation areas along the Fort Randall River Segment. This higher level of development, including more picnic tables, bathrooms, paved parking areas, and extensive state park camping facilities, accommodates a larger population than the Fort Randall River Segment. The combined population of Yankton (SD), Vermillion (SD), and Sioux City (IA) is approximately 100,000 people. Population centers of this size are not found along the Fort Randall, Garrison, or Fort Peck river segments. Table 5-22 lists recreation sites along the Gavins Point River Segment.

Table 5-22: Recreation Sites: Gavins Point River Segment

Site Name	Boat Ramps	Boat Trailer Parking	Camp Sites (RV, Camper, Tent)	Swimming Beach
Nebraska Tail Waters Boat Launch (1)	2	40	52	No
St. Helena Public Boat Launch (1)	1	100	None	No
Weisman Boat Ramp (1)	1	50	None	No
Mulberry Bend Boat Launch (1)	1	50	None	No
Chief White Crane State R.A. (2)	2	100	146	Yes
Yankton Riverside Park (2)	2	40	None	No
Clay County Park (2)	1	30	30	No
Myron Grove Boat Launch (2)	1	30	None	No
Brooky Bottom Boat Launch (1)	1	N/A	None	No
Bolton Landing (2)	Canoe	None	None	No
Ponca State Park R.A. (1)	1	Many	Many	No

R.A = Recreation Area, (1) Nebraska, (2) South Dakota

Note: Brooky Bottom boat launch site in Nebraska was inaccessible due to road conditions; Bolton Landing is a dirt access.

The 2000 Missouri River Recreational Use Survey (Mestl et al., 2001) included the Gavins Point River Segment, which was split into two reaches: Gavins Point Dam tail waters, and the Lower River. The Lower River reach extends from the tail waters of Gavins Point Dam to Sioux City, approximately 15 miles beyond the scope of this analysis (which ends at Ponca, NE). Fishing along the Gavins Point River Segment is very popular, with approximately 210,000 angler hours spent between April and December 2000. Approximately 85 percent (177,170 hours) of angler hours occurred between early April and mid-August and 15 percent (32,550 hours) occurred between mid-August and early December.

The 2000 Survey also indicates that hunting is a popular activity along this segment and takes place mainly between mid-October and mid-November. A small number of hunting hours (93) was reported for April in the Lower River reach of the segment as part of recent spring snow goose seasons. The low-lying flood plain and wetland areas along this segment provide waterfowl hunting opportunities, as do the inter-channel sandbars and their associated wetlands.

The 2000 Survey (Mestl et al., 2001) results showed that 50 percent more recreation hours were spent on the Gavins Point River Segment than on the combined Fort Randall River/Lewis & Clark Lake segments. However, when length of segment is considered, both had similar levels of total recreation in hours per river mile (4,846 recreation hours per river mile for the Gavins Point River Segment, and 4,791 recreation hours per river mile for the Fort Randall River/Lewis & Clark Lake segments). More fishing and boating occurred on the Gavins Point River Segment, but nearly six times more hunting occurred on the Fort Randall River/Lewis & Clark Lake segments than on the Gavins Point River Segment. This reflects a much more important fall recreational season in the Fort Randall River/Lewis & Clark Lake segments because of waterfowl hunting. Most of the recreation in the Gavins Point River Segment occurs during the summer.

Sightseeing in the Gavins Point River Segment is a year-round activity that may have been underestimated by previous recreational surveys. Monthly vehicle counts were recorded during 2006, 2007, and 2008 at the Mulberry Bend Overlook in Nebraska near the Vermillion-Newcastle Bridge (NPS 2009). Based on this data, an average of over 8,600 vehicles stop at this overlook between April 1 and November 30 while their occupants enjoy scenic views of this 59-mile District of the MNRR; furthermore, nearly 21 percent of the overlook visitation occurred in October and November.

The characteristics, amount, timing, and locations of various recreational activities in the two reaches of this segment (Gavins Point Dam tail waters and Lower River), including fishing, hunting, pleasure boating, picnicking, camping, bird watching, and sightseeing, are provided in Appendix D. In 2006, among person at last 16 years old (adults) recreating in Nebraska, residents of Nebraska accounted for approximately 94 percent of fishing days, 97 percent of hunting days, and 89 percent of wildlife watching days away from home. In 2006, expenditures in Nebraska related to recreational trips were approximately $19.70 per day for fishing, $28.57 per day for hunting, and $25.10 per day for wildlife watching. Trip-related expenditures in Nebraska for these three activities totaled over $130 million (USFWS/USCB, 2008).

5.3.5.6.6 Noise (Gavins Point River Segment)

Noise levels in the Gavins Point River Segment area vary geographically, by time of day, and seasonally. Relative tranquility is common in some of the more inaccessible areas, and sounds typical of more developed areas persist near Yankton, SD with bridge traffic and residences on the river. Recreation areas (e.g., Ponca State Park) that provide boat access to the river have greater levels of ambient noise associated with a larger number of recreational activities being concentrated along short reaches of the segment. Seasonal water-based recreation-related sounds (e.g., outboard motors, jet skis, and waterfowl hunting) are common in some areas (NPS, 1997).

5.3.5.7 Environmental Justice (Gavins Point River Segment)

According to the 2000 Census, the ethnic mix of residents in the first-tier South Dakota counties (Yankton, Clay, and Union) and the Nebraska counties (Cedar and Dixon) for the Gavins Point River Segment is presented in Table 5-23.

Table 5-23: Race in Gavins Point River Segment: South Dakota and Nebraska First Tier Counties

County	African American	Asian	Hispanic	Native American	White
Yankton	1.5 %	0.5 %	2.3 %	1.9 %	95.3 %
Clay	0.1 %	0.2 %	0.7 %	0.8 %	98.6 %
Union	0.3 %	2.2 %	1.6 %	0.6 %	96.3 %
Cedar	0.1 %	0.1 %	0.6 %	0.3 %	99.1 %
Dixon	0 %	0.2 %	7.5 %	0.6 %	98.5 %

Source: *http://factfinder.census.gov*

5.3.5.8 Cultural and Paleontological Resources (Gavins Point River Segment)

The Gavin's Point River segment contains cultural and paleontological resources. This downstream segment has not been as intensively inventoried as Corps project lands. The same major periods apply: Paleoindian, Archaic, Woodland, Plains Village, and Historic. Paleoindian sites, due to their age (from 11,000 years Before Present (BP)) are quite rare and have not been located along this reach. Sites from the other four periods would be more likely to occur in this segment.

The Archaic period (6,000 – 1 A.D.) followed the big game hunting period (Paleoindian – 11,000 – 6,000 BP). Archaic peoples appear to have been nomadic and gathered nuts, seeds, and berries. Their protein sources included a large variety of game, deer, bison, elk, pronghorn, rabbit, and other small mammals, fish, and amphibians. The Tramp Deep Site, located on Gavin's Point project lands, is associated with this time period.

The Woodland period ranged from 1 A.D. to 1000 A.D. The villages appear to be more permanent, large burial mounds give an indication of community activities, and horticultural tools indicate that some agricultural practices were taking place. Besides the agricultural practices, the Woodland people learned how to make pottery and developed the bow and arrow during this time.

The Plains Village period (1000 A.D. – 1780 A.D.) was a time of large earthlodge villages, reliance on agricultural crops, and regular bison hunts. The people of this period produced excellent quality pottery. The competition for resources was evident as many of these earthlodge villages had deep fortification ditches with log palisade walls for further protection. As these villagers were sedentary rather than nomadic, they succumbed to many of the Euro-american diseases brought in during the 1700s.

The Historic period (1780-1930) includes early steamboat traffic and wrecks, early Euro-American explorers, the Lewis and Clark expedition, and eventually, Euro-american settlers. Hutterites colonized some of the farmland south of the project lands which surround Gavin's

Point reservoir. Many other Hutterite colonies (in South Dakota) branched off the original Bon Homme Hutterite Colony, established in 1874.

The paleontological resources of this downstream area are not as well inventoried as the areas surrounding project lands. Should significant paleontological resources be located in or near proposed ESH development areas, the significant resources will be avoided.

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6 ENVIRONMENTAL CONSEQUENCES

The CEQ NEPA-implementing regulations describe the significance of environmental effects to require the consideration of two factors: context and intensity (40 CFR 1508.27). "Intensity" refers to the magnitude of a proposed action such as the areal extent of disturbance or the duration of activity needed to complete a project. Section 4.4 "Actions to Implement Alternatives by River Segment" summarized the intensity of the river segment-specific actions to implement each of the alternatives. The term "context" refers to the affected environment in which the proposed action would take place. In general, the more sensitive the context (i.e., the specific resource(s) in the proposed action's project area), the less intense an impact needs to be in order to be considered significant.[20]

Minimizing the environmental consequences of the ESH program relies heavily on a presumption of avoiding sensitive resources, as described in Sections 4.3.1, 4.4 and 4.5, and Appendices B and C. Table 4-12 illustrates the acres of impact by alternative for each project segment.

When the area needed to implement a programmatic alternative is less than the area remaining after eliminating known sensitive resources, the likelihood of incurring significant environmental consequences is diminished. Alternatively, when the areal extent needed to implement an alternative exceeds or approaches the area available after eliminating sensitive resources, the risk of incurring significant environmental consequences increases.

The three levels of exclusion zones are exclusionary, restrictive, and available, with exclusionary areas representing those areas with the most sensitive resources and available areas representing those areas with the greatest potential for creating ESH.

(1) Available Areas - Locations most suitable for and protective of nesting birds with minimal physical risk.

(2) Restrictive Areas - Locations where ESH could be created and replaced at relatively low physical risk, but would be within buffer limits of some sensitive resources. Examples include forests (increased predation risk) or boat ramps, recreation areas or domiciles (increased risk from recreational encroachment). Additional Federal and State coordination could be required to address site-specific concerns.

(3) Exclusionary Areas - Locations where creation and replacement of ESH would generally be excluded. Intrusion into these locations (e.g. within buffer limits of the thalweg, narrow river segments or intakes), could result in unsustainability of habitats, cause significant geomorphic alterations to the river corridor or risk physical and economic damages to major public and private infrastructure or land uses.

The environmental consequences for the alternatives analysis are a measure of the spatially defined need for an alternative relative to the area available after eliminating the sensitive features. The extent to which an alternative would require construction in the "available area," "restrictive area," or "exclusionary area" available for program implementation within a given segment is a measure of the potential significance of the environmental effects from

[20] For example, constructing a building on a dry, upland site may not be considered significant, whereas constructing the same building in a wetland would be significant.

implementing the alternative. The potential risk of incurring significant environmental effects is minimal (green) when constructing an alternative could be accomplished within the "available area,". However, when construction activities would occur in "restrictive areas," the risk of incurring significant impacts would be considered moderate (yellow). When construction activities would occur within "exclusionary areas," the risk of incurring significant impacts and unacceptable environmental, social, and cultural consequences would be considered high (red). Because this analysis is programmatic and not site-specific, the following discussion of the predicted environmental effects is described in terms of the risk of incurring significant effects.

The summary of the number of acres required by each alternative and whether construction would be required within the available, restrictive and exclusionary areas is in Table 4-12. The specific number of acres required within each area are summarized by segment for Fort Peck River Segment (Table 4-13), Garrison River Segment (Table 4-16), Ft. Randall River Segment (Table 4-19), Lewis and Clark Lake Segment (Table 4-22) and Gavins Point River Segment (Table 4-25). The potential of resource-specific impacts follows throughout Chapter 6, for each segment and alternative.

An additional analysis that relates to a measure of impacts is in Section 6.2, sediment relationship to sandbar creation. This section specifically addresses the availability of sediment in relation to each alternative. Throughout the segment- and alternative-specific discussions in Chapter 6, this sediment information is summarized in the sections entitled "Aggradation, Degradation and Erosion," and uses a similar, low/minimal (green), moderate (yellow) and high (red) scale of potential impacts.

Although known riverine features to be avoided have been mapped and accounted (as described in Appendices B and C), knowledge of environmental conditions at any site selected for construction remains incomplete until pre-construction evaluation. Many of the resources that state and federal agencies request that the Corps avoid in program implementation (e.g., mussel beds, turtle hibernating areas, cultural resources) would need site surveys prior to clearing a specific location for construction. Their absence or presence will not be ascertained until project sites are identified and examined.[21] Specific surveying requirements would be determined on a per project level as part of the individual project report and NEPA documentation.

This process of site-selection and pre-construction surveys could identify additional features to avoiding, but were not identified in the spatial avoidance process in the GIS analysis. From a practical standpoint, the site evaluations could result in the identification of conditions that further restrict the area available for construction. Again, this would be closely coordinated with federal and state agencies during the individual project report and NEPA process.

6.1 Subject Headings Eliminated from Analysis of Environmental Consequences

During the interdisciplinary consideration and evaluation of the affected environment (Section 5) and potential environmental consequences (Section 6), some subject areas would not be significantly adversely affected by any of the alternatives considered in the PEIS. Where there

[21] The standard procedures for these pre-construction surveys of the project footprint and associated staging areas can be found in Appendix H, section a.

were no potential effects identified to resource areas under any of the alternatives, the resource itself has been eliminated from further evaluation and analysis.

A primary assumption of program implementation is that sufficient emergent sandbar habitat can be maintained and created within a definable project area, while avoiding adverse effects to sensitive resources. The site selection process (Appendix G) and pre-construction site evaluation (Appendix H, section a), have been developed to identify sensitive resources (e.g., cultural or paleontological resources) or potential environmental liabilities (e.g., HTRW) that would always be avoided when selecting sites for ESH construction. Because of the pre-construction efforts to investigate sites to avoid these areas, the potential effects from encountering these factors during program implementation are not discussed further. In all cases, these areas would be programmatically avoided, regardless of the alternative implemented. This approach is consistent with CEQ guidance instructing that EISs are to be analytic and not encyclopedic and focus on potentially significant environmental impacts.

On that basis, there will be no further discussions under the following headings for the stated reasons:

- Physical Resources - Climate/Meteorology, Geology, and Soils[22] because the proposed actions would not measurably affect the climate, geology, or soils.
- Physical Resources – HTRW because contaminated areas would be always avoided.
- Water Resources – Water Use because proposed actions would not change patterns of non-recreational water use.
- Socioeconomic Resources – Land Use, Population, and Transportation would not be significantly impacted because the proposed actions would not permanently affect patterns of adjacent land use, result in employees permanently moving to new locations for work, or permanently affect the transportation infrastructure or usage. During pre-construction and implementation, the Corps may allow the use of public river access sites as staging areas by construction contractors after the appropriate coordination with partnering agencies and the public is conducted. In addition, these public access sites would be open for public recreational use as much as possible during construction. Where public river access does not exist, the Corps would develop a safe and stable location for landside equipment access to and egress from the river, as well as a staging area for equipment, materials and temporary field offices. Access to the river and use of the property would be with cooperation of willing landowners. All public and private access sites would be restored to their previous condition when ESH construction in the vicinity is completed (decommissioned).
- Cultural and Historic Resources – Regardless of the alternative selected the effects to cultural, historic and paleontological resources would be avoided through the site selection process; these sensitive resources would be included in the environmental buffers established during pre-construction. If any of these sypes of properties are discovered during an undertaking, the Corps would follow the procedure in EP 1130-2-540 (6-7)(d)(1), which states: “When a previously unrecorded cultural resource is discovered in the course of construction or while implementing other undertakings, including routine operation and maintenance, the

[22] Erosion issues will be addressed in Water Resources under Degradation, Aggradation, and Erosion.

contracting officer or other appropriate official shall, to the maximum extent practicable in the discretionary judgment of the contracting officer, require that any work in the immediate vicinity be halted until the situation is properly evaluated. Every reasonable and prudent effort should be made to avoid or minimize harm to the resource until it is professionally evaluated and the effects on it determined. If the property is determined to be significant, compliance with 36 CFR Part 800.11 must be initiated."

In the Fort Randall and Gavins Point River Segments, impacts to historic resources are considered because of the MNRR designation. The construction of sandbars within the Missouri River corridor will create a viewshed more in keeping with the landscape encountered by early explorers and settlers, such as Lewis and Clark. The impacts to the viewshed would only occur during construction and would be termporary in nature.

- Environmental Justice – Areas targeted for ESH restoration do not disproportionately adversely affect low income or Native American populations. There is little or no subsistence consumption of fish and game by Native Americans along the segments of the Missouri River proposed for ESH construction; hunting, fishing and trapping activities do not provide the principal portion of their diets. In addition, only aquatically approved herbicides will be used in removing vegetation from sandbars; therefore, there will be no adverse effects on the fisheries or impacts to the health of anglers (of all races, ethnic origins, and income categories) who catch and eat fish from the Missouri River.
- Socioeconomic Resources – Effects on Employment and Income Due to ESH Workers cannot be precisely quantified because the economic effects of ESH program implementation under the various action alternatives cannot be calculated, as a line item programmatic cost estimate for each of the alternatives was not developed. For all segments and all action alternatives, the increase in employment and income for the segments as a whole would not be significant. However, the hiring of seasonal workers to construct and maintain ESH would increase jobs and income, and these increases may be noteworthy locally but would not induce changes beyond those found in normal business cycles and accordingly are not considered to be significant. In addition, direct expenditures by these workers on food, lodging, and other items and direct expenditures on fuel and repairs for equipment used in ESH construction and maintenance activities would increase local business income. Based on 2001 and 2002 hunting and fishing information, the State of North Dakota estimated the average multiplier used for the computation of indirect effects due to in-state expenditures made by non-residents for hunting and fishing activities at 2.3 (Bangsund and Leistritz, 2003a, 2003b). Each dollar expended by non-state residents would generate $1.30 in indirect economic activity. The multiplier is not based on construction activity and the actual figure might be somewhat lower or higher. However, it is based on recent data and is considered adequate for purposes of this analysis. Expenditures related to ESH construction and maintenance activities would be over a relatively short duration. The increase in business activity would not be expected to result in local businesses having to add to existing capacity because these businesses are sized to accommodate peak summer visitation, whereas ESH construction activities would be conducted outside of the peak summer recreation season. The combined direct and indirect economic effects of ESH are not considered significant.
- Socioeconomic Resources – Effects of Potential Changes in Expenditures on the Regional Economy cannot be precisely quantified. Because many substitute recreational sites exist within each segment, visitors affected by use of a public boat ramp area and access road as a

contractor staging area are likely able to shift their recreational activities and recreational spending to another site within the segment. This shift within the segment, combined with the fact that ESH construction would occur outside of the peak summer recreation season, indicates that ESH construction would not likely result in a significant reduction in visitation or recreational expenditures in the segment. Total expenditures within each segment may likely increase due to 1) some ESH construction jobs being filled by otherwise unemployed or underemployed local residents (including Tribal members); and 2) non-local ESH construction workers purchasing lodging, food, fuel and other items locally. If such a net increase in regional income and expenditures occurs, there may be little likelihood of a reduction in tax receipts by local and county governments.

- Socioeconomic Resources – Effects of Potential Changes in Expenditures by Visitors from Within versus Outside the Region cannot be precisely quantified. Visitors from outside the region may have higher recreation-related expenditures in the region due to costs of travel, lodging, and food than those living in the region, and any adverse effects of ESH construction and maintenance may impact visitation from outside the region more than local visitation. As shown in Table 6-1, state residents accounted for 79% of fishing, hunting, and other wildlife-associated recreation days away from home spent in Montana, North Dakota, South Dakota, and Nebraska in 2001 (USFWS/USCB, 2002). If we assume that visitors from other regions similarly account for only 21% of visitation along each Missouri River segment, even if ESH-related adverse impacts on visitation are greater for those from outside the region than those living in the region, when taken in context with increases in the regional economy due to ESH construction and maintenance jobs, the total effects of ESH on the regional economy would not likely be significant.

Table 6-1: Wildlife-Associated Activity Days Away from Home, in Thousands of Days, Spent in Montana, North Dakota, South Dakota, and Nebraska, 2001.

ACTIVITY	Montana	N. Dakota	S. Dakota	Nebraska	TOTAL
BY STATE RESIDENTS:					
Fishing	3,515	1,969	2,238	2,916	10,638
Hunting	2,052	1,364	1,173	1,834	6,423
Other Wildlife Activities	187	38	71	115	411
SUBTOTAL:	5,754	3,371	3,482	4,865	17,472
PERCENT OF TOTAL:					79.0%
BY NON-RESIDENTS:					
Fishing	554	217	746	288	1,805
Hunting	390	271	1,252	370	2,283
Other Wildlife Activities	325	55	110	71	561
SUBTOTAL:	1,269	543	2,108	729	4,649
PERCENT OF TOTAL:					21.0%
TOTAL:	7,023	3,914	5,590	5,594	22,121

Source: U.S. Fish and Wildlife Service and U.S. Census Bureau. 2002. 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.

- Other Social Effects - Other Social Effects are not expected to be significant. No relocations of residences or businesses or significant adverse impacts to health and safety or community cohesion are likely because ESH construction would not result in an increased risk of flooding, increased water surface elevations, or changes in reservoir operations. Effects on recreational opportunities are not expected to be significant on a segment-wide basis. Effects of ESH on consumptive and non-consumptive recreational activities and opportunities may be beneficial (increased fish habitat and fishing success near backwaters dredged to provide material for ESH, and increases in amount and variety of birdwatching opportunities, respectively) or adverse (devegetation of islands eliminates them as deer browsing and deer hunting areas, and dredges may affect the quality of scenic views or outdoor photography opportunities, respectively). Several Corps procedures result in avoiding or minimizing effects on recreational opportunities. If a portion of a recreation area contains tern and/or plover nest(s), that portion would be posted to keep visitors from disturbing the birds or accidentally destroying nests, but the entire recreation area would not be closed. Major boat ramps and public access areas are included among the sensitive resources included within the environmental buffers when delineating ESH construction areas. Wherever possible, continued public recreational use of public river access sites utilized as contractor staging areas will be maintained. However, due to safety concerns at certain public access sites, public access may need to be temporarily stopped during construction, although such a closure has not occurred during the Corps' Existing Program of ESH construction. Any loss of recreational opportunities at a river access site that has been temporarily converted into a contractor staging area is only temporary because the contractor is required to restore the staging area as a recreational site when the ESH work is completed. Furthermore, similar recreational opportunities exist at other public river access sites nearby. Identification of substitute recreation sites is activity- and site-specific. These and other site-specific effects, and ways of avoiding, minimizing, and compensating for potential adverse effects, are more effectively and efficiently identified in the NEPA documents prepared for each proposal for ESH creation/maintenance that will be tiered under the ESH PEIS than in the PEIS itself.

6.2 SEDIMENT RELATIONSHIP TO SANDBAR CREATION

An analysis was conducted for each alternative to evaluate available sediment volume compared to the ESH program volume. The evaluation used the estimated annual ESH acres to create and replace the associated annual cubic yards of material for each alternative. The analysis did not include detailed sediment modeling or a sediment budget. Instead, available data from previous studies was used to assess the relative sediment magnitude of alternatives. Several factors should be considered when evaluating the presented data:

- Comparing ESH sediment placement volume should not be confused with estimating change to sediment movement rates. ESH sediment placement is not sediment removal from the system and is not an indicator of annual sediment continuity.
- The ESH construction method does not remove the placed bar material from the active river transport material; rather, the sediment is taken from the existing sediment supply within

the vicinity of the sandbar. The construction process re-arranges material within the active river bed.

- Construction restrictions on sediment removal depth prohibit creating sediment sinks. ESH construction methods are not significantly altering sediment within the reach and are generally seen to be near a net sediment balance.
- High flow periods since dam construction have been observed to create bar habitat. Mobilization of coarse bed materials due to increased stream power results in redistribution of the sediments at higher elevations. Numerical comparison of bar creation material volume to sediment transport volume within the reach is not available.

6.2.1 Sediment Sources

There are several sources of sediment material for islands and sandbars within the study reaches. These include the banks of the historic channel (developing new floodplain), bed of the main channel, islands and sandbars as well as the contributing tributaries and arroyos. Within the degradation reaches, the major tributaries that could provide significant sediment include the Niobrara and Yellowstone Rivers. The Niobrara River enters the Missouri River at the boundary between the Fort Randall River and Lewis and Clark Lake Segments. The Yellowstone River enters toward the downstream end of the Fort Peck River Segment. The Gavins Point River Segment has a number of moderate-size tributaries. The sediment size entering from the James River is quite dissimilar from that found in islands and sandbars and therefore is of limited value in terms of ESH potential (Biedenharn, 2001). For other tributaries, the volumes of tributary flows are but a small percentage of Missouri River flows in each segment. The tributaries may have some local influences, but in general are not a significant source of sediment.

6.2.2 Sediment Size

The analysis of potential sandbar habitat material provides useful information relevant to the analysis. Size of sediments within the banks, bars, and channel were examined within previous studies (Biedenharn, 2001). In general, bar material is generally coarser than bank material. In addition, the channel bed is slightly coarser than the bar material. ESH projects are generally constructed using available channel material. The percent of bank material within the sand fraction generally varies from 50 to 60 within the Fort Peck, Garrison, and Gavins Point River Segments. The Fort Randall River Segment has finer bank material with only about 20% of the material suitable for use as bar material (Biedenharn, 2001). The Lewis and Clark Lake Segment was not evaluated in the Biedenharn study (Biedenharn, 2001). However, the Niobrara River is a known sand source with input to the segment.

6.2.3 Sediment Impact

The Biedenharn study also included a quasi-sediment budget that provides relevant information regarding the average annual sediment movement. The Biedenharn study presents annual bed material loads determined using a sediment transport rating curve combined with a flow duration curve to develop an estimate of annual sediment transport volume. For each segment, the annual volume of material supplied by the banks large enough in size to be suitable for bar material was combined with the annual bed erosion volume. Sediment sinks with material deposited along the banks and within the bed were subtracted. The process produces a total bed material load at the downstream end of the reach. A second method to estimate annual sediment volume for each segment uses tabulated bank erosion volumes. Bank erosion rates were estimated using two sets of aerial photos separated by about 20 years within each segment. Bank erosion volumes were determined using average bank heights (Biedenharn, 2001). The bank and bar sediment size information was then used to estimate the percent of bank material available for bar formation.

Regarding this procedure, a few items should be considered:

- The calculated annual sediment values reflect the bed material load. This value is somewhat less, probably in the range of 5 to 15%, than the sand portion of the total load when considering all material sizes greater than 0.062 mm.
- The study reaches in the Biedenharn report (Biedenharn, 2001) only consider the degradation zone downstream of each dam. This underestimates sediment load for the ESH segments, especially within the Fort Peck segment due to the contribution of the Yellowstone River.
- Bank erosion rates are estimated from historic aerial photos between the 1970's and 1990's. Since bank erosion is highly correlated with flow releases, future bank erosion rates may differ significantly.
- For purposes of evaluating sediment movement and comparing to ESH construction, the bed material rate from the Biedenharn report (Biedenharn, 2001) was selected to provide an indication of the minimum material movement rate.

When available, a second method to indicate the sediment material movement within each reach was used to provide comparison data. The second method consisted of information from previous reports and the lost reservoir storage derived from survey data. Regarding this procedure, a few items should be considered:

- The volume reflects all material sizes. A reduction factor was applied to account for material smaller than 0.062 mm. Although the smaller material is transported and captured by the reservoirs, it is not likely to be used extensively in the creation of ESH habitat. A sand percentage of 40% was assumed for computations.
- Suspended sediment records only measure a portion of the total load. The unmeasured load usually consists of an additional 10 to 20% of the suspended load to reach the total load.

Using values from available data sources, the annual sediment volume values for each segment were compared to the ESH annual sediment replacement volume as shown in Table 6-2. The comparison utilizes two different sources, the Biedenharn report, as well as reach-specific information when available, noted in the two rows of information presented in the table for each reach. The comparison also utilizes a similar "scale" of risk of significant impacts to that discussed in Section 4.5 (available, restrictive and exclusionary areas). For this analysis:

Green (low): Annual cubic yards required by the Alternative are 0 – 40% of annual sediment volume for the segment. The risk of significant impacts regarding aggradation, degradation or erosion would be considered low.

Yellow (moderate): Annual cubic yards required by the Alternative are 40-100 % of annual sediment volume for the segment. The risk of significant impacts regarding aggradation, degradation or erosion would be considered moderate. Adaptive Management and monitoring are proposed to help address uncertainties associated with potential impacts (Appendix H).

Red (high): Annual cubic yards required by the Alternative are greater than 100 % of annual sediment volume for the segment. The risk of significant impacts regarding aggradation, degradation or erosion would be considered high. Adaptive Management and monitoring are proposed to help address uncertainties associated with potential impacts (Appendix H).

The sources utilized for the study report a range of sediment volumes and could indicate a range of potential impacts. Further discussion of sediment impacts are included in the "Aggradation, Degradation and Erosion" sub-sections arranged by Segment and Alternative in Sections 6.4 – 6.8). When a range of potential impacts was revealed, the higher level of potential impacts was assumed.

Table 6-2: Comparison of annual sediment volume for each segment and annual sediment volume required for each Alternative

Annual Sediment Volume (cu yds/yr)	Annual Cubic Yards Required by Alternative							Annl Sediment Volume Source
	ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist	
	Fort Peck							
958,000	1,552,370		1,552,370	831,836	216,746	17,574	-	Biedenharn, 2001, Tab 4-24, pg. 50; does not include Yellowstone River
5,010,000	1,552,370		1,552,370	831,836	216,746	17,574	-	Sum annual gage date from Missouri at Culbertson, Yellowstone at Sidney
	Garrison							
1,104,000	10,054,044	3,722,552	3,631,960	1,944,856	515,504	292,900	-	Biedenharn, 2001, Tab 4-24, pg. 50
1,350,000	10,054,044	3,722,552	3,631,960	1,944,856	515,504	292,900	-	USGS Report, Water Resources investigation Report 00-4072, Tab 2
	Fort Randall							
526,000	1,640,240	615,090	521,362	310,474	111,302	82,012	-	Biedenharn, 2001, Tab 4-24, pg. 50
	Lewis & Clark							
3,872,000	3,983,440	1,991,720	1,657,814	1,036,866	415,918	234,320	146,450	Lewis & Clark Lake area capacity tables 1955-2007
	Gavins Point							
3,679,000	10,890,022	4,038,026	5,172,614	2,800,124	773,256	333,906	732,250	Biedenharn, 2001, Tab 4-24, pg. 50
7,810,000	10,890,022	4,038,026	5,172,614	2,800,124	773,256	333,906	732,250	USACE, 2001, Sioux City Suspended Annual Load, Tab 6.1

Notes regarding this table:

*** The comparison utilizes two different sources, the Biedenharn report, as well as reach-specific information when available, noted in the two rows of information presented in the table for each reach. The information from Biedenharn was converted from cubic meters/yr to cubic yards/year for comparative purposes. Comparing ESH sediment placement volume should not be confused with estimating change to sediment movement rates. ESH sediment placement is not sediment removal from the system and is not an indicator of annual sediment continuity. Annual sediment volume reflects sediment from all sources (bed, bank, etc.)*

*** Assumptions were required to convert suspended sediment load and lake aggradation values to sediment comparable to ESH program volume. For suspended sediment, a value of 15% unmeasured was assumed to convert from suspended load to total load. For sediment size, a* *value was assumed for the sand fraction of the total load using 40% in the Fort Peck to Williston segment and 60% for the Gavins Point Dam to Ponca segment. The sand fraction value for each segment was estimated based on an average from several studies.*

It should be cautioned that Table 6-2 values comparing sediment volume are not suitable for estimating change to sediment movement rates. The ESH construction method does not remove this material from the active river transport material; rather, the sediment is taken from the river corridor materials within the vicinity of the sandbar. The high flow periods since dam construction have been observed to create bar habitat. These periods of natural bar creation do not correspond with a reduction in sediment load, indicating that the bar creation process and sediment load are not directly dependent variables.

Table 6-2 does indicate that a large amount of material is required for Alternatives 1, 2, 3, and 3.5 relative to the annual load within some of the segments. The largest relative ratio occurs in the Garrison River and Fort Randall River Segments. While other factors should also be considered, it is reasonable to assume that enacting the large material volume alternatives for a prolonged period of time is likely to encounter sediment issues. Possible issues include:

- Impacts to surrounding resources due to altered sediment concentrations.
- Possible reach-wide and localized impacts to channel evolution, bed, and bank materials. The Adaptive Management plan (Appendix H) summarizes potential investigations (monitoring) proposed to help address uncertainties associated with such impacts.
- Issues with locating suitable habitat sites as access to suitable local sediment sources (e.g size, composition, coarseness) for ESH may be limited.
- Possible impacts to ESH created habitat duration (increased erosion rates).

6.2.4 Summary

Evaluation was performed of the ESH segments to provide information regarding the geomorphic setting. No new analysis was performed for this study; presented information is derived from numerous existing reports. Analysis was also performed to evaluate available sediment volume compared to the ESH program volume. Significant conclusions relative to the ESH program segments and alternative evaluation are:

- Using the 70% value for the presence of bars (bars were present 70% of the time for that channel width), the channel widths for the Fort Peck, Garrison, and Gavins Point reaches are about 350 m, 800 m, and 1000 m, respectively. The threshold value for the Fort Randall reach is less defined. This information can be used when selecting ESH construction sites within each segment.
- The trend toward approaching dynamic equilibrium (Section 5.2.2) indicates that the river's response to dam construction and operations is declining. However, this also indicates that ESH program segments are not currently in a sediment balance or equilibrium condition.
- The new river planform is likely to have increased meandering and a reduced sediment load compared to the immediate post dam condition (see Section 5.2.2) (USACE, 1994b).
- The abundance of sediment supply in both the bed and banks indicates material will be available to replace ESH constructed habitat.
- Comparing ESH sediment placement volume should not be confused with estimating change to sediment movement rates. ESH sediment placement is not sediment removal from the system and is not an indicator of annual sediment continuity.

- Sediments used for the mechanical creation of ESH are not removed from availability to the system and should have a near net-zero impact on the river's sediment transport capacity and long term aggradational/degradational processes. This conclusion is supported by the recently published study performed by the National Research Council of the National Academies (NRC, 2010) which concluded that since the constructed bars gradually erode and sand is redistributed, there is no net effect on the river's sediment balance.
- Sediment analysis did demonstrate that Alternatives 1, 2, 3 and 3.5 will require a large amount of material relative to the annual load within some of the ESH segments, especially in the Garrison River and Fort Randall River Segments. It is reasonable to assume that enacting one of these alternatives for a prolonged period of time is likely to encounter sediment issues in some areas. Possible issues include impacts to surrounding resources, impacts to reach wide and local channel evolution, bed and bank materials, possible issues with locating suitable habitat sites, and impacts to habitat duration.

6.3 VEGETATION

Vegetation on the existing bars includes a mix of forbs, shrubs and trees and is largely dominated by willow species and young cottonwood trees on higher elevation bars. Projects intended to be built on existing vegetated bars would involve the removal of vegetation from those bars prior to construction. This is intended to create suitable bare sand habitat and reduce potential predator habitat, as well as slow the re-establishment of vegetation on the completed projects.

Vegetation removal activities would entail the use of herbicides on leafed-out vegetation by either helicopter, all terrain vehicle with boom, or backpack spray application methods followed by mowing of vegetation with sickle mower and overtopping with sediment to increase elevation as necessary. Spraying would follow BMPs and standard environmental protection specifications for handling of chemicals. Only aquatically approved chemicals would be used and in quantities deemed safe by the EPA. There are two types of herbicides proposed for use by the USACE on the Missouri River, Glyphosate and Imazapyr. Overtopping would involve the placement of material at least one foot above mowed stubble.

There are two types of herbicides approved for use by the Corps on the Missouri River, Glyphosate and Imazapyr. Glyphosate is designed to kill postemergent vegetation and moves to the root system to prevent re-growth. It controls most annual and perennial weeds and woody brush and trees (Tu et al. 2001) but must be applied to foliage, green stems, and cut stems because it cannot penetrate woody bark (Carlisle and Trevors 1988). Glyphosate does not have a residual effect because it is strongly bound to soil particles, making it unavailable for absorption by plant roots (Hance 1976). The other approved chemical, Imazapyr, is used for the control of terrestrial annual and perennial grasses and broadleaved herbs, woody species, and riparian and emergent aquatic species. Unlike Glyphosate it is useful in killing large woody species because it is absorbed quickly through plant tissue, can be taken up by roots, and has a slow breakdown in plants. It is useful for total vegetation control because at higher concentrations Imazapyr has a low soil adsorption rate, thus it remains available for plant uptake. Imazapyr is most effective on annual weed species when applied as a post-emergent herbicide and most effective on woody species when used as a pre-emergent (Tu et all 2001); however, it appears relatively ineffective on legume species (Fabaceae; (G. Jons, U.S. Army Corps of Engineers, personal communication 2007). The combination of these two herbicides could provide an effective treatment combination.

Vegetation removal would have localized impacts only on the islands and would not impact the general area due to the abundance of mature and immature wood- and shrublands. Removed vegetation could be pushed into the river, burned, piled in a designated area or hauled from the site. Pushing the vegetation into the river is a potential method of disposal because of the ease as well as the added benefit of returning critical habitat and complexity to the river. While the toxicity of the two aquatically approved herbicides is low, further information would be acquired regarding the effects of disposing sprayed vegetation in the river. Other disposal methods also present potential drawbacks. For example, burning can be a potentially property and life-threatening method and most sandbars lack sufficient combustible material to carry the fire. Piling material on the sandbars could inadvertently provide habitat for predators such as mink. Leaving material on the shorelines could encroach upon foraging habitat for the terns and plovers. Disposal methods of treated vegetation litter would be determined on a project-specific basis and coordinated as necessary.

Disturbance of vegetation due to construction activities is anticipated to be minimal. As part of the contract, disturbed areas would be restored following construction. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions as part of this program is not likely to have a significant impact on vegetation communities within the project area.

In order to determine the potential impacts to vegetation, an analysis of the 2005 habitat delineations and the exclusive and restrictive buffer zones was conducted. Table 6-3 displays the amount of different vegetation classes that fall within these three zones. The acres represent the amount of each class of vegetation that falls within these three different areas.

Table 6-3: Potential Acres of Vegetation Modification by Segment Using 2005 Classifications

	Available Area			Restrictive Area			Exclusionary Area		
	Herb/ Shrub/ Sapling	Forest	Wetland Matrix	Herb/ Shrub/ Sapling	Forest	Wetland Matrix	Herb/ Shrub/ Sapling	Forest	Wetland Matrix
Gavins Point	314	15	0	1350	1560	446	727	2750	242
Lewis and Clark Lake	567	7	0	276	168	7670	76	72	727
Fort Randall	553	42	0	1306	745	1576	305	72	108
Garrison	942	1	0	2156	651	459	1879	275	363
Fort Peck	1174	39	0	4728	2864	2876	2191	51	1226
Total	**3550**	**104**	**0**	**9816**	**5988**	**13027**	**5178**	**3220**	**2666**

In order to determine how much vegetation could potentially be impacted by each alternative, it was assumed that areas with existing vegetation would only be used for placement of ESH and not as borrow areas. This follows the assumptions of Appendix C which states that submerged sediments would be gathered from within the channel of the river in order to construct ESH. Additionally, areas with existing vegetation provide additional construction challenges when used as borrow sources due to the presence of organic material such as roots and debris.

Additionally, in order to disclose the maximum potential impacts, the analysis assumed that vegetated areas were the first areas in which ESH would be placed. This may not be the methodology of choice, but it provides a upper limit of potential impacts to vegetation. It was also assumed that ESH would be placed in the available area first, and would only move into the restrictive area if there was no more room to build in the available area. Using these assumptions, the acreage goal for each alternative, the amount of area within the three zones (available, restrictive and exclusionary), and the amount of vegetation within each of these zones, the maximum potential impacts for each alternative were derived (displayed in Table 6-4). Also note that a third class of vegetation called "Wetland Matrix" was included in this analysis, however, there were no impacts anticipated to this type as they did not appear within the available area.

Table 6-4: Potential Impacts to Vegetation Modification by Segment, by Alternative

	Existing Program		Alternative 5		Alternative 4		Alternative 3.5		Alternative 3		Alternative 2		Alternative 1	
	Herb/ Shrub/ Sapling	Forest	Herb/ Shrub/ Sapling	Forest	Herb/ Shrub/ Sapling	Forest	Herb/ Shrub/ Sapling	Forest	Herb/ Shrub/ Sapling	Forest	Herb/ Shrub/ Sapling	Forest	Herb/ Shrub/ Sapling	Forest
Gavins	314	15	314	15	314	15	314	15	314	15	314	15	1081	15
Lewis and Clark	50	0	80	0	142	0	354	0	566	0	567	7	567	7
Fort Randall	0	0	135	0	128	0	212	0	295	0	350	0	553	42
Garrison	0	0	500	0	588	0	942	1	942	1	942	1	942	1
Fort Peck	0	0	30	0	247	0	565	0	883	0	0	0	883	0
Total	364	15	1059	15	1419	15	2387	16	3000	16	2173	23	4026	65
Overall Total	379		1074		1434		2403		3016		2196		4091	

*Alternative 1: Gavins Point is highlighted because this alternative has the potential to impact vegetation within the area designated as "restrictive" after environmental buffers are applied (see Tables 4-12 and 4-25).

Vegetation Impacts for the Entire Program by Alternative:

Alternative 1:

Disturbance of vegetation due to construction efforts is anticipated to be low, impacting an estimated 4,091 acres, approximately 9% of all classes of existing vegetation (herb/forest/wetland) among all the segments. In the Gavins Point River Segment, construction activities would be within the restrictive area (see Sections 4.5 and 4.6; Table 4-25).

Alternative 2:

Disturbance of vegetation due to construction efforts is anticipated to be low, impacting an estimated 2,196 acres, approximately 5% of all classes of existing vegetation (herb/forest/wetland) among all the segments, all within the available area (see Sections 4.5 and 4.6).

Alternative 3:

Disturbance of vegetation due to construction activities is anticipated to be low, impacting an estimated 3,016 acres, approximately 7% of all classes of existing vegetation (herb/forest/wetland) among all the segments, all within the available area (see Sections 4.5 and 4.6).

Alternative 3.5:

Disturbance of vegetation due to construction activities is anticipated to be low, impacting an estimated 2,403 acres, approximately 6% of all classes of existing vegetation (herb/forest/wetland) among all the segments, all within the available area (see Sections 4.5 and 4.6).

Alternative 4:

Disturbance of vegetation due to construction activities is anticipated to be low, impacting an estimated 1,434 acres, approximately 3% of all classes of existing vegetation (herb/forest/wetland) among all the segments, all within the available area (see Sections 4.5 and 4.6).

Alternative 5:

Disturbance of vegetation due to construction activities is anticipated to be low, impacting an estimated 1,074 acres, approximately 2% of all classes of existing vegetation (herb/forest/wetland) among all the segments, all within the available area (see Sections 4.5 and 4.6).

Existing Program:

Disturbance of vegetation due to construction activities is anticipated to be low, impacting an estimated 379 acres, approximately 1% of all classes of existing vegetation (herb/forest/wetland) among all the segments, all within the available area (see Sections 4.5 and 4.6).

Overall:

It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in the target segments. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact within any of the segments, for any of the alternatives.

6.4 Fort Peck River Segment - Segment 2

Concerns have been raised regarding construction in the Fort Peck Segment, due to its designation as part of Recovery-Priority Area 2 (RPA 2 also includes the lower Yellowstone River), one of only six priority management areas that still provide suitable habitat for restoration and recovery of the endangered pallid sturgeon. Implementation of many of the larger alternatives risks construction-related effects to the endangered pallid sturgeon. Because of this, and lower bird usage in this segment as documented in the 2003 BiOp Amendment, the Fort Peck River Segment is considered a lower priority reach for ESH construction (creation and replacement), and any future construction needs would be identified through the adaptive management process, which provides the Corps the flexibility to construct there if needed or recommended by the USFWS through ongoing coordination. In addition, avoidance and minimization of impacts to pallid sturgeon due to construction activities would be ensured when site-specific restoration activities are undertaken. Local monitoring data and consultation with state and federal experts knowledgeable of specific sites and habitats important to pallid sturgeon would be used to identify and avoid high risk areas.

6.4.1 Alternatives 1 and 3 (Fort Peck River Segment)

The discussion of environmental consequences for Alternatives 1 and 3 has been combined for the Fort Peck River Segment because the acreage goals are the same. There is no discussion of the effects of Alternative 2 (2005 Goals) because none were identified in the 2003 BiOp Amendment.

As explained in Section 4.4, the Fort Peck River Segment has a measured high-bank to high-bank area of approximately 39,009 acres. After application of the environmental buffers to the segment, 3,825 residual acres, or 8.5% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating 883 acres of interchannel sandbar as part of Alternatives 1 and 3 would disturb 2,623 acres of river bottom habitat, meaning all construction activities could occur within the available area (see Sections 4.5 and 4.6; Table 4-13).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2015 within approximately 10 years of the ESH program initiation. Erosion would require the annual construction (combination of creation and replacement the first 10 years) and subsequent continual replacement of approximately 265 acres of habitat, based on the assumed annual lost habitat rate of 30 percent for these alternatives. Annual creation and/or replacement would require 178 days of mechanical work and 153 days of dredge operation that could be accomplished with 4 teams of mechanical operators and 4 dredges operating simultaneously to complete the work within the 47 available calendar days each autumn. Annual construction would disturb 787 acres, moving over 1.5 million cubic yards of material.

6.4.1.1 Physical Resources (Fort Peck River Segment, Alt. 1 & 3)

6.4.1.1.1 Air Quality (Fort Peck River Segment, Alt. 1 & 3)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more National Ambient Air Quality Standards (NAAQS). No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternatives 1 and 3 have not been calculated. However, this alternative represents the largest area of ESH to be created and the emissions from equipment operation (direct effects) would be the greatest. NAAQS parameters are in attainment of the air quality standards (USEPA, 2006) and therefore no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternatives 1 and 3 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.4.1.1.2 Aesthetics (Fort Peck River Segment, Alt. 1 & 3)

Potential aesthetic impacts from implementing Alternatives 1 and 3, including temporary and long-term visual changes, would be locally significant during construction. In order to create the 883 acres of ESH, 153 and 178 days of dredge and heavy equipment operation, respectively, from four sets of construction teams would be required at selected sites. Changes to vistas at the selected sites would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the valuable, rare, and desirable aesthetic resource ubiquitous in the Fort Peck River Segment. The long-term visual impacts resulting from the actions necessary for the annual replacement of 265 acres of ESH would not be aesthetically significant as the completed ESH would appear similar to high-elevation sandbars deposited during high releases. However, because of the intensity (i.e., magnitude) of construction required, and locally significant impacts during construction, construction of Alternative 1 would lead to significant effects on aesthetics.

6.4.1.2 Water Resources (Fort Peck River Segment, Alt. 1 & 3)

6.4.1.2.1 Surface Water Hydrology and Hydraulics (Fort Peck River Segment, Alt. 1 & 3)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg (deepest/fastest part of channel), minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because the necessary ESH would entail construction activities within the “available area,” which excludes the thalweg and high-energy flows identified, constructing (creating and replacing ESH) Alternatives 1 and 3 (883 acres of ESH) in the Fort Peck River Segment could be accomplished without risk of significantly encroaching into the available cross-sectional area (see Sections 4.5 and 4.6; Table 4-13).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.4.1.2.2 Aggradation, Degradation, and Erosion (Fort Peck River Segment, Alt. 1 & 3)

The Fort Peck River Segment demonstrates the lowest percentage of available project area to total riverine corridor area (9%) among all the segments. Construction activities could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-13). However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 1 and 3, it is estimated approximately 1.5 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Fort Peck River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-3).

Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis. Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

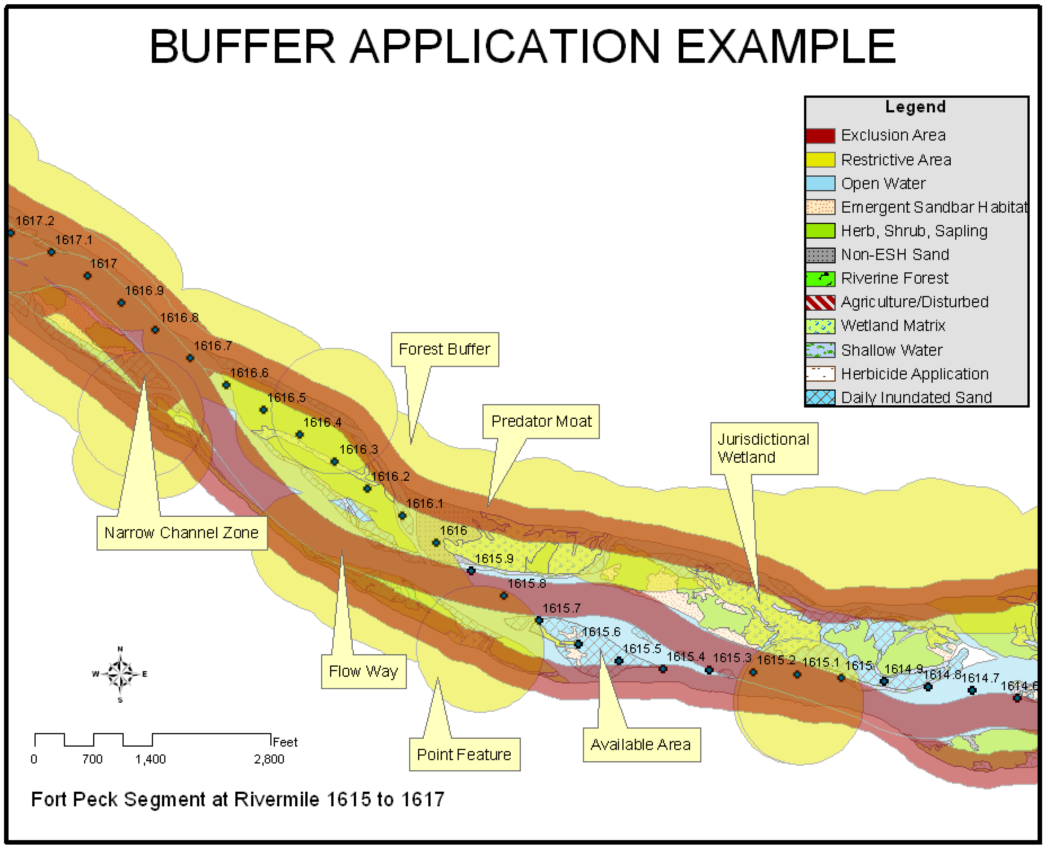

Figure 6-1: Buffer Application Example in the Fort Peck River Segment

6.4.1.2.3 Water Quality (Fort Peck River Segment, Alt. 1 & 3)

The following activities, necessary to construct and maintain the 883 acres of ESH under Alternatives 1 and 3 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 0.7 million CY of sand and sediments to reach the goal of 883 acres of ESH, and
- Annually placing of over 1.5 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality could result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen, and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

The State of Montana denied Section 401 certification for all activities authorized by NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Minimization of impacts to water quality during construction is important as leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.4.1.3 Biological Resources (Fort Peck River Segment, Alt. 1 & 3)

6.4.1.3.1 Vegetation (Fort Peck River Segment, Alt. 1 & 3)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 883 acres of herb/shrub/sapling (11% of this vegetation class) and 0 acres of forest in the Fort Peck River Segment, all within the available area (see Table 6-4 and Sections 4.5 and 4.6; Table 4-13). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in the target segments. Due to the abundance of vegetated sandbars in this segment, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not anticipated to have a significant impact.

6.4.1.3.2 Wetlands (Fort Peck River Segment, Alt. 1 & 3)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 4,100 acres of wetlands within the 39,009-acres of habitat from high-bank to high-bank. This represents approximately 11% of the total habitat within the segment. As depicted in Figure 6-1, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Approximately 787 acres would be disturbed annually to maintain the ESH. The spatial analysis demonstrated that sufficient non-wetland area is available to allow the construction of the necessary area without significant risks to existing wetlands.

6.4.1.3.3 Fish, Invertebrates, and Wildlife (Fort Peck River Segment, Alt. 1 & 3)

An approximate area of 787 acres would be disturbed annually to create and/or replace the ESH. There could be direct effects to fish and wildlife within the Fort Peck River Segment from constructing the 883 acres of ESH under Alternatives 1 and 3. However, avoidance of biologically important habitat (e.g., submerged aquatic vegetation) appears feasible in the Fort Peck River Segment through the application of pre-construction surveys and site selection criteria to minimize the risk of significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to the substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by the Corps' Engineering Research and Development Center (ERDC) from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging during dredging, and post dredging, to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16 Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Plovers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Mobile species of fish and wildlife would be expected to find refuge in the abundant nearby habitat until the construction disturbance ended. However, sessile and dormant species could be destroyed during construction. Indirect construction-related effects to fish and wildlife species (e.g., noise, vibration, equipment emissions) within adjacent terrestrial or aquatic habitat would persist for the duration of annual construction. The overall risk of significant effects to fish and wildlife would be low.

6.4.1.3.4 Federally Listed Species and Habitats (Fort Peck River Segment, Alt. 1 & 3)

As described in Section 5.2, the Fort Peck River Segment has five federally listed species that could be affected by implementing Alternatives 1 and 3. The potential effects to piping plover and least tern are addressed in the next section.

The black footed ferret (*Mustela nigripes*) has been re-released in Montana adjacent to the Fort Peck Reservoir and upstream of the Fort Peck River Segment of the Missouri River. No critical habitat has been designated for the black footed ferret within the Fort Peck River Segment of the Missouri River, and effects to black footed ferret or their critical habitat are highly unlikely under any of the action alternatives.

Effects of implementing Alternatives 1 and 3 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Fort Peck River Segment – in its entirety – is designated as Recovery-Priority Area 2 and is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded; have the highest habitat diversity; and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation and replacement. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, risks construction-related effects to the endangered pallid sturgeon.

6.4.1.3.5 Effects to Least Tern and Piping Plover (Fort Peck River Segment, Alt. 1 & 3)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

The CEQ's NEPA Regulations (40 CFR 1500-1508.8) state that an alternative's effects may be both beneficial and adverse. As such, the analysis of environmental effects is not restricted to the anticipated deleterious effects of program implementation but includes the analysis of the range of anticipated beneficial effects from implementing the alternatives being evaluated.

For each alternative, a given number of acres of ESH would be created and replaced. The estimated number of acres of nesting habitat, relative to the total number of other ESH acres is at a 3:1 ratio, as stipulated in the 2003 BiOp Amendment.[23] Therefore, in creating the 883 acres of ESH under Alternatives 1 and 3, 221 acres of nesting habitat would be created. Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support , assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 883 acres of ESH in the Fort Peck River Segment under Alternatives 1 and 3. The entire dataset for the Fort Peck River Segment (2000-2006) identified 6 piping plover nests and 97 least tern nests over the 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Peck River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plans for the least tern (USFWS, 1990) and piping plover (USFWS, 1988) do not establish segment-specific adult census goals for the Fort Peck River Segment. Instead, the recovery plans establish a Montana, statewide goal of 50 adult least terns and 60 adult pairs (120 adults) of piping plovers. The effect on the least tern and piping plover from creating 883 acres of ESH in the Fort Peck River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.4.1.4 Socioeconomic Resources (Fort Peck River Segment, Alt. 1 & 3)

6.4.1.4.1 Recreation (Fort Peck River Segment, Alt. 1 & 3)

Temporary indirect effects to recreation would result from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 47-day period available for construction each fall in the Fort Peck River Segment. Although the intensity of the disturbance to recreation could be large, few recreationists would be affected because relatively few people recreate in the Fort Peck River Segment. The greatest effects to recreation would be associated with hunters and anglers when their intended locations for outdoor recreation become dedicated to the annual creation and/or replacement of ESH. Because of the small number of participants, and the availability of alternative hunting and fishing sites, the effects on recreation would not be significant.

[23] The basis of the nesting area to plover foraging and brood rearing habitat ratios cited here are thoroughly explained in the Emergent Sandbar Habitat Creation and Replacement Assumptions, Appendix C.

6.4.1.4.2 Noise (Fort Peck River Segment, Alt. 1 & 3)

Alternatives 1 and 3 represent the largest area of ESH to be created in the Fort Peck River Segment. Creation of 883 acres of ESH would require the use of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 47-day period available for construction every year. However, given the remote location of this work, human receptors would likely not be affected by the noise.

6.4.2 Alternative 3.5 - Impact Level Identified with AMIP Preferred Alternative (Fort Peck River Segment)

As explained in Section 4.4, the Fort Peck River Segment has a measured high-bank to high-bank area of approximately 39,009 acres. After application of the environmental buffers to the segment, 3,825 residual acres, or 9% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Creating 565 acres of interchannel sandbar necessary as part of Alternative 3.5 would disturb 1,681 acres of river bottom habitat, meaning all construction activities could occur within the available area (see Sections 4.5 and 4.6; Table 4-13).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternative 3.5 goals, based on the 1998-2005 average, within approximately 10 years of the ESH program initiation. Erosion would require the annual construction (combination of creation and replacement the first 10 years) and subsequent continual replacement of approximately 142 acres of habitat (25 percent annual loss rate). Annual creation and/or replacement would require 95 days of mechanical work and 82 days of dredge operation that could be accomplished with two teams of mechanical operators and two dredges operating simultaneously to complete the work within the 47 available calendar days each autumn. Annual construction would disturb 422 acres, moving over 830,000 cubic yards of material.

6.4.2.1 Physical Resources (Fort Peck River Segment, Alt. 3.5)

6.4.2.1.1 Air Quality (Fort Peck River Segment, Alt. 3.5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA’s air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3.5 has not been calculated. However, this alternative represents the second largest area of ESH to create and the emissions from equipment operation (direct effects) would be the about 54 percent of the greatest (under alternatives 1 and 3). All NAAQS parameters are in attainment of the air quality standards (USEPA, 2006) and, therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3.5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.4.2.1.2 Aesthetics (Fort Peck River Segment, Alt. 3.5)

Potential aesthetic impacts from implementing Alternative 3.5 could be locally significant during construction. In order to create the 565 acres of ESH, 82 and 95 days of dredge and heavy equipment operation, respectively, using several construction teams, would be required at selected sites. Changes to vistas at the selected areas would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the valuable, rare, and desirable aesthetic resource ubiquitous in the Fort Peck River Segment. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 142 acres of ESH would not be aesthetically significant because the created ESH would appear similar to high-elevation sandbars deposited during high releases. The length of construction activities and level of equipment and teams needed to construct the level of habitat identified would be locally significant during construction. However, because of the intensity (i.e., magnitude) of construction required is less than Alternatives 1 and 3, and long-term visual impacts would be low, effects on aesthetics are expected to be moderate.

6.4.2.2 Water Resources (Fort Peck River Segment, Alt. 3.5)

6.4.2.2.1 Surface Water Hydrology and Hydraulics (Fort Peck River Segment, Alt. 3.5)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify Sensitive Resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because the necessary ESH could be constructed within the “available” area (see Sections 4.5 and 4.6; Table 4-13), which excludes the thalweg and high-energy flows identified, constructing (creating and/or replacing ESH) Alternative 3.5 (to reach the 565-acre goal of ESH) in the Fort Peck River Segment could be accomplished without risk of significantly encroaching into the available cross-sectional area.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.4.2.2.2 Aggradation, Degradation, and Erosion (Fort Peck River Segment, Alt. 3.5)

The Fort Peck River Segment demonstrates the lowest percentage of available project area to total riverine corridor area (9%) among all the segments. However, because construction activities would occur within the "available area," the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-13).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. Estimates indicate that this could be a large amount of material relative to annual sediment load. For alternative 3.5, it is estimated approximately 0.8 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Fort Peck River segment. Estimates indicate that this could be a moderate amount of material relative to annual sediment load (see Section 6.2 and Table 6-3).

Possible effects of this alternative include impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of inducing significant effects on aggradation, degradation, and erosion within the segment is likely to be moderate. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.4.2.2.3 Water Quality (Fort Peck River Segment, Alt. 3.5)

The following activities, necessary to create the 565 acres of ESH under Alternative 3.5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 0.4 million CY of sand and sediments to reach the goal of 565 acres of ESH, and
- Annually placing of over 0.8 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality could result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen, and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

The State of Montana denied Section 401 certification for all activities authorized by NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.4.2.3 Biological Resources (Fort Peck River Segment, Alt. 3.5)

6.4.2.3.1 Vegetation (Fort Peck River Segment, Alt. 3.5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 565 acres of herb/shrub/sapling (7% of this vegetation class) and 0 acres of forest in the Fort Peck River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-13). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in the target segments. Due to the abundance of vegetated sandbars in this segment, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not anticipated to have a significant impact.

6.4.2.3.2 Wetlands (Fort Peck River Segment, Alt. 3.5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 4,100 acres of wetlands within the 39,009-acres of habitat from high-bank to high-bank. This represents approximately 11% of the total habitat within the segment. As depicted in Figure 6-1, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Although an area of 142 acres would be disturbed annually to maintain the ESH, the spatial analysis showed that all construction activities would occur within the “available” area (see Sections 4.5 and 4.6; Table 4-13), demonstrating that sufficient non-wetland area is available to allow the creation and/or replacement of the necessary area without significant risks to existing wetlands.

6.4.2.3.3 Fish, Invertebrates and Wildlife (Fort Peck River Segment, Alt. 3.5)

Approximately 1,681 acres within the “available” area (see Sections 4.5 and 4.6; Table 4-13) would be directly disturbed to construct the habitat the first time and an area of 142 acres would be disturbed annually to replace the ESH. There could be direct effects to fish and wildlife within the Fort Peck River Segment from creating the 565 acres of ESH under Alternative 3.5. However, avoidance of biologically important habitat (e.g., submerged aquatic vegetation) appears feasible in the Fort Peck River Segment through the application of pre-construction surveys and site selection criteria to minimize the risk of significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity) and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, “Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data.” (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Mobile species of fish and wildlife would be expected to find refuge in the abundant nearby habitat until the construction disturbance ended. However, sessile and dormant species could be destroyed during construction. Indirect construction-related effects to fish and wildlife species (e.g., noise, vibration, equipment emissions) within adjacent terrestrial or aquatic habitat would persist for the duration of construction.

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

6.4.2.3.4 Federally Listed Species and Habitats (Fort Peck River Segment, Alt. 3.5)

As described in Section 5.2, the Fort Peck River Segment has five federally listed species that could be affected by implementing Alternative 3.5. The potential effects to piping plover and least tern are addressed in the next section.

The black footed ferret (*Mustela nigripes*) has been re-released in Montana adjacent to the Fort Peck Reservoir and upstream of the Fort Peck River Segment of the Missouri River. No critical habitat has been designated for the black footed ferret within the Fort Peck River Segment of the Missouri River, and effects to black footed ferret or their critical habitat are highly unlikely under any of the action alternatives.

Effects of implementing Alternative 3.5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration. There are five areas of Critical Habitat designated for the whooping crane and none of them are in

Montana or North Dakota. (They are located in Idaho, Kansas, Nebraska, Oklahoma, and Texas).

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be moderate risk to the remaining wild population of pallids from implementing this alternative. The Fort Peck River Segment – in its entirety – is currently[24] designated as Recovery-Priority Area 2 and is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded; have the highest habitat diversity; and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation and/or replacement. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, but within the "available area," risks moderate construction-related effects to the endangered pallid sturgeon.

6.4.2.3.5 Effects to Least Tern and Piping Plover (Fort Peck River Segment, Alt. 3.5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

The CEQ's NEPA Regulations (40 CFR 1500-1508.8) state that an alternative's effects may be both beneficial and adverse. As such, the analysis of environmental effects is not restricted to the anticipated deleterious effects of ESH program implementation, but includes the analysis of the range of anticipated beneficial effects from implementing the alternatives being evaluated.

For each alternative, a given number of acres of ESH would be created. The number of acres of nesting habitat, relative to the total number of other ESH acres is at a 3:1 ratio, as stipulated in the 2003 BiOp Amendment.[25] Therefore, in creating the 565 acres of ESH under Alternative 3.5, 189 acres of nesting habitat would be created. Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 883 acres of ESH in the Fort Peck River Segment under Alternative 3.5. The entire dataset for the Fort Peck River Segment (2000-2006) identified 6 piping plover nests and 97 least tern nests over the 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Peck River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

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[24] The Pallid Sturgeon Recovery Plan is currently being revised, including revisions to the Recovery Priority Management Areas for the species.

[25] The basis of the nesting area to plover foraging and brood rearing habitat ratios cited here are thoroughly explained in the Emergent Sandbar Habitat Construction and Maintenance Assumptions, Appendix C.

The recovery plans for the least tern (USFWS, 1990) and piping plover (USFWS, 1988) do not establish segment-specific adult census goals for the Fort Peck River Segment. Instead, the recovery plans establish a Montana, statewide goal of 50 adult least terns and 60 adult pairs (120 adults) of piping plovers. The effect on the least tern and piping plover from creating and/or replacing 565 acres of ESH in the Fort Peck River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.4.2.4 Socioeconomic Resources (Fort Peck River Segment, Alt. 3.5)

6.4.2.4.1 Recreation (Fort Peck River Segment, Alt. 3.5)

Temporary indirect effects to recreation would result from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 47-day period available for construction each fall in the Fort Peck River Segment. Although the intensity of the disturbance to recreation could be large, few recreationists would be affected because relatively few people recreate in the Fort Peck River Segment. The greatest effects to recreation would be associated with hunters and anglers when their intended locations for outdoor recreation become dedicated to the construction of ESH. Because of the small number of participants, and the availability of alternative hunting and fishing sites, the effects on recreation would not be significant, and would be less than the impacts associated with Alternatives 1 and 3.

6.4.2.4.2 Noise (Fort Peck River Segment, Alt. 3.5)

Alternative 3.5 represents an area of ESH to be created and/or replaced intermediate between Alternatives 3 and 4 in the Fort Peck River Segment. Construction of 565 acres of ESH would require the use of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 47-day period available for construction every year. However, given the remote location of this work, human receptors would likely not be affected by the noise.

6.4.3 Alternative 4 (Fort Peck River Segment)

As explained in Section 4.4, the Fort Peck River Segment has a measured high-bank to high-bank area of approximately 39,009 acres. After application of the environmental buffers to the segment, 3,825 residual acres, or 9% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Retaining the 248 acres of interchannel sandbar as part of Alternative 4 could disturb 737 acres of river bottom habitat, meaning all construction related activities could occur within the available area (see Sections 4.5 and 4.6; Table 4-13).

Erosion of the ESH would require the annual replacement of approximately 37 acres of habitat (15 percent annual loss rate). This replacement would require 25 days of mechanical work and 21 days of dredge operation that could be accomplished with one team of mechanical operators and one dredge operating simultaneously to complete the work within the 47 available calendar days each autumn. Annual construction would disturb 110 acres, moving over 200,000 cubic yards of material (216,746 CY).

6.4.3.1 Physical Resources (Fort Peck River Segment, Alt. 4)

6.4.3.1.1 Air Quality (Fort Peck River Segment, Alt. 4)

No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards. As such, detailed quantification of the direct and indirect effects of emissions associated with construction of Alternative 4 has not been calculated. Alternative 4 uses approximately 28% of the area of ESH for Alternatives 1 and 3 (248 vs. 883 acres), and would have commensurately less emissions from implementation. All NAAQS parameters are in attainment of the air quality standards (USEPA, 2006) and, therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 4 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.4.3.1.2 Aesthetics (Fort Peck River Segment, Alt. 4)

Potential aesthetic impacts from implementing Alternative 4, including temporary and long-term visual changes, would be locally significant during construction. In order to ensure that the 248 acres of ESH remain in this reach, fewer than 21of days of dredge operation and 25 days of heavy equipment operation would be required at selected sites annually. Changes to vistas at the selected would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the valuable, rare, and desirable aesthetic resource throughout the Fort Peck River Segment. The long-term visual impacts resulting from the actions necessary for the annual replacement of 37 acres of ESH would not be aesthetically significant as the constructed ESH would appear similar to high-elevation sandbars deposited during high releases. Because of the intensity (i.e., magnitude) of construction required is less than Alternatives 1 and 3, and long-term visual impacts would be not be significant, effects on aesthetics are expected to be moderate.

6.4.3.2 Water Resources (Fort Peck River Segment, Alt. 4)

6.4.3.2.1 Surface Water Hydrology and Hydraulics (Fort Peck River Segment, Alt. 4)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify Sensitive Resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Ensuring that the necessary ESH remains in the Fort Peck River Segment for Alternative 4 (248 acres) could be accomplished using less than 2% of the delineated riverine habitat, all within the "available area," (see Sections 4.5 and 4.6; Table 4-13) which excludes the thalweg and high-energy flows identified. Therefore, the risk of site-specific actions encroaching into the available cross-sectional area and significantly altering surface water hydrology and hydraulics from implementing Alternative 4 in the Fort Peck River Segment is not significant.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.4.3.2.2 Aggradation, Degradation, and Erosion (Fort Peck River Segment, Alt. 4)

The Fort Peck River Segment demonstrates the lowest percentage of available project area to total riverine corridor area (9%) among all the segments. However, because the 248 acres of ESH could be retained using less than 2% of the entire habitat and construction activities would occur within the "available area," the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-13).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For alternative 4, it is estimated approximately 0.22 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Fort Peck River segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.4.3.2.3 Water Quality (Fort Peck River Segment, Alt. 4)

The following activities, necessary to construct and maintain the 248 acres of ESH under Alternative 4 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 100,000 CY of sand and sediments to maintain 248 acres of ESH, and
- Annually placing of over 210,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

The State of Montana denied Section 401 certification for all activities authorized by NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.4.3.3 Biological Resources (Fort Peck River Segment, Alt. 4)

6.4.3.3.1 Vegetation (Fort Peck River Segment, Alt. 4)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 247 acres of herb/shrub/sapling (3% of this vegetation class) and 0 acres of forest in the Fort Peck River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-13). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in the target segments. Due to the abundance of vegetated sandbars in this segment, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not anticipated to have a significant impact.

6.4.3.3.2 Wetlands (Fort Peck River Segment, Alt. 4)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 4,100 acres of wetlands within the 39,009-acres of habitat from high-bank to high-bank. This represents approximately 11% of the total habitat within the segment. As depicted in Figure 6-1, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Approximately 37 acres would be disturbed annually to retain 248 acres of ESH in the Fort Peck River Segment. The spatial analysis demonstrated that sufficient non-wetland area is available to allow the construction and maintenance of the necessary area without significant risks to existing wetlands.

6.4.3.3.3 Fish, Invertebrates and Wildlife (Fort Peck River Segment, Alt. 4)

There could be localized direct effects to fish and wildlife within the Fort Peck River Segment from retaining the 248 acres of ESH under Alternative 4, but the risk is less than for Alternatives 1,3, and 3.5. Approximately 37 acres would be disturbed annually to retain the ESH. Avoidance of biologically important habitat (e.g., submerged aquatic vegetation) appears feasible in the Fort Peck River Segment through pre-construction surveys and adherence to the site selection criteria, effectively minimizing the risk of significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to the substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

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During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could

be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

6.4.3.3.4 Federally Listed Species and Habitats (Fort Peck River Segment, Alt. 4)

The effects to the black footed ferret (*Mustela nigripes*) and whooping crane (*Grus americana*) would be similar to those described above for Alternatives 1, 3, and 3.5.

Alternative 4 is approximately 28% of the area of ESH that would be retained for Alternatives 1 and 3 (248 vs. 883 acres), but there continues to be a moderate risk to the remaining wild population of pallid sturgeon (*Scaphirhynchus albus*) from implementing this alternative. The Fort Peck River Segment – in its entirety – is designated as Recovery-Priority Area 2 and is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf).

The recovery-priority areas are typically the least degraded and have the highest habitat diversity and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable for ESH. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, but still within "available area," risks moderate construction-related effects to the endangered pallid sturgeon.

6.4.3.3.5 Effects to Least Tern and Piping Plover (Fort Peck River Segment, Alt. 4)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 248 acres of ESH under Alternative 4, 62 acres of nesting habitat would be created. Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 248 acres of ESH in the Fort Peck River Segment under Alternative 4. The entire dataset for the Fort Peck River Segment (2000-2006) identified 6 piping plover nests and 97 least tern nests over the 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Peck River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plans for the least tern (USFWS, 1990) and piping plover (USFWS, 1988) do not establish segment-specific adult census goals for the Fort Peck River Segment. Instead, the recovery plans establish a Montana, statewide goal of 50 adult least terns and 60 adult pairs (120 adults) of piping plovers. The effect on the least tern and piping plover from retaining 248 acres of ESH in the Fort Peck River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.4.3.4 Socioeconomic Resources (Fort Peck River Segment, Alt. 4)

6.4.3.4.1 Recreation (Fort Peck River Segment, Alt. 4)

Temporary indirect effects to recreation would result from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality during the 25 days of mechanical work and 21 days of dredge work during the 47-day period available for construction each fall in the Fort Peck River Segment. Although the intensity of the disturbance to recreation could be large, few recreationists would be affected because few people recreate in the Fort Peck

River Segment. The greatest effects to recreation would be associated with the hunters and anglers when their intended locations for outdoor recreation become dedicated to the construction area for ESH. Because of the small number of participants, and the availability of alternative hunting and fishing sites, the effects on recreation would not be significant.

6.4.3.4.2 Noise (Fort Peck River Segment, Alt. 4)

Alternative 4 is 28% smaller than the area of ESH to be created under Alternatives 1 and 3 in the Fort Peck River Segment. Retaining 248 acres of ESH would require the use of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment 25 days of the 47-day period available for construction every year. However, given the remote location of this work, human receptors would likely not be affected by the noise.

6.4.4 Alternative 5 (Fort Peck River Segment)

As explained in Section 4.4, the Fort Peck Segment has a measured high-bank to high-bank area of approximately 39,009 acres. After application of the environmental buffers to the segment, 3,825 residual acres, or nearly 9% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Annual construction of the 30 acres of interchannel sandbar necessary for Alternative 5 could disturb 89 acres of river bottom habitat representing 0.2% of the entire habitat and meaning all construction activities would occur within the available area (see Sections 4.5 and 4.6; Table 4-13).

Because more than 89 acres of ESH was available in 2005, annual construction activities to achieve the quantity and quality of ESH habitat to meet the Alternative 5 goals would require the annual continual replacement of approximately 3 acres of habitat each and every year into the future. This construction and annual maintenance would require 2 days of mechanical work and 2 days of dredge operation that could be accomplished with one team of mechanical operators and one dredge operating simultaneously. Annual construction would disturb 3 acres, moving nearly 17,000 cubic yards of material (17,574 CY).

6.4.4.1 Physical Resources (Fort Peck River Segment, Alt. 5)

6.4.4.1.1 Air Quality (Fort Peck River Segment, Alt. 5)

No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards and detailed quantification of the direct and indirect effects of emissions associated with construction of Alternative 5 have not been calculated. This alternative is approximately 3% of the area of ESH for Alternatives 1 and 3 (30 vs. 883 acres), and would have commensurately less emissions from implementation. Because all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006) and such a smaller area of ESH is required to be constructed, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.4.4.1.2 Aesthetics (Fort Peck River Segment, Alt. 5)

Potential aesthetic impacts from implementing Alternative 5, including temporary and long-term visual changes, would be locally significant during construction activities. In order to retain the 30 acres of ESH, an average of 2 of days of dredge operation and 2 days of heavy equipment operation at selected sites would be required annually. Even with the smaller area needing construction, changes to vistas at the selected sites would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the valuable, rare, and desirable aesthetic resource. The long-term visual impacts resulting from the actions necessary for the annual average replacement of 3 acres of ESH would not be considered significant. The constructed ESH would appear similar to high-elevation sandbars deposited during high releases.

6.4.4.2 Water Resources (Fort Peck River Segment, Alt. 5)

6.4.4.2.1 Surface Water Hydrology and Hydraulics (Fort Peck River Segment, Alt. 5)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify Sensitive Resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Retaining the necessary ESH (30 acres) could be accomplished within the "available area," (see Sections 4.5 and 4.6; Table 4-13) which excludes the thalweg and high-energy flows identified. Therefore, the risk of site-specific actions encroaching into the available cross-sectional area and significantly altering surface water hydrology and hydraulics from implementing Alternative 5 in the Fort Peck River Segment would not be significant.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.4.4.2.2 Aggradation, Degradation, and Erosion (Fort Peck River Segment, Alt. 5)

The Fort Peck River Segment demonstrates the lowest percentage of available project area to total riverine corridor area (9%) among all the segments. However, because all construction related activities for the 30 acres of ESH could occur within the "available area," the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-13).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For alternative 5, it is estimated approximately 0.02 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Fort Peck River segment. For this segment and alternative, amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.4.4.2.3 Water Quality (Fort Peck River Segment, Alt. 5)

The following activities, necessary to retain the 30 acres of ESH under Alternative 5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of nearly 8,600 CY of sand and sediments to retain 30 acres of ESH, and
- Annually placing of over 17,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

The State of Montana denied Section 401 certification for all activities authorized by NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.4.4.3 Biological Resources (Fort Peck River Segment, Alt. 5)

6.4.4.3.1 Vegetation (Fort Peck River Segment, Alt. 5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 30 acres of herb/shrub/sapling (less than 1% of this vegetation class) and 0 acres of forest in the Fort Peck River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-13). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in the target segments. Due to the abundance of vegetated sandbars in this segment, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not anticipated to have a significant impact.

6.4.4.3.2 Wetlands (Fort Peck River Segment, Alt. 5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 4,100 acres of wetlands within the 39,009-acres of habitat from high-bank to high-bank in the Fort Peck River Segment. This represents approximately 11% of the total habitat within the segment. The de-selection process used to avoid sensitive resources included the areas of wetland habitat as sensitive feature to be avoided. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Approximately 89 acres, all within the “available” area, would be directly disturbed to construct the ESH over the course of the 10-year project and an area of 3 acres would be disturbed annually to maintain the ESH. This spatial analysis demonstrated that sufficient non-wetland area is available to allow the retention of the necessary ESH area without significant risks to existing wetlands.

6.4.4.3.3 Fish, Invertebrates and Wildlife (Fort Peck River Segment, Alt. 5)

There could be localized direct effects to fish and wildlife within the Fort Peck River Segment from retaining the 30 acres of ESH under Alternative 5, but the risk of is substantially less than for Alternatives 1 and 3. An average annual approximately 8 acres would be disturbed to retain the 30 acres of ESH. Avoidance of biologically important habitat (e.g., submerged aquatic vegetation) appears feasible in the Fort Peck River Segment through pre-construction surveys and adherence to the site selection criteria effectively minimizing the risk of significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge with dredged material was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Mobile species of fish and wildlife would be expected to find refuge in the abundant nearby habitat until the construction disturbance ended. However, sessile and dormant species could be destroyed during construction. Indirect construction-related effects to fish and wildlife species (e.g., noise, vibration, equipment emissions) within adjacent terrestrial or aquatic habitat would persist for the relatively brief duration of construction. Overall, there would be a low level of risk of significant effects to fish and wildlife.

6.4.4.3.4 Federally Listed Species and Habitats (Fort Peck River Segment, Alt. 5)

The effects to the black footed ferret (*Mustela nigripes*) and whooping crane (*Grus americana*) would be similar to those described above for Alternatives 1 and 3.

Alternative 5 represents approximately 3% of the area of ESH required for Alternatives 1 and 3 (30 vs. 883 acres), but there continues to be risks to the remaining wild population of pallid sturgeon (*Scaphirhynchus albus*) from implementing any of the action alternatives. The Fort Peck River Segment – in its entirety – is designated as Recovery-Priority Area 2 and is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf).

The recovery-priority areas are typically the least degraded, have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate “natural channel configuration of sandbars, side channels, and varied depths” also favor the retention of interchannel sandbar and would be favorable for ESH. Implementing any action alternative, even with such a small area of ESH constructed risks permanent construction-related effects to the endangered pallid sturgeon.

6.4.4.3.5 Effects to Least Tern and Piping Plover (Fort Peck River Segment, Alt. 5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 30 acres of ESH under Alternative 5, 8 acres of nesting habitat would be retained. Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 30 acres of ESH in the Fort Peck River Segment under Alternative 5. The entire dataset for the Fort Peck River Segment (2000-2006) identified 6 piping plover nests and 97 least tern nests over the 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Peck River Segment, even if this much habitat were retained. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plans for the least tern (USFWS, 1990) and piping plover (USFWS, 1988) do not establish segment-specific adult census goals for the Fort Peck River Segment. Instead, the recovery plans establish a Montana, statewide goal of 50 adult least terns and 60 adult pairs (120 adults) of piping plovers. The effect on the least tern and piping plover from retaining 30 acres of ESH in the Fort Peck River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.4.4.4 Socioeconomic Resources (Fort Peck River Segment, Alt. 5)

6.4.4.4.1 Recreation (Fort Peck River Segment, Alt. 5)

Temporary indirect effects to recreation would result from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day during the average 2 days of mechanical work and 2 days of dredge work needed to retain the 30 acres of ESH. Although the intensity of the disturbance to recreation during the active construction period at those construction sites could be large, very few recreationists would be affected because relatively few people recreate in the Fort Peck River Segment and the construction period is relatively short. The greatest effects on recreation would be associated with a limited number of hunters and anglers when their intended locations for outdoor recreation become dedicated to the construction period. Because of the small number of participants, the availability of alternative hunting and fishing sites and the smaller area of ESH being built, the effects on recreation would not be significant.

6.4.4.4.2 Noise (Fort Peck River Segment, Alt. 5)

Alternative 5 is would affect 3% of the area of ESH to be created under Alternatives 1 and 3 in the Fort Peck River Segment. Retention of the 30 acres of ESH would require the use of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously for an average of 2 days of the 47-day period available for construction every year. However, given the remote location of this work, human receptors would likely not be affected by the noise.

6.4.5 Existing Program and No Program (Fort Peck River Segment)

The Existing Program Alternative (continuing minimal construction) and the No Program Alternative will be considered together, since under the Existing Program, no construction will be done in the Fort Peck River Segment.

6.4.5.1 Physical Resources (Fort Peck River Segment, Existing & No Program)

6.4.5.1.1 Air Quality (Fort Peck River Segment, Existing & No Program)

Under the Existing Program and No Program Alternatives, potential direct and indirect air quality impacts associated with the construction of ESH would not occur and air quality would not change from existing conditions.

6.4.5.1.2 Aesthetics (Fort Peck River Segment, Existing & No Program)

There would be no temporary construction-related deterioration of visual resources or permanent changes to the visual resources the Fort Peck River Segment.

6.4.5.2 Water Resources (Fort Peck River Segment, Existing & No Program)

6.4.5.2.1 Surface Water Hydrology and Hydraulics (Fort Peck River Segment, Existing & No Program)

Without construction, potential direct and indirect effects to surface water hydrology and hydraulics would not occur.

6.4.5.2.2 Aggradation, Degradation, and Erosion (Fort Peck River Segment, Existing & No Program)

Review of the GIS mapping (as described in detail in Appendix B) demonstrated that 79 nests (out of 103 recorded in the Fort Peck Segment) were not within ESH delineated from the 1999 or 2005 imagery. In other words, nesting was occurring on interchannel sandbar that was not visible for delineation in either photoset. Therefore, nesting habitat appears to be being created by the operational regime of the river segment since 1997. Taking no action to mechanically create ESH may result in no significant change to the existing patterns of habitat use and nesting.

6.4.5.2.3 Water Quality (Fort Peck River Segment, Existing & No Program)

Absent the temporary construction-related effects to water quality predicted under the action alternatives, water quality would be predicted to be unchanged from the existing conditions.

6.4.5.3 Biological Resources (Fort Peck River Segment, Existing & No Program)

6.4.5.3.1 Vegetation (Fort Peck River Segment, Existing & No Program)

Taking no action to create or retain ESH within the Fort Peck River Segment would be predicted to have no effect on the existing patterns of vegetation observed.

6.4.5.3.2 Wetlands (Fort Peck River Segment, Existing & No Program)

Taking no action to create or retain ESH within the Fort Peck River Segment would be predicted to have no effect on the existing patterns of wetland observed. Habitat delineation, using the 1999 imagery, (see Appendix B) for the Fort Peck River Segment identified approximately 3,790 acres of wetland habitat; the same delineation procedures resulted in approximately 4,100 acres of wetland using the 2005 imagery. Because of the problems inherent in comparing the habitat delineations for the 2 years due to differences in stage at the time photos were collected, no inferences between the years can be made.

6.4.5.3.3 Fish, Invertebrates and Wildlife(Fort Peck River Segment, Existing & No Program)

Under the no action alternative, there would be no direct impacts to the fisheries and wildlife of the Fort Peck River Segment. In the absence of an ESH program, wildlife abundance and diversity within the segment would remain unchanged.

6.4.5.3.4 Federally Listed Species and Habitats (Fort Peck River Segment, Existing & No Program)

There were no anticipated effects to the black footed ferret (*Mustela nigripes*) or whooping crane (*Grus americana*) from the action alternatives; taking no action would also be predicted to have no effect.

The no action alternative is the only alternative that does not risk damaging effects to remaining wild population of pallid sturgeon (*Scaphirhynchus albus*) and their habitat. Implementing any of the action alternatives presents a risk within the designated critical habitat.

6.4.5.3.5 Effects to Least Tern and Piping Plover (Fort Peck River Segment, Existing & No Program)

Taking no action, would result in no ongoing construction effects and no additional created habitat. The small amount of ESH observed in the Fort Peck River Segment would likely remain available, although reconfigured in location, as the habitat being used by least terns and piping plovers appears to be being created by the operational regime of the river segment.

6.4.5.4 Socioeconomic Resources (Fort Peck River Segment, Existing & No Program)

Taking no action would be expected to avoid any of the effects to recreation or noise identified for Alternatives 1-5.

6.4.6 Summary of Predicted Effects in the Fort Peck River Segment

Table 6-5 presents a summary of the potential adverse effects of implementing the alternatives for the Fort Peck River Segment. These values are based on the descriptions of impacts for each resource, by segment, by alternative and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

Table 6-5: Summary of Potential Significant Adverse Effects to the Fort Peck River Segment

Parameter	Alternative 1 2015 Goals	Alternative 2 2005 Goals	Alternative 3 1998/1999 ESH	Alternative 3.5 Intermediate	Alternative 4 2005 ESH	Alternative 5 Nesting Patterns	Continue Existing Program	No Program
Air Quality	No	N/A	No	No	No	No	No	No
Aesthetics	High	N/A	High	Moderate	Moderate	No	No	No
Surface Water Hydrology & Hydraulics	No	N/A	No	No	No	No	No	No
Degradation, Aggradation, and Erosion	High	N/A	High	Moderate	Low	Low	No	No
Vegetation	Low	N/A	Low	Low	Low	Low	No	No
Water Quality	Low	N/A	Low	Low	Low	Low	No	No
Wetlands	Low	N/A	Low	No	No	No	No	No
Fish and Wildlife	Low	N/A	Low	Low	Low	Low	No	No
Pallid Sturgeon	High	N/A	High	Moderate	Moderate	No	No	No
Least Tern and Piping Plover	No	N/A	No	No	No	No	No	No
Recreation	No	N/A	No	No	No	No	No	No
Noise	No	N/A	No	No	No	No	No	No

6.5 GARRISON RIVER SEGMENT - SEGMENT 4

Concerns expressed by the State of North Dakota regarding the amount and locations of habitat constructed in its state have been recognized and will involve local monitoring and coordination with state and federal experts knowledgeable of specific sites and habitats.

6.5.1 Alternative 1 (Garrison River Segment)

As explained in Section 4.4, the Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 residual acres, or 18% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Constructing the 4,295 acres of interchannel sandbar necessary for Alternative 1 would disturb 12,756 acres of river bottom habitat requiring construction activities in both the restrictive and exclusionary areas, , increasing the risk of being unable to avoid sensitive resources (see Sections 4.5 and 4.6; Table 4-16).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2015 within approximately 10 years. Erosion (assumed rate of 40 percent per year) would require the initial construction and/or replacement of approximately 1718 acres of habitat each and every year. Annual construction would require 873 days of mechanical work and 750 days of dredge operation that could be accomplished with 15 teams of mechanical operators and 13 dredges operating simultaneously to complete the work within the 62 available calendar days each year. Annual construction would disturb 5,102 acres, moving over 10 million cubic yards of material.

6.5.1.1 Physical Resources (Garrison River Segment, Alt. 1)

6.5.1.1.1 Air Quality (Garrison River Segment, Alt. 1)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 1 not been calculated. However, this alternative represents the largest area of ESH to construct and/or replace, and the emissions from equipment operation (direct effects) would be the greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 1 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and

other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.5.1.1.2 Aesthetics (Garrison River Segment, Alt. 1)

Potential aesthetic impacts from implementing Alternative 1, including temporary and long-term visual changes, would be locally significant during construction. In order to create the goal of 4,295 acres of ESH, 750 of days of dredge and 873 days of heavy equipment operation, accomplished by large numbers of construction teams, would be required throughout the segment annually. Changes to vistas would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the Garrison River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of over 1,700 acres of ESH would also be highly aesthetically significant during construction. However, the constructed ESH would appear similar to high-elevation sandbars deposited during high releases. Because of the intensity (i.e., magnitude) of construction required, and locally significant impacts during construction, construction of Alternative 1 would lead to significant effects on aesthetics.

6.5.1.2 Water Resources (Garrison River Segment, Alt. 1)

6.5.1.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Alt. 1)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Alternative 1 would require construction activities in both the “restrictive” and “exclusionary” areas (12,756 acres needed vs. 4,361 acres “available”), indicating the potential of significant impacts to the available cross-sectional area and river hydraulics could be high (see Sections 4.5 and 4.6; Table 4-16) .

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.5.1.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Alt. 1)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 1 would likely be significant. The number of acres required under Alternative 1 is more than twice (4,361 acres vs. 2,066) the number of acres of ESH that existed in the Garrison River Segment after the 1997 releases. The area of high sand created by the 1996-1997 releases (measured at 2,066 acres in the 1998 imagery) was quickly eroded losing between 70% and 85% in a few years. Much of the sand was redistributed locally into DSPs because of the operating regime where daily power-peaking surges range from more than 5 feet in the upper portion, to just under a foot at Bismarck, ND. Lastly, the area of ESH for Alternative 1 encroaches into the "exclusionary area," (12,756 acres needed vs. 4,361 acres "available") after the identification of sensitive resources to be avoided in the segment, indicating the potential of significant impacts to surrounding area resources could be high (see Sections 4.5 and 4.6; Table 4-16).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 1, it is estimated approximately 10 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Garrison River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Constructing this large area of ESH would likely accelerate the rate of bedload movement from the degradation segment and accelerate deposition in the aggradation segment. The ongoing problems of increasing water surface elevations in the Bismarck, ND area and maintenance problems for water intakes in aggradation areas would likely be increased. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.5.1.2.3 Water Quality (Garrison River Segment, Alt. 1)

The following activities, necessary to annually construct the 1,718 acres of ESH in order to reach the ESH goal of 4,295 acres under Alternative 1, would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 3 million CY of sand and sediments to create 4,295 acres of ESH, and
- Annually placing of over 10 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

The State of North Dakota denied Section 401 certification for NWP 27 for all activities located in the Missouri River. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.5.1.3 Biological Resources (Garrison River Segment, Alt. 1)

6.5.1.3.1 Vegetation (Garrison River Segment, Alt. 1)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 942 acres of herb/shrub/sapling (19% of this vegetation class) and 1 acre of forest (less than 1% of this vegetation class) in the Garrison River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-16). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.5.1.3.2 Wetlands (Garrison River Segment, Alt. 1)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 822 acres of wetlands within the 24,518-acres of habitat from high-bank to high-bank. This represents approximately 3.4% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 1 would require activities in the restrictive and exclusionary areas (12,756 acres needed vs. 4,361 acres “available”), construction of this alternative would likely cause significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-16).

6.5.1.3.3 Fish, Invertebrates and Wildlife(Garrison River Segment, Alt. 1)

The direct effects to fish and wildlife within the Garrison River Segment from disturbing 12,756 acres of river bottom habitat, representing 52% of the entire high-bank to high-bank habitat, to construct Alternative 1 would likely create significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, “Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data.” (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, “Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations,” conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was position in the water column (versus the bottom of the river), and the filled barge with dredged material was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½” in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate’s effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Creating and/or replacing the habitat lost to erosion would annually require the replacement of approximately 1,718 acres of habitat directly affecting 5,102 acres, representing 21% of the high-bank to high-bank habitat. The construction of Alternative 1 in the Garrison River Segment would require construction activities in both "restrictive" and "exclusionary" areas, increasing the risk for significant impacts on sensitive resources (see Sections 4.5 and 4.6; Table 4-16).

6.5.1.3.4 Federally Listed Species and Habitats (Garrison River Segment, Alt. 1)

As described in Section 5.3, the Garrison River Segment has four federally listed species that could be affected by implementing Alternative 1. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 1 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain but limited, as the Garrison River Segment is not designated as a Recovery-Priority Area for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The intensity of actions required to implement Alternative 1 is so extensive that it would pose a high risk to any relic population of endangered pallid sturgeon in the segment.

6.5.1.3.5 Effects to Least Tern and Piping Plover (Garrison River Segment, Alt. 1)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 4,295 acres of ESH under Alternative 1, 1,074 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 4,295 acres of ESH in the Garrison River Segment under Alternative 1. The entire dataset for the Garrison River Segment (2000-2006) identified 349 piping plover nests and 316 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Garrison River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern does not establish segment-specific adult census goals for the Garrison River Segment. Instead, the recovery plan establishes a North Dakota, statewide goal of 250 adult least terns (USFWS, 1990). The piping plover recovery plan establishes a goal of 100 pairs (200 adults) for the Missouri River within the State of North Dakota. The effect on the least tern and piping plover from creating 4,295 acres of ESH in the Garrison River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.5.1.4 Socioeconomic Resources (Garrison River Segment, Alt. 1)

6.5.1.4.1 Recreation (Garrison River Segment, Alt. 1)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 62-day period available for construction each fall in the Garrison River Segment. Because construction is limited to the 62-day period in the fall, much of the summer peak recreation period is avoided. However, the intensity (i.e., magnitude) of construction required for building Alternative 1, would lead to significant effects on recreation. The greatest effects to recreation would be associated with the hunters and anglers because so much of the river landscape would be dedicated to the construction of ESH each fall. This would disrupt access to hunting and fishing areas and disturb recreationists as well as fish and wildlife, including migrating waterfowl.

6.5.1.4.2 Noise (Garrison River Segment, Alt. 1)

Alternative 1 represents the largest area of ESH to be constructed in the Garrison River Segment. Construction of 1,718 acres of ESH annually would require 15 teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), 13 dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 62-day period available for construction every year. Significant noise effects would be predicted.

6.5.2 Alternative 2 (Garrison River Segment)

As explained in Section 4.4, the Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 residual acres, or 18% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Creating 2,148 acres of interchannel sandbar necessary for Alternative 2 would disturb 6,380 acres of river bottom habitat, requiring construction activities in the "restrictive" area (see Sections 4.5 and 4.6; Table 4-16).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2005 within approximately 10 years. Erosion (assumed rate of 30 percent per year) would require the initial construction and and/or replacement of approximately 644 acres of habitat each and every year. Annual construction would require 327 days of mechanical work and 281 days of dredge operation that could be accomplished with 6 teams of mechanical operators and 5 dredges operating simultaneously to complete the work within the 62 available calendar days each fall. Annual construction would disturb 1,913 acres, moving over 3.7 million cubic yards of material.

6.5.2.1 Physical Resources (Garrison River Segment, Alt. 2)

6.5.2.1.1 Air Quality (Garrison River Segment, Alt. 2)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 2 not been calculated. However, this alternative represents second largest area of ESH to construct and the emissions from equipment operation (direct effects) would be the second greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006; therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 2 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis until the completion of construction. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction. The indirect effects to air quality of implementing Alternative 2 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis until the completion of construction. These would also be expected to not be significant.

6.5.2.1.2 Aesthetics (Garrison River Segment, Alt. 2)

Potential aesthetic impacts from implementing Alternative 2, including temporary and long-term visual changes, would be locally significant during construction. In order to create the 2,148 acres of ESH, 281 of days of dredge and 327 days of heavy equipment operation annually, accomplished by large numbers of construction teams, would be required throughout the segment. Changes to vistas would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the current Garrison River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 644 acres of ESH would not be aesthetically significant because the constructed ESH would appear similar to high-elevation sandbars deposited during high releases. Construction of Alternative 3 in the Garrison River Segment could lead to moderate effects on aesthetics.

6.5.2.2 Water Resources (Garrison River Segment, Alt. 2)

6.5.2.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Alt. 2)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Alternative 2 would require activities in the “restrictive area” (6,380 acres needed vs. 4,361 acres “available”) in the Garrison River Segment, posing a risk of encroaching into the available cross-sectional area; the risk of significant effects to the river hydraulics would be moderate (see Sections 4.5 and 4.6; Table 4-16).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.5.2.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Alt. 2)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 2 would likely be significant. The number of acres required under Alternative 2 is more than (2,148 acres vs. 2,066) the number of acres of ESH that existed in the Garrison River Segment after the 1997 releases. The area of high sand created by the 1996-1997 releases (measured at 2,066 acres in the 1998 imagery) was quickly eroded losing between 70% and 85% in a few years. Much of the sand was redistributed locally into DSPs because of the operating regime where daily power-peaking surges range from more than 5 feet in the upper portion, to just under a foot at Bismarck, ND. Lastly, Alternative 2 would require construction activities in the "restrictive" area (6,380 acres needed vs. 4,361 acres "available") after the identification of sensitive resources to be avoided in the segment, indicating the impact to surrounding area resources is anticipated to be moderate (see Sections 4.5 and 4.6; Table 4-16).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 2, it is estimated approximately 3.7 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Garrison River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2). Constructing this large area of ESH would likely accelerate the rate of bedload movement from the aggradation segment and accelerate deposition in the aggradation segment. The ongoing problems of increasing water surface elevations in the Bismarck, ND area and maintenance problems for water intakes in aggradation areas would likely be increased. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.5.2.2.3 Water Quality (Garrison River Segment, Alt. 2)

The following activities, necessary to construct the 2,148 acres of ESH under Alternative 2 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 1.4 million CY of sand and sediments to create and/or replace the 2,148 acres of ESH, and
- Annually placing of about 3.8 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

The State of North Dakota denied Section 401 certification for NWP 27 for all activities located in the Missouri River. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.5.2.3 Biological Resources (Garrison River Segment, Alt. 2)

6.5.2.3.1 Vegetation (Garrison River Segment, Alt. 2)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 942 acres of herb/shrub/sapling (19% of this vegetation class) and 1 acre of forest (less than 1% of this vegetation class) in the Garrison River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-16). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.5.2.3.2 Wetlands (Garrison River Segment, Alt. 2)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 822 acres of wetlands within the 24,518-acres of habitat from high-bank to high-bank in the Garrison River Segment. This represents approximately 3.4% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included isolating and excluding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 2 would require activities in “restricted areas” (6,380 acres needed vs. 4,361 acres “available”), construction of this alternative could pose moderate risk to existing wetlands (see Sections 4.5 and 4.6; Table 4-16).

6.5.2.3.3 Fish, Invertebrates and Wildlife(Garrison River Segment, Alt. 2)

The direct effects to fish and wildlife within the Garrison River Segment from disturbing 6,380 acres of river bottom habitat, representing 26% of the entire high-bank to high-bank habitat, to construct Alternative 2 could pose moderate effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), Lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, “Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data.” (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, “Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations,” conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge with dredged material was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the

Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Creating and/or replacing the habitat would annually require the replacement of approximately 644 acres of habitat directly affecting 1,913 acres (8%) of the high-bank to high-bank habitat. The construction of Alternative 2 in the Garrison River Segment would require activities in “restrictive” areas (see Sections 4.5 and 4.6; Table 4-16), posing a moderate risk to fish and wildlife.

6.5.2.3.4 Federally Listed Species and Habitats (Garrison River Segment, Alt. 2)

As described in Section 5.3, the Garrison River Segment has four federally listed species that could be affected by implementing Alternative 2. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 2 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain but limited, as the Garrison River Segment is not designated as a Recovery-Priority Area for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The intensity of actions required to implement Alternative 2 is so extensive that it would pose a risk to any relic population of endangered pallid sturgeon in the segment.

6.5.2.3.5 Effects to Least Tern and Piping Plover (Garrison River Segment, Alt. 2)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 2,148 acres of ESH under Alternative 2, 537 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 2,148 acres of ESH in the Garrison River Segment under Alternative 2. The entire dataset for the Garrison River Segment (2000-2006) identified 349 piping plover nests and 316 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Garrison River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern does not establish segment-specific adult census goals for the Garrison River Segment. Instead, the recovery plan establishes a North Dakota, statewide goal of 250 adult least terns (USFWS, 1990). The piping plover recovery plan establishes a goal of

100 pairs (200 adults) for the Missouri River within the State of North Dakota. The effect on the least tern and piping plover from constructing 2,148 acres of ESH in the Garrison River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.5.2.4 Socioeconomic Resources (Garrison River Segment, Alt. 2)

6.5.2.4.1 Recreation (Garrison River Segment, Alt. 2)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 62-day period available for construction each fall in the Garrison River Segment. Because construction is limited to the 62-day period in the fall, much of the summer peak recreation period is avoided. However, the intensity (i.e., magnitude) of construction required for building Alternative 2, would lead to significant effects to recreation during construction. The greatest effects to recreation would be associated with the hunters and anglers because so much of the river landscape would be dedicated to the construction of ESH each fall. This would disrupt access to hunting and fishing areas and disturb recreationists as well as fish and wildlife, including migrating waterfowl.

6.5.2.4.2 Noise (Garrison River Segment, Alt. 2)

Alternative 2 represents the second largest area of ESH to be constructed in the Garrison River Segment. Creation and/or replacement of 2,148 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 62-day period available for construction every year. Significant noise effects would be predicted during construction.

6.5.3 Alternative 3 (Garrison River Segment)

As explained in Section 4.4, the Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 residual acres, or 18% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Creating the 2,066 acres of interchannel sandbar as part of Alternative 3 would disturb 6,136 acres of river bottom habitat representing 25% of the entire high-bank to high-bank habitat and requiring construction in “restrictive” areas) (see Sections 4.5 and 4.6; Table 4-16).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet Alternative 3 goals within approximately 10 years. Erosion (assumed rate of 30 percent per year) would require the initial construction and /or replacement of approximately 620 acres of habitat each and every year. Annual construction would require 315 days of mechanical work and 271 days of dredge operation that could be accomplished with 6 teams of mechanical operators and 5 dredges operating simultaneously to complete the work within the 62 available calendar days each autumn. Annual construction would disturb 1,841 acres, moving over 3.6 million cubic yards of material.

6.5.3.1 Physical Resources (Garrison River Segment, Alt. 3)

6.5.3.1.1 Air Quality (Garrison River Segment, Alt. 3)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3 has not been calculated. However, this alternative represents third largest area of ESH to create, and the emissions from equipment operation (direct effects) would be third greatest for this segment. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.5.3.1.2 Aesthetics (Garrison River Segment, Alt. 3)

Potential aesthetic impacts from implementing Alternative 3, including temporary and long-term visual changes, would be locally significant during construction. In order to create the 2,066 acres of ESH, 271 of days of dredge and 315 days of heavy equipment operation, accomplished by large numbers of construction teams annually, would be required throughout the segment. Changes to vistas would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the current Garrison River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 620 acres of ESH would not be aesthetically significant as the constructed ESH would appear similar to high-elevation sandbars deposited during high releases. Construction of Alternative 3 in the Garrison River Segment could lead to moderate effects on aesthetics.

6.5.3.2 Water Resources (Garrison River Segment, Alt. 3)

6.5.3.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Alt. 3)

The potential effect to the river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because the area of ESH for Alternative 2 would require construction activities in the "restrictive" area (6,136 acres needed vs. 4,361 acres "available") in the Garrison River Segment, the risk of encroaching into the available cross-sectional area and causing significant effects to the river hydraulics would be moderate (see Sections 4.5 and 4.6; Table 4-16).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.5.3.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Alt. 3)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 3 would likely be significant. The number of acres required under Alternative 3 is the number of acres of ESH that existed in the Garrison River Segment after the 1997 releases. The area of high sand created by the 1996-1997 releases (2,066 acres in the 1998 imagery) was quickly eroded, losing between 70% and 85% in a few years. Much of the sand was redistributed locally into DSPs because of the operating regime where daily power-peaking surges range from more than 5 feet in the upper portion, to just under a foot at Bismarck, ND. In addition, the area of ESH for Alternative 3 would require construction activities in "restrictive" areas (6,136 acres needed vs. 4,361 acres "available") after the identification of sensitive resources to be avoided in the segment, indicating the impact to surrounding area resources is anticipated to be moderate (see Sections 4.5 and 4.6; Table 4-16).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 3, it is estimated approximately 3.6 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Garrison River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Creating this area of ESH would likely accelerate the rate of bedload movement from the aggradation segment and accelerate deposition in the aggradation segment. The ongoing problems of increasing water surface elevations in the Bismarck, ND area and maintenance problems for water intakes in aggradation areas would likely be increased.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.5.3.2.3 Water Quality (Garrison River Segment, Alt. 3)

The following activities, necessary to create the 2,066 acres of ESH under Alternative 3, would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 1.3 million CY of sand and sediments to create the 2,066 acres of ESH, and
- Annually placing of over 3.6 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

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Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.5.3.3 Biological Resources (Garrison River Segment, Alt. 3)

6.5.3.3.1 Vegetation (Garrison River Segment, Alt. 3)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 942 acres of herb/shrub/sapling (19% of this vegetation class) and 1 acre of forest (less than 1% of this vegetation class) in the Garrison River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-16). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.5.3.3.2 Wetlands (Garrison River Segment, Alt. 3)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 822 acres of wetlands within the 24,518-acres of habitat from high-bank to high-bank in the Garrison River Segment. This represents approximately 3.4% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included identifying and excluding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 3 would require activities in "restrictive" areas (6,136 acres needed vs. 4,361 acres "available"), construction of this alternative could pose moderate risk to existing wetlands (see Sections 4.5 and 4.6; Table 4-16).

6.5.3.3.3 Fish, Invertebrates and Wildlife (Garrison River Segment, Alt. 3)

The direct effects to fish and wildlife within the Garrison River Segment from disturbing 6,136 acres of river bottom habitat, representing 25% of the entire high-bank to high-bank habitat, to construct Alternative 3 could pose moderate effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge with dredged material was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging, to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Creating and/or replacing the habitat lost to erosion would annually require the placement of approximately 620 acres of habitat directly affecting 1,841 acres (8%) of the high-bank to high-bank habitat. The construction of Alternative 3 in the Garrison River Segment would require activities in "restrictive" areas, posing a moderate risk to fish and wildlife (see Sections 4.5 and 4.6; Table 4-16).

6.5.3.3.4 Federally Listed Species and Habitats (Garrison River Segment, Alt. 3)

As described in Section 5.3, the Garrison River Segment has four federally listed species that could be affected by implementing Alternative 3. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain but limited, as the Garrison River Segment is not designated as a Recovery-Priority Area for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The intensity of actions required to implement Alternative 3 is so extensive that it would pose a risk to any relic population of endangered pallid sturgeon in the segment.

6.5.3.3.5 Effects to Least Tern and Piping Plover (Garrison River Segment, Alt. 3)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 2,066 acres of ESH under Alternative 3, 517 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 2,066 acres of ESH in the Garrison River Segment under Alternative 3. The entire dataset for the Garrison River Segment (2000-2006) identified 349 piping plover nests and 316 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Garrison River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern does not establish segment-specific adult census goals for the Garrison River Segment. Instead, the recovery plan establishes a North Dakota, statewide goal of 250 adult least terns (USFWS, 1990). The piping plover recovery plan establishes a goal of 100 pairs (200 adults) for the Missouri River within the State of North Dakota. The effect on the least tern and piping plover from creating 2,066 acres of ESH in the Garrison River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.5.3.4 Socioeconomic Resources (Garrison River Segment, Alt. 3)

6.5.3.4.1 Recreation (Garrison River Segment, Alt. 3)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 62-day period available for construction each fall in the Garrison River Segment. Because construction is limited to the 62-day period in the fall, much of the summer peak recreation period is avoided. However, the intensity (i.e., magnitude) of construction required for building Alternative 3, would lead to significant effects to recreation during construction. The greatest effects to recreation would be associated with the hunters and anglers because so much of the river landscape would be dedicated to the annual construction of ESH each fall. This would disrupt access to hunting and fishing areas and disturb recreationists as well as fish and wildlife, including migrating waterfowl.

6.5.3.4.2 Noise (Garrison River Segment, Alt. 3)

Alternative 3 represents the third largest area of ESH to be constructed and maintained in the Garrison River Segment. Creation of 2,066 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 62-day period available for construction every year. Significant noise effects would be predicted during construction.

6.5.4 Alternative 3.5 - Impact Level Identified with AMIP Preferred Alternative (Garrison River Segment)

As explained in Section 4.4, the Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 residual acres, or 18% of the segment, remains as potentially available, while avoiding sensitive environmental resources. Creating the 1,327 acres of interchannel sandbar as part of Alternative 3.5 would disturb 3,941 acres of river bottom habitat, an all construction activities could occur within the “available” area (see Sections 4.5 and 4.6; Table 4-16).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternative 3.5 goal set by taking the average of the 1998 and 2005 goals within approximately 10 years. Erosion (assumed rate of 25 percent per year) would require the annual creation and/or replacement of approximately 332 acres of habitat each and every year. Annual construction would require 169 days of mechanical work and 145 days of dredge operation that could be accomplished with 3 teams of mechanical operators and 3 dredges operating simultaneously to complete the work within the 62 available calendar days each autumn. Annual construction would disturb 986 acres, moving over 1.9 million cubic yards of material.

6.5.4.1 Physical Resources (Garrison River Segment, Alt. 3.5)

6.5.4.1.1 Air Quality (Garrison River Segment, Alt. 3.5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS.

No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3.5 has not been calculated. However, this alternative represents the fourth largest area of ESH to create; therefore, emissions from equipment operation (direct effects) would be intermediate between Alternatives 3 and 4. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternatives 3.5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.5.4.1.2 Aesthetics (Garrison River Segment, Alt. 3.5)

Potential aesthetic impacts from implementing Alternative 3.5, including temporary visual changes, would be locally significant during construction. In order to create the 1,327 acres of ESH, 145 of days of dredge and 169 days of heavy equipment operation would be required annually for the 10-year project period, accomplished by large numbers of construction teams throughout the segment. Changes to vistas could be noticeable as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the current Garrison River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual replacement of 332 acres of ESH, however, would not be aesthetically significant, as the constructed ESH would appear similar to high-elevation sandbars deposited during high releases. Construction of Alternative 3.5 in the Garrison River Segment could lead to moderate effects on aesthetics.

6.5.4.2 Water Resources (Garrison River Segment, Alt. 3.5)

6.5.4.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Alt. 3.5)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because the area of ESH disturbance for Alternative 3.5 is all within the "available" area, which excludes the thalweg and high-energy flows identified in the Garrison River Segment, constructing Alternative 3.5 would not encroach into the available cross-sectional area and significant effects to the river hydraulics would not be likely (see Sections 4.5 and 4.6; Table 4-16).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.5.4.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Alt. 3.5)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 3.5 would likely not be significant. The number of acres required under Alternative 3.5 is considerably less than the number of acres of ESH that existed in the Garrison River Segment after the 1997 releases. The area of high sand created by the 1996-1997 releases (2,066 acres in the 1998 imagery) was quickly eroded, losing between 70% and 85% in a few years. Alternative 3.5 has an acreage midway between what was present in 1998 and what remained in 2005. Much of the sand that eroded was redistributed locally into DSPs because of the operating regime where daily power-peaking surges range from more than 5 feet in the upper portion, to just under a foot at Bismarck, ND. The area of disturbance needed for Alternative 3.5 is all within the "available" area after the identification of sensitive resources to be avoided in the segment, indicating the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-16).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 3.5, it is estimated approximately 1.9 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Garrison River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300’ to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.5.4.2.3 Water Quality (Garrison River Segment, Alt. 3.5)

The following activities, necessary to create the 1,327 acres of ESH under Alternative 3.5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 0.7 million CY of sand and sediments to create the 1,327 acres of ESH, and
- Annually placing of over 1.9 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

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Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

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Because the area needed to construct Alternative 3.5 does not exceed the “available” area, construction of this alternative would not likely cause significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-16).

6.5.4.3.3 Fish, Invertebrates and Wildlife (Garrison River Segment, Alt. 3.5)

The direct effects to fish and wildlife within the Garrison River Segment from disturbing 3,941 acres of river bottom habitat, representing nearly 16% of the entire high-bank to high-bank habitat to construct Alternative 3.5, would not pose significant effects to fish and wildlife.

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As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use.

Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Creating and/or replacing the habitat would annually require the construction of approximately 332 acres of habitat, directly affecting 986 acres of the high-bank to high-bank habitat. Because the area needed to construct Alternative 3.5 in the Garrison River Segment does not exceed the "available" area, construction of this alternative would not likely cause significant effects to fish and wildlife (see Sections 4.5 and 4.6; Table 4-16).

6.5.4.3.4 Federally Listed Species and Habitats (Garrison River Segment, Alt. 3.5)

As described in Section 5.3, the Garrison River Segment has four federally listed species that could be affected by implementing Alternative 3.5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3.5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration. There are five areas of Critical Habitat designated for the whooping crane and none of them are in North Dakota. (They are located in Idaho, Kansas, Nebraska, Oklahoma, and Texas).

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain but limited, as the Garrison River Segment is not designated as a Recovery-Priority Area for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The intensity of actions required to implement Alternative 3.5 is much reduced from Alternatives 1-3, and can be constructed within the "available area," posing a moderate risk to any relic population of endangered pallid sturgeon in the segment.

6.5.4.3.5 Effects to Least Tern and Piping Plover (Garrison River Segment, Alt. 3.5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 1,327 acres of ESH under Alternative 3.5, 332 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 1,327 acres of ESH in the Garrison River Segment under Alternative 3.5. The entire dataset for the Garrison River Segment (2000-2006) identified 349 piping plover nests and 316 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Garrison River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern does not establish segment-specific adult census goals for the Garrison River Segment. Instead, the recovery plan establishes a North Dakota, statewide goal of 250 adult least terns (USFWS, 1990). The piping plover recovery plan establishes a goal of 100 pairs (200 adults) for the Missouri River within the State of North Dakota. The effect on the least tern and piping plover from creating 1,327 acres of ESH in the Garrison River Segment is uncertain as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.5.4.4 Socioeconomic Resources (Garrison River Segment, Alt. 3.5)

6.5.4.4.1 Recreation (Garrison River Segment, Alt. 3.5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 62-day period available for construction each fall in the Garrison River Segment. Because construction is limited to the 62-day period in the fall, much of the summer peak recreation period is avoided. Even though the intensity (i.e., magnitude) of construction required for building Alternative 3.5 is substantially less than the larger acre Alternatives, the effects on recreation would likely be locally, moderately significant each fall. Equipment operations would disrupt access to some hunting and fishing areas, but alternate sites would probably be available. The noise could disturb nearby recreationists as well as wildlife, including migrating waterfowl.

6.5.4.4.2 Noise (Garrison River Segment, Alt. 3.5)

Alternative 3.5 represents the fourth largest area of ESH to be created in the Garrison River Segment. Creation of 1,327 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 62-day period available for construction every year. Moderate noise effects would be predicted during construction.

6.5.5 Alternative 4 (Garrison River Segment)

As explained in Section 4.4, the Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 residual acres, or 18% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining 588 acres of interchannel sandbar in the Garrison River Segment as part of Alternative 4 would disturb 1,746 acres of river bottom habitat, meaning all construction activities could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-16).

Erosion of the ESH available in 2005 would require the annual replacement of approximately 88 acres of habitat (15 percent annual loss rate). This annual replacement would require 45 days of mechanical work and 38 days of dredge operation that could be accomplished with one team of mechanical operators and one dredge operating simultaneously to complete the work within the 62 available calendar days each autumn. Annual construction would disturb 261 acres, moving over 515,000 cubic yards of material.

6.5.5.1 Physical Resources (Garrison River Segment, Alt. 4)

6.5.5.1.1 Air Quality (Garrison River Segment, Alt. 4)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 4 has not been calculated. This alternative represents the second smallest area of ESH to construct and the emissions from equipment operation (direct effects) would be the substantially less than Alternatives 1-3. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 4 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.5.5.1.2 Aesthetics (Garrison River Segment, Alt. 4)

Potential aesthetic impacts from implementing Alternative 4, including temporary and long-term visual changes, would be locally significant during construction but would affect a much smaller portion of the segment. In order to retain the 588 acres of ESH, 38 of days of dredge and 45 days of heavy equipment operation would be needed annually, accomplished by construction teams within the segment. In areas where construction was taking place, changes to vistas would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the current Garrison River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual replacement of 88 acres of ESH would be considerably less than for Alternatives 1-3, and the constructed ESH would appear similar to high-elevation sandbars deposited during high releases, resulting in low impacts.

6.5.5.2 Water Resources (Garrison River Segment, Alt. 4)

6.5.5.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Alt. 4)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Construction activities for Alternative 4 could all occur within the “available” area, and therefore would not be likely to risk significant effects to the river hydraulics (see Sections 4.5 and 4.6; Table 4-16).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.5.5.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Alt. 4)

The potential effects to aggradation, degradation, and erosion from constructing and maintaining Alternative 4 would likely not be significant. Because construction activities to provide the 588 acres required under Alternative 4 could all be within the “available” area (1,746 acres needed vs. 4,361 acres “available”) the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-16).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 4, it is estimated approximately 0.5 million cubic yards of annual placement would be necessary to meet and sustain acreage goals for available ESH for the Garrison River segment. Estimates indicate that this could be a moderate amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Possible effects of this alternative include impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of inducing significant effects on aggradation, degradation, and erosion within the segment is likely to be moderate. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100’ and dredging depth restricted to a maximum 4’ not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300’ to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.5.5.2.3 Water Quality (Garrison River Segment, Alt. 4)

The following activities, necessary to construct and maintain the 588 acres of ESH under Alternative 4 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 190,000 CY of sand and sediments to retain the 588 acres of ESH, and
- Annually placing of over 510,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

The State of North Dakota denied Section 401 certification for NWP 27 for all activities located in the Missouri River. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.5.5.3 Biological Resources (Garrison River Segment, Alt. 4)

6.5.5.3.1 Wetlands (Garrison River Segment, Alt. 4)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 588 acres of herb/shrub/sapling (12% of this vegetation class) and 0 acres of forest in the Garrison River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-16). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.5.5.3.2 Wetlands (Garrison River Segment, Alt. 4)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 822 acres of wetlands within the 24,518-acres of habitat from high-bank to high-bank in the Garrison River Segment. This represents approximately 3.4% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included identifying and excluding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 4 is well within the "available" area (1,746 acres needed vs. 4,361 acres "available"), construction of this alternative would likely not risk significant loss to existing wetlands.

6.5.5.3.3 Fish, Invertebrates and Wildlife (Garrison River Segment, Alt. 4)

The direct effects to fish and wildlife within the Garrison River Segment from disturbing 1,746 acres of river bottom habitat, representing 7% of the entire high-bank to high-bank habitat, to construct Alternative 4 would likely not create significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using 3 different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Retaining the habitat lost to erosion would annually require the replacement of approximately 88 acres of habitat directly, affecting 261 acres (1%) of the high-bank to high-bank habitat. Implementing Alternative 4 while avoiding biologically important habitat, wetlands, submerged aquatic vegetation, is feasible in the Garrison River Segment for Alternative 4 (see Sections 4.5 and 4.6; Table 4-16).

6.5.5.3.4 Federally Listed Species and Habitats (Garrison River Segment, Alt. 4)

As described in Section 5.3, the Garrison River Segment has four federally listed species that could be affected by implementing Alternative 4. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 4 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration. There are five areas of Critical Habitat designated for the whooping crane and none of them are in North Dakota. (They are located in Idaho, Kansas, Nebraska, Oklahoma, and Texas).

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain but limited, as the Garrison River Segment is not designated as a Recovery-Priority Area for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The intensity of actions required to implement Alternative 4 much less extensive than for Alternatives 1-3 and would pose considerably less risk to any relic population of endangered pallid sturgeon in the Segment.

6.5.5.3.5 Effects to Least Tern and Piping Plover (Garrison River Segment, Alt. 4)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 588 acres of ESH under Alternative 4, 147 acres of nesting habitat would be retained (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 588 acres of ESH in the Garrison River Segment under Alternative 4. The entire dataset for the Garrison River Segment (2000-2006) identified 349 piping plover nests and 316 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Garrison River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern does not establish segment-specific adult census goals for the Garrison River Segment. Instead, the recovery plan establishes a North Dakota, statewide goal of 250 adult least terns (USFWS, 1990). The piping plover recovery plan establishes a goal of 100 pairs (200 adults) for the Missouri River within the State of North Dakota. The effect on the least tern and piping plover from retaining 588 acres of ESH in the Garrison River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.5.5.4 Socioeconomic Resources (Garrison River Segment, Alt. 4)

6.5.5.4.1 Recreation (Garrison River Segment, Alt. 4)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 45 days during the 62-day period available for construction each fall in the Garrison River Segment. Because construction is limited to the 62-day period, much of the summer peak recreation period is avoided. The greatest effects to recreation would be associated with the hunters and anglers because their activities dominate the autumn riverine recreation. Even though the intensity (i.e., magnitude) of construction required for building Alternative 4 is substantially less than Alternatives 1-3, the effects on recreation would likely be locally, moderately significant each fall. Equipment operations would disrupt access to some hunting and fishing areas, but alternate sites would probably be available. The noise would disturb nearby recreationists as well as wildlife, including migrating waterfowl.

6.5.5.4.2 Noise (Garrison River Segment, Alt. 4)

Retention of the 588 acres of ESH under Alternative 4 would require teams of earth-moving equipment (e.g., dozers, scrapers, excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for much of the 62-day period available for construction with a single mechanical team and single dredge each fall. Significant noise effects would not be predicted given the fewer number of acres to be constructed.

6.5.6 Alternative 5 (Garrison River Segment)

As explained in Section 4.4, the Garrison River Segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 residual acres, or 18% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Retaining a minimum of 500 acres of interchannel sandbar as part of Alternative 5 would disturb 1,485 acres of river bottom habitat, all within the “available” area (see Sections 4.5 and 4.6; Table 4-16).

Erosion (assumed rate of 10 percent per year) would require the continual replacement of approximately 50 acres of habitat each and every year. This annual construction would require 25 days of mechanical work and 22 days of dredge operation that could be accomplished with 1 team of mechanical operators and 1 dredge operating simultaneously to complete the work within the 62 available calendar days each autumn. Annual construction would disturb 149 acres, moving over 292,000 cubic yards of material.

6.5.6.1 Physical Resources (Garrison River Segment, Alt. 5)

6.5.6.1.1 Air Quality (Garrison River Segment, Alt. 5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA’s air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 5 has not been calculated. This alternative represents the smallest area of ESH to construct and the emissions from equipment operation (direct effects) would be the substantially less than Alternatives 1-3. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.5.6.1.2 Aesthetics (Garrison River Segment, Alt. 5)

Potential aesthetic impacts from implementing Alternative 5, including temporary and long-term visual changes, would be locally significant during construction but would affect the portion of the segment for this alternative. In order to retain at least 500 acres of ESH, 25 of days of dredge and 22 days of heavy equipment operation would be required within the segment. In areas where construction was taking place, changes to vistas would be noticeable, as construction activities with landside modification for river access as well as in-river equipment operations would contrast with the current Garrison River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual replacement of 50 acres of ESH would also be minimal, and the constructed ESH would appear similar to high-elevation sandbars deposited during high releases, therefore impacts are expected to be low.

6.5.6.2 Water Resources (Garrison River Segment, Alt. 5)

6.5.6.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Alt. 5)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Construction activities related to Alternative 5 could all occur within the "available" area, and therefore would not be likely to encroach into the available cross-sectional area and would not risk significant effects to the river hydraulics (see Sections 4.5 and 4.6; Table 4-16).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.5.6.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Alt. 5)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 5 would likely not be significant. The 500 acres required under Alternative 5 could be constructed within the "available" area (1,485 acres needed vs. 4,361 acres "available"); the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-16).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 5, it is estimated approximately 0.3 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Garrison River segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.5.6.2.3 Water Quality (Garrison River Segment, Alt. 5)

The following activities, necessary to retain the 500 acres of ESH under Alternative 5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 100,000 CY of sand and sediments to retain the 500 acres of ESH, and
- Annually placing of over 290,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

The State of North Dakota denied Section 401 certification for NWP 27 for all activities located in the Missouri River. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.5.6.3 Biological Resources (Garrison River Segment, Alt. 5)

6.5.6.3.1 Vegetation (Garrison River Segment, Alt. 5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 500 acres of herb/shrub/sapling (10% of this vegetation class) and 0 acres of forest in the Garrison River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-16). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.5.6.3.2 Wetlands (Garrison River Segment, Alt. 5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 822 acres of wetlands within the 24,518-acres of habitat from high-bank to high-bank in the Garrison River Segment. This represents approximately 3.4% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included identifying and excluding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 5 is well within the “available” area (1,485 acres needed vs. 4,361 acres “available”),construction of this alternative would likely have low potential to result in a significant loss of existing wetlands (see Sections 4.5 and 4.6; Table 4-16).

6.5.6.3.3 Fish, Invertebrates and Wildlife (Garrison River Segment, Alt. 5)

The direct effects to fish and wildlife within the Garrison River Segment from disturbing 1,485 acres of river bottom habitat, representing 6% of the entire high-bank to high-bank habitat, to construct Alternative 5 would likely not be significant.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon

(*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could

be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

Retaining some of the habitat lost to erosion would annually require the replacement of approximately 50 acres of habitat directly affecting 149 acres (less than 1%) of the high-bank to high-bank habitat. Implementing Alternative 5 while avoiding biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible in the Garrison River Segment for Alternative 5, and the risk of significant effects from annual construction is low (see Sections 4.5 and 4.6; Table 4-16).

6.5.6.3.4 Federally Listed Species and Habitats (Garrison River Segment, Alt. 5)

As described in Section 5.3, the Garrison River Segment has four federally listed species that could be affected by implementing Alternative 5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration. There are five areas of Critical Habitat designated for the whooping crane and none of them are in North Dakota. (They are located in Idaho, Kansas, Nebraska, Oklahoma, and Texas). This alternative poses the least risk to disturbing whooping cranes during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain but limited, as the Garrison River Segment is not designated as a Recovery-Priority Area for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The intensity of actions required to implement Alternative 5 is the least for the Garrison River Segment and would pose the least risk to any relic population of endangered pallid sturgeon in the segment.

6.5.6.3.5 Effects to Least Tern and Piping Plover (Garrison River Segment, Alt. 5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining at least 500 acres of ESH under Alternative 5, 125 acres of nesting habitat would remain (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 500 acres of ESH in the Garrison River Segment under Alternative 5. The entire dataset for the Garrison River Segment (2000-2006) identified 349 piping plover nests and 316 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Garrison River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern does not establish segment-specific adult census goals for the Garrison River Segment. Instead, the recovery plan establishes a North Dakota, statewide goal of 250 adult least terns (USFWS, 1990). The piping plover recovery plan establishes a goal of 100 pairs (200 adults) for the Missouri River within the State of North Dakota. The effect on the least tern and piping plover from retaining at least 500 acres of ESH in the Garrison River Segment is uncertain as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.5.6.4 Socioeconomic Resources (Garrison River Segment, Alt. 5)

6.5.6.4.1 Recreation (Garrison River Segment, Alt. 5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during a portion of the 62-day period available for construction each fall in the Garrison River Segment. Because construction is limited to the 62-day period, much of the summer recreation period is avoided. The greatest effects to recreation would be associated with the hunters and anglers because their activities dominate the autumn riverine recreation. Even though the intensity (i.e., magnitude) of construction required for Alternative 5 is substantially less than Alternatives 1-3, the effects on recreation would likely be locally significant during the 3-4 weeks of annual construction. Equipment operations may disrupt access to some hunting and fishing areas, but alternate sites would be available. The noise would disturb nearby recreationists as well as wildlife, including migrating waterfowl.

6.5.6.4.2 Noise (Garrison River Segment, Alt. 5)

Retention of at least 500 acres of ESH under Alternative 5 would require teams of earth-moving equipment (e.g., dozers, scrapers, excavators), dredges, and other miscellaneous equipment continuously, 24 hours a day, for 25 days, for the 62-day period available for construction and a single mechanical team and dredge each fall to maintain the habitat. Significant noise effects to the entire segment would not be predicted given the fewer number of acres to be constructed, but there would be localized noise effects near active construction sites.

6.5.7 Existing Program Alternative and No Program (Garrison River Segment)

Since both the Existing Program Alternative and the No Program Alternative do not include construction within Garrison River Segment, these alternatives will be discussed together. The Existing Program only includes construction in Lewis & Clark Lake Segment and the Gavins Point River Segment.

6.5.7.1 Physical Resources (Garrison River Segment, Existing & No Program)

6.5.7.1.1 Air Quality (Garrison River Segment, Existing & No Program)

Under both Alternatives, potential direct and indirect air quality impacts associated with the construction of ESH in the Garrison River Segment would not occur and air quality would not change from existing conditions.

6.5.7.1.2 Aesthetics (Garrison River Segment, Existing & No Program)

There would be no temporary construction-related deterioration of visual resources or permanent changes to the visual resources of the Garrison River Segment.

6.5.7.2 Water Resources (Garrison River Segment, Existing & No Program)

6.5.7.2.1 Surface Water Hydrology and Hydraulics (Garrison River Segment, Existing & No Program)

Under both alternatives, potential direct and indirect effects to surface water hydrology and hydraulics would not occur.

6.5.7.2.2 Aggradation, Degradation, and Erosion (Garrison River Segment, Existing & No Program)

The Garrison River Segment is subject to daily power-peaking surges that change the river stage from more than 5 feet in the upper portion to just under a foot at Bismarck, ND. Similar to the Gavins Point River Segment, areas of high sand were created by the 1996-1997 high releases in some locations, but mostly less than 2 acres in area (Appendix B). Erosion from power peaking quickly removed between 70% and 85% of the area of sandbar and much of the sand was redistributed locally into DSPs. Because of the operating regime in the Garrison River Segment between 1998 and 2005, the fluvial (riverine) processes have annually created, new sandbar habitat that has been used for up to 45% of nest establishment in the segment (see Appendix B, Section 6.0). Because of this phenomenon in the Garrison River Segment, habitat that supports nesting appears to be being created by the operational regime of the river segment. Taking no action to mechanically create or retain ESH may result in no significant change to the existing patterns of habitat use and nesting.

6.5.7.2.3 Water Quality (Garrison River Segment, Existing & No Program)

Absent the construction-related effects to water quality predicted under the action alternatives, water quality would be predicted to be unchanged from the existing conditions.

6.5.7.3 Biological Resources (Garrison River Segment, Existing & No Program)

6.5.7.3.1 Vegetation (Garrison River Segment, Existing & No Program)

Under these alternatives, there would be no direct or indirect impacts to vegetation observed within the segment.

6.5.7.3.2 Wetlands (Garrison River Segment, Existing & No Program)

Under these alternatives, there would be no direct or indirect impacts to wetland observed within the segment.

6.5.7.3.3 Fish, Invertebrates and Wildlife (Garrison River Segment, Existing & No Program)

Under both alternatives, there would be no direct impacts to the fisheries and wildlife of the Garrison River Segment. In the absence of an ESH program, wildlife abundance and diversity within the segment would remain substantially unchanged

6.5.7.3.4 Federally Listed Species and Habitats (Garrison River Segment, Existing & No Program)

Under both alternatives, there would be no direct or indirect effects to the pallid sturgeon (*Scaphirhynchus albus*) or whooping crane (*Grus americana*) and their habitat.

6.5.7.3.5 Effects to Least Tern and Piping Plover

Under both alternatives, there would be no deleterious effects due to the lack of construction activities, but there would also be no beneficial effects to the least tern and piping plover and no additional habitat. The amount of ESH observed in the Garrison River Segment would likely remain available, although reconfigured in location, as the habitat being used by least terns and piping plovers appears to be being created by the operational regime of the river segment.

6.5.7.4 Socioeconomic Resources (Garrison River Segment, Existing & No Program)

Both alternatives would be expected to avoid any of the direct effects to recreation or noise identified for Alternatives 1-5.

6.5.8 Summary of Predicted Effects in the Garrison River Segment

Table 6-6 presents a summary of the effects of implementing the alternatives for the Garrison River Segment. These values are based on the descriptions of impacts for each resource, by segment, by alternative and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

Table 6-6: Summary of Potential Significant Adverse Effects in the Garrison River Segment

Parameter	Alternative 1 2015 Goals	Alternative 2 2005 Goals	Alternative 3 1998/1999 ESH	Alternative 3.5 Intermediate	Alternative 4 2005 ESH	Alternative 5 Nesting Patterns	Continue Existing Program	No Program
Air Quality	No	No	No	No	No	No	No	No
Aesthetics	High	Moderate	Moderate	Moderate	Low	Low	No	No
Surface Water Hydrology and Hydraulics	High	Moderate	Moderate	Low	Low	Low	No	No
Degradation, Aggradation, and Erosion	High	High	High	High	Moderate	Low	No	No
Water Quality	Low	Low	Low	Low	Low	Low	No	No
Vegetation	Low	Low	Low	Low	Low	Low	No	No
Wetlands	High	Moderate	Moderate	Low	Low	Low	No	No
Fish and Wildlife	High	Moderate	Moderate	Low	Low	Low	No	No
Pallid Sturgeon	High	High	High	Moderate	Low	Low	No	No
Least Tern and Piping Plover	No	No	No	No	No	No	No	No
Recreation	High	High	High	Moderate	Moderate	Low	No	No
Noise	High	High	High	Moderate	Low	Low	No	No

6.6 Fort Randall River Segment - Segment 8

All of the alternatives require the creation of ESH within the Missouri National Recreational River (MNRR) 39-Mile District. The NPS has stated that implementing the ESH program within the MNRR may create unacceptable significant and permanent effects. The NPS and the Corps manage the MNRR through a cooperative agreement. The NPS is represented on the ESH Project Delivery Team (PDT) and, therefore, is heavily involved in the selection and design of potential sites. In working with the NPS, the Corps identified different scales of implementation through the various alternatives, discussed how to minimize impacts, and utilized GIS buffers to identify sensitive resources (see Section 4.2.1). The NPS is the overall administrator for the MNRR and has responsibility for WSRA Section 7A determination of effects in the MNRR.

The Fort Randall River Segment is the upstream-most extent of the MNRR. By virtue of its inclusion in the Wild and Scenic Rivers System, the MNRR was so designated to preserve its free-flowing condition and its ORVs. The legislation adding the MNRR to the System specifically references the 1977 Corps' Umbrella Study that describes, in detail, the ORVs that made this segment eligible for inclusion in the System. The identified ORVs are*: recreation, fish and wildlife, and historic and cultural resources.* Additionally, the Wild and Scenic Rivers Act provides management mandates to agencies responsible for administering components of the System. Section 10(a), which establishes a non-degradation and enhancement policy, states, "Each component of the national wild and scenic rivers system shall be administered in such manner as to protect and enhance the values which caused it to be included in said system without, insofar as is consistent therewith, limiting other uses that do not substantially interfere with public use and enjoyment of these values."

Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.1 Alternative 1 (Fort Randall River Segment)

As explained in Section 4.4, the Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres. After application of the environmental buffers to the segment, 2,784 residual acres, or 20% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 700 acres of interchannel sandbar necessary for Alternative 1 would disturb 2,079 acres of river bottom habitat representing 15% of the entire high-bank to high-bank habitat. All construction activities could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-19).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2015 within approximately 10 years. Erosion (assumed rate of 40 percent per year) would require the continual construction of approximately 280 acres of habitat each and every year. Annual construction would require 115 days of mechanical work and 98 days of dredge operation that could be accomplished with 2 teams of mechanical operators and 2 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 832 acres, moving over 1.6 million cubic yards of material.

The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.1.1 Physical Resources (Fort Randall River Segment, Alt. 1)

6.6.1.1.1 Air Quality (Fort Randall River Segment, Alt. 1)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 1 has not been calculated. However, this alternative represents the largest area of ESH to be created in the Fort Randall River Segment, and the emissions from equipment operation (direct effects) would be the greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 1 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.6.1.1.2 Aesthetics (Fort Randall River Segment, Alt. 1)

Potential aesthetic impacts from implementing Alternative 1, including temporary and long-term visual changes, would be significant to the MNRR during construction. In order to create the 700 acres of ESH, 98 of days of dredge and 115 days of heavy equipment operation, accomplished by large numbers of construction teams, would be required annually throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Fort Randall River Segment landscape. However, the long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 280 acres of ESH would not be aesthetically significant. Constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR throughout this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Because of the intensity (i.e., magnitude) of construction required for building Alternative 1 in the Fort Randall River segment, effects to aesthetics would be significant.

6.6.1.2 Water Resources (Fort Randall River Segment, Alt. 1)

6.6.1.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Alt. 1)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because all construction activities for Alternative 1 could occur within the "available" area (2,079 acres needed vs. 2,784 acres "available") in the Fort Randall River Segment, creation of ESH as part of Alternative 1 would not be likely to encroach into the available cross-sectional area and would not risk significant effects to the river hydraulics (see Sections 4.5 and 4.6; Table 4-19).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.6.1.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Alt. 1)

The 700 acres of ESH required under Alternative 1 could be constructed within the "available" area (2,079 acres needed vs. 2,784 acres "available") (see Sections 4.5 and 4.6; Table 4-19).

However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 1, it is estimated approximately 1.6 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Fort Randall River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-3).Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.6.1.2.3 Water Quality (Fort Randall River Segment, Alt. 1)

The following activities, necessary to create the 700 acres of ESH under Alternative 1 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 490,000 CY of sand and sediments to create 700 acres of ESH, and
- Annually placing over 1.6 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler’s Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be moderate.

6.6.1.3 Biological Resources (Fort Randall River Segment, Alt. 1)

6.6.1.3.1 Vegetation (Fort Randall River Segment, Alt. 1)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 553 acres of herb/shrub/sapling (26% of this vegetation class) and 42 acres of forest (5% of this vegetation class) in the Fort Randall River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-19). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.6.1.3.2 Wetlands (Fort Randall River Segment, Alt. 1)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 1,684 acres of wetlands within the 13,790-acres of habitat from high-bank to high-bank. This represents approximately 12% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed for construction activities related to Alternative 1 is within the "available" area (2,079 acres needed vs. 2,784 acres "available"), construction of this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-19).

6.6.1.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Alt. 1)

The direct effects to fish and wildlife within the Fort Randall River Segment from disturbing 2,079 acres of river bottom habitat, representing 15% of the entire high-bank to high-bank habitat, to construct Alternative 1 could create significant effects to fish and wildlife. However, site selection and pre-construction site evaluations would identify areas to be avoided, minimizing the potential effects, and construction could occur within the available area defined after removing the sensitive areas (see Sections 4.5 and 4.6; Table 4-19).

Creating new and/or replacing eroded habitat would annually require the replacement of approximately 280 acres of habitat directly affecting 832 acres, representing approximately 6% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible for Alternative 1 in the Fort Randall River Segment.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. Although the alternative could be built within the "available area," because of the MNRR status, Alternative 1, with the largest amount of acres required in the Fort Randall River Segment, could cause significant effects to fish and wildlife.

6.6.1.3.4 Federally and State Listed Species and Habitats (Fort Randall River Segment, Alt. 1)

As described in Section 5.3, the Fort Randall River Segment has four federally listed species that could be affected by implementing Alternative 1. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 1 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be high risk of significant effects to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded and have the highest habitat diversity and, in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphological conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation and/or replacement. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, would risk permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 39-Mile District.

6.6.1.3.5 State Listed Species and Habitats (Fort Randall River Segment, Alt. 1)

The South Dakota Game, Fish and Parks (SDGFP) has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Fort Randall River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5, Appendix G, and Appendix H Section A, should minimize the risk of significant effects.

The Nebraska Game and Parks Commission (NGPC) identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.6.1.3.6 Effects to Tern and Piping Plover (Fort Randall River Segment, Alt. 1)

By creating the 700 acres of ESH under Alternative 1, 175 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 700 acres of ESH in the Fort Randall River Segment under Alternative 1. The entire dataset for the Fort Randall River Segment (2000-2006) ever identified 122 piping plover nests and 297 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Randall River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 80 adult least terns in the Fort Randall River Segment. There are no segment-specific goals for the piping plover in the Fort Randall River Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other Missouri River sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Fort Randall River Segment goal. The effect on the least tern and piping plover from creating 700 acres of ESH in the Fort Randall River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.6.1.4 Socioeconomic Resources (Fort Randall River Segment, Alt. 1)

6.6.1.4.1 Recreation (Fort Randall River Segment, Alt. 1)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available for construction each fall in the Fort Randall River Segment. ESH construction would require 115 days of mechanical work and 98 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally-significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall to Lewis & Clark Lake reach. All of these trips took place between mid-September and early December (Mestl et al., 2001). Construction equipment operations could impede access to hunting and fishing areas, and the noise would disturb recreationists and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Fort Randall River Segment is different than in the Fort Peck or Garrison River Segments because of the designation of the MNRR. This Segment's recreational resources are one of the ORVs cited in establishing the 39-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for building Alternative 1, would predictably lead to high risk of significant effects to visitation and recreation enjoyment, including impaired access to hunting and fishing sites, degradation of habitat that results in lower harvest rates for hunters and anglers, disturbance from noise to recreationists (including bird watchers as well as hunters and anglers) and to waterfowl, and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.6.1.4.2 Noise (Fort Randall River Segment, Alt. 1)

Alternative 1 represents the largest area of ESH to be created in the Fort Randall River Segment. Creation of 700 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the 77-day period available for construction every year. High risk of significant noise effects would be predicted because of the segment's designation as a Wild and Scenic River.

6.6.2 Alternative 2 (Fort Randall River Segment)

The Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres, and after application of the environmental buffers to the segment, 2,784 residual acres, or 20% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 350 acres of interchannel sandbar necessary for Alternative 2 would disturb 1,040 acres, and construction activities could all occur within the "available" area (see Sections 4.5 and 4.6; Table 4-19).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2005 within approximately 10 years. Erosion (assumed rate of 30 percent per year) would eventually require the continual replacement of approximately 105 acres of habitat each and every year. Annual construction and/or replacement would require 43 days of mechanical work and 37 days of dredge operation that could be accomplished with 1 team of mechanical operators and 1 dredge operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 312 acres, moving over 615,000 cubic yards of material.

The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.2.1 Physical Resources (Fort Randall River Segment, Alt. 2)

6.6.2.1.1 Air Quality (Fort Randall River Segment, Alt. 2)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 2 has not been calculated. However, this alternative represents the second largest area of ESH to create in the Fort Randall River Segment, and the emissions from equipment operation (direct effects) would be the second largest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 2 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.6.2.1.2 Aesthetics (Fort Randall River Segment, Alt. 2)

In order to create the 350 acres of ESH within a 10-year timeframe, 37 of days of dredge and 43 days of heavy equipment operation, accomplished by construction teams working at the same time would be required annually throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Fort Randall River Segment landscape. However, the long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 105 acres of ESH would not be aesthetically significant. Constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the designation as the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-19), the MNRR status could indicate moderate effects on aesthetics.

6.6.2.2 Water Resources (Fort Randall River Segment, Alt. 2)

6.6.2.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Alt. 2)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Construction activities for Alternative 2 could occur within the available area, and therefore would not be likely to encroach into the available cross-sectional area and would have a low risk of significant effects to the river hydraulics (see Sections 4.5 and 4.6; Table 4-19).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.6.2.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Alt. 2)

The 350 acres of ESH required under Alternative 2 could be constructed within the “available” area (1,040 acres needed vs. 2,784 acres “available”) (see Sections 4.5 and 4.6; Table 4-19). However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 2, it is estimated approximately 0.6 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Fort Randall River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis. Construction methods to limit impacts to surrounding resources include shoreline buffers of 100’ and dredging depth restricted to a maximum 4’ not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300’ to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.6.2.2.3 Water Quality (Fort Randall River Segment, Alt. 2)

The following activities, necessary to create the 350 acres of ESH under Alternative 2, would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging over 180,000 CY of sand and sediments to create 350 acres of ESH, and
- Annually placing over 0.6 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.6.2.3 Biological Resources (Fort Randall River Segment, Alt. 2)

6.6.2.3.1 Vegetation (Fort Randall River Segment, Alt. 2)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 350 acres of herb/shrub/sapling (16 % of this vegetation class) and 0 acres of forest in the Fort Randall River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-19). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.6.2.3.2 Wetlands (Fort Randall River Segment, Alt. 2)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 1,684 acres of wetlands within the 13,790-acres of habitat from high-bank to high-bank. This represents approximately 12% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 2 is within the "available" area (1,040 acres needed vs. 2,784 acres "available") (see Sections 4.5 and 4.6; Table 4-19), construction of this alternative would likely not result in a loss to existing wetlands.

6.6.2.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Alt. 2)

The direct effects to fish and wildlife within the Fort Randall River Segment from disturbing 1,040 acres of river bottom habitat, representing 8% of the entire high-bank to high-bank habitat, to construct Alternative 2 would likely not create significant effects to fish and wildlife. Construction could be completed within the "available" area after application of the environmental buffers (see Sections 4.5 and 4.6; Table 4-19).

Constructing the habitat would annually require the creation and/or replacement of approximately 105 acres of habitat directly affecting 312 acres (approximately 2%) of the high-bank to high-bank habitat. Implementing Alternative 2 while avoiding biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible in the Fort Randall River Segment, and the risk of significant effects from annual construction is low.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat.

Overall, there would be a moderate risk of significant effects to fish, invertebrates and wildlife. Although the area needed to construct Alternative 2 in the Fort Randall River Segment does not exceed the "available area," and the level of intensity of Alternative 2 is approximately half of Alternative 1, the MNRR status could indicate the risk of moderate effects on fish and wildlife.

6.6.2.3.4 Federally and State Listed Species and Habitats (Fort Randall River Segment, Alt. 2)

As described in Section 5.3, the Fort Randall River Segment has four federally listed species that could be affected by implementing Alternative 2. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 2 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration. There are five areas of Critical Habitat designated for the whooping crane and none of them are in South Dakota. (They are located in Idaho, Kansas, Nebraska, Oklahoma, and Texas; the Nebraska location is not on the Missouri River (USFWS, 2007)).

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementing this alternative would add the annual burden of construction within the Recovery-Priority Area and risks permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 39-Mile District.

6.6.2.3.5 State Listed Species and Habitats (Fort Randall River Segment, Alt. 2)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Fort Randall River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.6.2.3.6 Effects to Least Tern and Piping Plover (Fort Randall River Segment, Alt. 2)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 350 acres of ESH under Alternative 2, 88 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 350 acres of ESH in the Fort Randall River Segment under Alternative 2. The entire dataset for the Fort Randall River Segment (2000-2006) ever identified 122 piping plover nests and 297 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Randall River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 80 adult least terns in the Fort Randall River Segment. There are no segment-specific goals for the piping plover in the Fort Randall River Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other Missouri River sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Fort Randall River Segment goal. The effect on the least tern and piping plover from creating 350 acres of ESH in the Fort Randall River Segment is uncertain as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.6.2.4 Socioeconomic Resources (Fort Randall River Segment, Alt. 2)

6.6.2.4.1 Recreation (Fort Randall River Segment, Alt. 2)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week within the 77-day period available for construction each fall in the Fort Randall River Segment. Construction and/or replacement of ESH would require 43 days of mechanical work and 37 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall to Lewis & Clark Lake reach. All of these trips took place between mid-September and early December (Mestl et al., 2001). Construction operations could impede access to hunting and fishing areas, and the noise would disturb recreationists and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the designation of the MNRR. This segment's recreational resources are one of the ORVs cited in establishing the 39-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the Wild and Scenic River. The intensity (i.e., magnitude) of construction required for building Alternative 2, would likely lead to moderate effects to visitation and recreation enjoyment, including impaired access to hunting and fishing sites, degradation of habitat that results in lower harvest rates for hunters and anglers, disturbance from noise to recreationists (including bird watchers as well as hunters and anglers) and to waterfowl, and adverse impacts on scenic views due to the presence and operation of construction equipment.

6.6.2.4.2 Noise (Fort Randall River Segment, Alt. 2)

Alternative 2 represents the second largest area of ESH to be created in the Fort Randall River Segment. Creation of 350 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for much of the 77-day period available for construction every year. Moderate noise effects would be predicted because of the segment's designation as a Wild and Scenic River.

6.6.3 Alternative 3 (Fort Randall River Segment)

The Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres, and after application of the environmental buffers to the segment, 2,784 residual acres, or 20% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 295 acres of interchannel sandbar necessary for Alternative 3 would disturb 876 acres representing approximately 6% of the entire high-bank to high-bank habitat and requiring 31% of the available "available" area to construct the requisite acreage (see see Sections 4.5 and 4.6; Table 4-19).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the 1998 Actual goals within approximately 10 years. Erosion (assumed rate of 30 percent per year) would eventually require the replacement of approximately 89 acres of habitat each and every year. Annual construction would require 36 days of mechanical work and 31 days of dredge operation that could be accomplished with 1 team of mechanical operators and 1 dredge within the 77 available calendar days each autumn. Annual construction would disturb 264 acres, moving over 520,000 cubic yards of material.

The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.3.1 Physical Resources (Fort Randall River Segment, Alt. 3)

6.6.3.1.1 Air Quality (Fort Randall River Segment, Alt. 3)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3 has not been calculated. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to

1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.6.3.1.2 Aesthetics (Fort Randall River Segment, Alt. 3)

Potential aesthetic impacts from implementing Alternative 3, including temporary and long-term visual changes, would be significant to the MNRR during construction. In order to create the 295 acres of ESH, 31 of days of dredge and 36 days of heavy equipment operation, accomplished by one construction team, would be required annually within the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Fort Randall River Segment landscape. However, the long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 89 acres of ESH would not be aesthetically significant. Constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the Missouri MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-19), the MNRR status could indicate moderate effects on aesthetics.

6.6.3.2 Water Resources (Fort Randall River Segment, Alt. 3)

6.6.3.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Alt. 3)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Construction activities for Alternative 3 could all occur within the "available" area in the Fort Randall River Segment (876 acres needed vs. 2,784 acres "available") and would not be likely to encroach into the available cross-sectional area (see Sections 4.5 and 4.6; Table 4-19). Overall, there would be a low risk of significant effects to the river hydraulics.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.6.3.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Alt. 3)

Because the 295 acres of ESH required under Alternative 3 could be constructed within the “available” area (876 acres needed vs. 2,784 acres “available”) the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-19). However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 2, it is estimated approximately 0.5 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Fort Randall River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100’ and dredging depth restricted to a maximum 4’ not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300’ to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.6.3.2.3 Water Quality (Fort Randall River Segment, Alt. 3)

The following activities, necessary to create the 295 acres of ESH under Alternative 3 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 150,000 CY of sand and sediments to create 295 acres of ESH, and
- Annually placing of over 520,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.6.3.3 Biological Resources (Fort Randall River Segment, Alt. 3)

6.6.3.3.1 Vegetation (Fort Randall River Segment, Alt. 3)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 295 acres of herb/shrub/sapling (14 % of this vegetation class) and 0 acres of forest in the Fort Randall River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-19). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.6.3.3.2 Wetlands (Fort Randall River Segment, Alt. 3)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 1,684 acres of wetlands within the 13,790-acres of habitat from high-bank to high-bank. This represents approximately 12% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 3 is within the “available” area (876 acres needed vs. 2,784 acres “available”), construction of this alternative would likely not result in a loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-19).

6.6.3.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Alt. 3)

The direct effects to fish and wildlife within the Fort Randall River Segment from disturbing 876 acres of river bottom habitat, representing 6% of the entire high-bank to high-bank habitat, to construct Alternative 3 would likely not create significant effects to fish and wildlife. Construction could be completed within the “available” area after application of the environmental buffers, although resources identified during the pre-construction surveys would further reduce the available area to avoid significant effects to fish and wildlife.

Creating new habitat and/or replacing the habitat lost to erosion would annually require the replacement of approximately 89 acres of habitat directly affecting 264 acres (less than 2%) of the high-bank to high-bank habitat. Implementing Alternative 3 while avoiding biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible in the Fort Randall River Segment, and the risk of significant effects from annual maintenance is low.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, “Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data.” (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, “Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations,” conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½” in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate’s effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the

surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Fort Randall River Segment is different from the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat.

Overall, there would be a moderate risk of significant effects to fish, invertebrates and wildlife. Although the area needed to construct Alternative 3 in the Fort Randall River Segment does not exceed the "available area," the MNRR status could indicate the risk of moderate effects on fish and wildlife.

6.6.3.3.4 Federally and State Listed Species and Habitats (Fort Randall River Segment, Alt. 3)

As described in Section 5.3, the Fort Randall River Segment has four federally listed species that could be affected by implementing Alternative 3. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphological conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementing this alternative would add the annual burden of construction within the Recovery-Priority Area and would risk permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 39-Mile District.

6.6.3.3.5 State Listed Species and Habitats (Fort Randall River Segment, Alt. 3)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Fort Randall River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.6.3.3.6 Effects to Least Tern and Piping Plover (Fort Randall River Segment, Alt. 3)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 295 acres of ESH under Alternative 3, 74 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 295 acres of ESH in the Fort Randall River Segment under Alternative 3. The entire dataset for the Fort Randall River Segment (2000-2006) ever identified 122 piping plover nests and 297 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Randall River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 80 adult least terns in the Fort Randall River Segment. There are no segment-specific goals for the piping plover in the Fort Randall River Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other Missouri River sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Fort Randall River Segment goal. The effect on the least tern and piping plover from creating 295 acres of ESH in the Fort Randall River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.6.3.4 Socioeconomic Resources (Fort Randall River Segment, Alt. 3)

6.6.3.4.1 Recreation (Fort Randall River Segment, Alt. 3)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during a portion of the 77-day period available for construction each fall in the Fort Randall River Segment. Annual construction of ESH would require 36 days of mechanical work and 31 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall to Lewis & Clark Lake reach. All of these trips took place between mid-September and early December (Mestl et al., 2001) and coincide with the construction window. Construction operations could impede access to hunting and fishing areas, and the noise would disturb recreationists and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the designation of the MNRR. This segment's recreational resources are one of the ORVs cited in establishing the 39-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the Wild and Scenic River. The intensity (i.e., magnitude) of construction required for building and maintaining Alternative 3, would likely lead to moderate effects to visitation and recreation enjoyment.

6.6.3.4.2 Noise (Fort Randall River Segment, Alt. 3)

Alternative 3 represents the third largest area of ESH to be created in the Fort Randall River Segment. Creation of 295 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for much of the 77-day period available for construction every year. Moderate risk of significant noise effects would be predicted because of the segment's designation as a Wild and Scenic River.

6.6.4 Alternative 3.5 - Impact Level Identified with AMIP Preferred Alternative (Fort Randall River Segment)

The Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres and after application of the environmental buffers to the segment, 2,784 residual acres, or 20% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Creating the 212 acres of interchannel sandbar necessary for Alternative 3.5 would disturb 630 acres and could occur within the “available” area (see Sections 4.5 and 4.6; Table 4-19).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternate 3.5 goals,(average of 1998-2005), within approximately 10 years. Erosion (assumed rate of 25 percent per year) would eventually require the continual replacement of approximately 53 acres of habitat each and every year. Annual construction would require 22 days of mechanical work and 19 days of dredge operation that could be accomplished with 1 team of mechanical operators and 1 dredge within the 77 available calendar days each autumn. Annual construction would disturb 157 acres, moving over 310,000 cubic yards of material.

The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.4.1 Physical Resources (Fort Randall River Segment, Alt. 3.5)

6.6.4.1.1 Air Quality (Fort Randall River Segment, Alt. 3.5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA’s air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 35 has not been calculated. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3.5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and

other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.6.4.1.2 Aesthetics (Fort Randall River Segment, Alt. 3.5)

Potential aesthetic impacts from implementing Alternative 3.5, including temporary and long-term visual changes, would be high risk of significant effect to the MNRR during construction. In order to create the 212 acres of ESH, 19 days of dredge and 22 days of heavy equipment operation, accomplished by construction teams working at the same time, would be required throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Fort Randall River Segment landscape. However, the long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 53 acres of ESH would not be aesthetically significant. Constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This Segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-19), the MNRR status could indicate moderate effects on aesthetics.

6.6.4.2 Water Resources (Fort Randall River Segment, Alt. 3.5)

6.6.4.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Alt. 3.5)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because construction activities of Alternative 3.5 could occur within the "available" area (630 acres impacted vs. 2,784 acres "available") and would be unlikely to encroach into the available cross-sectional area, the risk of significant effects to the river hydraulics would be low (see Sections 4.5 and 4.6; Table 4-19).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.6.4.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Alt. 3.5)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 3.5 would likely be moderately significant. Because the 212 acres of ESH required under Alternative 3.5 could be constructed within the "available" area (630 acres impacted vs. 2,784 acres "available"), the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-19).

However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 3.5, it is estimated approximately 0.3 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Fort Randall River segment. Estimates indicate that this could be a moderate amount of material relative to annual sediment load. Possible effects of this alternative include impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of inducing significant effects on aggradation, degradation, and erosion within the segment is likely to be moderate. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.6.4.2.3 Water Quality (Fort Randall River Segment, Alt. 3.5)

The following activities, necessary to construct the 212 acres of ESH under Alternative 3.5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 93,000 CY of sand and sediments to create 212 acres of ESH, and
- Annually placing of nearly 310,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler’s Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.6.4.3 Biological Resources (Fort Randall River Segment, Alt. 3.5)

6.6.4.3.1 Vegetation (Fort Randall River Segment, Alt. 3.5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 212 acres of herb/shrub/sapling (10 % of this vegetation class) and 0 acres of forest in the Fort Randall River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-19). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.6.4.3.2 Wetlands (Fort Randall River Segment, Alt. 3.5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 1,684 acres of wetlands within the 13,790-acres of habitat from high-bank to high-bank. This represents approximately 12% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area impacted by constructing Alternative 3.5 would be within the “available” area (580 acres disturbed vs. 2,784 acres “available”), construction of this alternative would likely not result in a loss to existing wetlands and would pose a low risk of significant effects (see Sections 4.5 and 4.6; Table 4-19).

6.6.4.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Alt. 3.5)

The direct effects to fish and wildlife within the Fort Randall River Segment from disturbing 630 acres of river bottom habitat, representing 5% of the entire high-bank to high-bank habitat, to construct Alternative 3.5 would likely not create significant effects to fish and wildlife. Construction could be completed within the “available” area after application of the environmental buffers, avoiding significant effects to fish and wildlife (see Sections 4.5 and 4.6; Table 4-19).

Eventually habitat lost to erosion would annually require the replacement of approximately 53 acres of habitat directly affecting 157 acres (less than 1%) of the high-bank to high-bank habitat. Implementing Alternative 3.5 while avoiding biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible in the Fort Randall River Segment, and the risk of significant effects from annual construction is low.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate.

Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. Construction could be completed within the "available" area after application of the environmental buffers, avoiding significant effects to sensitive resources and fish and wildlife (see Sections 4.5 and 4.6; Table 4-19).

6.6.4.3.4 Federally and State Listed Species and Habitats (Fort Randall River Segment, Alt. 3.5)

As described in Section 5.3, the Fort Randall River Segment has four federally listed species that could be affected by implementing Alternative 3.5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3.5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate “natural channel configuration of sandbars, side channels, and varied depths” also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, risks permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 39-Mile District.

6.6.4.3.5 State Listed Species and Habitats (Fort Randall River Segment, Alt. 3.5)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Fort Randall River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and “At-Risk” species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.6.4.3.6 Effects to Least Tern and Piping Plover (Fort Randall River Segment, Alt. 3.5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 212 acres of ESH under Alternative 3.5, 53 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 212 acres of ESH in the Fort Randall River Segment under Alternative 3.5. The entire dataset for the Fort Randall River Segment (2000-2006) never identified 127 piping plover nests and 297 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Randall River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 80 adult least terns in the Fort Randall River Segment. There are no segment-specific goals for the piping plover in the Fort Randall River Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other Missouri River sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Fort Randall River Segment goal. The effect on the least tern and piping plover from creating 212 acres of ESH in the Fort Randall River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.6.4.4 Socioeconomic Resources (Fort Randall River Segment, Alt. 3.5)

6.6.4.4.1 Recreation (Fort Randall River Segment, Alt. 3.5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the a portion of the 77-day period available for construction each fall in the Fort Randall River Segment. Annual construction of ESH would require 22 days of mechanical work and 19 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall to Lewis & Clark Lake reach. All of these trips took place between mid-September and early December (Mestl et al., 2001) and coincide with the construction window. Construction operations could impede access to hunting and fishing areas, and the noise would disturb recreationists and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Fort Randall River Segment is different than that of the Fort Peck or Garrison River Segments because of the designation of the MNRR. This segment's recreational resources are one of the ORVs cited in establishing the 39-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the Wild and Scenic River. The intensity (i.e., magnitude) of construction required for building and maintaining Alternative 3.5, would likely lead to low effects to visitation and recreation enjoyment. .

6.6.4.4.2 Noise (Fort Randall River Segment, Alt. 3.5)

Alternative 3.5 represents the fourth largest area of ESH to be created in the Fort Randall River Segment. Construction of 212 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for much of the 77-day period available for construction every year. Low risk of significant noise effects would be predicted .

6.6.5 Alternative 4 (Fort Randall River Segment)

The Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres and after application of the environmental buffers to the segment, 2,784 residual acres, or 20% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Retaining the 128 acres of interchannel sandbar for Alternative 4 would disturb 380 acres and construction activities could occur within the “available” area (see Sections 4.5 and 4.6; Table 4-19).

Erosion of the ESH available in 2005 would require the annual replacement of approximately 19 acres of habitat (15 percent annual loss rate). This annual replacement would require 8 days of mechanical work and 7 days of dredge operation that could be accomplished with 1 team of mechanical operators and 1 dredge within the first few weeks of the 77 available calendar days each autumn. Annual construction would disturb 53 acres, moving over 110,000 cubic yards of material.

The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.5.1 Physical Resources (Fort Randall River Segment, Alt. 4)

6.6.5.1.1 Air Quality (Fort Randall River Segment, Alt. 4)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA’s air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 4 has not been calculated. However, this alternative represents the next to smallest area of ESH to construct in the Fort Randall River Segment, and the emissions from equipment operation (direct effects) would be second least. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 4 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.6.5.1.2 Aesthetics (Fort Randall River Segment, Alt. 4)

Potential aesthetic impacts from implementing Alternative 4, including temporary and long-term visual changes, would be second least among the Fort Randall alternatives, but may still be significant to the MNRR during construction. In order to retain the 128 acres of ESH, 7 days of dredge and 8 days of heavy equipment operation, accomplished by one construction teams, would be required throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Fort Randall River Segment landscape. However, the long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 19 acres of ESH would not be aesthetically significant. Constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment’s river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS’ mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Because of the lower intensity (magnitude) of construction, effects on aesthetics would be predicted to be low.

6.6.5.2 Water Resources (Fort Randall River Segment, Alt. 4)

6.6.5.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Alt. 4)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because construction activities of Alternative 4 would occur within the "available" area (380 acres needed vs. 2,784 acres "available") and would not encroach into the cross-sectional area of the river, the risk of significant effects to the river hydraulics would be low (see Sections 4.5 and 4.6; Table 4-19).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.6.5.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Alt. 4)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 4 would likely have low significance. Because the 128 acres of ESH required under Alternative 4 could be constructed within the "available" area (380 acres needed vs. 2,784 acres "available") the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-19).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.6.5.2.3 Water Quality (Fort Randall River Segment, Alt. 4)

The following activities, necessary to construct and maintain the 128 acres of ESH under Alternative 4 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 33,000 CY of sand and sediments to retain 128 acres of ESH, and
- Annually placing of over 110,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler’s Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.6.5.3 Biological Resources (Fort Randall River Segment, Alt. 4)

6.6.5.3.1 Wetlands (Fort Randall River Segment, Alt. 4)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 128 acres of herb/shrub/sapling (6 % of this vegetation class) and 0 acres of forest in the Fort Randall River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-19). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.6.5.3.2 Wetlands (Fort Randall River Segment, Alt. 4)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 1,684 acres of wetlands within the 13,790-acres of habitat from high-bank to high-bank. This represents approximately 12% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 4 is within the “available” area available (380 acres needed vs. 2,784 acres “available”), construction of this alternative would likely not result in a loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-19).

6.6.5.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Alt. 4)

The direct effects to fish and wildlife within the Fort Randall River Segment from disturbing 380 acres of river bottom habitat, representing 3% of the entire high-bank to high-bank habitat, to construct Alternative 4 would likely not create significant effects to fish and wildlife. Construction could be completed within the “available” area after application of the environmental buffers (see Sections 4.5 and 4.6; Table 4-19).

ESH lost to erosion would annually require the replacement of approximately 19 acres of habitat directly affecting 56 acres (less than 1%) of the high-bank to high-bank habitat. Implementing Alternative 4 while avoiding biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible in the Fort Randall River Segment, and the risk of significant effects from annual construction would be low.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon

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A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat.

6.6.5.3.4 Federally and State Listed Species and Habitats (Fort Randall River Segment, Alt. 4)

As described in Section 5.3, the Fort Randall River Segment has four federally listed species that could be affected by implementing Alternative 4. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 4 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphological conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH retention. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, would risk permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 39-mile District.

6.6.5.3.5 State Listed Species and Habitats (Fort Randall River Segment, Alt. 4)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Fort Randall River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.6.5.3.6 Effects to Least Tern and Piping Plover (Fort Randall River Segment, Alt. 4)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 128 acres of ESH under Alternative 4, 32 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 128 acres of ESH in the Fort Randall River Segment under Alternative 4. The entire dataset for the Fort Randall River Segment (2000-2006) ever identified 122 piping plover nests and 297 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Randall River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 80 adult least terns in the Fort Randall River Segment. There are no segment-specific goals for the piping plover in the Fort Randall River Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other Missouri River sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Fort Randall River Segment goal. The effect on the least tern and piping plover from retaining 128 acres of ESH in the Fort Randall River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.6.5.4 Socioeconomic Resources (Fort Randall River Segment, Alt. 4)

6.6.5.4.1 Recreation (Fort Randall River Segment, Alt. 4)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during some portion of the 77-day period available for construction each fall in the Fort Randall River Segment. Annual replacement of ESH would require 7 days of mechanical work and 6 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally-significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River and Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al., 2001) and coincide with the construction window. However, the limited scale of the annual construction for Alternative 4 could allow the work to be accomplished before much of the waterfowl migration and hunting season had passed, greatly reducing the potential impacts on autumn recreation as a whole.

The environmental context for the consideration of effects to recreation in the Fort Randall River Segment is different than that in the Fort Peck or Garrison River Segments because of the designation of the MNRR. This segment's recreational resources are one of the ORVs cited in establishing the 39-mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for Alternative 4, could result in minimal effects to recreation, and could also be completed early enough during the construction period to minimize the effect on visitation and recreation enjoyment during most of the autumn recreation season.

6.6.5.4.2 Noise (Fort Randall River Segment, Alt. 4)

Alternative 4 represents the second smallest area of ESH to be constructed annually in the Fort Randall River Segment. Retention of 128 acres of ESH would require a team of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the first two weeks of the 77-day period available for construction every year. Noise effects would be predicted to be moderate during the annual construction but may not threaten the ORVs for the 39-Mile District of the MNRR if the work could be accomplished quickly in the construction period. Overall effects would be low.

6.6.6 Alternative 5 (Fort Randall River Segment)

The Fort Randall River Segment has a measured high-bank to high-bank area of approximately 13,790 acres, and after application of the environmental buffers to the segment, 2,784 residual acres, or 20% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Creating the 135 acres of interchannel sandbar necessary for Alternative 5 would disturb 401 acres, and all construction activities could occur within the “available” area (see Sections 4.5 and 4.6; Table 4-19).

Erosion (assumed rate of 10 percent per year) would require the continual replacement of approximately 14 acres of habitat each and every year. This annual construction would require 6 days of mechanical work and 5 days of dredge operation that could be accomplished with 1 team of mechanical operators and 1 dredge within the first couple of weeks of the 77 available calendar days each autumn. Annual construction would disturb 42 acres, moving over 82,000 cubic yards of material.

The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.6.1 Physical Resources (Fort Randall River Segment, Alt. 5)

6.6.6.1.1 Air Quality (Fort Randall River Segment, Alt. 5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA’s air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 5 has not been calculated. However, this alternative represents the smallest area of

ESH to construct annually in the Fort Randall River Segment, and the emissions from equipment operation (direct effects) would be almost identical to Alternative 4. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.6.6.1.2 Aesthetics (Fort Randall River Segment, Alt. 5)

Potential aesthetic impacts from implementing Alternative 5, including temporary and long-term visual changes, would be the similar to Alternative 4 but may still be significant to the MNRR during construction. In order to create the 135 acres of ESH, 47 days of dredge and 55 days of heavy equipment operation, accomplished by a construction team, would be required within the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Fort Randall River Segment landscape. However, the long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 14 acres of ESH would not be aesthetically significant. Constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Fort Randall River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. The Fort Randall River Segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Because of the lower intensity (magnitude) of construction, effects on aesthetics would be predicted to be low.

6.6.6.2 Water Resources (Fort Randall River Segment, Alt. 5)

6.6.6.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Alt. 5)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Because construction activities for Alternative 5 could occur within the "available" area (401 acres needed vs. 2,784 acres "available"), activities would not likely encroach into the cross-sectional area of the river, and the risk of significant effects to the river hydraulics would be low (see Sections 4.5 and 4.6; Table 4-19.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.6.6.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Alt. 5)

The potential effects to aggradation, degradation, and erosion from constructing and maintaining Alternative 5 would likely not be significant. Because the 135 acres of ESH required under Alternative 5 could be constructed within the "available" area (401 acres needed vs. 2,784 acres "available") the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-19).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For alternative 5, it is estimated approximately 80,000 cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Fort Randall River segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode.

Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.6.6.2.3 Water Quality (Fort Randall River Segment, Alt. 5)

The following activities, necessary to create the 135 acres of ESH under Alternative 5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging of over 24,000 CY of sand and sediments to create 135 acres of ESH, and
- Annually placing of over 82,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The overall risk of significant water quality effects would be low.

6.6.6.3 Biological Resources (Fort Randall River Segment, Alt. 5)

6.6.6.3.1 Vegetation (Fort Randall River Segment, Alt. 5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 135 acres of herb/shrub/sapling (6 % of this vegetation class) and 0 acres of forest in the Fort Randall River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-19). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars in these reaches, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.6.6.3.2 Wetlands (Fort Randall River Segment, Alt. 5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 1,684 acres of wetlands within the 13,790-acres of habitat from high-bank to high-bank. This represents approximately 12% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 5 could be within the available area (373 acres needed vs. 2,784 acres “available”), construction of this alternative would likely not result in a loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-19).

6.6.6.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Alt. 5)

The direct effects to fish and wildlife within the Fort Randall River Segment from disturbing 401 acres of river bottom habitat, representing 3% of the entire high-bank to high-bank habitat, to construct Alternative 5 would likely not create significant effects to fish and wildlife. Construction could be completed within the “available” area after application of the environmental buffers although resources identified (see Sections 4.5 and 4.6; Table 4-19).

Creating the extremely small amount of new ESH and replacing the habitat lost to erosion would require the annual replacement of approximately 14 acres of habitat directly affecting 42 acres (less than 1%) of the high-bank to high-bank habitat. Implementing Alternative 5 while avoiding biologically important habitat (e.g., wetlands, submerged aquatic vegetation) is feasible in the Fort Randall River Segment and the risk of significant effects from annual construction would be low.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could

be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat.

6.6.6.3.4 Federally and State Listed Species and Habitats

As described in Section 5.3, the Fort Randall River Segment has four federally listed species that could be affected by implementing Alternative 5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphological conditions that facilitate “natural channel configuration of sandbars, side channels, and varied depths” also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, risks permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 39-Mile District.

6.6.6.3.5 State Listed Species and Habitats (Fort Randall River Segment, Alt. 5)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Fort Randall River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and “At-Risk” species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.6.6.3.6 Effects to Least Tern and Piping Plover (Fort Randall River Segment, Alt. 5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 135 acres of ESH under Alternative 5, 34 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 135 acres of ESH in the Fort Randall River Segment under Alternative 5. The entire dataset for the Fort Randall River Segment (2000-2006) ever identified 122 piping plover nests and 297 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Fort Randall River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 80 adult least terns in the Fort Randall River Segment. There are no segment-specific goals for the piping plover in the Fort Randall River Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with “other Missouri River sites” in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Fort Randall River Segment goal. The effect on the least tern and piping plover from constructing and maintaining 295 acres of ESH in the Fort Randall River Segment is uncertain as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.6.6.4 Socioeconomic Resources (Fort Randall River Segment, Alt. 5)

6.6.6.4.1 Recreation (Fort Randall River Segment, Alt. 5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during some portion of the 77-day period available for construction each fall in the Fort Randall River Segment. Annual creation and/or replacement of ESH would require 6 days of mechanical work and 5 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River and Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al., 2001) and coincide with the construction window. However, the limited scale of the annual construction for Alternative 5 could allow the work to be accomplished before much of the waterfowl migration and hunting season had passed, reducing the potential impacts on autumn recreation as a whole.

The environmental context for the consideration of effects to recreation in the Fort Randall River Segment is different from that in the Fort Peck or Garrison River Segments because of the designation of the MNRR. The Fort Randall River Segment’s recreational resources are one of the ORVs cited in establishing the 39-Mile District of the MNRR. The NPS’ mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. Construction could be completed early enough during the construction period to reduce the effect on visitation and recreation enjoyment during the autumn recreation season as a whole. The intensity (i.e., magnitude) of construction required for Alternative 5 would likely lead to only low effects to recreation.

6.6.6.4.2 Noise (Fort Randall River Segment, Alt. 5)

Alternative 5 represents the second area of ESH to be constructed annually in the Fort Randall River Segment. Creation and/or replacement of 135 acres of ESH would require a team of earth-moving equipment (e.g., dozers, scrapers, and excavators), a dredge, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for about the first 2 weeks of the 77-day period available for construction every year. Noise effects would be moderate during the annual construction, but may not threaten the ORVs for the 39-Mile District of the MNRR if the work could be accomplished quickly in the construction period. Overall effects would be low.

6.6.7 Existing Program Alternative and No Program Alternative (Fort Randall River Segment)

Neither the Existing Program Alternative nor the No Program Alternative would result in any construction in the Fort Randall River Segment. The Existing Program only focuses on the Lewis & Clark Lake Segment and the Gavins Point River Segment. Therefore, these two Alternatives will be discussed together. The Fort Randall River Segment is the upstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.6.7.1 Physical Resources (Fort Randall River Segment, Existing & No Program)

6.6.7.1.1 Air Quality (Fort Randall River Segment, Existing & No Program)

Under both alternatives, air quality would not change from existing conditions.

6.6.7.1.2 Aesthetics (Fort Randall River Segment, Existing & No Program)

There would be no temporary construction-related deterioration of visual resources or permanent changes to the visual resources of the Fort Randall River Segment; there would also be no effects to the outstandingly remarkable natural value in the 39-Mile District of the MNRR.

6.6.7.2 Water Resources (Fort Randall River Segment, Existing & No Program)

6.6.7.2.1 Surface Water Hydrology and Hydraulics (Fort Randall River Segment, Existing & No Program)

Under both alternatives, potential direct and indirect effects to surface water hydrology and hydraulics would not occur.

6.6.7.2.2 Aggradation, Degradation, and Erosion (Fort Randall River Segment, Existing & No Program)

The Fort Randall River Segment is subject to daily power-peaking surges that change the river stage dramatically from near the dam to the confluence with the Niobrara. Taking no action to mechanically create and/or replace ESH would not risk increasing erosion or deposition rates from program implementation.

6.6.7.2.3 Water Quality (Fort Randall River Segment, Existing & No Program)

Absent the construction-related effects to water quality predicted under the action alternatives, water quality would remain unchanged from the existing conditions.

6.6.7.3 Biological Resources (Fort Randall River Segment, Existing & No Program)

6.6.7.3.1 Vegetation (Fort Randall River Segment, Existing & No Program)

Under these alternatives, there would be no direct or indirect impacts to vegetation observed within the segment. Natural succession would continue.

6.6.7.3.2 Wetlands (Fort Randall River Segment, Existing & No Program)

Under these alternatives, there would be no direct or indirect impacts to wetland observed within the segment. Natural succession would continue.

6.6.7.3.3 Fish, Invertebrates and Wildlife (Fort Randall River Segment, Existing & No Program)

Under both alternatives, there would be no direct impacts to the fisheries and wildlife of the Fort Randall River Segment. In the absence of an ESH program, wildlife abundance and diversity within the segment would remain substantially unchanged.

6.6.7.3.4 Federally and State Listed Species and Habitats (Fort Randall River Segment, Existing & No Program)

Under either alternative, there would be no direct or indirect effects to the pallid sturgeon (*Scaphirhynchus albus*) or whooping crane (*Grus americana*) and their habitat. There would also be no direct or indirect effects to the false-map turtle (*Graptemys pseudogeographica*), sturgeon chub (*Macrhybopsis gelida*), lake sturgeon (*Acipenser fulvescens*), blue sucker (*Cycleptus elongates*), or sicklefin chub (*Macrhybopsis meeki*).

6.6.7.3.5 Effects to Least Tern and Piping Plover (Fort Randall River Segment, Existing & No Program)

There would be no deleterious effects to the ORVs within the MNRR from the ongoing construction activities, but there would also be no beneficial effects to the least tern and piping plover and no additional created habitat. The interchannel sandbar observed in the Fort Randall River Segment would likely persist in approximately the current quantities, although in a declining quality of nesting habitat as vegetation overtakes any remaining barren areas.

6.6.7.4 Socioeconomic Resources (Fort Randall River Segment, Existing & No Program)

Taking no action would be expected to avoid any of the direct effects to recreation or noise identified for Alternatives 1-5.

6.6.8 Summary of Predicted Effects in the Fort Randall River Segment

Table 6-7 presents a summary of the effects of implementing the alternatives for the Fort Randall River Segment. These values are based on the descriptions of impacts for each resource, by segment, by alternative, and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

Table 6-7: Summary of Potential Significant Adverse Effects in the Fort Randall River Segment

Parameter	Alternative 1 2015 Goals	Alternative 2 2005 Goals	Alternative 3 1998/1999 ESH	Alternative 3.5 Intermediate	Alternative 4 2005 ESH	Alternative 5 Nesting Patterns	Continue Existing Program	No Program
Air Quality	No	No	No	No	No	No	No	No
Aesthetics	High	Moderate	Moderate	Moderate	Low	Low	No	No
Surface Water Hydrology & Hydraulics	Low	Low	Low	Low	Low	Low	No	No
Degradation, Aggradation, & Erosion	High	High	High	Moderate	Low	Low	No	No
Water Quality	Moderate	Low	Low	Low	Low	Low	No	No
Vegetation	Low	Low	Low	Low	Low	Low	No	No
Wetlands	Low	Low	Low	Low	Low	Low	No	No
Fish and Wildlife	High	Moderate	Moderate	Low	Low	Low	No	No
Pallid Sturgeon	High	Moderate	Moderate	Low	Low	Low	No	No
Least Tern and Piping Plover	No	No	No	No	No	No	No	No
Recreation	High	Moderate	Moderate	Low	Low	Low	No	No
Noise	High	Moderate	Moderate	Low	Low	Low	No	No

6.7 Lewis & Clark Lake Segment - Part of Segment 9

6.7.1 Alternative 1 (Lewis & Clark Lake Segment)

As explained in Section 4.5, the Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 1,360 acres of interchannel sandbar necessary for Alternative 1 would disturb 2,594 acres of river bottom habitat, and could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a relatively static water surface elevation; and all of the habitat must be constructed with dredges.

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2015 within approximately 10 years. Erosion (assumed rate of 50 percent per year) would ultimately require the replacement of approximately 680 acres of habitat each and every year. Annual construction would require 797 days of dredge operation that could be accomplished with 11 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 1,297 acres, moving over 3.9 million cubic yards of material.

The Lewis & Clark Lake Segment begins at approximately the end of the MNRR's 39-Mile District and, therefore, considers only the indirect effects to the ORVs of the 39-Mile District.

6.7.1.1 Physical Resources (Lewis & Clark Lake Segment, Alt. 1)

6.7.1.1.1 Air Quality (Lewis & Clark Lake Segment, Alt. 1)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 1 has not been calculated. However, this alternative represents the largest area of ESH to construct in the Lewis & Clark Lake Segment, and the emissions from equipment operation (direct effects) would be the greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006), no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 1 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and

other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.1.1.2 Aesthetics (Lewis & Clark Lake Segment, Alt. 1)

Potential aesthetic impacts from implementing Alternative 1, including temporary and long-term visual changes, would be considerable because of the magnitude of annual construction. In order to create the 1,360 acres of ESH within the 10-year project timeframe, there would be 797 of days of dredge work annually, and the operation would be accomplished by a large number of dredges working simultaneously throughout the segment. Changes to vistas would be noticeable, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape. The long-term visual impacts resulting from the actions necessary for the eventual annual replacement of 680 acres of ESH would be moderate, as the resulting barren ESH would contrast many sandbars, which are usually heavily vegetated in the upper reach of the Lewis & Clark Lake pool.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the extension to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-22), the magnitude of construction and the MNRR status could indicate high effects on aesthetics.

6.7.1.2 Water Resources (Lewis & Clark Lake Segment, Alt. 1)

6.7.1.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Alt. 1)

The potential effect to Lewis and Clark Lake was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Figure 6-1 is a screen-capture example of the analysis of a river reach described in Appendix B.

Because construction activities for Alternative 1 could occur within the "available" area (2,594 acres needed vs. 4,711 acres "available") the risk of significant effects to the backwater and pool hydraulics would be low (see Sections 4.5 and 4.6; Table 4-22).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels. For all projects, designs would be developed so as to not significantly alter the conveyance capacity of the lake's inflows.

6.7.1.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Alt. 1)

Because the 1,360 acres of ESH required under Alternative 1 could be constructed within the "available" area (2,594 acres needed vs. 4,711 acres "available"), the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-22).

However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 1, it is estimated approximately 4.0 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Lewis & Clarke Lake Segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Possible effects of this alternative include impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.1.2.3 Water Quality (Lewis & Clark Lake Segment, Alt. 1)

The following activity, necessary to construct and maintain the 1,360 acres of ESH under Alternative 1 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

Annually dredging and placing of 4 million CY of sand and sediments to ultimately create and retain 1,360 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that utilizing material from the lake bottom for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges and the substrate contains a much smaller particle size and more organic content, a measurable deterioration in water quality could occur. Overall, a moderate risk of significant effects to the 37 water supply intakes located on Lewis and Clark Lake, including 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes is possible.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects.

6.7.1.3 Biological Resources (Lewis & Clark Lake Segment, Alt. 1)

6.7.1.3.1 Vegetation (Lewis & Clark Lake Segment, Alt. 1)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 567 acres of herb/shrub/sapling (62% of this vegetation class) and 7 acres of forest (3% of this vegetation class) in the Lewis and Clark Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.1.3.2 Wetlands (Lewis & Clark Lake Segment, Alt. 1)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 1 occurs within the “available” area (2,594 acres needed vs. 4,711 acres “available”), construction of this alternative would likely not result in a direct significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

However, the indirect effects to wetlands from annually constructing the 1,360 acres would likely result in significant effects. The extent of dredging required annually to attain and retain the requisite number of acres (3.9 million cubic yards) would suspend large quantities of silt and sediment throughout the segment beginning in mid September. This annual suspension of silt would affect the last 2-3 months of the growing season by inhibiting photosynthesis. This chronic (i.e., annual) reduction in primary productivity for plankton as well as hydrophytes and vascular plants could diminish the vigor of existing wetlands and submerged aquatic vegetation leading to changes in species abundance and diversity over time. These changes could lead to greater success for invasive species such as purple loosestrife and reed canary grass.

6.7.1.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Alt. 1)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 2,594 acres of river bottom habitat, representing 15% of the entire high-bank to high-bank habitat, to construct Alternative 1 could create significant effects to fish and wildlife in this wetlands-dominated segment. This segment is particularly biologically rich because so much of the habitat is wetlands. However, site selection and pre-construction site evaluations would identify areas to be avoided, minimizing the potential effects, and construction activities could occur within the available area defined after removing the sensitive areas (see Sections 4.5 and 4.6; Table 4-22).

Ultimately replacing the habitat lost to subsidence, succession, and erosion would annually require the replacement of approximately 680 acres of habitat directly affecting 1,297 acres, representing approximately 8% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) appears to be feasible for Alternative 1 in the Lewis & Clark Lake Segment.

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.1.3.2) would predictably lead to decline in the forage base as well as the habitat quality for fish and wildlife. Over time, these changes could be significant.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the

surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the Recreational River's 39-Mile District, in this case fish and wildlife, could be affected by the extension to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the alternative could be built within the "available" area (see Sections 4.5 and 4.6; Table 4-22), because of potential indirect effects to the MNRR, Alternative 1, with the largest amount of acres required in the Lewis and Clark Lake Segment, could cause significant effects to fish and wildlife.

6.7.1.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 1)

As described in Section 5.3, the Lewis & Clark Lake Segment has four federally listed species that could be affected by implementing Alternative 1. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 1 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be moderate risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some reaches still exhibit a natural channel configuration of sandbars, side channels, and varied depths Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, risks moderate construction-related effects to the endangered pallid sturgeon.

6.7.1.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 1)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of such a large area of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.1.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Alt. 1)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 1,360 acres of ESH under Alternative 1, 340 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 1,360 acres of ESH in the Lewis & Clark Lake Segment under Alternative 1. The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 119 piping plover nests and 195 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Lewis & Clark Lake Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis and Clark Lake goal.[26] The effect on the least tern and piping plover from constructing and maintaining 1,360 acres of ESH in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.7.1.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Alt. 1)

6.7.1.4.1 Recreation (Lewis & Clark Lake Segment, Alt. 1)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available for construction each fall in the Lewis & Clark Lake Segment. Annual construction would require 11 dredges operating for a combined 797 days each autumn to complete the work within the 77 days.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River and Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al., 2001). At 24 hours a day for 77 days. the construction within the Lewis & Clark Lake Segment would create significant recreation conflicts for waterfowl hunters and other recreationists. The intensity (i.e., magnitude) of construction required for building Alternative 1 would predictably lead to significant effects to visitation and recreation enjoyment, including impaired access to hunting and fishing sites, degradation of habitat that results in lower harvest rates for hunters and anglers, disturbance from noise to recreationists (including bird watchers as well as hunters and anglers) and to waterfowl, and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.7.1.4.2 Noise (Lewis & Clark Lake Segment, Alt. 1)

Alternative 1 represents the largest area of ESH to be created in the Lewis & Clark Lake Segment. Construction of 680 acres of ESH annually would require dredges and other miscellaneous equipment continuously operating (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. This would likely lead to significant construction-related noise effects.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the Recreational River's 39-Mile District could be affected, in this case recreation, by the extension to construction required downriver. The NPS'

[26] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.2 Alternative 2 (Lewis & Clark Lake Segment)

As explained in Section 4.5, the Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 680 acres of interchannel sandbar necessary for Alternative 2 would disturb 1,297acres of river bottom habitat. Construction activities could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a nearly static water surface elevation; therefore, all of the habitat must be constructed with dredges.

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2005 within approximately 10 years. Erosion (assumed rate of 50 percent per year) would ultimately require the continual replacement of approximately 340 acres of habitat each and every year. Annual construction would require 398 days of dredge operation that could be accomplished with 6 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 649 acres, moving over 1.9 million cubic yards of material.

The Lewis & Clark Lake Segment begins at approximately the end of the MNRR's 39-Mile District and, therefore, considers only the indirect effects to the ORVs of the 39-Mile District.

6.7.2.1 Physical Resources (Lewis & Clark Lake Segment, Alt. 2)

6.7.2.1.1 Air Quality (Lewis & Clark Lake Segment, Alt. 2)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 2 has not been calculated. However, this alternative represents the second largest area of ESH to construct in the Lewis & Clark Lake Segment, and the emissions from equipment operation (direct effects) would be the second greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 2 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.2.1.2 Aesthetics (Lewis & Clark Lake Segment, Alt. 2)

Potential aesthetic impacts from implementing Alternative 2, including temporary and long-term visual changes, would be considerable because of the magnitude of annual construction. In order to create the 680 acres of ESH, annually there would be 398 days of dredge operation that would be accomplished by a large number of dredges working simultaneously throughout the segment. Changes to vistas would be noticeable, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual replacement of 340 acres of ESH would be moderate, as the resulting barren ESH would contrast many sandbars, which are usually heavily vegetated in the upper reach of the Lewis & Clark Lake pool.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-22), the magnitude of construction and indirect effects to the MNRR could indicate moderate effects on aesthetics.

6.7.2.2 Water Resources (Lewis & Clark Lake Segment, Alt. 2)

6.7.2.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Alt. 2)

The potential effect to the Lewis and Clark Lake hydraulics (e.g., changes in the currents in the nearby channels among the sediments and any increased velocities that may induce erosion of these deposits) was assessed in the GIS analysis described in Appendix B. Because construction activities for Alternative 2 could occur within the "available" area in the Lewis & Clark Lake Segment (1,297 acres needed vs. 4,711 acres "available"), activities would be unlikely to encroach into the cross-sectional area of the river, and the risk of significant effects to the backwater and pool hydraulics would be low (see Sections 4.5 and 4.6; Table 4-22).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.7.2.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Alt. 2)

The 680 acres of ESH required under Alternative 2 could be constructed using 8% of the high-bank to high-bank habitat and only 28% of the "available" area (1,297 acres needed vs. 4,711 acres "available"), indicating the impact to surrounding area resources would be anticipated to be low (see Sections 4.5 and 4.6; Table 4-22).

However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 2, it is estimated approximately 1.9 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Lewis and Clarke Lake segment. Estimates indicate that this could be a moderate amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Possible effects of this alternative include impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of inducing significant effects on aggradation, degradation, and erosion within the segment is likely to be moderate. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.2.2.3 Water Quality (Lewis & Clark Lake Segment, Alt. 2)

The following activity, necessary to construct the 680 acres of ESH under Alternative 2 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

Annually dredging and placing of over 1.9 million CY of sand and sediments to ultimately create and retain 680 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that utilizing material from the lake bottom for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges and the substrate contains a much smaller particle size and more organic content, a measurable deterioration in water quality could occur. The overall risk to the 37 water supply intakes located on Lewis and Clark Lake, including 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes, is unknown.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler’s Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Effects on water quality are anticipated to be moderate.

6.7.2.3 Biological Resources (Lewis & Clark Lake Segment, Alt. 2)

6.7.2.3.1 Vegetation (Lewis & Clark Lake Segment, Alt. 2)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 567 acres of herb/shrub/sapling (62% of this vegetation class) and 7 acres of forest (3% of this vegetation class) in the Lewis and Clark Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.2.3.2 Wetlands (Lewis & Clark Lake Segment, Alt. 2)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included avoiding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because Alternative 2 could be constructed within the "available" area (1,297 acres needed vs. 4,711 acres "available"), this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

However, the indirect effects to wetlands from constructing the 340 acres would likely result in moderate effects. The extent of dredging required annually creating and/or replacing the requisite number of acres (1.9 million cubic yards) would suspend large quantities of silt and sediment throughout the segment beginning in mid September. This annual suspension of silt would affect the last 2-3 months of the growing season by inhibiting photosynthesis. This chronic (i.e., annual) reduction in primary productivity for plankton as well as hydrophytes and vascular plants could diminish the vigor of existing wetlands and submerged aquatic vegetation, leading to changes in species abundance and diversity over time. These changes could lead to greater success for invasive species such as purple loosestrife and canary grass.

6.7.2.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Alt. 2)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 1,233 acres of river bottom habitat, representing 8% of the entire high-bank to high-bank habitat, to construct Alternative 2 could create moderate effects to fish and wildlife in this wetlands-dominated and biologically diverse segment. This segment is particularly biologically rich because so much of the habitat is wetlands. Site selection and pre-construction site evaluations would identify areas to be avoided, and construction activities would occur within the "available" area defined after removing the sensitive areas (see Sections 4.5 and 4.6; Table 4-22).

Constructing the habitat lost to subsidence, succession, and erosion would annually require the replacement of approximately 340 acres of habitat annually, directly affecting 649 acres, representing approximately 4% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) appears to be feasible for Alternative 2 in the Lewis & Clark Lake Segment.

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.2.3.2) would predictably lead to decline in the forage base and the habitat quality for fish and wildlife. Over time, these changes could be moderate.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques, found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was position placed in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use.

Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case fish and wildlife, could be affected by the extension to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the alternative could be built within the "available area," because of the indirect effects to the MNRR, Alternative 2 could cause moderate effects to fish and wildlife in the Lewis and Clark Lake Segment.

6.7.2.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 2)

As described in Section 5.3, the Lewis and Clark Lake has four federally listed species that could be affected by implementing Alternative 2. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 2 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be moderate risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, would risk moderate construction-related effects to the endangered pallid sturgeon.

6.7.2.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 2)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of such a large area of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.2.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Alt. 2)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 680 acres of ESH under Alternative 2, 170 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 680 acres of ESH in the Lewis & Clark Lake Segment under Alternative 2. The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 119 piping plover nests and 195 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Lewis & Clark Lake Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis & Clark Lake Segment goal.[27] The effect on the least tern and piping plover from constructing 680 acres of ESH in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.7.2.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Alt. 2)

6.7.2.4.1 Recreation (Lewis & Clark Lake Segment, Alt. 2)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day; 7 days a week during the entire 77-day period available each fall in the Lewis & Clark Lake Segment. Annual construction would require at least 6 dredges operating for a combined 398 days each autumn to complete the work within the 77 days.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally-significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River to Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al, 2001). The seven-day, 24-hour a day annual construction within the Lewis & Clark Lake Segment would create significant recreation conflicts for waterfowl hunters and other recreationists. The intensity (i.e., magnitude) of construction required for building Alternative 2, would predictably lead to significant effects to visitation and recreation enjoyment, including impaired access to hunting and fishing sites; degradation of habitat that results in lower harvest rates to hunters and anglers, disturbance from noise to recreationists (including bird watchers as well as hunters and anglers) and to waterfowl, and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.7.2.4.2 Noise (Lewis & Clark Lake Segment, Alt. 2)

Alternative 2 represents the second largest area of ESH to be constructed in the Lewis & Clark Lake Segment. Construction of 340 acres of ESH would require dredges and other miscellaneous equipment continuously operating (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. This would likely lead to significant construction-related noise effects.

[27] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

The environmental context for the consideration of noise effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District could be affected, in this case recreation, by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.3 Alternative 3 (Lewis & Clark Lake Segment)

The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 566 acres of interchannel sandbar necessary for Alternative 3 would disturb 1,080 acres of river bottom habitat, and construction activities would occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a nearly static water surface elevation; therefore, all of the habitat must be constructed with dredges.

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternative 3 goals based on the 1998 quantities, within approximately 10 years. Erosion (assumed rate of 50 percent per year) would ultimately require the continual replacement of approximately 283 acres of habitat each and every year. Annual construction would require 332 days of dredge operation that could be accomplished with 5 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 540 acres, moving over 1.6 million cubic yards of material.

The Lewis & Clark Lake Segment begins at approximately the end of the MNRR's 39-Mile District and, therefore, considers only the indirect effects to the ORVs of the 39-Mile District.

6.7.3.1 Physical Resources (Lewis & Clark Lake Segment, Alt. 3)

6.7.3.1.1 Air Quality (Lewis & Clark Lake Segment, Alt. 3)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3 has not been calculated. However, this alternative represents the third largest area of ESH to construct in the Lewis & Clark Lake Segment and the emissions from equipment operation (direct effects) would be the third greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006), no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.3.1.2 Aesthetics (Lewis & Clark Lake Segment, Alt. 3)

Potential aesthetic impacts from implementing Alternative 3, including temporary and long-term visual changes, would be moderate because of the magnitude of annual construction. In order to create the 566 acres of ESH, annually there would be 332 of days of dredge operation that would be accomplished by a large number of dredges working simultaneously throughout the segment. Changes to vistas would be noticeable, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual construction of 283 acres of ESH would be moderate.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-22), the magnitude of construction and indirect effects to the MNRR could indicate moderate effects on aesthetics.

6.7.3.2 Water Resources (Lewis & Clark Lake Segment, Alt. 3)

6.7.3.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Alt. 3)

The potential effect to Lewis & Clark Lake was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to lake level include impacts to channels among the sediment deposits at the headwaters of the lake. Figure 6-1 is a screen-capture example of a river reach analysis described in Appendix B

Because Alternative 3 would entail construction activities within the "available" area (1,080 acres needed vs. 4,711 acres "available"), activities are unlikely to encroach into the cross-sectional area of the river, and the risk of significant effects to the backwater and pool hydraulics would be low (see Sections 4.5 and 4.6; Table 4-22).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.7.3.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Alt. 3)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 3 would likely not be significant. Because the 566 acres of ESH required under Alternative 3 could be constructed within the "available" area (1,080 acres needed vs. 4,711 acres "available"), the impact to surrounding area resources is anticipated to be low using 6% of the high-bank to high-bank habitat and only 23% of the.

However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 3, it is estimated approximately 1.7 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Lewis and Clarke Lake segment. Estimates indicate that this could be a moderate amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Possible effects of this alternative include impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted, and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of inducing significant effects on aggradation, degradation, and erosion within the segment is likely to be moderate. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.3.2.3 Water Quality (Lewis & Clark Lake Segment, Alt. 3)

The following activity, necessary to create the 566 acres of ESH under Alternative 3 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging and placing of over 1.6 million CY of sand and sediments to ultimately create and retain 566 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that utilizing coarser, "sandy" material from lake bottom for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges and the substrate contains a much smaller particle size and more organic content, a measurable deterioration in water quality could occur. The overall risk to the 37 water supply intakes located on Lewis and Clark Lake, including 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes is unknown.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence best management practices during construction should minimize the risk of unintended water quality effects. Impacts to water quality are anticipated to be moderate.

6.7.3.3 Biological Resources (Lewis & Clark Lake Segment, Alt. 3)

6.7.3.3.1 Vegetation (Lewis & Clark Lake Segment, Alt. 3)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 566 acres of herb/shrub/sapling (62% of this vegetation class) and 0 acres of forest in the Lewis and Clark Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.3.3.2 Wetlands (Lewis & Clark Lake Segment, Alt. 3)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included avoiding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because construction activities of Alternative 3 could occur within the “available” area (1,080 acres needed vs. 4,711 acres “available”), construction of this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

However, the indirect effects to wetlands from annually replacing the 283 acres would likely result in moderate effects. The extent of dredging required annually to construct the requisite number of acres (1.6 million cubic yards) would suspend large quantities of silt and sediment throughout the segment beginning in mid September. This annual suspension of silt would affect the last 2-3 months of the growing season by inhibiting photosynthesis. This chronic (i.e., annual) reduction in primary productivity for plankton as well as hydrophytes and vascular plants could diminish the vigor or existing wetlands and submerged aquatic vegetation leading to changes in species abundance and diversity over time. These changes could lead to greater success for invasive species such as purple loosestrife and canary grass.

6.7.3.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Alt. 3)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 1,080 acres of river bottom habitat, representing 6% of the entire high-bank to high-bank habitat, to construct Alternative 3 could create moderate effects to fish and wildlife in this wetlands-dominated and biologically diverse segment. Site selection and pre-construction site evaluations would identify areas to be avoided, but construction activities could occur within the available area (see Sections 4.5 and 4.6; Table 4-22).

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.3.3.2) would predictably lead to a moderate decline in the forage base as well as the habitat quality for fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon did show some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case fish and wildlife, could be affected by the extension to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the alternative could be built within the "available area," because of the indirect effects to the MNRR, Alternative 3 could cause moderate effects to fish and wildlife in the Lewis and Clark Lake Segment.

6.7.3.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 3)

As described in Section 5.3, the Lewis & Clark Lake Segment has four federally listed species that could be affected by implementing Alternative 3. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be moderate risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to

Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, would risk moderate construction-related effects to the endangered pallid sturgeon.

6.7.3.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 3)

The SDGFP have indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of such a large area of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.3.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Alt. 3)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 566 acres of ESH under Alternative 3, 141 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 566 acres of ESH in the Lewis & Clark Lake Segment under Alternative 3. The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 119 piping plover nests and 195 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Lewis & Clark Lake Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis

& Clark Lake Segment goal.[28] The effect on the least tern and piping plover from creating 566 acres of ESH in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.7.3.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Alt. 3)

6.7.3.4.1 Recreation (Lewis & Clark Lake Segment, Alt. 3)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available each fall in the Lewis & Clark Lake Segment. Annual construction would require at least 5 dredges operating for a combined 332 days each autumn to complete the work within the 77 days.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River to Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al, 2001). The seven-day, 24-hour a day annual construction within the Lewis & Clark Lake Segment would create significant recreation conflicts for waterfowl hunters and other recreationists. The intensity (i.e., magnitude) of construction required for building Alternative 3, would predictably lead to significant effects to visitation and recreation enjoyment , including: impaired access to hunting and fishing sites; degradation of habitat that results in lower harvest rates for hunters and anglers; disturbance from noise to recreationists (including bird watchers as well as hunters and anglers) and to waterfowl; and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.7.3.4.2 Noise (Lewis & Clark Lake Segment, Alt. 3)

Alternative 3 represents the third largest area of ESH to be constructed in the Lewis & Clark Lake Segment. Annual construction of 283 acres of ESH would require dredges and other miscellaneous equipment continuously operating (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. This would likely lead to significant construction-related noise effects.

The environmental context for the consideration of noise effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR’s 39-Mile District could be affected, in this case recreation, by the extent of construction required just downriver. The NPS’ mandate

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[28] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.4 Alternative 3.5 - Impact Level Identified with AMIP Preferred Alternative (Lewis & Clark Lake Segment)

The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 354 acres of interchannel sandbar necessary for Alternative 3.5 would disturb 675 acres of river bottom habitat, and construction activities could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a nearly static water surface elevation; therefore, all of the habitat must be constructed with dredges.

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternative 3.5 goals, set from the average of 1998 and 2005 values, within approximately 10 years. Erosion (assumed rate of 50 percent per year) would require ultimately the continual replacement of approximately 177 acres of habitat each and every year. Annual construction would require 207 days of dredge operation that could be accomplished with 3 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 338 acres, moving over 1 million cubic yards of material.

The Lewis & Clark Lake Segment begins at the end of the MNRR's 39-Mile District and,, therefore, only the indirect effects to the ORVs of the 39-Mile District are considered.

6.7.4.1 Physical Resources (Lewis & Clark Lake Segment, Alt. 3.5)

6.7.4.1.1 Air Quality (Lewis & Clark Lake Segment, Alt. 3.5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3.5 has not been calculated. However, this alternative represents the fourth largest area of ESH to construct in the Lewis & Clark Lake Segment and the emissions from equipment operation (direct effects) would be the greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006), and no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3.5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.4.1.2 Aesthetics (Lewis & Clark Lake Segment, Alt. 3.5)

Potential aesthetic impacts from implementing Alternative 3.5, including temporary and long-term visual changes, would be moderate because of the magnitude of annual construction. In order to create the 354 acres of ESH, annually there would be 207 days of dredge operation that would be accomplished by a large number of dredges working simultaneously throughout the segment. Changes to vistas would be noticeable, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual construction of 177 acres of ESH would also be would be moderate, as the resulting barren ESH would contrast many sandbars, which are usually heavily vegetated in the upper reach of the Lewis & Clark Lake pool.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Although the "available area" is not exceeded (see Sections 4.5 and 4.6; Table 4-22), the magnitude of construction and the indirect effects on the MNRR could indicate moderate effects on aesthetics.

6.7.4.2 Water Resources (Lewis & Clark Lake Segment, Alt. 3.5)

6.7.4.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Alt. 3.5)

The potential effect to Lewis and Clark Lake was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Figure 6-1 is a screen-capture example of the analysis of a river reach described in Appendix B.

Because construction activities for Alternative 3.5 could occur within the "available" area (675 acres needed vs. 4,711 acres "available"), and would not be likely to encroach into the cross-sectional area, the risk of significant effects to the backwater and pool hydraulics would be low (see Sections 4.5 and 4.6; Table 4-22).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.7.4.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Alt. 3.5)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 3.5 would likely not be significant. Because the 354 acres of ESH required under Alternative 3.5 could be constructed within the “available” area (675 acres disturbed vs. 4,711 acres “available”), the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-22).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For alternative 3.5, it is estimated approximately 1.0 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Lewis and Clarke Lake segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100’ and dredging depth restricted to a maximum 4’ not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300’ to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.4.2.3 Water Quality (Lewis & Clark Lake Segment, Alt. 3.5)

The following activity, necessary to create the 354 acres of ESH under Alternative 3.5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

Annually dredging and placing of over 1 million CY of sand and sediments to ultimately create 354 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges, and the substrate contains a much smaller particle size and more organic content, a measurable deterioration in water quality could occur. The overall risk to the 37 water supply intakes located on Lewis and Clark Lake, including 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes is unknown.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Impacts are anticipated to be low.

6.7.4.3 Biological Resources (Lewis & Clark Lake Segment, Alt. 3.5)

6.7.4.3.1 Vegetation (Lewis & Clark Lake Segment, Alt. 3.5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 354 acres of herb/shrub/sapling (39% of this vegetation class) and 0 acres of forest in the Lewis and Clark Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.4.3.2 Wetlands (Lewis & Clark Lake Segment, Alt. 3.5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included avoiding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 3.5 is within the “available” area available (675 acres disturbed vs. 4,711 acres “available”), construction of this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

Indirect effects to wetlands from annually constructing the 177 acres would also likely not be significant. The extent of dredging required annually creating and/or replacing the requisite number of acres (1million CY) would locally suspend some quantities of silt and sediment immediately around and downstream from construction sites beginning in mid September. This annual suspension of silt may affect the last 2-3 months of the growing season by inhibiting photosynthesis. This reduction in primary productivity for plankton as well as hydrophytes and vascular plants may diminish the vigor or existing wetlands and submerged aquatic vegetation leading to changes in species abundance and diversity temporarily.

6.7.4.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Alt. 3.5)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 675 acres of river bottom habitat, representing 4% of the entire high-bank to high-bank habitat, to construct Alternative 3.5 could temporarily affect to fish and wildlife in this wetlands-dominated and biologically diverse segment. This segment is particularly biologically rich because so much of the habitat is wetlands. Site selection and pre-construction site evaluations would identify areas to be avoided, but construction could occur within the available area (see Sections 4.5 and 4.6; Table 4-22).

Replacing the habitat lost to subsidence, succession, and erosion would annually require the construction of approximately 177 acres of habitat directly affecting 338 acres, representing approximately 2% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) appears to be feasible for Alternative 3.5 in the Lewis & Clark Lake Segment.

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.4.3.2) would predictably lead to a temporary decline in the forage base as well as the habitat quality for fish and wildlife. Over time, these changes are anticipated to be low.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case fish and wildlife, could be affected by the construction recommended just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Construction of this alternative would be anticipated to cause only minimal effects to fish and wildlife.

6.7.4.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 3.5)

As described in Section 5.3, the Lewis & Clark Lake has four federally listed species that could be affected by implementing Alternative 3.5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3.5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be low risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation and maintenance. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area and within the "available area," would risk low construction-related effects to the endangered pallid sturgeon.

6.7.4.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 3.5)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of large areas of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.4.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Alt. 3.5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 354 acres of ESH under Alternative 3.5, 89 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 566 acres of ESH in the Lewis & Clark Lake Segment under Alternative 3.5. The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 525 piping plover nests and 792 least tern nests over the entire 7-year period.

The Recovery Plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis & Clark Lake Segment goal.[29] The effect on the least tern and piping plover from creating 354 acres of ESH in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.7.4.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Alt. 3.5)

6.7.4.4.1 Recreation (Lewis & Clark Lake Segment, Alt. 3.5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day; 7 days a week during the entire 77-day period available each fall in the Lewis & Clark Lake Segment. Annual construction would require 3 dredges operating for a combined 207 days each autumn to complete the work within the 77 days.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River to Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al, 2001). The 7-day, 24-hour a day annual construction within the Lewis & Clark Lake Segment may create significant recreation conflicts for waterfowl hunters and other recreationists. The relatively low intensity (i.e., magnitude) of construction required for building Alternative 3.5, may lead to localized significant effects to visitation and recreation enjoyment, and lead to moderate effects on visitation and recreation enjoyment.

6.7.4.4.2 Noise (Lewis & Clark Lake Segment, Alt. 3.5)

Alternative 3.5 represents the fourth largest area of ESH to be constructed in the Lewis & Clark Lake Segment. Creation of 354 acres of ESH would require dredges to be continuously operating (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. Only dredges (not mechanical equipment) would be used in Lewis and Clark Lake due to reservoir nature of the segment. This would likely lead to moderate construction-related noise effects.

The environmental context for the consideration of noise effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District could be affected, in

[29] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

this case recreation, by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.5 Alternative 4 (Lewis & Clark Lake Segment)

The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining the 142 acres of interchannel sandbar necessary for Alternative 4 would disturb 271 acres of river bottom habitat, and could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a nearly static water surface elevation; therefore, all of the habitat must be constructed with dredges.

Erosion of the ESH available in 2005 would require the annual replacement of approximately 71 acres of habitat (50 percent annual loss rate). This annual construction would require 83 days of dredge operation that could be accomplished with 2 dredges operating for much of the period to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 135 acres, moving over 415,000 cubic yards of material.

The Lewis & Clark Lake Segment begins at approximately the end of the MNRR's 39-Mile District and, therefore, considers only the indirect effects to the ORVs of the 39-Mile District.

6.7.5.1 Physical Resources (Lewis & Clark Lake Segment, Alt. 4)

6.7.5.1.1 Air Quality (Lewis & Clark Lake Segment, Alt. 4)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 4 has not been calculated. However, this alternative represents one of the smallest areas of ESH to construct in the Lewis & Clark Lake Segment and the emissions from equipment operation (direct effects) would be the relatively smaller than Alternatives 1-3.5. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 4 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.5.1.2 Aesthetics (Lewis & Clark Lake Segment, Alt. 4)

Potential aesthetic impacts from implementing Alternative 4, including temporary and long-term visual changes, would be low because of the relatively lesser magnitude of annual construction. In order to retain the 142 acres of ESH, two dredges working simultaneously within the segment annually would accomplish 83 of days of dredge operation. Changes to vistas would be noticeable, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual replacement of 71 acres of ESH would be minimal.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the extension to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.5.2 Water Resources (Lewis & Clark Lake Segment, Alt. 4)

6.7.5.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Alt. 4)

The potential effect to Lewis and Clark Lake was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Figure 6-1 is a screen-capture example of the analysis of a river reach described in Appendix B.

Because construction activities of could occur within the "available" area for Alternative 4 in the Lewis & Clark Lake Segment (271 acres needed vs. 4,711 acres "available") (see Sections 4.5 and 4.6; Table 4-22), and activities would not be likely to encroach into the cross-sectional area, the risk of significant effects to the backwater and pool hydraulics would be low (see Sections 4.5 and 4.6; Table 4-22).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.7.5.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Alt. 4)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 4 would likely not be significant. Because the 142 acres of ESH required under Alternative 4 could be constructed within the "available" area (271 acres needed vs. 4,711 acres "available"), the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-22).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.5.2.3 Water Quality (Lewis & Clark Lake Segment, Alt. 4)

The following activity, necessary to construct the 142 acres of ESH under Alternative 4 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging and placing of over 415,000 CY of sand and sediments to retain 142 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen, and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally utilizing coarser, "sandy" material from the lake bottom for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges, and the substrate contains a much smaller particle size and more organic content, a localized deterioration in water quality could occur. The overall risk to the 37 water supply intakes located on Lewis and Clark Lake, including 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes is unknown.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence best management practices during construction should minimize the risk of unintended water quality effects. Impacts would be anticipated to be low.

6.7.5.3 Biological Resources (Lewis & Clark Lake Segment, Alt. 4)

6.7.5.3.1 Vegetation (Lewis & Clark Lake Segment, Alt. 4)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 142 acres of herb/shrub/sapling (15% of this vegetation class) and 0 acres of forest in the Lewis and Clark Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.5.3.2 Wetlands (Lewis & Clark Lake Segment, Alt. 4)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included avoiding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because construction activities for Alternative 4 could occur within the "available" area (271 acres needed vs. 4,711 acres "available"), construction of this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

Because of the smaller scale of this alternative, the indirect effects to wetlands from annually retaining the 142 acres would not likely result in significant effects. The extent of dredging required annually constructing the requisite number of acres (415,000 cubic yards) would suspend silt and sediment in proximity to the construction sites, but on a much smaller scale than for Alternatives 1-3.5. This reduction in primary productivity for plankton as well as hydrophytes and vascular plants could temporarily diminish the vigor or existing wetlands and submerged aquatic vegetation near construction sites, but would not be at a scale that would likely lead to segment-wide changes in species abundance or diversity over time.

6.7.5.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Alt. 4)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 271 acres of river bottom habitat, representing 1.6% of the entire high-bank to high-bank habitat, to construct Alternative 4 would likely not create significant effects to fish and wildlife in this wetlands-dominated and biologically diverse segment. Site selection and pre-construction site evaluations would identify areas to be avoided, and construction could occur within the available area (see Sections 4.5 and 4.6; Table 4-22).

Replacing the habitat lost to subsidence, succession, and erosion would annually require the construction of approximately 71 acres of habitat directly affecting 135 acres, representing approximately 1% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) appears to be feasible for Alternative 4 in the Lewis & Clark Lake Segment.

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.5.3.3) would be substantially less than for Alternatives 1-3.5 and would not be likely to cause a significant decline in the forage base or the habitat quality for fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data."

(Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case fish and wildlife, could be affected by the extension to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Construction of Alternative 4 would not pose significant effects to fish and wildlife.

6.7.5.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 4)

As described in Section 5.3, the Lewis & Clark Lake Segment has four federally listed species that could be affected by implementing Alternative 4. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 4 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there could be minimal risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, risks minimal construction-related effects to the endangered pallid sturgeon.

6.7.5.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 4)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of such a large area of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The Nebraska Game and Parks Commission (NGPC) identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.5.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Alt. 4)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 142 acres of ESH under Alternative 4, 35 acres of nesting habitat would be retained (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 142 acres of ESH in the Lewis & Clark Lake Segment under Alternative 4 The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 119 piping plover nests and 195 least tern nests over the entire 7-year period.

The recovery plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis & Clark Lake Segment goal.[30] The effect on the least tern and piping plover from retaining 142 acres of ESH in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

[30] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

6.7.5.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Alt. 4)

6.7.5.4.1 Recreation (Lewis & Clark Lake Segment, Alt. 4)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during much of the 77-day period available each fall in the Lewis & Clark Lake Segment. Construction would require at least 2 dredges operating for a combined total of 83 days each autumn to complete the work within the 77 days.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River to Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al, 2001). The 7-day, 24-hour a day annual construction within the Lewis & Clark Lake Segment would create significant recreation conflicts for waterfowl hunters and other recreationists. The intensity (i.e., magnitude) of construction required for building Alternative 4, would predictably lead to locally significant effects to visitation and recreation enjoyment. Access to some hunting and fishing sites may be impaired. However, because only two dredges would be operating, alternative sites would probably be available where noise was far enough away to not disturb waterfowl and the habitat was not degraded enough to significantly reduce harvest rates for hunters and anglers. Effects to visitation and recreation enjoyment are anticipated to be low.

6.7.5.4.2 Noise (Lewis & Clark Lake Segment, Alt. 4)

Alternative 4 represents a markedly smaller area of ESH to be constructed in the Lewis & Clark Lake Segment. Retention of the 142 acres of ESH would still require dredges and other miscellaneous equipment continuously operating (24 hours a day - 7 days a week) for much of the 77-day period available for construction every year. This would likely lead to minimal construction-related noise effects.

The environmental context for the consideration of noise effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District could be affected, in this case recreation, by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. The effects from noise are anticipated to be low.

6.7.6 Alternative 5 (Lewis & Clark Lake Segment)

The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining the 80 acres of interchannel sandbar necessary for Alternative 5 would disturb 153 acres of river bottom habitat, and construction activities would occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a nearly static water surface elevation); therefore, all of the habitat must be constructed with dredges.

Erosion (assumed rate of 50 percent per year) would require the continual replacement of approximately 40 acres of habitat each and every year. This annual construction would require 47 days of dredge operation that could be accomplished with 1 dredge each autumn. Annual construction would disturb 76 acres, moving over 234,000 cubic yards of material.

The Lewis & Clark Lake Segment begins at near the end of the MNRR's 39-Mile District. Therefore, only the indirect effects to the ORVs of the 39-Mile District are considered.

6.7.6.1 Physical Resources (Lewis & Clark Lake Segment, Alt. 5)

6.7.6.1.1 Air Quality (Lewis & Clark Lake Segment, Alt. 5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 5 has not been calculated. However, this alternative represents the largest area of ESH to construct in the Lewis & Clark Lake Segment and the emissions from equipment operation (direct effects) would be the greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage, and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.6.1.2 Aesthetics (Lewis & Clark Lake Segment, Alt. 5)

Potential aesthetic impacts from implementing Alternative 5, including temporary and long-term visual changes, would be slight because of the relatively lesser magnitude of initial and annual construction. In order to create the 80 acres of ESH, one dredge would be required annually within the segment to accomplish the 47 days of dredge operation. Changes to vistas would be limited, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape, but on a much smaller scale. The long-term visual impacts resulting from the actions necessary for the annual replacement of 40 acres of ESH would not be aesthetically significant.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the limited extend of construction if the site being built was within the line of sight of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.6.2 Water Resources (Lewis & Clark Lake Segment, Alt. 5)

6.7.6.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Alt. 5)

The potential effect to Lewis and Clark Lake was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Figure 6-1 is a screen-capture example of the analysis of a river reach described in Appendix B.

Because the area of ESH for Alternative 5 is substantially less than the "available" area (see Sections 4.5 and 4.6; Table 4-22), which excludes the thalweg and high-energy flows identified, (153 acres needed vs. 4,711 acres "available") in the Lewis & Clark Lake Segment, constructing Alternative 5 would not be likely to encroach into the available cross-sectional area and would not risk significant effects to the backwater and pool hydraulics.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.7.6.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Alt. 5)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 5 would likely not be significant. Because the 80 acres of ESH required under Alternative 5 could be constructed within the "available" area (153 acres needed vs. 4,711 acres "available"), the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-22).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.6.2.3 Water Quality (Lewis & Clark Lake Segment, Alt. 5)

The following activity, necessary to retain the 80 acres of ESH under Alternative 5 would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging and placing of over 230,000 CY of sand and sediments to retain 80 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that utilizing coarser, "sandy" material from the lake bottom for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges, and the substrate contains a much smaller particle size and more organic content, a localized deterioration in water quality could occur, but the scale of construction would diminish the overall risk to the 37 water supply intakes, 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes located on Lewis and Clark Lake.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence best management practices during construction should minimize the risk of unintended water quality effects. Effects are anticipated to be low.

6.7.6.3 Biological Resources (Lewis & Clark Lake Segment, Alt. 5)

6.7.6.3.1 Vegetation (Lewis & Clark Lake Segment, Alt. 5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 80 acres of herb/shrub/sapling (9% of this vegetation class) and 0 acres of forest in the Lewis and Clark Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.6.3.2 Wetlands (Lewis & Clark Lake Segment, Alt. 5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included avoiding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 5 is substantially less than the "available" area (153 acres needed vs. 4,711 acres "available"), construction of this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

Because of the smaller scale of this alternative, the indirect effects to wetlands from retaining the 80 acres would not likely result in significant effects. The extent of dredging required for annually constructing the requisite number of acres (234,320 CY) would suspend silt and sediment in proximity to the construction sites, but on a much smaller scale than for Alternatives 1-3.5. This reduction in primary productivity for plankton as well as hydrophytes and vascular plants could temporarily diminish the vigor or existing wetlands and submerged aquatic vegetation near construction sites, but would not be at a scale that would likely lead to segment-wide changes in species abundance or diversity over time.

6.7.6.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Alt. 5)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 153 acres of river bottom habitat, representing 0.9% of the entire high-bank to high-bank habitat, to construct Alternative 5 would likely not create significant effects to fish and wildlife in this wetlands-dominated and biologically diverse segment. Site selection and pre-construction site evaluations would identify areas to be avoided, and construction could occur within the available area (see Sections 4.5 and 4.6; Table 4-22).

Replacing the habitat lost to subsidence, succession, and erosion would annually require the construction of approximately 40 acres of habitat directly affecting 76 acres, representing approximately 0.4% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) appears to be feasible for Alternative 5 in the Lewis & Clark Lake Segment.

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.6.3.2) would be substantially less than for Alternatives 1-3.5 and would not be likely to cause a significant decline in the forage base or the habitat quality for fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case fish and wildlife, could be affected by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Construction of Alternative 5 in the Lewis and Clark Lake Segment would not pose significant effects to fish and wildlife.

6.7.6.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 5)

As described in Section 5.3, the Lewis & Clark Lake has four federally listed species that could be affected by implementing Alternative 5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there could be minimal risk to the remaining wild population of pallids from implementing this alternative. The Fort Randall River Segment, from 20 miles upstream of the mouth of the Niobrara River to Lewis and Clark Lake, is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Because it is substantially smaller in scale than the other action alternatives, implementing Alternative 5, with the annual burden of construction within the Recovery-Priority Area, risks minimal construction-related effects to the endangered pallid sturgeon.

6.7.6.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Alt. 5)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of such a large area of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.6.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Alt. 5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 80 acres of ESH under Alternative 5, 20 acres of nesting habitat would be retained (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 80 acres of ESH in the Lewis & Clark Lake Segment under Alternative 5. The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 119 piping plover nests and 195 least tern nests over the entire 7-year period.

The recovery plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South Dakota (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis & Clark Lake Segment goal.[31] The effect on the least tern and piping plover from retaining 80 acres of ESH in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.7.6.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Alt. 5)

6.7.6.4.1 Recreation (Lewis & Clark Lake Segment, Alt. 5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during much of the 77-day period available each fall in the Lewis & Clark Lake Segment. Construction would require at least 1 dredge operating for 47 days each autumn to complete the work within the 77 days.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River to Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al, 2001). The 7-day, 24-hour a day annual construction within the Lewis & Clark Lake Segment would create minimal recreation conflicts for waterfowl hunters and other recreationists. The intensity (i.e., magnitude) of

[31] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

construction required for building and Alternative 5, would predictably lead to temporary effects to visitation and recreation enjoyment. Access to some hunting and fishing sites would be impaired, but because only 1 or 2 dredges will be operating, alternative sites would be available where noise was too far away to disturb waterfowl and where habitat was not degraded enough to significantly reduce harvest rates for hunters and anglers. In addition, construction activities would occur for only half the fall recreational season. Therefore, after the construction equipment was removed, the ambient noise levels, viewsheds, and access to hunting and fishing sites would be restored. Effects to visitation and recreation enjoyment would be low.

6.7.6.4.2 Noise (Lewis & Clark Lake Segment, Alt. 5)

Alternative 5 represents the second smallest area of ESH to be constructed in the Lewis & Clark Lake Segment. Retention of the 80 acres of ESH would still require dredges and other miscellaneous equipment continuously operating (24 hours a day - 7 days a week) for a portion of the 77-day period available for construction the first year. This would likely lead to temporary construction-related noise effects.

The environmental context for the consideration of noise effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District could be affected, in this case recreation, by the extend to construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. The effects of noise are anticipated to be low.

6.7.7 Existing Program Alternative (Lewis & Clark Lake Segment)

The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers to the segment, 4,711 residual acres, or 27% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining the 50 acres of interchannel sandbar necessary for continuing the Existing Program would disturb 95 acres of river bottom habitat, and construction activities could occur within the "available" area (see Sections 4.5 and 4.6; Table 4-22). This segment has a nearly static water surface elevation; therefore, all of the habitat must be constructed with dredges.

Annual construction of 25 acres of ESH to continue the Existing Program in the Lewis & Clark Lake Segment would require 29 days of dredge operation (1 dredge) and would move over 146,000 cubic yards of riverbed material (146,450 cy). Construction of only 25 acres per year would result in the decline from 142 acres in 2005 to 50 acres in less than 10 years, assuming an annual loss rate of 50 percent per year.

The Lewis & Clark Lake Segment begins at approximately the end of the MNRR's 39-Mile District and therefore considers only the indirect effects to the ORVs of the 39-Mile District.

6.7.7.1 Physical Resources (Lewis & Clark Lake Segment, Existing Program)

6.7.7.1.1 Air Quality (Lewis & Clark Lake Segment, Existing Program)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with continued implementation of the Existing Program has not been calculated. However, this alternative represents the smallest area of ESH to construct in the Lewis & Clark Lake Segment and the emissions from equipment operation (direct effects) would be the least. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing the Existing Program would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.7.7.1.2 Aesthetics (Lewis & Clark Lake Segment, Existing Program)

Potential aesthetic impacts from implementing the Existing Program Alternative, including temporary and long-term visual changes, would be slight because of the relatively lesser magnitude of annual construction. In order to retain the 50 acres of ESH, one dredge within the segment would accomplish the 29 of days of dredge operation. Changes to vistas would be limited, as construction activities with landside modification for access as well as in-pool equipment operations would contrast with the Lewis & Clark Lake Segment landscape, but on a much smaller scale. The long-term visual impacts resulting from the actions necessary for the annual construction of 25 acres of ESH would not be aesthetically significant.

The environmental context for the consideration of aesthetic effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case recreation, could be affected by the limited extend of construction if the site being built was within the line of sight of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.7.2 Water Resources (Lewis & Clark Lake Segment, Existing Program)

6.7.7.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, Existing Program)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Figure 6-1 is a screen-capture example of the analysis of a river reach described in Appendix B.

Because the area of ESH for the Existing Program Alternative is substantially less than the "available" area (95 acres needed vs. 4,711 acres "available") in the Lewis & Clark Lake Segment, constructing this alternative would not be likely to encroach into the available cross-sectional area and would not risk significant effects to the backwater and pool hydraulics (see Sections 4.5 and 4.6; Table 4-22).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.7.7.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, Existing Program)

The potential effects to aggradation, degradation, and erosion from constructing the Existing Program Alternative would likely not be significant. Because the 25 acres of ESH proposed could be constructed within the "available" area (95 acres needed vs. 4,711 acres "available"), the impact to surrounding area resources is anticipated to be low (see Sections 4.5 and 4.6; Table 4-22).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For the existing program, it is estimated approximately 0.14 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Lewis and Clarke Lake segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300’ to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.7.7.2.3 Water Quality (Lewis & Clark Lake Segment, Existing Program)

The following activity, necessary to retain the 50 acres of ESH under the Existing Program Alternative would cause direct impacts from a temporary decrease in water quality in the immediate vicinity:

- Annually dredging and placing of over 146,000 CY of river bottom sand and sediments to retain 50 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a temporary, localized reduction in dissolved oxygen, and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that utilizing coarser, “sandy” material from the lake bottom for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants. Because this segment must be constructed exclusively with dredges, and the substrate contains a much smaller particle size and more organic content, a temporary, localized deterioration in water quality could occur, but the scale of construction would diminish the overall risk to the 37 water supply intakes, 2 municipal water supply facilities, 6 domestic intakes, and 2 public intakes located on Lewis and Clark Lake.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Section 401 Certification (state water quality) has been issued by the State of Nebraska for activities authorized by NWP 27. The State of South Dakota denied Section 401 certification for the construction of small nesting islands under NWP 27. If the Section 401 Certification has been denied in the state where a project will occur, or if the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable State which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence best management practices during construction should minimize the risk of unintended water quality effects. Effects on water quality are anticipated to be low.

6.7.7.3 Biological Resources (Lewis & Clark Lake Segment, Existing Program)

6.7.7.3.1 Vegetation (Lewis & Clark Lake Segment, Existing Program)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 50 acres of herb/shrub/sapling (5% of this vegetation class) and 0 acres of forest in the Lewis and Clark Segment, all within the available area (see Table 6-4; also (see Sections 4.5 and 4.6; Table 4-22). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.7.7.3.2 Wetlands (Lewis & Clark Lake Segment, Existing Program)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 8,397 acres of wetlands within the 17,157-acres of habitat from high-bank to high-bank. This represents approximately 49% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included avoiding the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct the existing program is substantially less than the "available" area (95 acres impacted vs. 4,711 acres "available"), construction of this alternative would likely not result in a significant loss to existing wetlands (see Sections 4.5 and 4.6; Table 4-22).

Because of the smaller scale of this alternative, the indirect effects to wetlands from retaining the 50 acres would not likely result in significant effects. The extent of dredging required for annually constructing the requisite number of acres (146,450 cubic yards) would suspend silt and sediment in proximity to the construction sites, but on a much smaller scale than for Alternatives 1-5. This chronic (i.e., annual) reduction in primary productivity for plankton as well as hydrophytes and vascular plants could temporarily diminish the vigor or existing wetlands and submerged aquatic vegetation near construction sites, but would not be at a scale that would likely lead to segment-wide changes in species abundance or diversity over time.

6.7.7.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, Existing Program)

The direct effects to fish and wildlife within the Lewis & Clark Lake Segment from disturbing 48 acres of river bottom habitat, representing 0.3% of the entire high-bank to high-bank habitat, to continue with the Existing Program would likely not create significant effects to fish and wildlife in this wetlands-dominated and biologically diverse segment. Site selection and pre-construction site evaluations would identify areas to be avoided, and construction would require using only 2% of the available area annually, defined after removing the sensitive areas (see Sections 4.5 and 4.6; Table 4-22).

Replacing the habitat lost to subsidence, succession, and erosion would annually require the construction of approximately 25 acres of habitat directly affecting 48 acres, representing approximately 0.3% of the high-bank to high-bank habitat. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) appears to be feasible for the Existing Program Alternative in the Lewis & Clark Lake Segment.

The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation (as described in Section 6.7.7.3.2) would be substantially less than for action Alternatives 1-5 and would not be likely to cause a significant decline in the forage base or the habitat quality for fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District, in this case fish and wildlife, could be affected by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other

ORVs. The indirect effects of the existing program would be substantially less than for action Alternatives 1-5 and would not be likely to cause a significant impacts fish and wildlife.

6.7.7.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, Existing Program)

As described in Section 5.3, the Lewis & Clark Lake has four federally-listed species that could be affected by continued implementation of the Existing Program. The potential effects to piping plover and least tern are addressed in the next section.

Effects of continued implementation of the Existing Program on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there could be minimal risk to the remaining wild population of pallids from implementing this alternative. Although substantially smaller in scale than the other action alternatives, continued implementation of the Existing Program, with the annual burden of construction, would only pose a slight risk to the endangered pallid sturgeon.

6.7.7.3.5 State Listed Species and Habitats (Lewis & Clark Lake Segment, Existing Program)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Lewis & Clark Lake Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of such a large area of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant effects.

6.7.7.3.6 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, Existing Program)

By annually constructing 25 acres of ESH under the Existing Program, 6 acres of nesting habitat would be created annually and, assuming a 50% loss rate, would provide 50 acres with 12.5 acres of nesting habitat (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 50 acres of ESH in the Lewis & Clark Lake Segment under the Existing Program. The entire dataset for the Lewis & Clark Lake Segment (2000-2006) identified 119 piping plover nests and 195 least tern nests over the entire 7-year period.

The recovery plan for the least tern (USFWS, 1990) does not establish a segment-specific recovery goal for adult least terns in the Lewis & Clark Lake Segment. However, the least tern recovery plan (USFWS, 1990) establishes a goal for 20 adults from "other Missouri River sites" and this number was assumed for the Lewis & Clark Lake Segment goal. There are also no segment-specific goals for the piping plover in the Lewis & Clark Lake Segment (USFWS, 1988). However, all of the 75 adult pairs (150 adults) associated with "other sites" in South (USFWS, 1988) (but not in the Gavins Point River Segment) were assumed for a Lewis & Clark Lake Segment goal.[32] The effect on the least tern and piping plover from constructing 25 acres of ESH annually in the Lewis & Clark Lake Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.7.7.4 Socioeconomic Resources (Lewis & Clark Lake Segment, Existing Program)

6.7.7.4.1 Recreation (Lewis & Clark Lake Segment, Existing Program)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality 24 hours a day, 7 days a week during the 29 construction days needed each fall in the Lewis & Clark Lake Segment. First time construction could be done with only one dredge (29 days) working within the segment to construct the requisite acres within the allowable period.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports a regionally significant autumnal recreation involving waterfowl hunting. In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River to Lewis & Clark Lake Segments. All of these trips took place between mid-September and early December (Mestl et al, 2001). The 7-day, 24-hour a day annual construction within the Lewis & Clark Lake Segment may create short-term localized recreation conflicts for waterfowl hunters and other recreationists. Access to some hunting and fishing sites would be impaired, but because only one dredge would be operating, alternative sites would be available where noise was too far away to disturb waterfowl and where habitat was not degraded enough to significantly reduce harvest rates for hunters and anglers. In addition, construction and maintenance activities would occur for only half the fall recreational season. Therefore, after the construction equipment was removed, the ambient noise levels, viewsheds, and access to hunting and fishing sites would be restored. The low intensity (i.e., magnitude) of construction required for continuing with the Existing Program of 25 acres annually would not lead to locally significant effects to visitation and recreation enjoyment.

[32] The same assumption was made for the Fort Randall River Segment in Section 6.4.1.3.5.

6.7.7.4.2 Noise (Lewis & Clark Lake Segment, Existing Program)

The Existing Program Alternatives represents the smallest area of ESH to be constructed in the Lewis & Clark Lake Segment. Retention of the 50 acres of ESH would still require dredges and other miscellaneous equipment continuously operating (24 hours a day - 7 days a week) for the 38% of the period available for construction the first year (29 days of the 77 days available). This would not lead to significant construction-related noise effects.

The environmental context for the consideration of noise effects in the Lewis & Clark Lake Segment must consider the potential for indirect effects to the MNRR because the segments are adjoining. The ORVs cited in establishing the MNRR's 39-Mile District could be affected, in this case recreation, by the extent of construction required just downriver. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs.

6.7.8 No Program (Lewis & Clark Lake Segment)

6.7.8.1.1 Air Quality (Lewis & Clark Lake Segment, No Program)

Under the no action alternative, potential direct and indirect air quality impacts associated with the construction of ESH in the Lewis & Clark Lake Segment would not occur and air quality would not change from existing conditions.

6.7.8.1.2 Aesthetics (Lewis & Clark Lake Segment, No Program)

Without implementation of any of the action alternatives, there would be no construction-related deterioration of visual resources or permanent changes to the visual resources of the Lewis & Clark Lake Segment; there would also be no indirect effects to the outstandingly remarkable natural values in the 39-mile portion of the MNRR.

6.7.8.2 Water Resources (Lewis & Clark Lake Segment, No Program)

6.7.8.2.1 Surface Water Hydrology and Hydraulics (Lewis & Clark Lake Segment, No Program)

Under the no action alternative, potential direct and indirect effects to surface water hydrology and hydraulics would not occur.

6.7.8.2.2 Aggradation, Degradation, and Erosion (Lewis & Clark Lake Segment, No Program)

The Lewis & Clark Lake Segment is subject to the diminished effects of the daily power-peaking surges from the Fort Randall Dam releases. Taking no action to mechanically create ESH would not risk increasing erosion or deposition rates from program implementation.

6.7.8.2.3 Water Quality (Lewis & Clark Lake Segment, No Program)

Absent the construction-related effects to water quality predicted under the action alternatives, water quality would remain unchanged from the existing conditions.

6.7.8.3 Biological Resources (Lewis & Clark Lake Segment, No Program)

6.7.8.3.1 Vegetation (Lewis & Clark Lake Segment, No Program)

Under the no action alternative, there would be no direct or indirect impacts to vegetation observed within the segment.

6.7.8.3.2 Wetlands (Lewis & Clark Lake Segment, No Program)

Under the no action alternative, there would be no direct or indirect impacts to wetland observed within the segment.

6.7.8.3.3 Fish, Invertebrates and Wildlife (Lewis & Clark Lake Segment, No Program)

Under the no action alternative, there would be no direct or indirect impacts to the fisheries and wildlife of the Lewis & Clark Lake Segment. In the absence of an ESH construction program, wildlife abundance and diversity within the segment would remain substantially unchanged.

6.7.8.3.4 Federally and State Listed Species and Habitats (Lewis & Clark Lake Segment, No Program)

Under the no action alternative, there would be no direct or indirect effects to the pallid sturgeon (*Scaphirhynchus albus*) or whooping crane (*Grus americana*) and their habitat. There would also be no direct or indirect effects to the false-map turtle (*Graptemys pseudogeographica*), sturgeon chub (*Macrhybopsis gelida*), lake sturgeon (*Acipenser fulvescens*), blue sucker (*Cycleptus elongates*), or sicklefin chub (*Macrhybopsis meeki*).

6.7.8.3.5 Effects to Least Tern and Piping Plover (Lewis & Clark Lake Segment, No Program)

Taking no action, there would be no deleterious effects to the wetlands or fish and wildlife from the ongoing construction activities, but there would also be no beneficial effects to the least tern and piping plover and no additional habitat. The interchannel sandbar observed in the Lewis & Clark Lake Segment would likely diminish to none remaining as vegetation overtakes any remaining barren areas. Taking no action would also not provide ESH, thereby indirectly diminishing the ORVs (fish and wildlife) within the adjacent MNRR.

6.7.8.4 Socioeconomic Resources (Lewis & Clark Lake Segment, No Program)

Taking no action would avoid any of the direct effects to recreation or noise identified for Alternatives 1-5.

6.7.9 Summary of Predicted Effects in the Lewis & Clark Lake Segment

Table 6-8 presents a summary of the effects of implementing the alternatives for the Lewis & Clark Lake Segment. These values are based on the descriptions of impacts for each resource, by segment, by alternative and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

Table 6-8: Summary of Potential Significant Adverse Effects in the Lewis & Clark Lake Segment

Parameter	Alternative 1 2015 Goals	Alternative 2 2005 Goals	Alternative 3 1998/1999 ESH	Alternative 3.5 Intermediate	Alternative 4 2005 ESH	Alternative 5 Nesting Patterns	Continue Existing Program	No Program
Air Quality	No	No	No	No	No	No	No	No
Aesthetics	High	Moderate	Moderate	Moderate	Low	Low	No	No
Surface Water Hydrology and Hydraulics	Low	Low	Low	Low	Low	Low	Low	No
Degradation, Aggradation, and Erosion	High	Moderate	Moderate	Low	Low	Low	Low	No
Water Quality	Moderate	Moderate	Moderate	Low	Low	Low	Low	No
Vegetation	Low	Low	Low	Low	Low	Low	Low	No
Wetlands	High	Moderate	Moderate	Low	Low	Low	Low	No
Fish and Wildlife	High	Moderate	Moderate	Low	Low	Low	Low	No
Pallid Sturgeon	Moderate	Moderate	Moderate	Low	Low	Low	Low	No
Least Tern and Piping Plover	No	No	No	No	No	No	No	No
Recreation	High	High	High	Moderate	Low	Low	Low	No
Noise	High	High	High	Moderate	Low	Low	Low	No

6.8 GAVINS POINT RIVER SEGMENT - SEGMENT 10

All of the alternatives require the creation of ESH within the MNRR's 59-Mile District. The NPS has stated that implementing the program within the MNRR may create unacceptably significant and permanent effects. The NPS and the Corps manage the MNRR through a cooperative agreement. The NPS is represented on the ESH Project Delivery Team (PDT) and, therefore, is heavily involved in the selection of and design of potential sites. In working with the NPS, the Corps identified different scales of implementation through the various alternatives, discussed how to minimize impacts, and utilized GIS buffers to identify sensitive resources (see Section 4.2.1). The NPS is the overall administrator for the MNRR and has responsibility for WSRA Section 7A determination of effects in the MNRR.

The Gavins Point River Segment is the downstream-most extent of the MNRR. By virtue of its inclusion in the Wild and Scenic Rivers System, the MNNR was designated to preserve its free-flowing condition and its ORVs. The legislation adding the MNRR to the System specifically references the 1977 Corps Umbrella Study that describes, in detail, the ORVs that made this segment eligible for inclusion in the System. The identified ORVs are*: recreation, fish and wildlife, historic, and cultural resources.* The Umbrella Study also pointed out specific river features that were recognized as having outstandingly remarkable natural value. These features include the river setting at Goat Island, including the entrance of the James River and Missouri chutes paralleling Goat Island; the general high bank shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs, particularly at river miles 763, 776, and 787 [Gavins Point River Segment, or the 59-Mile District of the MNRR]. Additionally, the Wild and Scenic Rivers Act provides management mandates to agencies responsible for administering components of the System. Section 10(a), which establishes a non-degradation and enhancement policy, states, “Each component of the national wild and scenic rivers system shall be administered in such manner as to protect and enhance the values which caused it to be included in said system without, insofar as is consistent therewith, limiting other uses that do not substantially interfere with public use and enjoyment of these values.”

Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.1 Alternative 1 (Gavins Point River Segment)

As explained in Section 4.4, the Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres. After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Creating the 4,648 acres of interchannel sandbar necessary for Alternative 1 would disturb 13,805 acres of river bottom habitat representing 59% of the entire high-bank to high-bank habitat. Construction activities would be required in both the “restrictive” and “exclusionary” areas , increasing the risk of being unable to avoid sensitive resources (see Sections 4.5 and 4.6; Table 4-25).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2015 within approximately 10 years. Erosion (assumed rate of 40 percent per year) would eventually require the continual replacement of approximately 1,859 acres of habitat each and every year. Annual construction would require 761 days of mechanical work and 653 days of dredge operation that would require 10 teams of mechanical operators and 9 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 5,521 acres, moving over 10.8 million cubic yards of material.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.1.1 Physical Resources (Gavins Point River Segment, Alt. 1)

6.8.1.1.1 Air Quality (Gavins Point River Segment, Alt. 1)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 1 has not been calculated. However, this alternative represents the largest area of ESH to construct in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be the greatest. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006), and no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 1 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.8.1.1.2 Aesthetics (Gavins Point River Segment, Alt. 1)

Potential aesthetic impacts from implementing Alternative 1, including temporary and long-term visual changes, would be significant to the MNRR during construction. In order to create the 4,648 acres of ESH, the equivalent of 653 days of dredge work and 761 days of heavy equipment operation, accomplished by large numbers of construction teams, would be required annually throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 1,859 acres of ESH would also be aesthetically significant. However, the constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Because of the intensity (i.e., magnitude) of construction required, and locally significant impacts during construction, construction of Alternative 1 would lead to significant effects on aesthetics.

6.8.1.2 Water Resources (Gavins Point River Segment, Alt. 1)

6.8.1.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Alt. 1)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

The number of acres of ESH to be created under Alternative 1 is 1.6 times the number of acres of ESH that existed in the Gavins Point River Segment after the 1996-1997 releases (2,944 measured in 1998 imagery vs. 4,648 acres for Alternative 1). In addition, the area to be disturbed to construct Alternative 1 would require construction activities within both the "restrictive" and "exclusionary" areas (13,805 acres needed vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25). Such activities could potentially encroach into the available cross-sectional area, risk significant effects to the river hydraulics, and lead to significant bank erosion; indicating the potential of significant impacts to the available cross-sectional area and river hydraulics could be high.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.1.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Alt. 1)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 1 would most likely be significant. The number of acres of ESH required under Alternative 1 would mean construction activities within the "restrictive" and "exclusionary" areas (13,805 acres needed vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25).

Constructing the enormous area of ESH would annually mobilize previously stable sediments, accelerating the rate of bedload movement through the segment. Absent a substantial source of new sediment material in the segment, implementation of this alternative could eventually diminish the substrate available for sandbar formation.

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 1, it is estimated approximately 10.9 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.1.2.3 Water Quality (Gavins Point River Segment, Alt. 1)

The following activities, necessary to construct the 4,648 acres of ESH under Alternative 1 would cause direct impacts from a temporary decrease in water quality throughout the segment:

- Annually dredging of over 3.2 million CY of sand and sediments to create 4,648 acres of ESH, and
- Annually placing of over 10.8 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler’s Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects, and expected impacts from the extent of annual construction would be high.

6.8.1.3 Biological Resources (Gavins Point River Segment, Alt. 1)

6.8.1.3.1 Vegetation (Gavins Point River Segment, Alt. 1)

Disturbance of vegetation due to construction activities could impact an estimated 1081 acres of herb/shrub/sapling (45% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment. Approximately 767 acres of the herb/shrub/sapling class removal would occur in the restrictive area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-25), therefore impacts are anticipated to be moderate. However, because it is not anticipated that all potential vegetation modification would be carried out in a single growth season, there is an abundance of vegetated sandbars and a trend of progressive vegetation of bare sandbars, vegetation modification would be unlikely to have long-term impacts to vegetation in the Gavins Point River Segment.

6.8.1.3.2 Wetlands (Gavins Point River Segment, Alt. 1)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 1 would require activities within the "restrictive" and "exclusionary" areas (13,805 acres needed vs. 3,881 acres "available"), construction of this alternative would likely result in a significant loss of existing wetlands (see Sections 4.5 and 4.6; Table 4-25).

6.8.1.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Alt. 1)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 13,805 acres of river bottom habitat, representing 59% of the entire high-bank to high-bank habitat, to construct Alternative 1 would predictably create significant effects to fish and wildlife. Site selection and pre-construction site evaluations would identify additional areas to be avoided.

Annually creating new habitat and/or replacing that lost to erosion would require the construction of approximately 1,859 acres of habitat directly affecting 5,521 acres. The 5,521 acres disturbed annually are 24% of the high-bank to high-bank habitat and require activities in the "exclusionary" and "restrictive" areas (13,805 acres needed vs. 3,881 acres "available"), making it challenging to avoid sensitive resources and increasing the risk of significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. Because of the intensity (magnitude) of construction, effects on fish and wildlife would be predicted to be high.

6.8.1.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Alt. 1)

As described in Section 5.3, the Gavins Point River Segment has four federally-listed species that could be affected by implementing Alternative 1. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 1 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels,, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, risks significant construction-related effects to the endangered pallid sturgeon. Actions that could risk significant effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 59-Mile District of the MNRR.

6.8.1.3.5 State Listed Species and Habitats (Gavins Point River Segment, Alt. 1)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 1 risks significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 1 risks significant effects to these species.

6.8.1.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Alt. 1)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 4,648 acres of ESH under Alternative 1, 1,162 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 4,648 acres of ESH in the Gavins Point River Segment under Alternative 1. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Gavins Point River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in the Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from constructing 4,648 acres of ESH in the Gavins Point River Segment is uncertain as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.1.4 Socioeconomic Resources (Gavins Point River Segment, Alt. 1)

6.8.1.4.1 Recreation (Gavins Point River Segment, Alt. 1)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available for construction each fall in the Gavins Point River Segment. Construction and would require the equivalent of 761 days of mechanical work and 653 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December; autumn hunting accounted for 1,378 hours of recreation. Implementing Alternative 1 would cause significant conflicts with recreation. Construction equipment operations could impede access to hunting and fishing areas, and the noise would disturb recreators as well as wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the designation of the MNRR. This segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for building Alternative 1, would predictably lead to significant effects to visitation and recreation enjoyment, including impaired access to hunting and fishing sites, degradation of habitat that results in lower harvest rates for hunters and anglers, disturbance from noise to outdoors enthusiasts (including bird watchers as well as hunters and anglers) and to waterfowl, and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.8.1.4.2 Noise (Gavins Point River Segment, Alt. 1)

Alternative 1 represents the largest area of ESH to be created in the Gavins Point River Segment. Construction of 4,648 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment continuously (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. Significant noise effects would be predicted because of the disruption to recreation and the segment’s designation as a Wild and Scenic River.

6.8.2 Alternative 2 (Gavins Point River Segment)

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres (see Section 4.4). After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially “available” while avoiding sensitive environmental resources. Constructing the 2,324 acres of interchannel sandbar necessary for Alternative 2 would disturb 6,902 acres of river bottom habitat, and construction activities could occur in the “restrictive” area (6,902 acres required vs. 3,881 “available) (see Sections 4.5 and 4.6; Table 4-25).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet the 2003 BiOp Amendment goals for 2005 within approximately 10 years. Erosion (assumed rate of 30 percent per year) would eventually require the continual replacement of approximately 2,324 acres of habitat each and every year. Annual construction would require 285 days of mechanical work and 245 days of dredge operation that would require 4 teams of mechanical operators and 4 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 2,070 acres, moving over 4 million cubic yards of material.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.2.1 Physical Resources (Gavins Point River Segment, Alt. 2)

6.8.2.1.1 Air Quality (Gavins Point River Segment, Alt. 2)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA’s air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 2 has not been calculated. However, this alternative represents the third largest area of ESH to construct in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be the less than for Alternatives 1 and 3, but substantially more that Alternatives 4 and 5. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006), and no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 2 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.8.2.1.2 Aesthetics (Gavins Point River Segment, Alt. 2)

Potential aesthetic impacts from implementing Alternative 2, including temporary and long-term visual changes, would be significant to the MNRR during construction. In order to create the 2,324 acres of ESH, the equivalent of 245 of days of dredge and 285 days of heavy equipment operation, accomplished by large numbers of construction teams, would be required annually throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 697 acres of ESH would also be aesthetically significant. However, the constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers. The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment’s river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS’ mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Significant aesthetic effects to the MNRR would be certain. Because of the intensity (i.e., magnitude) of construction required, and locally significant impacts during construction, construction of Alternative 2 could lead to significant effects on aesthetics.

6.8.2.2 Water Resources (Gavins Point River Segment, Alt. 2)

6.8.2.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Alt. 2)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Creating the number of acres of ESH for Alternative 2 (2,324) would require activities in the “restrictive” area (6902 acres needed vs. 3,881 acres “available”) (see Sections 4.5 and 4.6; Table 4-25). Constructing Alternative 2 could increase the need to encroach into the available cross-sectional area, indicating the potential of significant impacts to surrounding area resources could be moderate.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.2.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Alt. 2)

The number of acres of ESH required under Alternative 2 would require building into the “restrictive” area (6,902 acres needed vs. 3,881 acres “available”). The impact to surrounding area resources could be moderate (see Sections 4.5 and 4.6; Table 4-25).

However, when comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 2, it is estimated approximately 4.1 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-2 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100’ and dredging depth restricted to a maximum 4’ not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.2.2.3 Water Quality (Gavins Point River Segment, Alt. 2)

The following activities, necessary to create the 2,324 acres of ESH under Alternative 2 would cause direct impacts from a temporary decrease in water quality in the segment:

- Annually dredging of over 1.2 million CY of sand and sediments to create 2,324 acres of ESH, and
- Annually placing of over 4.0 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Impacts to water quality are anticipated to be moderate.

6.8.2.3 Biological Resources (Gavins Point River Segment, Alt. 2)

6.8.2.3.1 Vegetation (Gavins Point River Segment, Alt. 2)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 314 acres of herb/shrub/sapling (13% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-25). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.8.2.3.2 Wetlands (Gavins Point River Segment, Alt. 2)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because construction activities for Alternative 2 would occur within the "restrictive" area (6,902acres needed vs. 3,881 acres "available"), construction of this alternative would likely result in a moderate risk of impacts to existing wetlands (see Sections 4.5 and 4.6; Table 4-25).

6.8.2.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Alt. 2)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 6,902 acres of river bottom habitat, representing 30% of the entire high-bank to high-bank habitat, to construct Alternative 2 could pose moderate effects to fish and wildlife. Site selection and pre-construction site evaluations would identify additional areas to be avoided.

Annually creating new habitat and/or replacing that lost to erosion would require the construction of approximately 697 acres of habitat, directly affecting 2,070 acres, or 9% of the high-bank to high-bank habitat. The construction of Alternative 2 in the Gavins Point River Segment would require activities in "restrictive" areas (see Sections 4.5 and 4.6; Table 4-25), posing a moderate risk to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity) and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using 3 different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells, but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace

1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. The construction of Alternative 2 in the Gavins Point River

Segment would require activities in "restrictive" areas (see Sections 4.5 and 4.6; Table 4-25), posing a moderate risk to fish and wildlife.

6.8.2.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Alt. 2)

As described in Section 5.3, the Gavins Point River Segment has four federally listed species that could be affected by implementing Alternative 2. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 2 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation this alternative, with the annual burden of construction within the Recovery-Priority Area, risks significant construction-related effects to the endangered pallid sturgeon. Actions that could risk significant effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 59-Mile District of the MNRR.

6.8.2.3.5 State Listed Species and Habitats (Gavins Point River Segment, Alt. 2)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 2 risks significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 2 risks significant effects to these species.

6.8.2.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Alt. 2)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 2,324 acres of ESH under Alternative 2, 581 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 2,324 acres of ESH in the Gavins Point River Segment under Alternative 2. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Gavins Point River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in the Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from constructing 2,324 acres of ESH in the Gavins Point River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.2.4 Socioeconomic Resources (Gavins Point River Segment, Alt. 2)

6.8.2.4.1 Recreation (Gavins Point River Segment, Alt. 2)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available for construction each fall in the Gavins Point River Segment. Construction and would require the equivalent of 285 days of mechanical work and 245 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December; autumn hunting accounted for 1,378 hours of recreation. Implementing Alternative 2 would cause significant conflicts with recreation. Construction equipment operations could impede access to hunting and fishing areas, and the noise would disturb outdoors enthusiasts and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the designation of the MNRR. This Segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for building Alternative 2, would predictably lead to significant effects to visitation and recreation enjoyment, including: impaired access to hunting and fishing sites, degradation of habitat that results in lower harvest rates for hunters and anglers, disturbance from noise to recreators (including bird watchers as well as hunters and anglers) and to waterfowl and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.8.2.4.2 Noise (Gavins Point River Segment, Alt. 2)

Creation of 2,324 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment operating continuously (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. Significant noise effects would be predicted because of the disruption to recreation and the segment's designation as a Wild and Scenic River.

6.8.3 Alternative 3 (Gavins Point River Segment)

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres (see Section 4.4). After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 2,994 acres of interchannel sandbar necessary for Alternative 3 would disturb 8,744 acres of river bottom habitat and require construction activities in "restrictive" areas (8,744 acres required, vs. 3,881 acres available) (see Sections 4.5 and 4.6; Table 4-25).

ESH construction includes mechanical creation and replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternative 3 goals based on the 1998 data within approximately 10 years. Erosion (assumed rate of 30 percent per year) would require the continual creation and/or replacement of approximately 883 acres of habitat each and every year. Annual construction would require 361 days of mechanical work and 310 days of dredge operation that would require 5 teams of mechanical operators and 5 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 2,623 acres, moving over 5.1 million cubic yards of material.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.3.1 Physical Resources (Gavins Point River Segment, Alt. 3)

6.8.3.1.1 Air Quality (Gavins Point River Segment, Alt. 3)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS.

No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3 has not been calculated. However, this alternative represents the second largest area of ESH to construct in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be second most. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction.

6.8.3.1.2 Aesthetics (Gavins Point River Segment, Alt. 3)

Potential aesthetic impacts from implementing Alternative 3, including temporary and long-term visual changes, would be significant to the MNRR during construction. In order to create the 2,944 acres of ESH, annually 310 days of dredge and 361 days of heavy equipment operation, accomplished by large numbers of construction teams, would be required throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 883 acres of ESH would also be aesthetically significant. However, the constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Significant aesthetic effects to the MNRR would be certain. Because of the intensity (i.e., magnitude) of construction required, and locally significant impacts during construction, construction of Alternative 3 could lead to significant effects on aesthetics.

6.8.3.2 Water Resources (Gavins Point River Segment, Alt. 3)

6.8.3.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Alt. 3)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Creating the number of acres of ESH for Alternative 3 (2,944) would require disturbing 8,744 acres, requiring activities in the "restrictive" area (8,744 required acres vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25). Constructing Alternative 3 could potentially encroach into the available cross-sectional area, indicating the potential of significant impacts to surrounding area resources could be moderate.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.3.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Alt. 3)

The number of acres of ESH required under Alternative 3 would require construction activities within the "restrictive" area (8,744 acres needed vs. 3,881 acres "available"). The impact to surrounding area resources would be anticipated to be moderate (see Sections 4.5 and 4.6; Table 4-25).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 3, it is estimated approximately 5.2 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment. Estimates indicate that this could be a large amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Likely effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be high. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.3.2.3 Water Quality (Gavins Point River Segment, Alt. 3)

The following activities, necessary to create the 2,944 acres of ESH under Alternative 3 would cause direct impacts from a temporary decrease in water quality in the segment:

- Annually dredging of over 1.5 million CY of sand and sediments to create 2,944 acres of ESH, and
- Annually placing of over 5.1 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Impacts to water quality are anticipated to be moderate.

6.8.3.3 Biological Resources (Gavins Point River Segment, Alt. 3)

6.8.3.3.1 Vegetation (Gavins Point River Segment, Alt. 3)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 314 acres of herb/shrub/sapling (13% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-25). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.8.3.3.2 Wetlands (Gavins Point River Segment, Alt. 3)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to construct Alternative 3 would require activities in "restrictive areas," (8,744 acres needed vs. 3,881 acres "available"), construction of this alternative could result in moderate impacts to existing wetlands.

6.8.3.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Alt. 3)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 8,744 acres of river bottom habitat, and requiring activities in "restrictive areas" (see Sections 4.5 and 4.6; Table 4-25), to construct Alternative 3 could create moderate effects to fish and wildlife. Site selection and pre-construction site evaluations would identify additional areas to be avoided.

Annually creating new ESH and replacing ESH lost to erosion would require the construction of approximately 883 acres of habitat directly affecting 2,623 acres. The 2,623 acres disturbed annually are 11% of the high-bank to high-bank habitat and 68% (2,623 vs. 3,881) of the "available" area. An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) for construction is not feasible for Alternative 3 in the Gavins Point River Segment, and significant effects to fish and wildlife would be almost certain

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge which was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian

Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. Because of the MNRR status of this reach, and that Alternative 3 would require activities in "restrictive areas," moderate risks could be posed to fish and wildlife.

6.8.3.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Alt. 3)

As described in Section 5.3, the Gavins Point River Segment has four federally listed species that could be affected by implementing Alternative 3. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be significant risk to the remaining wild population of pallids from implementing this alternative. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area and higher acreage requirements than Alternatives 2 and 3.5, risks permanent construction-related effects to the endangered pallid sturgeon. Actions that could risk permanent effects to the presence of pallid sturgeon within the MNRR also threaten the ORV for fish and wildlife in the 59-Mile District of the MNRR.

6.8.3.3.5 State Listed Species and Habitats (Gavins Point River Segment, Alt. 3)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 3 risks significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in

Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 3 risks significant effects to these species.

6.8.3.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Alt. 3)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 2,944 acres of ESH under Alternative 3, 736 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 2,944 acres of ESH in the Gavins Point River Segment under Alternative 3. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Gavins Point River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from creating 2,944 acres of ESH in the Gavins Point River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.3.4 Socioeconomic Resources (Gavins Point River Segment, Alt. 3)

6.8.3.4.1 Recreation (Gavins Point River Segment, Alt. 3)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available for construction each fall in the Gavins Point River Segment. Construction and would require the equivalent of 361 days of mechanical work and 310 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December;

autumn hunting accounted for 1,378 hours of recreation. Implementing Alternative 3 would cause significant conflicts with recreation. Construction equipment operations could impede access to hunting and fishing areas, and the noise would disturb recreationists and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the designation of the MNRR. The Gavins Point River Segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for building Alternative 3, would predictably lead to significant effects to visitation and recreation enjoyment, including impaired access to hunting and fishing sites, degradation of habitat that results in lower harvest rates for hunters and anglers, disturbance from noise to recreationists (including bird watchers as well as hunters and anglers) and to waterfowl, and adverse impacts on scenic views due to the presence and operations of construction equipment.

6.8.3.4.2 Noise (Gavins Point River Segment, Alt. 3)

Creation of 2,944 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment operating continuously (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. Significant noise effects would be predicted because of the disruption to recreation and the segment's designation as a Wild and Scenic River.

6.8.4 Alternative 3.5 - Impact Level Identified with AMIP Preferred Alternative (Gavins Point River Segment)

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres (see Section 4.4). After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Creating the 1,912 acres of interchannel sandbar necessary for Alternative 3.5 would disturb 5,679 acres of river bottom habitat and require construction activities within the "restrictive" areas (5,679 acres required vs. 3,881 acres "available) (see Sections 4.5 and 4.6; Table 4-25).

ESH construction includes mechanical creation and/or replacement activities to achieve the quantity and quality of ESH habitat to meet the Alternative 3.5 goals within approximately 10 years. Creation of new ESH and/or replacement of ESH lost due to erosion (assumed rate of 25 percent per year) would require the construction of approximately 478 acres of habitat each and every year. Annual construction and would require 196 days of mechanical work and 168 days of dredge operation that would require 3 teams of mechanical operators and 3 dredges operating simultaneously to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 1,420 acres, moving over 2.8 million cubic yards of material.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.4.1 Physical Resources (Gavins Point River Segment, Alt. 3.5)

6.8.4.1.1 Air Quality (Gavins Point River Segment, Alt. 3.5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 3.5 has not been calculated. However, this alternative represents the fourth largest area of ESH to create in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be fourth most. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 3.5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction. Impacts to air quality would not be significant.

6.8.4.1.2 Aesthetics (Gavins Point River Segment, Alt. 3.5)

Potential aesthetic impacts from implementing Alternative 3.5, including temporary and long-term visual changes, would be moderate to the MNRR during construction. In order to create the 1,912 acres of ESH, annually 168 of days of dredge and 196 days of heavy equipment operation, accomplished by large numbers of construction teams, would be required throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape.

The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 478 acres of ESH could be moderately significant. However, the constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Moderate aesthetic effects to the MNRR would occur during construction.

6.8.4.2 Water Resources (Gavins Point River Segment, Alt. 3.5)

6.8.4.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Alt. 3.5)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Creating the number of acres of ESH for Alternative 3.5 (1,912) would require activities within the "restrictive" areas (5,679 acres required vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25). Constructing Alternative 3.5 could potentially encroach into the available cross-sectional area, risking moderate effects to the river hydraulics; however, the use of construction constraints reduce the likelihood of impacts by avoidance. In addition, the Adaptive Management strategy (Appendix H) would seek to reduce impacts by improving methods and reducing acreage targets by meeting bird metrics (measurements) before full implementation is required.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.4.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Alt. 3.5)

The number of acres of ESH required under Alternative 3.5 would require construction activities within the "restrictive" area (5,679 acres impacted vs. 3,881 acres "available"). The impact to surrounding area resources would be anticipated to be moderate (see Sections 4.5 and 4.6; Table 4-25).

When comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative, some concerns can be raised. For alternative 3.5, it is estimated approximately 2.8 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment. Estimates indicate that this could be a moderate amount of material relative to annual sediment load (see Section 6.2 and Table 6-2).

Potential effects of this alternative include eventual impacts to surrounding resources due to elevated sediment concentrations, issues with locating suitable habitat sites as local sediment sources become restricted and decreased durability and longevity of created ESH habitat. Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be moderate. Refer to Section 6.2 and Table 6-3 for an additional discussion of sediment impact analysis.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.4.2.3 Water Quality (Gavins Point River Segment, Alt. 3.5)

The following activities, necessary to create the 1,912 acres of ESH under Alternative 3.5 would cause direct impacts from a temporary decrease in water quality in the segment:

- Annually dredging of over 800,000 CY of sand and sediments to create 1,912 acres of ESH, and
- Annually placing of over 2.8 million CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. The temporary and local effects during construction could result in moderate deterioration in water quality from this extent of annual construction.

6.8.4.3 Biological Resources (Gavins Point River Segment, Alt. 3.5)

6.8.4.3.1 Vegetation (Gavins Point River Segment, Alt. 3.5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 314 acres of herb/shrub/sapling (13% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment, all within the available area (see Table 6-4; also see Sections 4.5 and 4.6; Table 4-25). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.8.4.3.2 Wetlands (Gavins Point River Segment, Alt. 3.5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in

Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because the area needed to create Alternative 3.5 would require construction activities within the "restrictive" area (5,679 acres impacted vs. 3,881 acres "available"), construction of this alternative could result in moderate impacts to existing wetlands (see Sections 4.5 and 4.6; Table 4-25).

6.8.4.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Alt. 3.5)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 5,679 acres of river bottom habitat, representing 24% of the entire high-bank to high-bank habitat, to construct Alternative 3.5 would predictably create moderate effects to fish and wildlife during construction. Site selection and pre-construction site evaluations could identify additional local areas to be avoided.

Annually constructing new ESH and/or replacing the habitat lost to erosion would require the construction of approximately 478 acres of habitat directly affecting 1,420 acres, 6% of the high-bank to high-bank habitat. The construction of Alternative 3.5 in the Gavins Point River Segment would require activities within the "restrictive" area (5,679 acres impacted vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25), posing a moderate risk to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. The construction of Alternative 3.5 in the Gavins Point River Segment would require activities in "restrictive" areas (see Sections 4.5 and 4.6; Table 4-25), posing a moderate risk to fish and wildlife.

6.8.4.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Alt. 3.5)

As described in Section 5.3, the Gavins Point River Segment has four federally listed species that could be affected by implementing Alternative 3.5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 3.5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be moderate risk to the remaining wild population of pallids from implementing this alternative. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some reaches, still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, but less acres required than Alternatives 1-3, risks moderate construction-related effects to the endangered pallid sturgeon.

6.8.4.3.5 State Listed Species and Habitats (Gavins Point River Segment, Alt. 3.5)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 3.5 risks significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk, but the extent of habitat needing to be manipulated under Alternative 3.5 risks significant effects to these species.

6.8.4.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Alt. 3.5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By creating the 1,912 acres of ESH under Alternative 3.5, 478 acres of nesting habitat would be created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 1,912 acres of ESH in the Gavins Point River Segment under Alternative 3.5. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from creating 1,912 acres of ESH in the Gavins Point River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.4.4 Socioeconomic Resources (Gavins Point River Segment, Alt. 3.5)

6.8.4.4.1 Recreation (Gavins Point River Segment, Alt. 3.5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week during the entire 77-day period available for construction each fall in the Gavins Point River Segment. Construction would require the equivalent of 196 days of mechanical work and 168 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December; autumn hunting accounted for 1,378 hours of recreation. Implementing Alternative 3.5 could cause moderate conflicts with recreation. Construction equipment operations could impede access to hunting and fishing areas, and the noise could disturb recreationists and wildlife, including waterfowl.

In addition, the environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the designation of the MNRR. This segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for building Alternative 3.5, could lead to moderate effects to visitation and recreation enjoyment.

6.8.4.4.2 Noise (Gavins Point River Segment, Alt. 3.5)

Creation of 1,912 acres of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges, and other miscellaneous equipment operating continuously (24 hours a day - 7 days a week) for the entire 77-day period available for construction every year. Moderate noise effects would be predicted because of the disruption to recreation and the segment's designation as a Wild and Scenic River.

6.8.5 Alternative 4 (Gavins Point River Segment)

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres (see Section 4.4). After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining the 880 acres of interchannel sandbar necessary for Alternative 4 would disturb 2,614 acres of river bottom habitat. Construction activities could occur within the "available" area after eliminating environmentally sensitive areas (2,614 acres required vs. 3,881 "available") (see Sections 4.5 and 4.6; Table 4-25).

Erosion of the ESH available in 2005 would require the annual replacement of approximately 132 acres of habitat (15 percent annual loss rate). This annual construction would require 54 days of mechanical work and 46 days of dredge operation that would require a single mechanical operator and a single dredge operating to complete the work within the 77 available calendar days each autumn. Annual construction would disturb 392 acres, moving over 770,000 cubic yards of material.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.5.1 Physical Resources (Gavins Point River Segment, Alt. 4)

6.8.5.1.1 Air Quality (Gavins Point River Segment, Alt. 4)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 4 has not been calculated. However, this alternative represents the third smallest area of ESH to construct in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be the substantially less than for Alternatives 1-3.5. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 4 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction. Impacts to air quality would not be significant.

6.8.5.1.2 Aesthetics (Gavins Point River Segment, Alt. 4)

Potential aesthetic impacts from implementing Alternative 4, including temporary and long-term visual changes, would be significantly less than for Alternatives 1-3.5, but may still be significant to the MNRR during construction. In order to retain the 880 acres of ESH, 46 of days of dredge and 54 days of heavy equipment operation would be required annually throughout the segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 132 acres of ESH would not be aesthetically significant. The constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers. The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Due to the minimal amount of acres to be placed with Alternative 4, aesthetic effects to the MNRR would be low.

6.8.5.2 Water Resources (Gavins Point River Segment, Alt. 4)

6.8.5.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Alt. 4)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Retaining the number of acres of ESH for Alternative 4 (880) would require disturbing 2,614 acres, with construction activities occurring within the "available" area (2,614 vs. 3,881 acres "available") of the Gavins Point River Segment. Allowing for careful selection of construction sites, constructing Alternative 4 could be accomplished without significantly affecting the available cross-sectional area (see Sections 4.5 and 4.6; Table 4-25).

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.5.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Alt. 4)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 4 would be substantially less than for Alternatives 1-3.5. The number of acres of ESH required under Alternative 4 would require using 11% of the high-bank to high-bank habitat. Because construction activities could occur within the "available" area (2,614 acres needed vs. 3,881 acres "available"), the impact to surrounding area resources would be anticipated to be low (see Sections 4.5 and 4.6; Table 4-25).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For alternative 4, it is estimated approximately 0.7 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.5.2.3 Water Quality (Gavins Point River Segment, Alt. 4)

The following activities, necessary to construct the 880 acres of ESH under Alternative 4 would cause direct impacts from a temporary decrease in water quality in the segment:

- Annually dredging of over 230,000 CY of sand and sediments to retain 880 acres of ESH, and
- Annually placing of over 770,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Impacts to water quality from annual construction would be expected to be low.

6.8.5.3 Biological Resources (Gavins Point River Segment, Alt. 4)

6.8.5.3.1 Vegetation (Gavins Point River Segment, Alt. 4)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 314 acres of herb/shrub/sapling (13% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment, all within the available area (see Table 6-4; also (see Sections 4.5 and 4.6; Table 4-25). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.8.5.3.2 Wetlands (Gavins Point River Segment, Alt. 4)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because construction activities for Alternative 4 could occur within the "available" area (2,614 acres needed vs. 3,881 acres "available"), construction of this alternative could be accomplished without a significant loss of existing wetlands (see Sections 4.5 and 4.6; Table 4-25).

6.8.5.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Alt. 4)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 2,614 acres of river bottom habitat, representing 11% of the entire high-bank to high-bank habitat to construct Alternative 4, could pose minimal effects to fish and wildlife. Site selection and pre-construction site evaluations would be expected to identify additional areas to be avoided.

Annually retaining the habitat lost to erosion would require the replacement of approximately 132 acres of habitat directly affecting 392 acres. The 392 acres disturbed annually are 1.6% of the high-bank to high-bank habitat and construction activities could occur within the "available" area(392 acres vs. 3,881 "available" acres). An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) for initial construction may be feasible for Alternative 4 in the Gavins Point River Segment, and significant effects to fish and wildlife would be avoidable. The extent of construction would not be expected to create significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity). and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*), and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½” in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate’s effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

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Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. Effects to fish and wildlife would be anticipated to be low.

6.8.5.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Alt. 4)

As described in Section 5.3, the Gavins Point River Segment has four federally listed species that could be affected by implementing Alternative 4. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 4 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there would be minimal risk to the remaining wild population of pallids from implementing this alternative. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery of the species (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf). The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segments still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative, with the annual burden of construction within the Recovery-Priority Area, poses a low risk of construction-related effects to the endangered pallid sturgeon.

6.8.5.3.5 State Listed Species and Habitats (Gavins Point River Segment, Alt. 4)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk. The extent of habitat needing to be manipulated under Alternative 4 is substantially less than for Alternatives 1-3.5, diminishing the risks of significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk. The extent of habitat needing to be manipulated under Alternative 4 is substantially less than for Alternatives 1-3.5, diminishing the risks of significant effects to these species.

6.8.5.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Alt. 4)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 880 acres of ESH under Alternative 4, 220 acres of nesting habitat would be retained (see Appendix C). Segment-specific measurements of nesting densities were developed for both species as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 880 acres of ESH in the Gavins Point River Segment under Alternative 4. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period. This is not intended to predict the number of least terns or piping plovers that would be expected to utilize the Gavins Point River Segment, even if this much habitat were created. Instead, it offers another way of examining the appropriateness of the number of acres required under the different alternatives.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from retaining 880 acres of ESH in the Gavins Point River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.5.4 Socioeconomic Resources (Gavins Point River Segment, Alt. 4)

6.8.5.4.1 Recreation (Gavins Point River Segment, Alt. 4)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week during a portion of the 77-day period available for construction each fall in the Gavins Point River Segment. Construction would require 54 days of mechanical work and 46 days of dredge operation each autumn within the segment.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December; autumn hunting accounted for 1,378 hours of recreation. Implementing Alternative 4 would cause minimal conflicts with recreation during construction.

In addition, the environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the designation of the MNRR. The Gavins Point River Segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. The intensity (i.e., magnitude) of construction required for building Alternative 4 would be unlikely to create locally significant effects to visitation and recreation enjoyment. Access could be impaired to some hunting and fishing sites, but alternative sites may be available during each construction year, where noise was far enough away to not disturb waterfowl, and habitat was not degraded enough to significantly reduce harvest rates for hunters and anglers. In addition, construction activities would occur during only a portion of the fall recreational season. Also, after the equipment was removed, the ambient noise levels, viewsheds, and access to hunting and fishing sites would be restored. Overall impacts to visitation and recreation are anticipated to be low.

6.8.5.4.2 Noise (Gavins Point River Segment, Alt. 4)

Construction of 132 acres of ESH would require a team of earth-moving equipment (e.g., dozers, scrapers, and excavators), a dredge, and other miscellaneous equipment operating almost continuously (24 hours a day - 7 days a week) for a portion of the entire 77-day period available for construction annually. The potential of noise impacts would be low. .

6.8.6 Alternative 5 (Gavins Point River Segment)

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres (see Section 4.4). After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining 570 acres of interchannel sandbar necessary for Alternative 5 would disturb 1,693 acres of river bottom habitat. Construction activities could occur within the "available" area (1,693 acres vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25).

Erosion (assumed rate of 10 percent per year) would require the replacement of approximately 57 acres of habitat each and every year. This annual replacement would require 23 days of mechanical work and 20 days of dredge operation that would require a single mechanical operator and a single dredge less than one-third of the available 77 available calendar days each autumn. Annual construction would disturb 169 acres, moving over 330,000 cubic yards of material.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.6.1 Physical Resources (Gavins Point River Segment, Alt. 5)

6.8.6.1.1 Air Quality (Gavins Point River Segment, Alt. 5)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of Alternative 5 has not been calculated. However, this alternative represents the smallest area of ESH to construct in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be the substantially less than for Alternative 1-3,5. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction. Overall, no risk of significant air quality effects would be predicted.

6.8.6.1.2 Aesthetics (Gavins Point River Segment, Alt. 5)

Potential aesthetic impacts from implementing Alternative 5, including temporary and long-term visual changes, would be significantly less than for Alternatives 1-3.5, but may still be significant to the MNRR during construction. In order to create the 570 acres of ESH, annually 20 of days of dredge and 23 days of heavy equipment operation at designated project sites within segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape. The long-term visual impacts resulting from the actions necessary for the annual creation and/or replacement of 57 acres of ESH (23 days of mechanical work and 20 days of dredge operation) would be markedly less than Alternatives 1-4 and would not be characterized as aesthetically significant. The constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Because of the reduced number of acres of ESH to maintain, significant aesthetic effects to the MNRR during construction would not be likely.

6.8.6.2 Water Resources (Gavins Point River Segment, Alt. 5)

6.8.6.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Alt. 5)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Constructing Alternative 5 (570 acres) would be the least among the action alternatives and would require disturbing 1,693 acres. Construction activities could occur within the "available" area (1,693 vs. 3,881 acres "available") of the Gavins Point River Segment (see Sections 4.5 and 4.6; Table 4-25) and could be accomplished without significantly affecting the available cross-sectional area.

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.6.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Alt. 5)

The potential effects to aggradation, degradation, and erosion from constructing Alternative 5 would be the least among the action alternatives and substantially less than for Alternatives 1-3.5. The number of acres of ESH required under Alternative 5 would require using 7% of the high-bank to high-bank habitat. Construction activities could occur within the "available" area (1,693 acres needed vs. 3,881 acres "available"). The impact to surrounding area resources would be anticipated to be low (see Sections 4.5 and 4.6; Table 4-25).

Possible impacts may be evaluated by comparing estimates of total sediment load to the volume of sediment required to meet the acreage goals for the stated alternative. For alternative 5, it is estimated approximately 0.3 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.6.2.3 Water Quality (Gavins Point River Segment, Alt. 5)

The following activities, necessary to retain the 570 acres of ESH under Alternative 5 would cause direct impacts from a temporary decrease in water quality in proximity to selected construction sites:

- Annually dredging of over 100,000 CY of sand and sediments to retain 570 acres of ESH, and
- Annually placing of over 330,000 CY of river bottom sand and sediments at constructed sites.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, "sandy" material from "open channel" areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in "more than minimal individual or cumulative adverse environmental effects to the aquatic resources," an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler's Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Alternative 5 represents the least amount of construction among the action alternatives and significantly less construction than required for Alternatives 1-4, therefore risks to water quality are expected to be low.

6.8.6.3 Biological Resources (Gavins Point River Segment, Alt. 5)

6.8.6.3.1 Vegetation (Gavins Point River Segment, Alt. 5)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 314 acres of herb/shrub/sapling (13% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment, all within the available area (see Table 6-4; also (see Sections 4.5 and 4.6; Table 4-25). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.8.6.3.2 Wetlands (Gavins Point River Segment, Alt. 5)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because construction activities for Alternative 5 could occur within the "available" area (1,693 acres needed vs. 3,881 acres "available"), construction of this alternative could be accomplished without a significant loss of existing wetlands (see Sections 4.5 and 4.6; Table 4-25).

6.8.6.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Alt. 5)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 1,693 acres of river bottom habitat, representing 7% of the entire high-bank to high-bank habitat, to construct Alternative 5, could pose minimal effects to fish and wildlife if not implemented cautiously. Site selection and pre-construction site evaluations are essential and would be expected to identify additional areas to be avoided.

Annually constructing the habitat lost to erosion would require the replacement of approximately 57 acres of habitat directly affecting 169 acres. Construction activities for the 1,69e acres disturbed annually could occur within the "available" area (1,693 acres vs. 3,881acres of "available") (see Sections 4.5 and 4.6; Table 4-25). An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) for construction appears feasible for Alternative 5 in the Gavins Point River Segment, and significant effects to fish and wildlife should be avoidable. The extent of construction would not be expected to create significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism's direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use. Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the

surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. Overall impacts to fish and wildlife are expected to be low.

6.8.6.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Alt. 5)

As described in Section 5.3, the Gavins Point River Segment has four federally listed species that could be affected by implementing Alternative 5. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing Alternative 5 on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but even with the substantially diminished area of ESH to be constructed under Alternative 5, there may still be low risk to the remaining wild population of pallids. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segment still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH construction. Implementation of this alternative, poses a low risk of construction-related effects to the endangered pallid sturgeon.

6.8.6.3.5 State Listed Species and Habitats (Gavins Point River Segment, Alt. 5)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk. The extent of habitat needing to be manipulated under Alternative 5 is the least among the action alternatives diminishing the risks of significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk. The extent of habitat needing to be manipulated under Alternative 5 is the least among the action alternatives diminishing the risks of significant effects to these species.

6.8.6.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Alt. 5)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By retaining the 570 acres of ESH under Alternative 5, 143 acres of nesting habitat would be retained (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 570 acres of ESH in the Gavins Point River Segment under Alternative 5. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from retaining 570 acres of ESH in the Gavins Point River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.6.4 Socioeconomic Resources (Gavins Point River Segment, Alt. 5)

6.8.6.4.1 Recreation (Gavins Point River Segment, Alt. 5)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week during a portion of the 77-day period available for construction. Annual construction would cause 24 hour a day, 7 day a week disturbance for approximately one-third of the 77-day construction period each fall in the Gavins Point River Segment. Construction would require 23 days of mechanical work and 20 days of dredge operation each autumn.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December; autumn hunting accounted for 1,378 hours of recreation. Implementing Alternative 5 would not cause significant conflicts with recreation during construction. Construction operations would last only about one-third of the fall recreational season, greatly reducing the impacts on autumn recreation as a whole.

The environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the designation of the MNRR. The Gavins Point River Segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. Because Alternative 5 would have the least construction, the intensity (i.e., magnitude) of construction required for building Alternative 5,would pose a low risk of locally significant effects to visitation and recreation enjoyment. Access to some hunting and fishing sites would be impaired, but because only 1 dredge will be operating during construction, some alternative sites would be available where the noise was too far away to disturb waterfowl and the fish and wildlife habitat was not degraded enough to significantly reduce harvest rates for hunters and anglers. In addition, construction activities would occur for only one-third of the fall recreational season. Also, after the construction equipment was removed, the ambient noise levels, viewsheds, and access to hunting and fishing sites would be restored.

6.8.6.4.2 Noise (Gavins Point River Segment, Alt. 5)

Retention of 570 acres of ESH would require one team of earth-moving equipment (e.g., dozers, scrapers, excavators), a dredge, and other miscellaneous equipment operating continuously (24 hours a day - 7 days a week) for just over one-third of the 77-day construction period annually. Noise effects are not anticipated to be significant.

6.8.7 Continue Existing Program (Gavins Point River Segment)

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres (see Section 4.4). After application of the environmental buffers to the segment, 3,881 residual acres, or 17% of the segment, remains as potentially "available" while avoiding sensitive environmental resources. Retaining the 125 acres of interchannel sandbar within the Existing Program would disturb 2,474 acres of river bottom habitat. Construction activities could occur within the "available" area (2,474 acres vs. 3,881 acres "available") (see Sections 4.5 and 4.6; Table 4-25).

The Existing Program in the Gavins Point River Segment would require the construction of 125 acres per year, requiring 46 days of mechanical work (1 mechanical crew), 40 days of dredge operation (1 dredge), and excavation of over 730,000 cubic yards of riverbed material. The current rate of 125 acres per year means that the amount of ESH in this reach would decline to about 833 acres (from 880 in 2005) over the next 2 to 3 decades, assuming an annual loss rate of 15 percent.

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.7.1 Physical Resources (Gavins Point River Segment, Existing Program)

6.8.7.1.1 Air Quality (Gavins Point River Segment, Existing Program)

The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to state or Federal Implementation Plans) dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more NAAQS. No detailed conformity analyses are required because all of the counties are in attainment of the EPA's air quality standards.

As such, detailed quantification of the direct effects of emissions associated with construction of the Existing Program Alternative has not been calculated. However, this alternative represents the second smallest area of ESH to construct in the Gavins Point River Segment, and the emissions from equipment operation (direct effects) would be the substantially less than for Alternative 1-4. Currently all NAAQS parameters are in attainment of the air quality standards (USEPA, 2006); therefore, no risk of significant direct effects would be predicted.

The indirect effects to air quality of implementing Alternative 5 would be related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. These would also be expected to not be significant. Actual calculations would be part of the permitting process when detailed information about actual equipment, fuel usage and construction would be known.

As the areas where work is to be conducted are rural in nature, the existing vegetation would be able to absorb the additional carbon emissions during normal photosynthesis processes. The plants along the riparian corridor are largely C3, meaning their growth is limited by carbon and other gasses, not sun and water. While it would be remiss to suggest that additional emissions would benefit the local environment, the presence of an abundance of C3 plants would efficiently fix additional carbon. Studies have shown that the current atmosphere on average is about 380ppm (parts per million) of carbon (Tans 2009). C3 plants respond favorably with increased carbon (increasing atmospheric carbon could increase plant growth) upwards to 1200ppm carbon (Bazzaz and Carlson 1984). Again, this is not an implication that there would be no significant impacts, only that in the heavily vegetated areas near where diesel engines would be operated, the local biota should be able to absorb changes in air quality for the relatively short durations of construction. Overall, no significant effects to air quality are anticipated.

6.8.7.1.2 Aesthetics (Gavins Point River Segment, Existing Program)

Potential aesthetic impacts from continued implementation of the Existing Program Alternative, including temporary and long-term visual changes, would be significantly less than for Alternatives 1-4. In order to create the 125 acres of ESH, 40 of days of dredge and 46 days of heavy equipment operation would be required at designated project sites within segment. During construction, changes to vistas, including the historic views as witnessed by early explorers and settlers such as Lewis and Clark, would be noticeable. Temporary, construction-related activities including in-river equipment operations and landside modifications for river access would contrast with the Gavins Point River Segment landscape. However, when construction activities were completed, the constructed ESH would appear similar to high-elevation sandbars deposited during prolonged high releases, and would be more similar to the historic viewshed encountered by early explorers and settlers.

The environmental context for the consideration of aesthetic effects in the Gavins Point River Segment is different from that of the Fort Peck or Garrison River Segments because of the presence of the MNRR. This segment's river features (…shoreline forest dominated by cottonwood trees; clusters of sandbars; and the Nebraska wooded bluffs) are included in the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other ORVs. Significant aesthetic effects to the MNRR are not anticipated.

6.8.7.2 Water Resources (Gavins Point River Segment, Existing Program)

6.8.7.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, Existing Program)

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. The analysis used GIS as a screening tool to identify sensitive resources to avoid. Features related to river stage include actual active thalweg, minimum thalweg width, and narrow channel width (high erosion potential). Figure 6-1 is a screen-capture example of the analysis described in Appendix B.

Construction under the Existing Program (125 acres) would be the second least among the alternatives and would require disturbing 371 acres, approximately 10% of the "available" area identified in the analysis (371 vs. 3,881 acres "available") of the Gavins Point River Segment. The Existing Program Alternative could be accomplished without significantly affecting the available cross-sectional area, risking significant effects to the river hydraulics, and risking significant bank erosion. However, site selection and pre-construction site evaluations would be expected to identify additional areas to be avoided (construction constraints

A more detailed hydraulic/geomorphic assessment would be completed during site-specific Planning, Engineering and Design. Project site selection is performed using available channel width criteria that provides insight regarding the presence of bars and islands (Biedenharn, 2001). The Biedenharn study (Biedenharn, 2001) determined that local channel geometry, and in particular channel width, is one of the dominant factors that affect bar and island morphology within the Missouri River (Biedenharn, 2001). This study found threshold values for channel width below which the persistence of bars was unlikely. Using the relationship for channel width to bar presence minimizes potential site impacts. In addition, final site designs are developed to avoid floodplain impacts. Project formulation is conducted so as to not significantly alter the conveyance capacity of the overall channel or subchannels.

6.8.7.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, Existing Program)

The potential effects to aggradation, degradation, and erosion from continued construction under the Existing Program would be the next to the least among the alternatives and up to substantially less than for Alternatives 1-4. The number of acres of ESH required under the Existing Program would require using 1.6% of the high-bank to high-bank habitat annually and require 64% of the area available when avoiding sensitive resources (2474 acres needed vs. 3,881 acres "available"). The impact to surrounding area resources would be anticipated to be minimal (see Sections 4.5 and 4.6; Table 4-25).

For the existing program, it is estimated approximately 0.7 million cubic yards of annual placement will be necessary to meet and sustain acreage goals for available ESH for the Gavins Point River segment. For this segment and alternative, the amount of material required for construction of habitat compared to annual sediment load is not significant (see Section 6.2 and Table 6-2). Precise determination of sediment impacts is difficult due to the many unknowns. Based on the comparison of the annual material construction volume to the estimated sediment load, the risk of eventual significant effects on aggradation, degradation and erosion within the segment is likely to be low.

Construction methods to limit impacts to surrounding resources include shoreline buffers of 100' and dredging depth restricted to a maximum 4' not to exceed the thalweg or lowest elevation in the channel. Sandbar location within widened river reaches increases constructed bar longevity and limits changes in flow distribution and possible impacts to adjacent areas. Dredge material would be taken from sediments within the high-water elevation of the Missouri River, emulating a natural process of redistribution of sediments in the river and resulting in no net addition or removal of sediment from the system, even as the constructed sandbars naturally erode. Placement of ESH material will occur no closer than generally 300' to the nearest bankline to avoid increased shoreline erosion. The restrictions act in combination to avoid impacts to adjacent banklines, confine borrowed materials to the active bed material transport layer, and limit risk of shifting of the thalweg (deepest/fastest part of channel) due to construction activities.

The need for pre- and post-construction surveys would be assessed on an individual project basis. Survey information could include size, shape, and elevation of sandbars relative to stage; bank line erosion rates; and general channel stability.

6.8.7.2.3 Water Quality (Gavins Point River Segment, Existing Program)

The following activities, necessary to construct the 125 acres of ESH under the Existing Program Alternative would cause minor direct impacts from a temporary decrease in water quality in proximity to selected construction sites:

Annually dredging of almost 220,000 CY of river bottom sand and sediments to annually construct the ESH, and

Annually placing of over 730,000 CY of sand and sediments annually to construct 125 acres of ESH.

The localized temporary decrease in water quality would result from an increase in turbidity and suspended sediments and a mobilization of nutrients and detritus from the bottom. This could potentially lead to a localized reduction in dissolved oxygen and a potential for the mobilization of contaminants sequestered in bottom sediments. When dredging materials for ESH construction, it is generally believed that avoiding bottom sediments from vegetated backwater areas and utilizing coarser, “sandy” material from “open channel” areas for fill reduces the amount of organic matter and the potential for the fill to contain sequestered nutrients and possible contaminants.

Projects may be authorized under the Section 404 Nationwide Permit 27 (NWP 27) (March 12, 2007, Federal Register, 72 FR, 11092) (Section 3.6). The NWP 27 authorizes Aquatic Habitat Restoration, Establishment and Enhancement Activities. In order to be authorized by NWP 27, the activity must not result in more than minimal individual or cumulative adverse environmental effects to the aquatic resources. All 29 general conditions of the NWP 27 apply.

If actions of a particular project are deemed to potentially result in “more than minimal individual or cumulative adverse environmental effects to the aquatic resources,” an Individual Permit (IP) would be pursued for that project.

Within the MNRR, no blanket 401 certification has been issued with the NWP 27 due to the fact that it is a Class A stream within the Wild & Scenic River system. If the project requires an IP, a project-specific Section 401 Certification will be obtained from the applicable States which will certify that the proposed action will not violate State water quality standards. National Pollutant Discharge Elimination System (NPDES) permits (Section 402) must also be obtained from the applicable state.

In coordination with the State of Nebraska, a sediment sampling and elutriate testing project was conducted in 2009 to address state concerns regarding fill contamination for future projects located along the Nebraska border upstream of Kensler’s Bend (i.e., RM 745).

Leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects. Significant impacts to water quality are not anticipated.

6.8.7.3 Biological Resources (Gavins Point River Segment, Existing Program)

6.8.7.3.1 Vegetation (Gavins Point River Segment, Existing Program)

Disturbance of vegetation due to construction activities is anticipated to low, impacting an estimated 314 acres of herb/shrub/sapling (13% of this vegetation class) and 15 acres of forest (less than 1% of this vegetation class) in the Gavins Point River Segment, all within the available area (see Table 6-4; also (see Sections 4.5 and 4.6; Table 4-25). It is not anticipated that all potential vegetation modification would be carried out in a single growth season and it would be unlikely to have long-term impacts to vegetation in this segment. Due to the abundance of vegetated sandbars, as well as the trend of progressive vegetation of bare sandbars, removal of vegetation due to the proposed actions is not believed to have a significant impact in this segment.

6.8.7.3.2 Wetlands (Gavins Point River Segment, Existing Program)

Characterization of the wetlands habitat from the 2005 aerial photography identified approximately 688 acres of wetlands within the 23,228-acres of habitat from high-bank to high-bank. This represents approximately 3% of the total habitat within the segment. As described in Appendix B, the de-selection process used to avoid sensitive resources included the areas of wetland habitat. In addition, site-specific pre-construction surveys for wetlands would avoid what has not already been identified through the sensitive resources database.

Because construction activities could occur within the “available” area construction of this alternative could be accomplished without a significant loss of existing wetlands (see Sections 4.5 and 4.6; Table 4-25).

6.8.7.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, Existing Program)

The direct effects to fish and wildlife within the Gavins Point River Segment from disturbing 371 acres of river bottom habitat, representing 1.6% of the entire high-bank to high-bank habitat, to construct the Existing Program Alternative would not likely create significant effects to fish and wildlife if implemented cautiously. Site selection and pre-construction site evaluations are essential and would be expected to identify additional areas to be avoided.

An attempt to avoid biologically important habitat (e.g., wetlands, submerged aquatic vegetation) for construction appears feasible for the Existing Program in the Gavins Point River Segment and significant effects to fish and wildlife should be avoidable. The extent of construction would not be expected to create significant effects to fish and wildlife.

Current evidence suggests a low risk of entrainment for fish during dredging operations. An extensive laboratory study was designed to study three measures of swimming performance, rheotaxis (the response of an organism to orientate itself to the stimulus of the environment), endurance (how long and organism can maintain its current activity), and behavior, (an organism’s direct responses to a stimulus) (Hoover et. al. 2005), for three fish species of interest, paddlefish (*Polyodon spathula*), lake sturgeon (*Acipenser fulvescens*) and pallid sturgeon (*Scaphirhynchus albus*). As paddlefish are pelagic, or open water, swimmers, this study found they were at little to no risk of entrainment. Lake sturgeon are demersal, bottom swimmers, but also showed little risk of entrainment, possibly because they do not rest on the bottom substrate. Pallid sturgeon showed some risk of entrainment in this laboratory study, largely due to substrate resting behavior they exhibited. The researchers of this study stated, "Total risk of entrainment, however, is a cumulative value associated with behavioral, physiological and demographic data." (Hoover et. al. 2005). This was research conducted fully in controlled laboratory settings. Additional field results have shown extremely limited entrainment due to dredging.

A field study, "Evaluating Potential Entrainment of Pallid Sturgeon during Sand Mining Operations," conducted by ERDC from September 30 to October 2, 2008 using three different sampling techniques found no entrainment of fish as a result of dredging operations performed (ERDC 2008). In the first technique, the dredged material was directly assessed by use of a mesh screen to determine if entrainment had occurred. In the second technique, the head of the dredge was positioned in the water column (versus the bottom of the river), and the filled barge was then seined. The third technique involved trawling for fish pre-dredging, during dredging, and post dredging to determine what fish were present in the immediate vicinity of the dredge. Using these three techniques, no fish were taken. In the first technique, there were remnants of gastropod shells but that was the only evidence of living organisms (ERDC 2008). In fact for the entire period of 1990-2005, there are fewer than 25 confirmed cases of sturgeon entrainment by dredges operating in Gulf and Atlantic waters (Hoover et. al. 2005).

Another potential area for impacts could be increased turbidity. High concentrations of fine-grained, inorganic particles can smother stream-bed and bank habitats, burying and suffocating eggs and newly hatched organisms, and can damage to gill structures. Reduced light penetration may reduce the growth of aquatic plants, affecting food, cover, and daily oxygen production. On the other hand, a moderate increase in turbidity may be beneficial to some native species, as turbidity on the Missouri River has decreased dramatically since closing of the dams. Regarding fine organic materials, borrow material is taken from areas thought to avoid high organic concentrations, in order to avoid water quality issues and because the preferred material for ESH is more sandy. All species existed in the pre-dam Missouri River that had turbidity levels thought to be 10 to 100 times greater. As a comparison, today, many native fish species such as sicklefin chub, sturgeon chub, flathead chub, western silvery minnow, and sauger are common in the lower Yellowstone River, which is characterized by a near natural flow regime and a high sediment load (i.e. secchi disk depths of only ½" in main channel habitats, extremely turbid water). Pallid sturgeon are also known to prefer turbid water and are frequently captured in this portion of the Yellowstone River; this is one of the few areas in the upper Missouri River basin where pallid spawning has been identified.

During the mechanical creation of the sandbar habitat there could be the potential for the substrate to be disturbed. Dredging could displace existing material and could cause a temporary decrease to invertebrate species density and relative abundance (Whiles and Wallace 1995). The potential disturbances from construction would mimic natural disturbances that occur during seasonal flooding. Invertebrates are in general successful at colonization after a disturbance due to relatively short lifecycles and adaptive resiliency to the riverine habitat (Whiles and Wallace 1995). The construction activities would be conducted and completed during defined construction time periods limiting the duration of the disturbance. Short term disturbances could be anticipated to pose only a temporary short term effect to the existing invertebrate community localized in the vicinity of the construction activity (Lake2000). Therefore, no significant impacts to invertebrates are anticipated due to mechanical creation of habitat.

As vegetation is cleared, there could be the potential for Glyphosate or Imazapyr to enter the substrate. Glyphosate and Imazapyr are both approved by the EPA for aquatic use.

Glyphosate's effect on invertebrates appears to be largely tied to changes in vegetation. When used at recommended application rates, there are little or no direct effects to aquatic arthropods, soilborne microbial communities, nematodes or stream macro-invertebrate communities (Guiseppe et al., 2006). Aquatic invertebrates were similarly unaffected by herbicide applications in wetlands (Gardner, 2005). Studies suggest that imazapyr applications in wetlands do not affect the invertebrate community (Fowlkes et al., 2002). Additionally, glyphosate did not lead to mortality or have effects on the reproduction rates of earthworms (Yasmin and Souza, 2007). Tests of the imazapyr formulation Arsenal found that toxicity to fruit flies was from the surfactant nonylphenol ethoxylate and not from imazapyr itself (Grisolia et. al., 2004). Therefore, no significant impacts to invertebrates are anticipated due to herbicide spraying.

In a Herptofaunal Inventory of the Missouri National Recreational River and Niobrara National Scenic River, turtle nesting success was found to be related to the use of sandbars and small islands. The ESH created would potentially provide increased opportunities for reptilian breeding success; however the majority of amphibian species (such as Woodhouse's Toad) have been spotted utilizing the islands and sand bars within the river (Fogell and Cunninghamm 2005).

Shorebird species other than piping plovers and least terns have been documented nesting on ESH constructed by the Corps of Engineers. These include the American Avocet, Killdeer, Snowy Plover and Spotted Sandpiper. In 2008 Virginia Polytechnic Institute (VPI) researchers found 16Killdeer and Spotted Sandpiper nests and 2 Snowy Plover nests constructed sandbars. In 2009 the VPI researchers found 50 Killdeer and Spotted Sandpiper nests, 10 Snowy Plover nests and 1 American Avocet nest on the constructed sandbars. Of particular interest are the Snowy Plovers whose normal breeding range limit is western Kansas and eastern Colorado. Among waterfowl, Canada Geese have been documented nesting on the constructed sandbars.

The constructed sandbars provide stopover foraging sites for species migrating between breeding and wintering grounds in the spring and fall. Shorebird species that have been documented on the constructed sandbars include Semi-palmated Povers, Ruddy Turnstones, Avocets, Hudsonian Godwits, and various Horned Owls, Red Winged Blackbirds, Yellow Headed Blackbirds, Kingbirds and various species of Swallows.

The environmental context for the consideration of fish and wildlife effects in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the presence of the MNRR. The Gavins Point River Segment's fish and wildlife resources are one of the ORVs cited in establishing the MNRR through this segment. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of other fish and wildlife species and habitat. The extent of construction would not be expected to create significant effects to fish and wildlife.

6.8.7.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, Existing Program)

As described in Section 5.3, the Gavins Point River Segment has four federally listed species that could be affected by continued implementation of the Existing Program. The potential effects to piping plover and least tern are addressed in the next section.

Effects of implementing the Existing Program on the whooping crane (*Grus americana*) would be limited to seasonal disturbance while roosting or feeding in wetlands during migration.

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but the substantially diminished area of ESH to be constructed under the existing program would not pose a significant risk to the remaining wild population of pallids. The Gavins Point River Segment is one of only six priority management areas that still provide suitable habitat for restoration and recovery (http://ecos.fws.gov/docs/recovery_plans/1993/931107.pdf) of the species. The recovery-priority areas are typically the least degraded and have the highest habitat diversity, and in some segment still exhibit a natural channel configuration of sandbars, side channels, and varied depths. The geomorphological conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation. Implementation of this alternative would not pose significant construction-related effects to the endangered pallid sturgeon.

6.8.7.3.5 State Listed Species and Habitats (Gavins Point River Segment, Existing Program)

The SDGFP has indicated that the state-listed threatened false-map turtle (*Graptemys pseudogeographica*) may occur within the Gavins Point River Segment. Because these turtles typically hibernate in soft sediments on the river bottom from October to April, they would be particularly vulnerable to the direct effects of construction. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk. The extent of habitat needing to be manipulated under the Existing Program is the least among the alternatives diminishing the risks of significant effects to the false-map turtle.

The NGPC identified four fish species that were of state concern: the state-endangered sturgeon chub (*Macrhybopsis gelida*), state-threatened lake sturgeon (*Acipenser fulvescens*), and "At-Risk" species blue sucker (*Cycleptus elongates*) and sicklefin chub (*Macrhybopsis meeki*). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk. The extent of habitat needing to be manipulated under the Existing Program is the second least among the alternatives, diminishing the risks of significant effects to these species.

6.8.7.3.6 Effects to Least Tern and Piping Plover (Gavins Point River Segment, Existing Program)

Increasing turbidity in areas where birds forage could be a potential impact of construction. Shallow water zones utilized by the tern and plover adjacent to nesting areas are less impacted by turbidity than the thalweg (deepest/fastest part of channel). Any changes in turbidity in shallow water areas would be expected to be minor, localized and temporary.

By constructing 125 acres of ESH annually (ultimately ending in 833 acres in 2 to 3 decades), 208 acres of nesting habitat would be eventually created (see Appendix C). Segment-specific measurements of nesting densities were developed for both species, as described in Appendix B. A simple multiplication of the nesting density times the number of acres of nesting habitat determines the number of nests that the created habitat could support, assuming two adults per nest, the species-specific number of adults that could be accommodated by providing 125 acres of ESH annually in the Gavins Point River Segment under the Existing Program. The dataset for the Gavins Point River Segment (2000-2006) identified 1,175 piping plover nests and 1,416 least tern nests over the entire 7-year period.

The recovery plan for the least tern (USFWS, 1990) establishes a segment-specific goal of 400 adult least terns in the Gavins Point River Segment. The recovery plan for the piping plover establishes a segment-specific goal of 250 adult pairs (500 adults) in Gavins Point River Segment (USFWS, 1988). The effect on the least tern and piping plover from constructing a 125 acres of ESH each year in the Gavins Point River Segment is uncertain, as other factors besides the number of acres of ESH limit their abundance.

The creation of habitat to support least terns and piping plovers is the purpose of the ESH program, and therefore additional acres of habitat could be considered positive. While construction activities could create disturbances, they are anticipated to occur before the birds are present for their nesting and rearing season. As additional habitat is provided, the effects of localized natural events on the least terns and plovers could be minimized, both within and among the segments.

6.8.7.4 Socioeconomic Resources (Gavins Point River Segment, Existing Program)

6.8.7.4.1 Recreation (Gavins Point River Segment, Existing Program)

The direct effects to recreation would be from construction-related noise, vibration, fugitive emissions, and deterioration in water quality 24 hours a day, 7 days a week for a portion of the 77-day period available for construction. Construction would require one team of mechanical operators (46 days) and one dredges (40 days) working throughout the segment to construct the requisite acres within the allowable period each year.

Because construction is limited to the fall, much of the summer recreation would not be affected. However, this river segment supports substantial recreation in the form of fishing and waterfowl hunting. The Mestl et al (2001) study of recreation identified that 15% (32,550 hours) of the fishing in the Gavins Point River Segment occurred between mid-August and early December; autumn hunting accounted for 1,378 hours of recreation. Continued implementation of the Existing Program could cause minor conflicts with recreation during construction. Construction equipment operations would impede access to some hunting and fishing areas, and the noise would disturb recreationists and wildlife, including waterfowl.

The environmental context for the consideration of effects to recreation in the Gavins Point River Segment is different from that of the Fort Peck River or Garrison River Segments because of the designation of the MNRR. The Gavins Point River Segment's recreational resources are one of the ORVs cited in establishing the 59-Mile District of the MNRR. The NPS' mandate establishes a non-degradation and enhancement policy requiring a careful consideration of the trade-offs between the benefits to the least tern and piping plover at the expense of a significantly diminished recreational experience within the MNRR. Access to some hunting and fishing sites would be impaired, but because only one dredge will be operating during construction, some alternative sites would be available where the noise was too far away to disturb waterfowl and the fish and wildlife habitat was not degraded enough to significantly reduce harvest rates for hunters and anglers. Also, after the construction equipment was removed, the ambient noise levels, viewsheds, and access to hunting and fishing sites would be restored. No significant impacts to visitation or recreation are anticipated.

6.8.7.4.2 Noise (Gavins Point River Segment, Existing Program)

Construction of 125 acres of ESH would require dredges and mechanical equipment operating continuously (24 hours a day - 7 days a week) for a portion of the 77-day period available for construction every year. Low noise effects would be predicted during this timeframe.

6.8.8 No Program (Gavins Point River Segment)

The Gavins Point River Segment is the downstream-most extent of the MNRR. Impacts to the MNRR are specifically discussed by Alternative under the sub-sections for resources that are also ORVs: aesthetics, fish and wildlife (also in Federal and State listed species) and recreation resources. Cultural and historic resources are discussed in general in Section 6.1 under headings eliminated from detailed consideration.

6.8.8.1 Physical Resources (Gavins Point River Segment, No Program)

6.8.8.1.1 Air Quality (Gavins Point River Segment, No Program)

Under the no action alternative, potential direct and indirect air quality impacts associated with the construction of ESH in the Gavins Point River Segment would not occur and air quality would not change from existing conditions.

6.8.8.1.2 Aesthetics (Gavins Point River Segment, No Program)

Without implementation of any of the action alternatives, there would be no temporary construction-related deterioration of visual resources or permanent changes to the visual resources of the Gavins Point River Segment; there would also be no effects to the outstandingly remarkable natural value in the 59-Mile District of the MNRR.

6.8.8.2 Water Resources (Gavins Point River Segment, No Program)

6.8.8.2.1 Surface Water Hydrology and Hydraulics (Gavins Point River Segment, No Program)

Under the no action alternative, potential direct and indirect effects to surface water hydrology and hydraulics would not occur.

6.8.8.2.2 Aggradation, Degradation, and Erosion (Gavins Point River Segment, No Program)

Taking no action to mechanically construct ESH would not risk increasing erosion or deposition rates from program implementation.

6.8.8.2.3 Water Quality (Gavins Point River Segment, No Program)

Absent the construction-related effects to water quality predicted under the action alternatives, water quality would remain unchanged from the existing conditions.

6.8.8.3 Biological Resources (Gavins Point River Segment, No Program)

6.8.8.3.1 Vegetation (Gavins Point River Segment, No Program)

Under the no action alternative, there would be no direct or indirect impacts to vegetation observed within the segment.

6.8.8.3.2 Wetlands (Gavins Point River Segment, No Program)

Under the no action alternative, there would be no direct or indirect impacts to wetland observed within the segment.

6.8.8.3.3 Fish, Invertebrates and Wildlife (Gavins Point River Segment, No Program)

Under the no action alternative, there would be no direct impacts to the fisheries and wildlife of the Gavins Point River Segment. In the absence of an ESH program, wildlife abundance and diversity within the segment would remain substantially unchanged.

6.8.8.3.4 Federally and State Listed Species and Habitats (Gavins Point River Segment, No Program)

Under the no action alternative, there would be no direct or indirect effects to the pallid sturgeon (*Scaphirhynchus albus*) or whooping crane (*Grus americana*) and their habitat. There would also be no direct or indirect effects to the false-map turtle (*Graptemys pseudogeographica*), sturgeon chub (*Macrhybopsis gelida*), lake sturgeon (*Acipenser fulvescens*), blue sucker (*Cycleptus elongates*), or sicklefin chub (*Macrhybopsis meeki*).

6.8.8.3.5 Effects to Least Tern and Piping Plover (Gavins Point River Segment, No Program)

Taking no action, there would be no deleterious effects to the ORVs within the MNRR from the ongoing construction activities, but there would also be no beneficial effects to the least tern and piping plover and no additional created habitat. The interchannel sandbar observed in the Gavins Point River Segment would likely persist in approximately the current quantities at nearly the existing locations, although with decreasing quality of nesting habitat as vegetation overtakes any remaining barren areas. Failing to take action to mechanically create ESH would lead to least tern and piping plover reproduction success as observed prior to the 1996-1997 high releases from the Gavins Point Dam.

6.8.8.4 Socioeconomic Resources (Gavins Point River Segment, No Program)

Taking no action would be expected to avoid any of the direct effects to recreation or noise identified for Alternatives 1-5.

6.8.9 Summary of Predicted Effects in the Gavins Point River Segment

Table 6-9 presents a summary of the effects of implementing the alternatives for the Gavins Point River Segment. These values are based on the descriptions of impacts for each resource, by segment, by alternative and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

Table 6-9: Summary of Potential Significant Adverse Effects in the Gavins Point River Segment

Parameter	Alternative 1 2015 Goals	Alternative 2 2005 Goals	Alternative 3 1998/1999 ESH	Alternative 3.5 Intermediate	Alternative 4 2005 ESH	Alternative 5 Nesting Patterns	Continue Existing Program	No Program
Air Quality	No	No	No	No	No	No	No	No
Aesthetics	High	High	High	Moderate	Low	Low	No	No
Surface Water Hydrology and Hydraulics	High	Moderate	Moderate	Moderate	Low	Low	No	No
Degradation, Aggradation, and Erosion	High	High	High	Moderate	Low	Low	Low	No
Water Quality	High	Moderate	Moderate	Moderate	Low	Low	No	No
Wetlands	High	Moderate	Moderate	Moderate	Low	Low	No	No
Vegetation	Moderate	Low	Low	Low	Low	Low	Low	No
Fish and Wildlife	High	Moderate	Moderate	Moderate	Low	Low	Low	No
Pallid Sturgeon	High	High	High	Moderate	Low	Low	No	No
Least Tern and Piping Plover	No	No	No	No	No	No	No	No
Recreation	High	High	High	Moderate	Low	Low	Low	No
Noise	High	High	High	Moderate	Low	Low	Low	No

6.9 UNAVOIDABLE ADVERSE IMPACTS

Council on Environmental Quality (CEQ) regulations require a discussion of any potential adverse environmental effects that cannot be avoided should the proposal be implemented (40 C.F.R. 1502.16). Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize the risk of significant unavoidable adverse impacts. Potential unavoidable adverse impacts by resource category are discussed below.

6.9.1 Air Quality

Unavoidable adverse impacts related to air quality would be limited to indirect effects related to the emissions from transportation of personnel and equipment to and from the job sites on a daily basis annually. No risk of significant long-term adverse effects would be predicted for any of the proposed alternatives.

6.9.2 Aesthetics

For each of the proposed alternatives, potential unavoidable adverse aesthetic impacts include annual and the accumulation of longer-term visual changes. Impacts would be considerable because of the magnitude of annual construction. Changes to vistas would occur as annual construction activities with landside modification for access as well as in-pool equipment operations would contrast with the various river segment landscapes. The visual impacts resulting from the accumulation of ESH resulting from the annual creation and/or replacement of ESH could be aesthetically significant.

6.9.3 Surface Water Hydrology and Hydraulics

The potential effect to river stage was assessed in the GIS analysis described in Appendix B. Potential unavoidable adverse impacts are anticipated to be highest in the Garrison River Segment, assuming implementation of one of Alternatives 1-3. Constructing the number of acres of ESH for Alternatives 1-3 would require disturbing substantially more than the “available” area identified in the analysis for the Garrison River Segment. Constructing any one of Alternatives 1-3 in the Garrison River Segment could potentially encroach into the available cross-sectional area, risk significant effects to the river hydraulics, and lead to significant bank erosion; however, the use of construction constraints could reduce the likelihood of impacts by avoidance.

6.9.4 Aggradation, Degradation and Erosion

The potential effects to aggradation, degradation, and erosion from constructing any one of Alternatives 1-3 in the Garrison River Segment would almost certainly be significant. The number of acres of ESH required under Alternative 1-3 would require using a high percentage of high-bank to high-bank habitats and substantially exceed the area available when avoiding sensitive resources. The risk of unavoidable adverse impacts to aggradation, degradation, and erosion is decreased, although still moderate, in the Garrison River Segment assuming implementation of Alternatives 3.5, and far less for Alternatives or 4 or 5. All other river segments have a low risk of unavoidable adverse impacts in relation to aggradation, degradation, and erosion.

6.9.5 Water Quality

A localized construction-related decrease in water quality could result from an increase in turbidity and suspended sediments, a mobilization of nutrients and detritus from the bottom, potentially leading to a localized reduction in dissolved oxygen, and a potential for the mobilization of contaminants sequestered in bottom sediments. Minimization of impacts to water quality during construction is important as leaks from fuel/hydraulics of earth-moving equipment can create water quality effects during the construction process. Adherence to best management practices during construction should minimize the risk of unintended water quality effects.

6.9.6 Wetlands

The potential for unavoidable adverse impacts to wetlands is highest in the Garrison River and Lewis and Clark Lake Segments, assuming the implementation of Alternatives 1-3. The remaining alternatives have a low risk of adversely impacting wetland across all segments. Indirect effects to wetlands from annually constructing ESH could result in unavoidable adverse impacts. The extent of dredging required annually to create or retain the requisite number of acres would suspend large quantities of silt and sediment beginning in mid September. This annual suspension of silt would affect the last 2-3 months of the growing season by inhibiting photosynthesis. This chronic (i.e., annual) reduction in primary productivity for plankton as well as hydrophytes and vascular plants could diminish the vigor or existing wetlands and submerged aquatic vegetation leading to changes in species abundance and diversity over time. These changes could lead to greater success for invasive species such as purple loosestrife and reed canary grass.

6.9.7 Fish & Wildlife

The unavoidable adverse impacts to fish and wildlife due to construction of ESH would be caused by the direct temporary displacement of fish and wildlife from active construction zones and from temporary disruption of wildlife movement through construction zones. Alternatives 1-3 carry the highest risk for unavoidable adverse impacts; however, site selection and pre-construction site evaluations would identify areas to be avoided, minimizing the potential effects. The indirect effects to primary productivity, submerged aquatic vegetation, and wetlands vegetation would predictably lead to decline in the forage base as well as the habitat quality for fish and wildlife. Over time, these changes could be significant.

6.9.8 Federally and State Listed Species and Habitats

The potential effects to the pallid sturgeon (*Scaphirhynchus albus*) are uncertain, but there could be unavoidable adverse impacts to pallid sturgeon populations from implementation of any one of Alternatives 1-4. Of the aforementioned alternatives, Alternative 4 carries the lowest risk of unavoidable impacts to pallid sturgeon. The geomorphologic conditions that facilitate "natural channel configuration of sandbars, side channels, and varied depths" also favor the retention of interchannel sandbar and would be favorable sites for ESH creation and/or retention. The potential annual burden of construction within Recovery-Priority Areas risks permanent construction-related effects to the endangered pallid sturgeon.

6.9.9 Recreation

The highest risk for unavoidable adverse impacts to recreation is associated with the implementation of Alternatives 1-3 in all reaches except for the Fort Peck River segment where none of the alternatives carry a high risk of causing unavoidable adverse impacts to recreation. The direct unavoidable adverse effects to recreation would be from construction-related noise, vibration, fugitive emissions, and a localized deterioration in water quality during the entire period available for construction each year. Because construction is limited to the fall, much of the summer recreation would not be affected. However, river segments that support significant autumnal recreation such as fishing, hunting, and bird-watching would be adversely affected

6.9.10 Noise

The highest risk for unavoidable adverse noise impacts is associated with the implementation of Alternatives 1-3, with the exception of in the Fort Peck River segment where none of the alternatives carry a high risk of causing unavoidable adverse noise impacts. Construction of ESH would require teams of earth-moving equipment (e.g., dozers, scrapers, and excavators), dredges and other miscellaneous equipment operating almost continuously (24 hours a day - 7 days a week) for the entire 62- or 77-day period available for construction annually. Significant noise effects would be predicted, disrupting to recreation.

6.10 Relationship Between Short-Term Uses of the Environment and Long-Term Productivity

CEQ regulations require a discussion of the relationship between short-term uses of the environment and the environment's long-term productivity (40 C.F.R. 1502.16).

Implementation of the ESH program would result in various impacts related to construction of ESH. As discussed in preceding sections, the majority of impacts associated with construction of ESH would be temporary, short-term impacts. Consistent implementation of the site selection and pre-construction site surveys, as described in Section 3.5 and Appendix G, should minimize short-term impacts and protect long-term productivity of the environment. The proposed ESH program is grounded in a comprehensive planning process which considers key resource components of the of the river ecosystem. The short-term resource uses are not anticipated to have a detrimental effect on the long-term productivity of the environment.

6.11 Irreversible or Irretrievable Commitments of Resources

CEQ regulations require a discussion of any irretrievable and irreversible commitments of resources (40 C.F.R. 1502.16). Irretrievable impacts involve an initial loss of a resource value and an eventual restoration of that value. Irreversible impacts involve a loss of a resource value that can never be restored.

Implementation of the ESH program involves commitment of a variety of natural, physical, human, and fiscal resources. Areas converted to ESH are considered an irreversible commitment of resources during the period it remains as ESH. Given the program will follow an Adaptive Management approach, created ESH could be returned to its former state if a more-suitable location is identified based on new knowledge. A comprehensive citing process will be used to identify candidate areas for ESH creation with a high potential for success; therefore, it is unlikely that ESH areas would be returned to their former condition.

Given the amount of ESH to be created or retained, a considerable amount of fossil fuel, labor, and non-retrievable funding will be expended. Additionally, large amounts of sediment will be relocated to construct the ESH areas. The commitment of these resources is based upon the concept that least terns, piping plovers, the river ecosystem, and residents of the surrounding region will benefit from implementation of the ESH program.

6.12 LIST OF REQUIRED FEDERAL PERMITS AND OTHER AUTHORIZATIONS

The permits and approvals shown in Table 6-10 will be required to implement the proposed project.

Table 6-10: Required permits and approvals

Agency	Permit(s)	Activities	Area
Corps of Engineers, Regulatory Branch	Rivers and Harbors Act Section 10, Clean Water Act Section 404	ESH Construction	All Areas
Corps of Engineers, Floodplain Management Section	"No-Rise" Certificate (Coordinate with State and Local Floodplain Agencies)	ESH Construction	All Areas
Corps of Engineers, Cultural Resources Section & State and Tribal Historic Preservation Offices	Section 106 Historical and Cultural Resources Protection	ESH Construction	Each State
Fish and Wildlife Service	Migratory Bird Depredation Permit	Predation Control (Avian Predators)	All Areas
Montana Department of Environmental Quality	National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activities	ESH Construction	Montana
Montana Department of Environmental Quality	Section 401 Water Quality Certification, 318 Authorization (Short-Term Water Quality Standard for Turbidity)	ESH Construction	Montana
Montana Department of Fish, Wildlife and Parks	Montana Stream Protection Act 124 Permit, Scientific Collector's Permit	ESH Construction	Montana
Montana Department of Natural Resources and Conservation / County Floodplain Administrators	Floodplain Development Permit, Navigable Waterways License / Easement / Lease	ESH Construction	Montana
National Park Service	Wild and Scenic Rivers Act Section 7a, Scientific Research and Collecting Permit	ESH Construction, Predation Control	Recreational River Reaches – Nebraska, South Dakota
Nebraska Department of Environmental Quality	National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activities	ESH Construction	Nebraska
Nebraska Department of Environmental Quality	Section 401 Water Quality Certification	ESH Construction	Nebraska
Nebraska Department of Game and Parks	Capture Permit	Predation Control	Nebraska
Nebraska Department of Natural Resources / Counties	Floodplain Development Permit	ESH Construction	Nebraska
North Dakota Counties	Floodplain Development Permit	ESH Construction	North Dakota
North Dakota Department of Health	Section 401 Water Quality Certification	ESH Construction	North Dakota
North Dakota Department of Health/North Dakota	National Pollutant Discharge Elimination System General Permit for Storm Water Discharges	ESH Construction	North Dakota

Department of Transportation	Associated with Construction Activities		
North Dakota Game and Fish Department	Permit	Predation Control	North Dakota
North Dakota State Water Commission	Authorization to Construct Within Islands and Beds of Navigable Streams (Sovereign Lands Permit)	ESH Construction	North Dakota
South Dakota Department of Environment and Natural Resources	National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activities	ESH Construction	South Dakota
South Dakota Department of Environment and Natural Resources	Section 401 Water Quality Certification	ESH Construction	South Dakota
South Dakota Department of Game Fish and Parks	Scientific Collector's Permit	Predation Control	South Dakota
U.S. Department of Agriculture	Wildlife Services Permit (37)	Predation Control	All Areas

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7 SUMMARY AND COMPARISON OF ENVIRONMENTAL EFFECTS

7.1 SUMMARY OF ENVIRONMENTAL EFFECTS OF THE ACTION ALTERNATIVES

The following table provides a summary of the segment-specific impacts, by alternative, represented in Chapter 6. The remainder of this chapter provides a summary of the basin-wide impacts of implementing the six action alternatives.

Table 7-1: Summary: Potential Significant Adverse Segment-Specific Effects, by Alternative

Segment-Specific Summary of Potential Significant Adverse Effects by Alternative																																								
Parameter	Alt 1 2015 Goals					Alt 2 2005 Goals					Alt 3 1998/1999 ESH					Alt 3.5 Intermediate					Alt 4 2005 ESH					Alt 5 Nesting Patterns					Existing Program					No Program				
	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP	FP	GA	FR	LC	GP
Air Quality	N	N	N	N	N	na	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Aesthetics	H	H	H	H	H	na	M	M	M	H	H	M	M	M	H	M	M	M	M	M	M	L	L	L	L	N	L	L	L	L	N	N	N	N	N	N	N	N	N	N
Surface Water H&H	N	H	L	L	H	na	M	L	L	M	N	M	L	L	M	N	L	L	L	M	N	L	L	L	L	N	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Degredation Aggradation Erosion	H	H	H	H	H	na	H	H	M	H	H	H	H	M	H	M	H	M	L	M	L	M	L	L	L	L	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Water Quality	L	L	M	M	H	na	L	L	M	M	L	L	L	M	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Vegetation	L	L	L	L	M	na	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Wetlands	L	H	L	H	H	na	M	L	M	M	L	M	L	M	M	N	L	L	L	M	N	L	L	L	L	N	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Fish & Wildlife	L	H	H	H	H	na	M	M	M	M	L	M	M	M	M	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Pallid Sturgeon	H	H	H	M	H	na	H	M	M	M	H	H	M	M	H	M	M	L	L	M	M	L	L	L	L	N	L	L	L	L	N	N	N	L	N	N	N	N	N	N
Terns & Plovers	N	N	N	N	N	na	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Recreation	N	H	H	H	H	na	H	M	H	H	N	H	M	H	H	N	M	L	M	M	N	M	L	L	L	N	L	L	L	L	N	N	N	L	L	N	N	N	N	N
Noise	N	H	H	H	H	na	H	M	H	H	N	H	M	H	H	N	M	L	M	M	N	L	L	L	L	N	L	L	L	L	N	N	N	L	L	N	N	N	N	N

FP = Fort Peck GA = Garrison F = Fort Randall LC = Lewis & Clark Lake GP = Gavins Point
N = None H = High M = Moderate L = Low na = Not Applicable

The values in Table 7-1 are based on the descriptions of impacts for each resource, by segment, by alternative, and on professional judgment. This information was applied using a matrix approach to ascertain a value of High, Moderate, or Low. For example, if there was a high but local recreational impact and other sites within a reasonable distance offered equivalent recreational opportunities, the potential impact on recreation is considered Moderate for the segment as a whole for that alternative.

7.1.1 Alternative 1

Compliance with the 2003 BiOp Amendment RPA (Alternative 1, 2015 Goals) for mitigation of jeopardy to least terns and piping plovers in the upper Missouri requires the creation and sustained maintenance of 11,886 acres of ESH within the high-bank to high-bank riverine corridor of the designated segments (Fort Peck River, Garrison River, Fort Randall River, Lewis and Clark Lake, and Gavins Point River). The measured total riverine habitat--including open water--within the segments is approximately 117,702 acres. The estimated total area of impact, including both the ESH area and the area needed for materials borrow (i.e., sand) is approximately 33,857 acres (29%) of this area permanently impacted by the creation of ESH. In addition, annual construction of the ESH within these segments would disturb approximately 13,540 acres (12%) of the total riverine habitat every year.

Meeting the habitat goals of this alternative, assuming construction in just 1 year, would require moving over 69 million cubic yards of material with approximately 5,293 days of dredge operation and 4,499 days of mechanical work. Spreading the construction over 10 years, annual construction (creation and/or replacement of ESH) of 4,802 acres would require moving over 28 million cubic yards of material with approximately 2,451 days of dredge operation and 1,926 days of mechanical work each and every year at an estimated annual cost of $197 million if fully implemented (including construction, planning, engineering and design, and contingency).

7.1.2 Alternative 2

Construction of Alternative 2 (2005 Goals) in the upper Missouri River requires the creation of 5,502 acres of ESH within the high-bank to high-bank riverine corridor of the designated segments (Fort Peck River, Garrison River, Fort Randall River, Lewis and Clark Lake, and Gavins Point River Segments). The measured total riverine habitat--including open water--within the segments is approximately 117,702 acres. The estimated total area of impact, including both the ESH area and the area needed for materials borrow (i.e., sand) is approximately 15,619 acres (13%) of this area permanently impacted by the creation of ESH. In addition, annual construction of the ESH within these segments would disturb approximately 4,943 acres (6%) of the total riverine habitat every year.

Meeting the habitat goals of this alternative, assuming construction in just 1 year, would require moving over 32 million cubic yards of material with approximately 2,492 days of dredge operation and 2,069 days of mechanical work. Spreading the construction over 10 years, annual construction (creation and/or replacement of ESH) of 1,786 acres would require moving over 10 million cubic yards of material with approximately 961 days of dredge operation and 656 days of mechanical work in each and every year at an estimated annual cost of $73 million if fully implemented (including construction, planning, engineering and design, and contingency).

7.1.3 Alternative 3

Construction of Alternative 3 (actual 1998/1999 habitat) requires the creation of 6,754 acres of ESH within the high-bank to high-bank riverine corridor of the designated segments (Fort Peck River, Garrison River, Fort Randall River, Lewis and Clark Lake, and Gavins Point River Segments). The measured total riverine habitat--including open water--within the segments is approximately 117,702 acres. The estimated total area of impact, including both the ESH area and the area needed for materials borrow (i.e., sand) is approximately 19,458 acres (17%) of this area permanently impacted by the creation of emergent sandbar habitat. In addition, annual construction (creation and/or replacement) of the ESH within these segments would disturb approximately 6,055 acres (5%) of the total riverine habitat every year.

Meeting the habitat goals of this alternative, assuming construction in just 1 year, would require moving over 39 million cubic yards of material with approximately 2,838 days of dredge operation and 2,653 days of mechanical work. Spreading the construction over 10 years, annual construction and subsequent maintenance of 2,140 acres would require moving over 12 million cubic yards of material with approximately 1,096 days of dredge operation and 891 days of mechanical work each and every year at an estimated annual cost of $88 million if fully implemented (including construction, planning, engineering and design, and contingency).

7.1.4 Alternative 3.5 - Impact Level Identified with AMIP Preferred Alternative

Construction of Alternative 3.5 (Average between 1998 - 2008 Habitat) requires the creation and sustained maintenance of 4,370 acres of ESH within the high-bank to high-bank riverine corridor of the designated segments (Fort Peck River, Garrison River, Fort Randall River, Lewis and Clark Lake, and Gavins Point River Segments). The measured total riverine habitat--including open water--within the segments is approximately 117,702 acres. The estimated total area of impact, including both the ESH area and the area needed for materials borrow (i.e., sand) is approximately 12,606 acres (11%) of this area permanently impacted by the creation of ESH. In addition, annual construction (creation and/or replacement) of the ESH within these segments would disturb approximately 3,323 acres (3%) of the total riverine habitat every year.

Meeting the habitat goals of this alternative, assuming construction in just 1 year, would require moving over 25 million cubic yards of material with approximately 1,827 days of dredge operation and 1,722 days of mechanical work. Spreading construction over 10 years, annual construction of 1,182 acres would require moving over 6.9 million cubic yards of material with approximately 621 days of dredge operation and 481 days of mechanical work in each and every year at an estimated annual cost of $48.5 million if fully implemented (including construction, planning, engineering and design, and contingency).

7.1.5 Alternative 4

Meeting the ESH requirements of Alternative 4 (Actual 2005 Habitat) requires the sustained retention of 1,986 acres of ESH within the high-bank to high-bank riverine corridor of the designated segments (Fort Peck River, Garrison River, Fort Randall River, Lewis and Clark Lake, and Gavins Point River Segments). The measured total riverine habitat--including open water--within the segments is approximately 117,702 acres. Annual replacement of the ESH within these segments would disturb approximately 955 acres (0.8%) of the total riverine habitat every year. Total impacted area would be dependent on whether existing sandbars were retained or new ones constructed in other areas as existing ESH was eroded.

Annual construction (replacement only for this alternative) of 347 acres would require moving over 2 million cubic yards of material with approximately 196 days of dredge operation and 131 days of mechanical work at an estimated average annual cost of $14.3 million if fully implemented (including construction, planning, engineering and design, and contingency).

7.1.6 Alternative 5

Meeting the ESH requirements of Alternative 5 (Meet Fledge Ratios) requires the sustained retention of 1,315 acres of ESH within the high-bank to high-bank riverine corridor of the designated segments (Fort Peck River, Garrison River, Fort Randall River, Lewis and Clark Lake, and Gavins Point River Segments). The measured total riverine habitat--including open water--within the segments is approximately 117,702 acres. Annual construction of the ESH within these segments would disturb approximately 445 acres (0.4%) of the total riverine habitat every year. Total impacted area would be dependent on whether existing sandbars were retained or new ones constructed in other areas as existing ESH was eroded.

Annual construction (replacement only for this alternative) of 164 acres would require moving over 960,000 cubic yards of material with approximately 95 days of dredge operation and 56 days of mechanical work each and every year at an estimated annual cost of $6.7 million if fully implemented (including construction, planning, engineering and design, and contingency).

7.1.7 Existing Program

Meeting the ESH requirements of the Existing Program requires the sustained retention of 833 acres of ESH within the high-bank to high-bank riverine corridor of the Gavins Point River Segment and 50 acres of ESH in the Lewis & Clark Lake Segment. Annual construction of the ESH within these two segments would disturb approximately 58 acres of the total riverine habitat every year.

The Existing Program alternative consists of annually constructing 125 acres of ESH in the Gavins Point River Segment and 25 acres of ESH in the Lewis & Clark Lake Segment. Assuming an annual loss rate of 15 percent in the Gavins Point River Segment and 50 percent in the Lewis and Clark Lake Segment, the ultimate habitat created would be 833 acres (down from 880 acres in 2005 to 843 acres 10 years later) and 50 acres, respectively. Total impacted area would be dependent on whether existing sandbars were retained or new ones constructed in other areas as existing ESH was eroded.

The estimated annual cost for construction of the Existing Program would be $6.1 million (including construction, planning, engineering and design, and contingency).

8 AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

The ESH program will take a programmatic approach to compliance with Section 404(b)(1) of the Clean Water Act through a strategy of avoidance and minimization of impacts.

There will also be a programmatic approach to Real Estate issues with respect to a project's effect on a local land-owner and how the pursuit of easements within the MRRP would benefit the least tern and piping plover.

Sensitive resources, when discovered within a project footprint, will be addressed. Sensitive resource concerns vary by state.

8.1 SUMMARY OF MEASURES TO AVOID AND MINIMIZE RESOURCES

The interagency processes, used to coordinate the location of construction sites site-specific surveys (if warranted), and the use of the sensitive resources GIS data layers for project citing will allow the ESH program to avoid and minimize significant impacts to sensitive resources under all but the alternatives with the larger acreage goals. Specific resources, such as cultural sites and wetlands, require site-specific information; therefore, construction cannot be approved in a programmatic sense.

8.1.1 Cultural Resources

Each proposed sandbar habitat area will be checked to see if the area has been inventoried for cultural resources. Records and literature at the appropriate State Archeological Research Center, museums, Tribes, Tribal Historic Preservation Officers (THPO), and historical societies will be reviewed to determine if any cultural or historic sites are located near the proposed sandbar area, staging area, access and haul roads, or any other areas to be impacted by the proposed construction. If the area has not been inventoried, an investigation will be conducted prior to any construction activities. Particular attention will be given to the locations (if known) of steamboat wrecks. The only exception to this would be for recently (within the past 50 years) accreted lands. These types of locations would unlikely contain significant resources.

The results of the literature and records search (and possible investigation and report) will accompany a Section 106 compliance letter from the Corps to the appropriate State Historic Preservation Office or THPO inviting their concurrence to the Corps' determination of effect.

8.1.2 Wetlands

Information on site-specific wetlands impacts will be coordinated with the Corps' Regulatory Office for the appropriate state as part of the Section 404 process. Coordination will also be done under Section 401 with the appropriate state water office. Where appropriate, coordination will also be done with the NPS through the 404 and 401 processes. See Section 3.6 for more information.

8.1.3 Missouri National Recreational River

The 2003 BiOp Amendment specifies habitat goals within the 59-Mile and 39-Mile Districts of the MNRR. The NPS and the Corps manage the MNRR through a cooperative agreement. The In preparation of this Draft PEIS, the Corps worked with the NPS to identify different scales of implementation through the various alternatives, discussed how to minimize impacts, and utilized GIS buffers to identify sensitive resources (see Section 4.2.1). As project implementation continues, NPS is represented on the ESH Project Delivery Team (PDT) and, therefore, is heavily involved in the selection of and design of potential sites. The NPS is the overall administrator for the MNRR and has responsibility for WSRA Section 7A determination of effects in the MNRR. If there are concerns regarding specific resources within a potential project area, site-specific coordination and surveys, if required, could be performed.

8.1.4 Other Sensitive Resources

Other resources identified in scoping will be considered when identifying site-specific construction. If warranted, site-specific surveys will be conducted. An Environmental Checklist of applicable laws and policies will be used to ensure proper compliance and coordination (see Chapter 9).

9 COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

Construction of the site specific proposed actions will not commence until the proposed action achieves environmental compliance with all applicable laws and regulations, as described below.

American Indian Religious Freedom Act (AIRFA) Of 1978, 42 U.S.C. 1996.

In compliance. AIRFA protects the rights of Native Americans to exercise their traditional religions by ensuring access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. The proposed actions would not adversely affect the protections offered by this Act. Access to sacred sites by Tribal members would not be affected.

Bald Eagle Protection Act, 16 U.S.C. Sec. 668, 668 note, 668a-668d.

In compliance. This Act prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions for the scientific or exhibition purposes, for religious purposes of Indian Tribes, or for the protection of wildlife and agriculture or for preservation of the species. The Corps has coordinated, and will continue to coordinate, with the USFWS and the appropriate state agencies to avoid taking the species during construction activities and will follow the USFWS's guidelines regarding eagle nests. See Endangered Species Act below.

CEQ Memorandum, August 10, 1980, Interagency Consultation to Avoid or Mitigate Adverse Effects on Rivers in the Nationwide Inventory**.**

In compliance. This memorandum states that each federal agency shall take care to avoid or mitigate adverse effects on rivers identified in the Nationwide Inventory (FR 1980). See Federal Water Project Recreation Act below.

Clean Air Act, as amended 42 U.S.C. 1857h-7, et seq.

In compliance. The purpose of this Act is to protect public health and welfare by the control of air pollution at its source and to set forth primary and secondary National Ambient Air Quality Standards to establish criteria for states to attain or maintain. Some temporary emission releases may occur during construction activities; however, air quality is not expected to be impacted to any measurable degree, and no long-term effects on air quality are anticipated.

Clean Water Act, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251, et seq.

In compliance. The objective of the CWA, as amended, (Federal Water Pollution Control Act) 33 U.S.C. 1251, et seq. is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (33 U.S.C. 1251). The Corps regulates discharges of dredge or fill material into waters of the United States pursuant to Section 404 of the CWA. This permitting authority applies to all waters of the United States including water deemed jurisdictional by virtue of possession of a significant nexus with traditionally navigable waters. The selection of disposal sites for dredged or fill material is done in accordance with the Section 404(b)(1) guidelines, which were developed by the U.S. EPA (see 40 CFR Part 230). Most of the dredging activities for these projects will be covered under a type of Section 404 permit called a Nationwide 27 permit which authorizes Aquatic Habitat Restoration, Establishment, and Enhancement Activities (72 FR 11092). Section 401 of the CWA allows states to grant or deny water quality certification for any activity that results in a discharge into waters of the United

States and requires a Federal permit or license. Certification requires a finding by the effected states that the activities permitted would comply with all water quality standards individually or cumulatively over the term of the permit. If Section 401 water quality certification has not already been issued for the proposed project, certification will be obtained before construction begins.

If a project would require an IP, a Section 401 Certification must be obtained from the appropriate state that "certifies" that the proposed actions will not "violate" state water quality standards. The state will issue a 401 Certification letter for the proposed project, which may require elutriate testing for specific contaminants. If required per the State 401 Certification, the Corps will collect sediment samples from representative sites within the project area for elutriate testing.

<u>Comprehensive Environmental Response, Compensation and Liability Act of 1980</u>

Not applicable. Typically, CERCLA is triggered by (1) the release or substantial threat of a release of a hazardous substance into the environment or (2) the release or substantial threat of a release of any pollutant or contaminant into the environment that presents an imminent threat to the public health and welfare. To the extent that such knowledge is available, 40 CFR Part 373 requires notification of CERCLA hazardous substances in a land transfer.

<u>Endangered Species Act, as amended, 16 U.S.C. 1531, et seq.</u>

Section 7 (16 U.S.C. 1536) states that all federal departments and agencies shall, in consultation with and with the assistance of the Secretary of the Interior, ensure that any actions authorized, funded, or carried out by them do not jeopardize the continued existence of any threatened or endangered (T&E) species or result in the destruction or adverse modification of habitat of such species that is determined by the Secretary to be critical. This PEIS has analyzed the potential effects of project implementation and the resulting environmental changes from the project and has determined that the ESH program is not likely to adversely impact T&E species. This program is not likely to adversely affect the bald eagle, but a site survey prior to construction of a project is recommended to ensure there are not any nests in the project area.

<u>Environmental Justice (E.O. 12898, Federal Actions to Address Environmental Justice in minority and low income populations, 11 February 1994)</u>

In compliance. Federal agencies shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. The ESH program does not impact minority or low-income populations disproportionately.

<u>Farmland Protection Policy Act, 7 U.S.C. 4201, et seq.</u>

In compliance. This Act instructs the Department of Agriculture, in cooperation with other departments, agencies, independent commissions, and other units of the federal government to develop criteria for identifying the effects of federal programs on the conversion of farmland to non-agricultural uses. No farmland would be converted to non-agricultural use as a result of the ESH program. As such, no impact is anticipated.

<u>Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1(12), et seq.</u>

In compliance. The Act establishes the policy that consideration be given to the opportunities for outdoor recreation and fish and wildlife enhancement in the investigating and planning of any federal navigation, flood control, reclamation, hydroelectric, or multipurpose water resource project, whenever any such project can reasonably serve either or both purposes consistently**.** Impacts to recreational activities by the ESH program are identified in this PEIS.

Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661, et seq.

In compliance. The Fish and Wildlife Coordination Act requires governmental agencies, including the Corps, to coordinate activities with the USFWS so that adverse effects on fish and wildlife would be minimized when water bodies are proposed for modification. Additional verbal and email communication was initiated to ensure that USFWS concerns were addressed and that input was received with regard to the proposed project.

Flood plain Management (E.O. 11988) 42 CFR 26951

In compliance. Section 1 of the Executive Order requires that each agency provides leadership and takes action to reduce the risk of flood loss; to minimize the impact of floods on human safety, health and welfare; and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Land and Water Conservation Fund Act (LWCFA), as Amended, 16 U.S.C. 4601-4601-11, et seq.

Not applicable. Planning for recreation development at Corps projects is coordinated with the appropriate states so that the plans are consistent with public needs as identified in the State Comprehensive Outdoor Recreation Plan. The Corps must coordinate with the NPS to ensure that no property acquired or developed with assistance from this Act would be converted to any use other than outdoor recreation uses. If conversion is necessary, approval by the NPS is required, and plans are developed to relocate or re-create affected recreational opportunities. No lands involved in the ESH program have been, or will be, acquired or developed with funds of the Land and Water Conservation Fund Act.

Migratory Bird Treaty Act 1918, Executive Order 13186 (2001) (MBTA)

Partial Compliance. This law affirms, or implements, the United States' commitment to four international conventions with Canada, Japan, Mexico, and Russia for the protection of shared migratory bird resources. The MBTA governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over-utilization. Executive Order 13186 (2001) directs executive agencies to take certain actions to implement the act. The Corps will perform surveys for migratory birds and nests prior to construction and will be in consultation with the USFWS with regard to impact on migratory birds.

National Environmental Policy Act, as amended, 42 U.S.C. 4321, et seq.

In Compliance. This PEIS has been prepared following NEPA requirements.

National Historic Preservation Act, as amended, 16 U.S.C. 470a, et seq.

In compliance. Federal agencies having direct or indirect jurisdiction over a proposed federal or federally assisted undertaking shall take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places. Prior to selection of the sandbar location and the staging areas, a cultural resources investigation will be conducted. Should National Register eligible sites be located, the proposed undertaking will be relocated to an area without significant sites. If any resources are found during the implementation of any ESH project, the contractor is required to stop work and contact the Corps' Omaha District Office immediately.

Noise Control Act of 1972, 42 U.S.C. Sec. 4901 to 4918

In compliance. This Act establishes a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. Federal agencies are required to limit noise emissions to within compliance levels. Noise emission levels at any ESH project site would increase above current levels temporarily due to construction; however, appropriate measures would be taken to keep the noise level within the compliance levels. No long-term increases of noise disturbances are anticipated.

North American Wetlands Conservation Act, 16 U.S. C. Sec. 4401 et. seq.

In compliance. This Act establishes the North American Wetlands Conservation Council (16 U.S.C. 4403) to recommend wetlands conservation projects to the Migratory Bird Conservation Commission. Section 9 of the Act (16 U.S.C. 4408) addresses the restoration, management, and protection of wetlands and habitat for migratory birds on federal lands. Federal agencies acquiring, managing, or disposing of federal lands and waters are to cooperate with the USFWS to restore, protect, and enhance wetland ecosystems and other habitats for migratory birds, fish, and wildlife on their lands, to the extent consistent with their missions and statutory authorities. The ESH program does not involve any federal lands.

Protection of Wetlands (E.O.11990)

Federal agencies shall take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agencies' responsibilities. Each agency, to the extent permitted by law, shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds (1) that there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. In making this finding, the head of the agency may take into account economic, environmental, and other pertinent factors. Each agency shall also provide opportunity for early public review of any plans or proposals for new construction in wetlands.

Watershed Protection and Flood Prevention Act, 16 U.S.C. 1101, et seq.

Not applicable. This Act authorizes the Secretary of Agriculture to cooperate with states and other public agencies in works for flood prevention and soil conservation and the conservation, development, utilization, and disposal of water. This act imposes no requirements on Corps Civil Works projects.

Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271, et seq.

In compliance. This Act establishes that certain rivers of the Nation, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. A Section 7(a) evaluation would be pursued through individual site- or project-specific Environmental Assessments to analyze impacts of proposed projects and determine whether those impacts would constitute a direct and adverse effect on the river or its resources.

Summary of Mitigation for Impacted Resources

Whether there is a need for mitigation or not will vary, depending on which ESH program alternative is selected for implementation. There are ESH program options under which levels of habitat construction could always remain within the “available” area and, therefore, avoid impacting sensitive resources. Impacts to wetlands will be addressed through the General Permit for the ESH program. Impacts to cultural resources will be avoided.

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10 CUMULATIVE EFFECTS

Cumulative effects result "from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non federal) or person undertakes such actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time" (40 CFR 1508.7). These actions include projects conducted by government agencies, businesses, or individuals that are within the spatial and temporal boundaries of the actions considered in this PEIS. Cumulative actions, when viewed with other proposed actions, can have cumulatively significant effects and should, therefore, be discussed in the same impact statement. Similar actions are defined as actions that, when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequence together, such as timing or geography.

Since this PEIS is a "programmatic" approach to impacts within an ongoing ESH program over various segments over time, in essence, the "cumulative" impacts of the ESH program implementation have already been addressed in Chapter 6, Environmental Consequences. However, "cumulative" also is inclusive of other related past, present and future actions.

The construction and operation of the Missouri River Main Stem Reservoir System and the Missouri River Bank Stabilization and Navigation Project (BSNP) significantly altered the Missouri River by creating a system of six dams and channelizing the Missouri River from Sioux City, Iowa to St. Louis Missouri. These alterations resulted in significant flow changes within the four river segments and the creation of the one lake segment being addressed in this PEIS. The six dams and their associated lakes affect the geomorphologic, hydrologic, ecological, social, cultural and economic conditions along the Missouri River. The hydrologic and geomorphic processes that historically created habitat for least terns and piping plovers are greatly reduced. Channelization, irrigation, construction of reservoirs and pools, and managed river flows have contributed to the elimination of much of the emergent sandbar habitat that is critical to least terns and piping plovers for reproduction.. Reservoir storage and irrigation depletions of flows responsible for building and scouring sandbars has resulted in encroachment of vegetation onto sandbars along most of the open river reaches, further reducing least tern and piping plover nesting habitat. In addition, river main stem reservoirs now trap much of the sediment load resulting in alterations to the natural erosion and deposition process, and causing degradation of the river bed in most of the open river reaches below the dams. This has reduced the rate of natural formation of suitable sandbar nesting habitat. Below Sioux City, under the Missouri River BSNP, the Missouri River was engineered into a single, narrow, deep, navigation channel, effectively eliminating most sandbars between Sioux City, Iowa and St. Louis, Missouri. These changes, along with associated river bottom degradation immediately downstream from the dams and aggradation in the slack water of reservoir pools, have significantly altered the natural ability of the Missouri River to create emergent sandbar habitat for least terns and piping plovers.

Operation of the Missouri River Mainstem Reservoir System was reviewed and subsequently modified via the 2004 Master Manual EIS to benefit the listed species, including least terns and piping plovers. The operational changes include spring rises and intrasystem regulation changes that affect tern and plover habitat. However, as discussed in the Cumulative Impacts section of the Final Master Manual EIS, these operational changes are anticipated to produce only minimal amounts of habitat. This section states that the flow modifications, in particular the prescribed spring pulse, "does not provide island building for terns and plovers" and "may not even be of sufficient magnitude or duration to adequately scour vegetation off of the sandbars and islands". It also states, "Considerably more habitat will have to be constructed to meet minimal needs, as identified in the BiOp." More information regarding least tern and piping plover habitat is contained in the Cumulative Impacts section and the associated spring rise and intrasystem regulation discussions in the Master Manual EIS, from which this PEIS is tiered.

The Cumulative Impacts section of the Final Master Manual EIS also included information regarding other projects or facilities within the basin that could affect or be dependent upon the Mainstem Reservoir System. Considerations within the Upper basin included recreation development around the upper three lakes, water supply projects and additional bank stabilization or flood control projects.

While not selected as the preferred alternative, for reference, compliance with the 2003 BiOp Amendment RPA (2015 Goals: Alternative 1) would require 11,886 acres of ESH within the project area, which is approximately 117,702 acres. Estimates of the potential total area of impact (ESH and borrow areas)[33], would accrue to approximately 33,857 acres (29% of this area) and 69 million cubic yards of material. In addition, 13,540 acres (12% of that area) would be annually impacted for ESH creation and replacement during the initial 10-year construction period. As described throughout Chapter 6, implementation of the RPA as published in the 2003 BiOp Amendment has the potential for high/significant cumulative impacts to other uses, functions, resources, and processes of the riverine corridor. To implement the Preferred Alternative (an Adaptive Management Implementation Process with a maximum number of acres associated with Alternative 3.5) up to its fullest extent, approximately 4,370 acres would be created in all five segments. The potential total area of impact (ESH and borrow areas), would accrue to approximately 12,606 acres (11% of the project area) and approximately 17 million cubic yards of material. In addition, 3,320 acres (3% of the project area) would be annually impacted for ESH creation and replacement during the initial 10-year construction period. Additional discussion of the cumulative effects of Alternative 3.5 is after Table 10-1.To put this in perspective with the current program, since 2004, the Corps' Omaha District has completed a number of ESH projects within the Gavins Point River and Lewis and Clark Lake Segments. These projects are listed in Table 10-1 below and sum to approximately 600 acres of ESH. The potential total area of impact (ESH and borrow areas), would accrue to approximately 2,569 acres (2% of the project area), and 6.2 million cubic yards of material, with 419 acres (0.3% of the project area) annually impacted over a 10-year construction period.

[33] See Appendix C: Emergent Sandbar Habitat Construction and Maintenance Assumptions. Assumes a construction period of 1 year.

Table 10-1: Completed ESH Projects within the Gavins Point River and Lewis and Clark Lake Segments

River Mile Location	Year Constructed	Constructed Acres	Cubic Yards
754	2004	40	533,240
761	2005	54	311,940
770	2005/06	52	331,570
774	2008	49	302,370
775	2008	44	321,740
777	2007/08	89	631,430
791	2007/08	40	300,000
826	2008	43	543,380
827	2007/2008	90.3	2,650,000
781.0	2009	40	172,303
781.4	2009	60	120,400
TOTAL		601.3	6,218,373

For this document, the cumulative effect of implementing an alternative is a measure of the spatially defined area of need for an alternative relative to the area available after eliminating the sensitive features. The extent to which an alternative exceeds the area available for program implementation within a given segment is a measure of the potential significance of the cumulative environmental effects from implementing the alternative.

When environmentally sensitive features can be avoided during construction, the potential risk of incurring significant cumulative environmental effects can be reduced. Therefore when construction activities could take place in the available area, the risk of significant impacts would be considered low or minimal (green). However, when construction activities would take place in the restrictive area, the risk of significant impacts would be considered moderate (yellow). When construction activities would take place in the exclusionary areas, the risk of incurring significant and unacceptable cumulative environmental, social, and cultural consequences could be high (red).

When environmental buffers were applied to the segments, environmentally sensitive areas were identified to programmatically avoid. For the Preferred Alternative (AMIP with a maximum up to 4,370 acres associated with Alternative 3.5), the area disturbed is within the available area for the Fort Peck River, Garrison River, Fort Randall River, and Lewis and Clark Lake Segments. However, construction of the maximum acres in the Gavins Point River Segment would require construction activities in the restrictive area, requiring additional coordination with state and federal agencies to avoid sensitive resources as the program is progressively implemented.

The area disturbed for each alternative is summarized in Table 10-2. The impacts of the lesser alternatives could still result in moderate to low cumulative impacts, including impacts to the MNRR with regard to noise, view shed and recreational conflicts (see Chapters 6 and 7).

Table 10-2: Acres Impacted in Available, Restrictive and Exclusionary Areas

Segment	Area Type (Ac)	Area Impacted*: # Acres Required, Including Borrow Areas (By Alternative, By Segment)						
		ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist
Ft. Peck	Total Available Area	3,825	--	3,825	3,825	3,825	3,825	--
	Available	2,623	--	2,623	1,681	737	89	--
	Restrictive	0	--	0	0	0	0	--
	Exclusionary	0	--	0	0	0	0	--
	Total Impacted	2,623	--	2,623	1,681	737	89	--
Garrison	Total Available Area	4,361	4,361	4,361	4,361	4,361	4,361	--
	Available	4,361	4,361	4,361	3,941	1,746	1,485	--
	Restrictive	5,317	2,019	1,775	0	0	0	--
	Exclusionary	3,078	0	0	0	0	0	0
	Total Impacted	12,756	6,380	6,136	3,941	1,746	1,485	--
Ft. Randall	Total Available Area	2,784	2,784	2,784	2,784	2,784	2,784	--
	Available	2079	1,040	876	630	380	401	--
	Restrictive	0	0	0	0	0	0	--
	Exclusionary	0	0	0	0	0	0	--
	Total Impacted	2,079	1,040	876	630	380	401	--
Lewis & Clark	Total Available Area	4,711	4,711	4,711	4,711	4,711	4,711	4,711
	Available	2,594	1,297	1,080	675	271	153	95
	Restrictive	0	0	0	0	0	0	0
	Exclusionary	0	0	0	0	0	0	0
	Total Impacted	2,594	1,297	1,080	675	271	153	95
Gavins Pt.	Total Available Area	3,881	3,881	3,881	3,881	3,881	3,881	3,881
	Available	3,881	3,881	3,881	3,881	2,614	1,693	2,474
	Restrictive	5,999	3,021	4,863	1,798	0	0	0
	Exclusionary	3,925	0	0	0	0	0	0
	Total Impacted	13,805	6,902	8,744	5,679	2,614	1,693	2,474
117,702	Overall Total	33,857	15,619	19,459	12,606	5,748	3,821	2,569

Cumulative impacts to the two river segments within the MNRR, the 59-Mile District (Gavins Point River Segment) and the 39-Mile District (Fort Randall River Segment), were considered. Based on analysis and a construction methodology designed to avoid impacts to the cross-section of the river (e.g. borrowing material from active channel; placement and borrow area buffers; restrictions on dredging depth), no significant impacts that would affect bank erosion or stability of the river are anticipated. However, public concern regarding bank erosion, as well as interest in bank stabilization, have been ongoing absent of the ESH program, and are anticipated to continue as additional acres of ESH are created in these two segments. Because the program would be implemented incrementally, unique opportunities for monitoring and Adaptive Management allow for a flexible approach to meeting the biological metrics for the least tern and piping plover. The Adaptive Management plan (Appendix H) summarizes potential investigations (monitoring) proposed to help address uncertainties associated with such impacts. The Corps will continue to address concerns as they arise and coordinate with the USFWS, NPS, state agencies and landowners.

While cumulative impacts could be anticipated, particularly under the larger alternatives, by implementing the ESH program, numerous acres of ESH would be created, and adult least tern and piping plover numbers are projected to increase over the life of the program under all action alternatives (Alternatives 1 through 5). ESH also benefits other shorebirds and many native fish, amphibian and reptilian species. In addition, construction of ESH is expected to have a net positive effect in stimulating the local and regional economy.

10.1 REASONABLY FORESEEABLE FUTURE ACTIONS

10.1.1 Spring Pulse Flow Modification

The spring pulse flow modification is a temporary increase in releases from dams during the springtime that is designed to enhance the development of favorable conditions for successful spawning of pallid sturgeon. The spawning cue flows for the pallid sturgeon are not expected to be of sufficiently large enough (cubic feet per second) or duration (number of days continuously held above a certain flow) to create ESH at elevations necessary to support nesting.

The 2000 BiOp asserts that a May spring pulse would significantly increase the amount of islands and sandbars in the un-channelized reach between Gavins Point Dam and Ponca, NE (Gavins Point River Segment). Based on observations after the 3 high-flow years of 1995, 1996, and 1997 that the area of islands and sandbars was increased temporarily, the 2000 BiOp uses these 3 years as examples to indicate geomorphologic changes that could result from spring pulses. The hydrographs for the flows (1995-1997) that created islands and sandbars show that these flows were not spring pulses as discussed in the RPA, but that they were in essence high-flow periods of long duration that lasted from spring into fall. In reference to volume of flow, 1995 represented the 102nd highest volume of flow in 104 years, 1996 represented the 98th highest volume of flow in 104 years, and 1997 represented the highest volume in the entire 104 years of record. To compare the geomorphic change resulting from three successive extreme flow events for long durations to the effects of a brief spring pulse, as described in the 2000 BiOp, is not valid and is misleading (Jorgensen, 2003). More information regarding least tern and piping plover habitat is contained in the Cumulative Impacts section and the associated spring rise discussion in the Master Manual EIS, from which this PEIS is tiered.

10.1.2 System Unbalancing for Three Main Reservoirs

The Corps has the authority under the existing Master Water Control Manual to implement intra-system unbalancing. Limited to the upper three reservoirs in the system (Fort Peck, Sakakawea, and Oahe) this water management operation consists of making deliberate changes to the summer pool water surface elevations in the reservoirs to improve habitat for fish spawning and shoreline-nesting birds. Based on the availability of water in the system, a 3-year cyclical pattern is implemented whereby the water level is maintained about 3 feet below normal the first year, followed by maintaining the lake about 3 feet above normal the second year (i.e., 6 foot change), and maintaining a steadily declining lake back to the normal range the third year. This 3-year cycle would be rotated among the upper three lakes on an annual basis so that each year one lake is high, one is low, and the third is floating. Table 10-3 depicts the 3-year cycle of lake unbalancing.

The benefits of managing the upper three reservoirs in such a fashion are derived by creating the predictable availability of submerged vegetation to improve fish spawning during the high-water year, and the reciprocal availability of exposed sand beaches during the low-water year for shoreline nesting birds. By purposefully lowering lake levels approximately 3 feet during the low year, bare shoreline sand is exposed for bird nesting habitat. During the year of exposure, vegetation will flourish in the exposed areas. Refilling the reservoir inundates the previous year's vegetation providing important spawning and nursery fishery habitat the subsequent spring. Intra-system unbalancing cannot be implemented during excessively wet years or during drought conditions and has not been practiced in the early 2000s.

Another potential benefit of the intra-system unbalancing is the flow variability that may result downstream of Fort Peck and Garrison Dams. In years when the upstream reservoir is being drawn down, the flow through one of these two reaches may be high enough to scour vegetation from the sandbars. Conversely, when the upstream reservoir is being filled, the flow through one of these reaches may be lower than usual, exposing more sandbar habitat for the least terns and piping plovers.

More information regarding least tern and piping plover habitat is contained in the Cumulative Impacts section and the associated intrasystem regulation discussion in the Master Manual EIS, from which this PEIS is tiered.

Table 10-3: System Unbalancing Summary

Year	Fort Peck		Garrison		Oahe	
	March 1	Rest of Year	March 1	Rest of Year	March 1	Rest of Year
1	High	Float	Low	Hold Peak	Raise and hold during spawn	Float
2	Raise and hold during spawn	Float	High	Float	Low	Hold Peak
3	Low	Hold Peak	Raise and hold during spawn	Float	High	Float

10.1.3 Exotic Plant Management in the MNRR

The following description of the exotic plant management in the MNRR is taken from the NPS' 2005 Northern Great Plains Exotic Plant Management Plan and Environmental Assessment (NPS, 2005).

The scope of the Exotic Plant Management Plan was to develop a long-term management plan that would reduce the impacts of (or threats from) exotic plants to native plant communities and other natural and cultural resources, including cultural landscapes, at 13 park units, including the MNRR. Because this project involved multiple parks, the approach was to develop a general plan that provided resource managers with multiple treatment options for exotic plant management. Resource managers could then select the most appropriate treatment option or combination of treatments included in the Management Plan/Environmental Assessment to minimize potential impacts and maximize overall management success.

The plan considers all treatment methods that are currently being implemented by the national park units, or that may be used in the foreseeable future. Proposed treatments include:

Cultural Treatments — practices that promote the growth of desirable plants and reduce the opportunities for exotic plants to grow. Examples include irrigation and seeding of native plant species.

Manual/Mechanical Treatments — physical damage to or removal of part or all or of the plant. Examples include hand pulling, cutting, grubbing, haying, and mowing.

Biological Treatments — biological control, or biocontrol - the use of "natural enemies", such as insects and microorganisms to reduce the abundance of exotic plants. Natural enemies are imported from areas where the target exotic plant occurs as a native plant and are deliberately released into areas where the plant is exotic. Examples include plant-feeding insects such as flea beetles (*Aphthona lacertosa*) for leafy spurge (*Euphorbia esula*) and leaf beetles (*Galerucella* spp.) for purple loosestrife. Approved biological agents will be host-specific and have a negligible risk for becoming a pest.

Chemical Treatments — applying pesticides as prescribed by their labels, using a variety of application methods. Examples of application methods include portable sprayers, all terrain vehicles (ATVs) equipped with sprayers, and aerial application (helicopter and fixed wing).

Prescribed Fire Treatments — applying fire to a predetermined area to reduce the growth of exotic plants and to increase the growth of desirable plants.

Individual treatments, or combinations of those treatments, would be implemented, as appropriate, to control exotic plants in the parks. Parks would cooperate with state, county, private, tribal, and federal officials and would be necessary in parks with management partnerships such as the MNRR (NPS, 2005).

The primary exotic plants of concern at MNRR are purple loosestrife, tamarisk, leafy spurge, Canada thistle, plumeless thistle, and musk thistle. Others include Russian olive, bull thistle, common reed, and spotted knapweed. Every river mile located within the MNRR, excluding the lower 8 miles of Verdigre Creek, is designated piping plover critical habitat and purple loosestrife is present throughout much of this habitat. Tamarisk is a recent invader of this critical habitat.

The MNRR area includes five South Dakota counties and four Nebraska counties. Management partnerships, such as the South Dakota/Nebraska Purple Loosestrife Association, have been successful at pulling together multiple partners, including federal, state, tribal, and private landowners to treat purple loosestrife infestations. Another partnership is the Northeast Nebraska Weed Management Area, which also includes federal, state, tribal, and private landowners. The NPS participates in these partnerships; however, property owners carry out much of the exotic plant management treatment on non-NPS lands. MNRR resource staff manages the 250 acres of NPS-owned property. Regardless of land ownership, a combination of exotic plant treatments is used on target species.

Purple loosestrife and leafy spurge infestations are typically treated with biological control and chemical treatments. Thistle species control incorporates mechanical, biological, and chemical treatments. MNRR also plans on treating tamarisk later this year (2004) using imazapyr. Purple loosestrife infestations were mapped in 2003 on the lower 15 miles of the Niobrara River by the EPMT. Global Positioning System (GPS) mapping of exotic plant infestations on NPS owned property began in 2004.

The overall effects of these actions are expected to be positive, with the cumulative effects being a reduction in invasive species on the system.

11 TRIBAL CONSULTATION

Since the ESH program (and the PEIS) is part of the larger MRRP effort, Tribal consultation has been addressed as part of the overall MRRP effort, starting in 2005. Initially, the Corps' Omaha District sent out letters to each of the 28 Tribes within the Missouri River Programmatic Agreement, dated July 25, 2005. Follow-up phone inquiries were made regarding Tribal interest in the project at various dates in 2005 through 2008. Additionally, face to face consultation was held opportunistically as part of scheduled meetings within the MRRP.

For example, Corps staff coordinated with the following Tribes as part of a series of plenary meetings related to the MRRP Spring Rise Program during 2005:

Ft. Peck - Ft. Peck, Montana
Three Affiliated Tribes - Lake Sakakawea, North Dakota
Standing Rack Sioux Tribe- Lake Oahe, North and South Dakota
Cheyenne River Sioux Tribe- Lake Oahe, South Dakota
Lower Brule Sioux Tribe- Big Bend, South Dakota
Crow Creek Sioux Tribe - Big Bend, South Dakota
Yankton Sioux Tribe - Gavins Point, South Dakota
Santee Sioux Tribe - Gavins Point, Nebraska
Omaha Tribe - Below Gavins Point, Nebraska
Sac & Fox Nation, - Below Gavins Point, Kansas
Sisseton Wahpeton Oyate-- Off River Aquifer, North and South Dakota
The meetings were held in the following locations on the following dates:
Missouri Western State University, St. Joseph, Missouri, June 1-2, 2005
North Dakota Fish & Game, Bismarck, North Dakota, June 28-29, 2005
National Park Service, Omaha, Nebraska, July 26-28, 2005

Additional coordination during 2008 is captured in the following chart:

Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation	Poplar, MT	9-Apr-08		
Blackfeet Tribe	Browning, MT			8-May-08
Cheyenne River Sioux Tribe	Eagle Butte, SD		2-Apr-08	
Chippewa-Cree Tribe of the Rocky Boys Reservation	Box Elder, MT			
Crow Creek Sioux Tribe	Fort Thompson, SD			
Crow Nation	Crow Agency, MT			8-Apr-08
Eastern Shoshone Tribe	Fort Washakie, WY			
Flandreau Santee Sioux Tribe	Flandreau, SD		8-Apr-08	
Fort Belknap Indian Community	Harlem, MT	6-May-08		
Iowa Tribe of Kansas and Nebraska	White Cloud, KS		8-Sep-08	25-Mar-08

Kickapoo Tribe of Indians in Kansas	Horton, KS	17-Apr-08	8-Sep-08	
Lower Brule Sioux Tribe	Lower Brule, SD			
Northern Arapaho Tribe	Fort Washakie, WY			
Northern Cheyenne Tribe	Lame Deer, MT			
Oglala Sioux Tribe	Pine Ridge, SD			
Omaha Tribe of Nebraska	Macy, NE	15-May-08		
Ponca Tribe of Nebraska	Niobrara, NE			
Prairie Band of the Potawatomi Nation	Mayette, KS			
Rosebud Sioux Tribe	Rosebud, SD		7-Apr-08	
Sac and Fox Nation of Missouri in Kansas and Nebraska	Reserve, KS		8-Sep-08	25-Mar-08
Santee Sioux Nation	Niobrara, NE			
Sisseton-Wahpeton Sioux Tribe	Agency Village, SD			
Spirit Lake Sioux Tribe	Fort Totten, ND			
Standing Rock Sioux Tribe	Fort Yates, ND			
Three Affiliated Tribes - Mandan, Hidatsa, and Arikara	New Town, ND	14-Mar-08		
Turtle Mountain Band of Chippewa	Belcourt, ND			
Winnebago Tribe of Nebraska	Winnebago, NE			15-May-08
Yankton Sioux Tribe	Marty, SD			

12 PUBLIC INVOLVEMENT

12.1 Scoping Process

In August 2003, the Corps issued a public notice initiating a programmatic Environmental Assessment (EA) for this project. At that time, the Corps formally solicited comments from agencies and began to collect comments on what should be evaluated and considered in the EA. The Corps held formal scoping meetings in support of the EA in September 2004, conducting public meetings in Bismarck, ND and Yankton, SD. Based on the responses from agencies and the public, the Corps elevated the level of analysis and public review to the current Programmatic EIS.

To ensure that all issues related to the proposed ESH program were addressed, the Corps opened an additional comment period to receive recommendations from interested agencies, local and regional stakeholders, and the public. Those providing comments were encouraged to identify areas of concern, recommend issues and potential effects to be addressed in the EIS, and suggest alternatives that should be analyzed. The comment period was extended for 45 days from the date of Notice of Intent publication (August 12, 2005) in the Federal Register (Federal Register, 2005).

The Corps invited full public participation to promote open communication and better decision-making. All persons and organizations that were interested in the ESH program were urged to participate in this NEPA process. Public comments are welcome anytime throughout the NEPA process. Formal opportunities for public participation include: (1) during the 45-day public scoping comment period via mail, telephone or e-mail; (2) during review and comment on this Draft PEIS; (3) at public meetings to be held after release of the Draft PEIS; and (4) during review of the Final PEIS (anticipated late 2010). Schedules and locations for future meetings will be announced in local news media. Interested parties may also request to be included on the mailing list for public distribution of meeting announcements and documents by contacting: Cynthia S. Upah, CENWO–PM–AC, 1616 Capitol Ave., Omaha, NE, 68102, phone: (402) 995-2672, email: *Cynthia.S.Upah@usace.army.mil.*

12.2 Major Issues Identified for Analysis During Scoping

The major issues identified for analysis during scoping are identified in Appendix E

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14 DISTRIBUTION LIST

A public notice of the availability of the Draft ESH PEIS was sent to approximately numerous individuals, agencies, Tribes, special interest groups and other organizations. This notice included information regarding the location of libraries where the entire PEIS could be reviewed, where the Draft PEIS was available electronically on the Internet, schedule of public hearings, opportunity to comment on the Draft PEIS and where the full copy of the document or an electronic version on compact disc could be obtained.

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Washington, DC 20515-1505

Honorable William L. Clay, Jr.
Missouri Representative
U.S. House of Representatives
2418 RHOB
Washington, DC 20515-2501

Honorable W. Todd Akin
Missouri Representative
U.S. House of Representatives
117 CHOB
Washington, DC 20515-2502

Honorable Russ Carnahan
Missouri Representative
U.S. House of Representatives
1710 LHOB
Washington, DC 20515-2503

Honorable Ike Skelton
Missouri Representative
U.S. House of Representatives
2206 RHOB
Washington, DC 20515-2504

Honorable Emanuel Cleaver II
Missouri Representative
U.S. House of Representatives
1027 LHOB
Washington, DC 20515-2505

Honorable Sam Graves
Missouri Representative
U.S. House of Representatives
1415 LHOB
Washington, DC 20515-2506

Honorable Roy Blunt
Missouri Representative
U.S. House of Representatives
2229 RHOB
Washington, DC 20515-2507

Honorable Jo Ann Emerson
Missouri Representative
U.S. House of Representatives
2440 RHOB
Washington, DC 20515-2508

Honorable Blaine Luetkemeyer
Missouri Representative
U.S. House of Representatives
1118 LHOB
Washington, DC 20515-2509

Honorable Denny Rehberg
Montana Representative
U.S. House of Representatives
2448 RHOB
Washington, DC 20515-2601

Honorable Jeff Fortenberry
Nebraska Representative
U.S. House of Representatives
1535 LHOB
Washington, DC 20515-2701

Honorable Lee Terry
Nebraska Representative
U.S. House of Representatives
2331 RHOB
Washington, DC 20515-2702

Honorable Adrian Smith
Nebraska Representative
U.S. House of Representatives
503 CHOB
Washington, DC 20515-2703

Honorable Earl R. Pomeroy III
North Dakot Representative
U.S. House of Representatives
1501 LHOB
Washington, DC 25015-3401

Honorable Stephanie H Sandlin
South Dakota Representative
U.S. House of Representatives
331 CHOB
Washington, DC 25015-4101

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US Army Corps
of Engineers
Omaha District

Draft Programmatic Environmental Impact Statement for the Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Appendix A

Notice of Intent Dated 12 August 2005

October 2010

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at the time and in the manner permitted by the Board.

Brenda S. Bowen,
Army Federal Register Liaison Officer.
[FR Doc. 05–15988 Filed 8–11–05; 8:45 am]
BILLING CODE 3710–08–M

DEPARTMENT OF DEFENSE

Department of the Army Board of Visitors, United States Military Academy (USMA)

AGENCY: Department of the Army, DoD.

ACTION: Notice of open meeting.

SUMMARY: In accordance with section 10(a)(2) of the Federal Advisory Committee Act (Pub. L. 92–463), announcement is made of the following committee meeting:

Name of Committee: Board of Visitors, United States Military Academy.

Date: Friday, September 16, 2005.

Place of Meeting: Superintendent's Conference Room, Taylor Hall, 2nd floor, Bldg 600, West Point, NY.

Start Time of Meeting: Approximately 1 p.m.

FOR FURTHER INFORMATION CONTACT: Lieutenant Colonel Shaun T. Wurzbach, United States Military Academy, West Point, NY 10996–5000, (845) 938–4200.

SUPPLEMENTARY INFORMATION: *Proposed Agenda:* Annual Fall Meeting of the Board of Visitors. Review of the Academic, Military and Physical Programs at the USMA. Sub Committee meetings on Academics, Military/ Physical and Quality of Life to be held prior to Annual Fall Meeting.

Brenda S. Bowen,
Army Federal Register Liaison Officer.
[FR Doc. 05–15987 Filed 8–11–05; 8:45 am]
BILLING CODE 3210–08–M

DEPARTMENT OF DEFENSE

Department of the Army; Corps of Engineers

Notice of Intent To Prepare a Programmatic Environmental Impact Statement for the Maintenance and Creation of Emergent Sandbar Habitat on the Upper Missouri River

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DOD.

ACTION: Notice of intent.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA), the U.S. Army Corps of Engineers (Corps), DoD, Omaha District will prepare a Programmatic Environmental Impact Statement (EIS). The EIS will evaluate potential effects to the natural, physical, and human environment that may result from implementation of a program for the mechanical maintenance and creation of emergent sandbar nesting habitat within the free-flowing reaches of the upper Missouri River from Fort Peck, MT downstream to near Sioux City, IA. The emergent sandbar habitat maintenance and creation program proceeds from a defined regulatory process wherein the Corps formally consulted with the U.S. Fish and Wildlife Service (Service), which provided a Biological Opinion (BiOp) on how the Corps may avoid placing populations of federally-listed shorebirds, the interior least tern (*Sterna antillarum*) and piping plover (*Charadrius melodus*), in jeopardy of extinction. Scientific opinion asserts that the areal extent of emergent sandbar habitat directly controls the nesting opportunities and thus the reproductive success for the Missouri River populations of these species. The implementation of this programmatic habitat management action is the Corps' response to, and demonstration of, compliance with the findings of the BiOp stemming from a formal Section 7 consultation with the Service under the Endangered Species Act. Through the findings and recommendations contained within the 2000 BiOp as amended (2003), the Service identified mechanical habitat manipulation as part of a Reasonable and Prudent Alternative (RPA) that the Corps could implement to avoid jeopardy to these two listed species. This Programmatic EIS will tier from the Missouri River Mainstem Reservoir System Master Water Control Manual Final EIS (Master Manual, March 2004), incorporating by reference the general discussions and the affected environment and will evaluate the mechanical maintenance and creation of nesting habitat for the piping plover and interior least tern. Within the Master Manual Final EIS, the Corps acknowledged the need to implement actions to ensure protection of interior least tern and piping plover, but deferred detailed discussions of how these protective measures would be implemented to a future NEPA document. This programmatic EIS is that lower tiered document.

ADDRESSES: Send written comments and suggestions concerning this proposed project to Rebecca J. Latka, CENWO– PM–AE, 106 South 15th Street Omaha, NE 68102, phone: (402) 221–4602, e-mail: *rebecca.j.latka@usace.army.mil.*

FOR FURTHER INFORMATION CONTACT: Questions about the overall emergent sandbar habitat program, should be directed to Ms. Kelly Crane, Operations Project Manager, Oahe Project Office, 28563 Powerhouse Road, Pierre, SD 57501 (605) 224–5862 x3000; e-mail: *kelly.a.crane@usace.army.mil.*

SUPPLEMENTARY INFORMATION:

1. Public Participation

a. In August 2003, the Corps issued a public notice initiating a programmatic Environmental Assessment (EA) for this project. At that time, the Corps formally solicited comments from agencies and began to collect comments on what should be evaluated and considered in the EA. The Corps held formal scoping meetings in support of the EA in September 2004, conducting public meetings in Bismarck, ND and Yankton, SD. Based on the responses from agencies and the public, the Corps elevated the level of analysis and public review to a Programmatic EIS. The National Park Service and the U.S. Fish and Wildlife Service have agreed to participate as Cooperating Agencies for the Programmatic EIS.

b. To ensure that all issues related to the proposed program are addressed, the Corps will open an additional comment period to receive recommendations from interested agencies, local and regional stakeholders, and the public. Those providing comments are encouraged to identify areas of concern, recommend issues and potential effects to be addressed in the EIS, and suggest alternatives that should be analyzed. The comment period will extend for 30 days from the date of this Notice's publication in the **Federal Register**. The Corps anticipates that a draft Programmatic EIS will be available for public and agency review in early 2006. When the Notice of Availability appears in the **Federal Register**, the Draft Programmatic EIS will be circulated for a 45-day comment period.

c. The Corps invites full public participation to promote open communication and better decision-making. All persons and organizations that have an interest in the program are urged to participate in this NEPA process. Assistance will be provided upon request to anyone having difficulty with understanding how to participate. Public comments are welcome anytime throughout the NEPA process. Formal opportunities for public participation include: (1) During the 30-day public scoping comment period via mail, telephone or e-mail; (2) during review and comment on the Draft Programmatic EIS (approximately early

2006); (3) at public meetings to be held after release of the Draft Programmatic EIS (anticipated early 2006); and (4) during review of the Final Programmatic EIS (anticipated summer 2006). Schedules and locations will be announced in local news media. Interested parties may also request to be included on the mailing list for public distribution of meeting announcements and documents. (*See* **ADDRESSES**.)

d. The Programmatic EIS will focus on, but is not limited to, the following environmental issues: Effects on wetlands; water quality; fish and wildlife resources (including threatened and endangered species); air quality; hazardous, toxic, and radioactive waste; aesthetic resources; recreation; Recreational River segments of the National Wild and Scenic Rivers System; and cultural resources (including archaeological sites and tribal lands). The Corps will evaluate the environmental effects (both adverse and beneficial as well as acute and cumulative) of the proposed actions.

2. Background

a. The Missouri River drainage basin is approximately 530,000 square miles in area, occupying approximately one sixth of the continental United States. Originating at Three Forks, Montana, where the Gallatin, Jefferson, and Madison rivers merge, the Missouri flows over 2,500 river miles east and southeast to its confluence with the Mississippi River just above St. Louis, Missouri. The Missouri River Mainstem Reservoir System is comprised of six dam and reservoir projects operated by the Corps and authorized by the Rivers and Harbors Act of 1935 and the Flood Control Act of 1944. To formalize the management and operations of the system, nearly 40 years ago the Corps developed a detailed management plan, the Missouri River Main Stem Reservoir System Master Water Control Manual (''Master Manual''). Within the Master Manual, the Corps identifies the Congressionally authorized interests and sets forth a management plan to best meet the needs for the system. The Master Manual describes the water control plan and the objectives for the integrated regulation of the System by providing guidance for the regulation of the Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, and Gavins Point projects. The habitat manipulations evaluated in this Programmatic EIS are limited in geographic scope to actions within the four free-flowing reaches of the river between the Fort Peck Dam in eastern Montana at river mile 1,771 and river mile 740, near Sioux City, Iowa.

b. Intended to be a living document revised in response to the changing conditions of the Missouri River and those who use the resource, the Master Manual was revised in 1973, 1975, and 1979. In the late 1980s, the Corps began to revise the Master Manual again in response to the first major drought since the reservoir system become operational. The changes to the Master Manual describe physical and management changes of the river that begin saving water in the three biggest reservoirs (Fort Peck, Sakakawea, and Oahe) earlier in a drought than under the previous Water Control Plan and that halt navigation earlier during periods of extreme drought. The Corps believes these changes best meet the overall uses along the main stem and the needs of the people of the basin during periods of drought. Revision of the Master Manual is a process that requires the Corps to consult with other agencies and comply with various other laws, regulations, and procedures. In accordance with the requirements of NEPA, the Corps began the administrative process of evaluating the effects to the human environment from the Master Manual's water management alternatives in an Environmental Impact Statement.

c. Within the context of the ongoing NEPA evaluation for the Master Manual revision, the Corps initiated consultation in 1989 with the Service regarding operation of the Missouri River Main Stem Reservoir System and the Master Manual revision. This consultation was conducted under the provisions of Section 7 of the Endangered Species Act, which requires federal agencies to consult with the Service when the agency's proposed actions may affect the status of species listed as endangered or threatened. For the Missouri River operations by the Corps, the species being addressed in the 1989 consultation were the endangered interior least tern (*Sterna antillarum*), the threatened northern Great Plains piping plover (*Charadrius melodus*), and the then-endangered bald eagle (*Haliaeetus leucocehpalus*). Subsequently, the pallid sturgeon (*Scaphirhynchus albus*) was listed as endangered in 1990 and is addressed by the Corps and the Service.

d. Throughout the 1990s, the Service and the Corps conducted informal and formal Section 7 consultations, resulting in the issuance of a final BiOp by the Service in 2000. The 2000 BiOp found that the proposed drought management actions in the revised Master Manual would result in jeopardy to the interior least tern, pallid sturgeon, and piping plover, but no jeopardy to the bald eagle.

e. The Service provided the Corps with a Reasonable and Prudent Alternative (RPA) to the current Water Control Plan at that time, which, if implemented, would reverse the jeopardy finding. In November 2003, the Corps reinitiated formal consultation under Section 7. In December 2003, the Service issued an Amended BiOp (USFWS, 2003) that specified a single RPA for the pallid sturgeon, interior least tern, and piping plover. That single RPA allows for the mechanical maintenance and creation of emergent sandbar habitat to avoid jeopardy to the bird species. In March 2004, the Corps published a Final EIS and Record of Decision on the Missouri River Main Stem Reservoir System Master Water Control Manual, and completed the revision of the Master Manual. The Master Manual Final EIS, Record of Decision, and 2003 Amended BiOp can be obtained on line at: *http://www.nwd-mr.usace.army.mil/mmanual/mastman.htm*.

3. Purpose and Need for Corps Action

a. The purpose of and need for Corps action results from formal Section 7 consultation and by a defined regulatory process. The Endangered Species Act (ESA) directs the Service to assist other Federal agencies in ensuring that their actions will not jeopardize the continued existence of threatened or endangered species. Section 7(a)(2) of the ESA states, ''Each Federal agency shall, in consultation with and with the assistance of the Secretary [of Interior], insure that any action authorized, funded, or carried out by such agency * * * is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical.'' This consultation process is referred to as ''Section 7 Consultation.''

b. Throughout the formal process of revising the Master Manual (including the Master Manual Draft and Final EIS), the Corps has consulted with the Service, which has expressed its opinion through the 2000 BiOp as amended (2003), as to the actions the Corps might implement to avoid jeopardy to populations of the interior least tern and piping plover. The amended BiOp states that when habitat goals (as measured in the acres of available emergent sandbar for bird nesting) are not met through flow regulation and tern and/or plover fledge ratio goals have not been met for the 3-year running average, other means (*e.g.*, mechanical creation of habitat) will be necessary to ensure the availability of habitat to meet fledge ratio goals.

c. When conditions on the Missouri River do not result in sufficient emergent sandbar habitat, the Corps will mechanically maintain or create emergent sandbar habitat to meet the amended BiOp habitat goals. The need for this action is to ensure that operation of the Missouri River System—as described in the Corps' revised Master Manual and FEIS—will not result in jeopardy to these listed species.

4. Proposed Action and Alternatives

a. The Reasonable and Prudent Alternative included in the 2003 amended BiOp identifies maintenance of fledge ratios (*i.e.*, the number of chicks fledged from each pair of nesting adults) as the key measure to ensure protection of the interior least tern and piping plover. When the running 3-year average fledge ratios fall below thresholds established in the amended BiOp and habitat goals are not met through sediment deposition resulting from natural and regulated flow, the Corps proposes to use mechanical methods to maintain and create emergent sandbar nesting habitat.

b. Alternatives—

(1) Maintain and create emergent sandbar habitat to meet the goals established for 2015 in the amended BiOp (Largest Possible Habitat Manipulation).

(2) Maintain and create emergent established in the amended BiOp for sandbar habitat to meet the goals 2005.
(3) Maintain the acreage of emergent sandbar habitat as measured from actual photo interpretation of the 1998 and 1999 (Fort Peck Reach) aerial photographs. (Acreage determination in progress).
(4) Maintain the acreage of emergent sandbar habitat as measured from actual photo interpretation of the 2005 aerial photos (Maintain Existing Conditions). (Acreage determination in progress).
(5) Implement the minimal number of habitat manipulation actions necessary to maintain fledge ratios above designated thresholds.
(6) Take no action to implement the interior least tern and piping plover aspects of the RPA from the amended BiOp (No Action).
c. The Corps anticipates comments recommending that flow management from the mainstem dams be manipulated to achieve the acreage goals identified in the amended BiOp. Operation of the mainstem dams and the consideration of flow options to manipulate habitat were addressed in the Master Manual EIS and Record-of-Decision published in 2004. This programmatic EIS will focus exclusively on the mechanical maintenance and creation of habitat. In any given year, flow conditions may provide sufficient emergent sandbar habitat to obviate the need for mechanical habitat manipulation assessed under this program. When those conditions occur, the Corps will not manipulate habitat. A number of flow-altering pilot projects are in various stages of planning and assessment under separate NEPA reviews (*e.g.*, Fort Peck Mini-Test). To the extent that these flow manipulations provide additional emergent sandbar habitat, they will reduce the extent of the mechanical habitat manipulation required to meet the amended BiOp goals. Flow changes are also proposed for pallid sturgeon goals targeted for 2006 within the amended BiOp, and are being evaluated through a separate process. Information on this project can be found at: *http://www.nwd mr.usace.army.mil/mmanual/mast-man.htm*.
d. Since this EIS is programmatic, specific sites for habitat maintenance or creation will not be selected in the EIS. Rather, the programmatic EIS will outline a framework of site-selection criteria, local coordination, permitting actions, surveys, and additional steps that will be taken before site-specific work is accomplished. These steps will vary by method and by river reach, and the level of site-specific effort will be proportional to the potential for disturbance anticipated.
e. An engineering appendix describing intended construction, implementation, and maintenance procedures for each of the emergent sandbar habitat management methods and practices will be included as an appendix to the Programmatic EIS. The appendix will describe each habitat manipulation element, using diagrams, typical layout plans, pictures, tables, and cross-sections to describe what will be done and how it will be accomplished. Each description will specify process, expectations for outcome, expected productivity, materials, equipment, work force, supervision, inspection, ingress/egress considerations, timing, off-site disposal, fuel and hazardous chemical handling/ application, and best management practices to be employed to minimize environmental effects. The engineering appendix will specify additional field data to be collected, studies, and analyses that will be conducted to design the habitat maintenance and creation measures.
Brenda S. Bowen,
Army Federal Register Liaison Officer.
[FR Doc. 05–15986 Filed 8–11–05; 8:45 am]
BILLING CODE 3710–62–P

DEPARTMENT OF EDUCATION

Notice of Proposed Information Collection Requests

AGENCY: Department of Education. **SUMMARY:** The Leader, Information Management Case Services Team, Regulatory Information Management Services, Office of the Chief Information Officer, invites comments on the proposed information collection requests as required by the Paperwork Reduction Act of 1995. **DATES:** Interested persons are invited to submit comments on or before October 11, 2005. **SUPPLEMENTARY INFORMATION:** Section 3506 of the Paperwork Reduction Act of 1995 (44 U.S.C. Chapter 35) requires that the Office of Management and Budget (OMB) provide interested Federal agencies and the public an early opportunity to comment on information collection requests. OMB may amend or waive the requirement for public consultation to the extent that public participation in the approval process would defeat the purpose of the information collection, violate State or Federal law, or substantially interfere with any agency's ability to perform its statutory obligations. The Leader, Information Management Case Services Team, Regulatory Information Management Services, Office of the Chief Information Officer, publishes that notice containing proposed information collection requests prior to submission of these requests to OMB. Each proposed information collection, grouped by office, contains the following: (1) Type of review requested, *e.g. new, revision, extension, existing or reinstatement; (2) Title; (3) Summary of the collection; (4) Description of the need for, and proposed use of, the* information; (5) Respondents and frequency of collection; and (6) Reporting and/or Recordkeeping burden. OMB invites public comment. The Department of Education is especially interested in public comment addressing the following issues: (1) Is this collection necessary to the proper functions of the Department; (2) will this information be processed and used in a timely manner; (3) is the estimate of burden accurate; (4) how might the Department enhance the quality, utility, and clarity of the information to be collected; and (5) how might the Department minimize the burden of this collection on the respondents, including through the use of information technology.

Dated: August 8, 2005.
Angela C. Arrington,
Leader, Information Management Case Services Team, Regulatory Information Management Services, Office of the Chief Information Officer.

Office of Safe and Drug Free Schools

Type of Review: New.
Title: Alcohol, Other Drug, and Violence Prevention Survey of American College Campuses.
Frequency: On Occasion.
Affected Public: Not-for-profit institutions.
Reporting and Recordkeeping Hour Burden:
Responses: 1,050.
Burden Hours: 871.
Abstract: This survey's purpose is to determine the state of alcohol and other drug abuse and violence prevention in higher education and assess current and emerging needs of institutions of higher education and their surrounding communities.

Requests for copies of the proposed information collection request may be accessed from *http://edicsweb.ed.gov*, by selecting the ''Browse Pending Collections'' link and by clicking on link number 2815. When you access the information collection, click on ''Download Attachments'' to view. Written requests for information should be addressed to U.S. Department of Education, 400 Maryland Avenue, SW., Potomac Center, 9th Floor, Washington, DC 20202–4700. Requests may also be electronically mailed to the Internet address *OCIO_RIMG@ed.gov* or faxed to 202–245–6621. Please specify the complete title of the information collection when making your request.
Comments regarding burden and/or the collection activity requirements should be directed to Kathy Axt at her e-mail address *Kathy.Axt@ed.gov*. Individuals who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 1–800–877– 8339.

[FR Doc. 05–16023 Filed 8–11–05; 8:45 am]

BILLING CODE 4000–01–U

DEPARTMENT OF ENERGY

Office of Science; DOE/NSF Nuclear Science Advisory Committee

AGENCY: Department of Energy.

ACTION: Notice of open meeting.

SUMMARY: This notice announces a meeting of the DOE/NSF Nuclear Science Advisory Committee (NSAC). Federal Advisory Committee Act (Pub. L. 92–463, 86 Stat. 770) requires that public notice of these meetings be announced in the **Federal Register**.

DATES: Monday, August 29, 2005; 8:30 a.m. to 3 p.m. **ADDRESSES:** Doubletree Hotel, 1750 Rockville Pike, Rockville, Maryland 20852–1699.

FOR FURTHER INFORMATION CONTACT: Brenda L. May, U.S. Department of Energy; SC–26/Germantown Building, 1000 Independence Avenue, SW., Washington, DC 20585–1290; Telephone: 301–903–0536

SUPPLEMENTARY INFORMATION:
Purpose of Meeting: To provide advice and guidance on a continuing basis to the Department of Energy and the National Science Foundation on scientific priorities within the field of basic nuclear science research.
Tentative Agenda: Agenda will include discussions of the following:

Monday, August 29, 2005

- Reports from Department of Energy and National Science Foundation
- Perspectives from Department of Energy and National Science Foundation
- Presentation of the Neutrino Scientific Assessment Group Subcommittee Report

- Public Comment (10-minute rule)

Public Participation: The meeting is open to the public. If you would like to file a written statement with the Committee, you may do so either before or after the meeting. If you would like to make oral statements regarding any of these items on the agenda, you should contact Brenda L. May, 301–903–0536 or *Brenda.May@science.doe.gov* (e-mail). You must make your request for an oral statement at least 5 business days before the meeting. Reasonable provision will be made to include the scheduled oral statements on the agenda. The Chairperson of the

US Army Corps
of Engineers
Omaha District

Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Appendix B

Analysis of Spatial, Topographic, Hydrologic, Substrate and Nesting Data from the Upper Missouri River

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October 2010

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1 Background and Organization of the Document

This document provides the results of technical analyses conducted to support the U.S. Army Corps of Engineers (Corps) Programmatic Environmental Impact Statement (PEIS) for the Upper Missouri River Emergent Sandbar Habitat Creation and Maintenance Program. The program will be implemented to avoid jeopardy to two species of listed birds, the interior least tern[1] and the piping plover. Both of these species currently breed on emergent sandbars in the river

The US Fish and Wildlife Service (USFWS) expressed its opinion through the 2000 BiOp, as amended (2003), regarding the actions that U.S. Army Corps of Engineers (Corps) might implement to avoid jeopardy to populations of the least tern and piping plover. That opinion included a Reasonable and Prudent Alternative (RPA) wherein the Corps of Engineers would mechanically create and maintain an area of interchannel sandbar habitat by 2015 within five segments of the upper Missouri River.

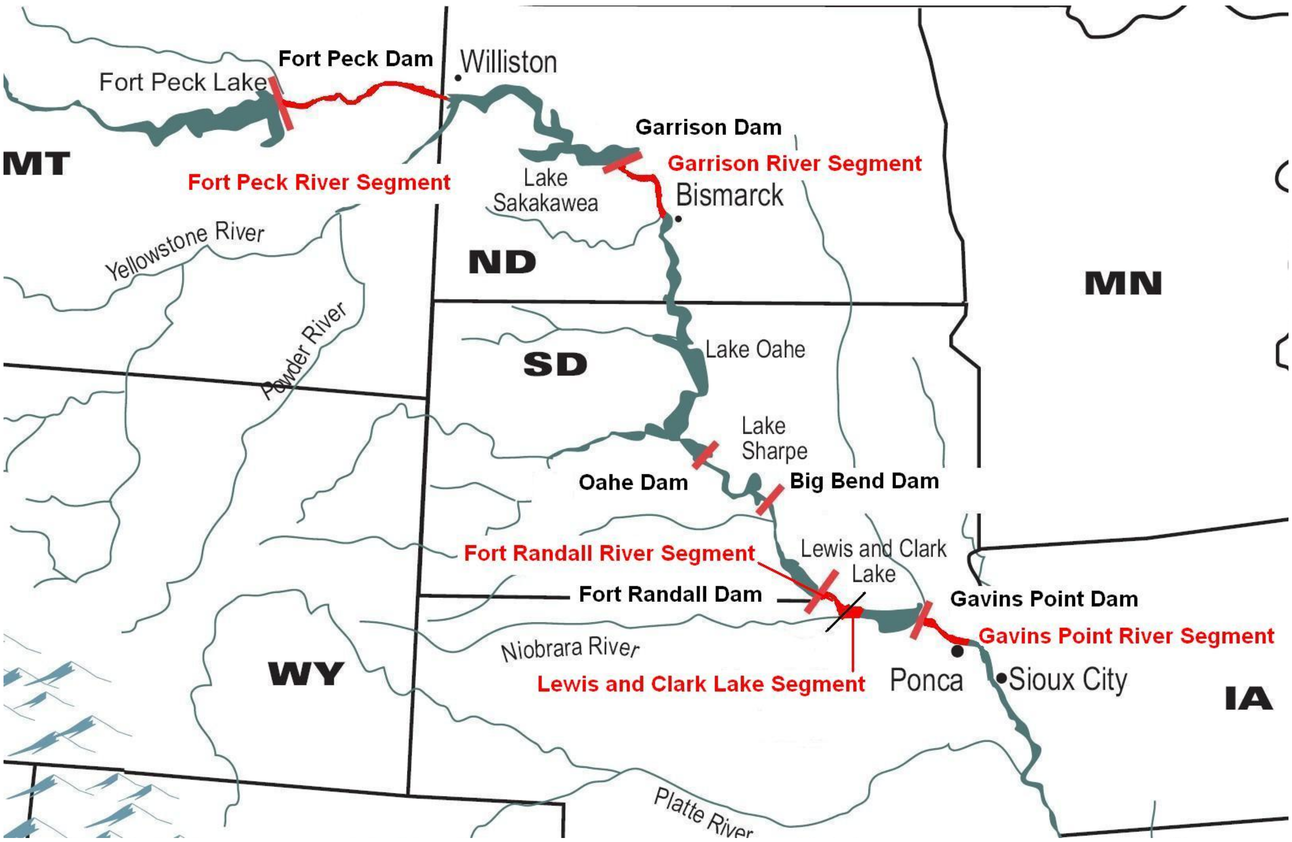
Compliance with the USFWS 2003 BiOp Amendment acreage goals for 2015 in the upper Missouri River requires the creation and sustained maintenance of nearly 12,000 acres of emergent sandbar habitat (ESH) within the five segments shown in Table 1-1. The total riverine area for implementing these actions is 117,000 acres, and is located within 400 river miles. The overall range of the study area is over 1,000 river miles, and is distributed throughout Nebraska, South Dakota, North Dakota, and Montana. Figure 1-1 provides a general overview of the project area. The five river/lake segments highlighted are in red.

Table 1-1
Study Area Segments

Segment Name	Segment Length (miles)	Bounding Features
Gavins Point River Segment	58.1	Ponca State Park boat ramp near Ponca, NE to Gavins Point Dam
Lewis and Clark Lake Segment	16.9	Headwaters above Lewis and Clark Lake to upstream of Niobrara River confluence
Fort Randall River Segment	35.0	Upstream of Niobrara River confluence to Fort Randall Dam tailrace
Garrison River Segment	86.1	Headwaters of Lake Oahe, south of Bismarck, ND to Garrison Dam tailrace
Fort Peck River Segment	203.5	Headwaters of Lake Sakakawea near Williston, ND to Fort Peck Dam tailrace
TOTAL	399.6	

[1] The interior population of least terns shall herein be referred to as “least tern”.

Figure 1-1
Regional Overview of the Study Area



The goals established for 2015 in the 2003 BiOp Amendment are provided in Table 1-2. These goals represent the amount of habitat creation and maintenance required by the RPA.

Table 1-2
ESH Acreage Goals for 2015 (PEIS Alternative 1)

Study Area Segment	ESH Acreage Goal
Fort Peck River Segment	883
Garrison River Segment	4,295
Fort Randall River Segment	700
Lewis and Clark Lake Segment	1,360
Gavins Point River Segment	4,648
TOTAL	11,886

1.1 Purpose of the Investigation

The USFWS established the goals described above for avoiding jeopardy to the least tern and piping plover. The Corps is obligated to quantify the environmental effects of meeting the stated regulatory objective in the PEIS. The analyses described within this document provide the basis for estimating the environmental consequences of the alternatives considered in the PEIS.

1.1.1 Establish ESH Acreage Goals for PEIS Alternatives 3, 4, and 5

In addition to providing the basis for estimating environmental consequences of all alternatives in the PEIS, the analyses included in this document establish ESH goals for three alternatives included in the PEIS. Alternatives 3, 4 and 5 are described below.

Because there is such a large gap in the acres identified in Alternatives 3 and 4 (6,754 – 1,985 acres), Alternative 3.5 was included in the PEIS after this analysis (Appendix B) was complete to represent an average between those alternatives and fill in the scale of the amount of acres evaluated.

PEIS Alternative 3: Create and Maintain ESH Area as Present in 1998/1999

Aerial imagery from 1998 was used to delineate the riverine habitat for the Gavins Point River Segment, the Lewis and Clark Lake Segment, the Fort Randall River Segment, and the Garrison River Segment. Because 1998 imagery was not available for the Fort Peck River Segment, the reach was delineated using 1999 imagery. Using similar methods to delineate ESH that had been performed by the Corps to support the BiOp preparation, the acreage of interchannel sandbar was measured for each of the segments. Results of the analysis provided in this document established ESH acreage goals for PEIS Alternative 3, which are shown in Table 1-3.

Table 1-3
Emergent Sandbar Habitat Acreage Goals Established – PEIS Alternative 3

Study Area Segment	ESH Acreage Goal
Fort Peck River Segment	883
Garrison River Segment	2,066
Fort Randall River Segment	295
Lewis and Clark Lake Segment	566
Gavins Point River Segment	2,944
TOTAL	6,754

PEIS Alternative 4: Maintain and Create ESH Area As Present in 2005

During the 2005 nesting season, adult census numbers were at or above the long-term recovery goals for the upper Missouri River populations and reproduction goals, as set by the 2003 BiOp Amendment, were met for both species. Aerial imagery was collected during the 2005 breeding season for all study area segments, and habitat delineations described in this document were used to accurately measure acreage of ESH that was present in the 2005 imagery for each of the five study area segments. Acreage goals established for PEIS Alternative 4 are based on the acreage delineated from 2005 imagery, and are shown below in Table 1-4.

Table 1-4
Emergent Sandbar Habitat Acreage Goals Established – PEIS Alternative 4

Study Area Segment	ESH Acreage Goal
Fort Peck River Segment	247
Garrison River Segment	588
Fort Randall River Segment	128
Lewis and Clark Lake Segment	142
Gavins Point River Segment	880
TOTAL	1,985

PEIS Alternative 5: Create and Replace ESH Area Derived from Nesting Patterns

Alternative 5 of the PEIS was described in the Notice of Intent as, "*Manipulate Sufficient Habitat to Maintain Fledge Ratios*." During the formulation of alternatives, Alternative 5 was conceived to represent an amount of acreage used for nesting by terns and plovers during the period of analysis. The analysis used to develop this alternative used nesting records and other GIS data to approximate the number of acres of nesting habitat and used the BiOp design criteria for the amount of foraging and brood-rearing habitat that should accompany nesting habitat, to derive an estimate of the total acreage of ESH that was utilized by terns and plovers during the period of analysis. Analyses conducted for establishing the area of nesting-habitat occupied by least terns and piping plovers in each segment of the study area are described in this document. Acreage goals established for PEIS Alternative 5 by analyses described in this document are shown in Table 1-5 below.

Table 1-5
Emergent Sandbar Habitat Acreage Goals Established – PEIS Alternative 5

Study Area Segment	ESH Acreage Goal
Fort Peck River Segment	30
Garrison River Segment	500
Fort Randall River Segment	135
Lewis and Clark Lake Segment	80
Gavins Point River Segment	570
TOTAL	1,315

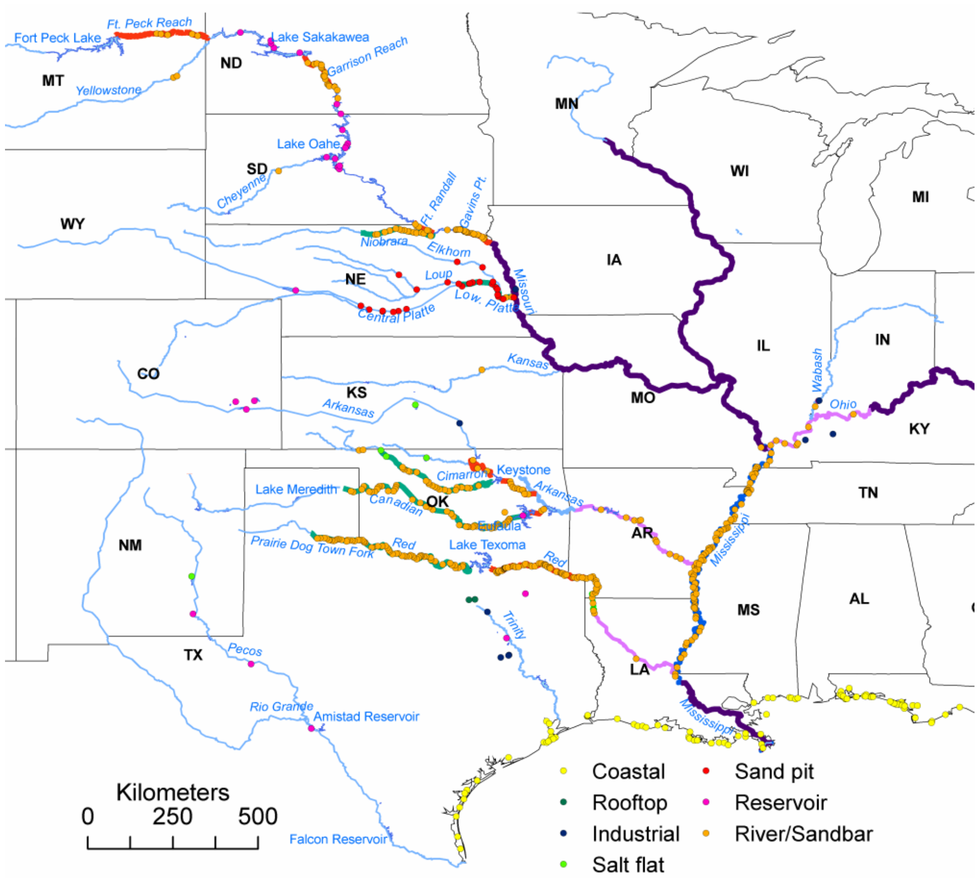
1.2 Least Tern and Piping Plover Range and Habitat

The evaluation of data and literature described throughout this appendix led to observations relating to the physical nature of riverine sandbars used by least terns and piping plovers during the nesting season. Background on the geographic range and habitat of these species is discussed below.

1.2.1 The Range-Wide Distribution of Least Terns

Least terns are a widespread species with a breeding range that extends well beyond the boundaries of the upper Missouri River. From a regulatory standpoint, least terns are segregated into three distinct populations by the USFWS. Two of these populations are listed as endangered (the California and interior populations) and a third (the coastal population) is not federally listed. Missouri River least terns are considered part of the interior least tern population, which is defined as any least tern more than 50 miles inland from the Gulf of Mexico coast (see Figure 1-2).

Figure 1-2
Range-Wide Distribution of Interior Least Terns



1.2.2 The Range-Wide Distribution of Piping Plovers

The USFWS also segregates piping plovers throughout North America into three separate populations. Two are listed as threatened (the Great Plains population and the Atlantic Coast population) and one is listed as endangered (the Great Lakes population). Figure 1-3 depicts the approximate areas for breeding and wintering piping plovers. Missouri River piping plovers are considered part of the Great Plains population. The Great Plains population is patchily distributed, with large population segments on reservoirs, alkali lakes, and to a lesser degree, rivers. Most individuals breed from Nebraska north through Prairie Canada (Haig et al. 2005).

Figure 1-3
Piping Plover Breeding and Wintering Range

1.2.3 The Importance of Riverine Sandbars

Least terns and piping plovers on the Missouri River differ in their proportional reliance on riverine sandbars. The Corps has conducted an annual survey (referred to as the "adult census") across all breeding areas for least terns and piping plovers on the Missouri River from 1988 through 2006. Between 1988 and 2006, an average of 78.9 percent of all Missouri River least terns were counted on riverine sandbars (minimum year = 71.6 percent, maximum year = 87.4 percent). During the same time period, an average of 54.3 percent of all Missouri River piping plovers were counted on riverine sandbars (minimum year = 32.1 percent, maximum year = 92.4 percent).

1.3 Scope of the Analysis

A variety of technical investigations and analyses were conducted to quantify the environmental consequences of alternatives evaluated in the PEIS. Principal technical activities are briefly introduced below, and then described in more detail in subsequent sections of this appendix.

1.3.1 Habitat Delineations

The initial component of the investigations, a detailed mapping of habitat types within the riverine corridor of the designated free-flowing segments of the Missouri River, was conducted using georectified aerial imagery, processed using ESRI ArcMap 9x software. Manual digitization of low altitude class 1 infrared imagery collected during May 1998[2], July 1999[3] and May 2005 was used to create habitat mapping. The accuracy of polygon delineations was field verified using survey-grade GPS equipment. Limited data verification activities took place at numerous quality control sites[4] distributed throughout the study area, and included the collection of topographic, substrate, and vegetation data. GPS equipment also was used to field delineate several thousand meters of boundary lines, which were compared with delineations based on aerial imagery interpretation. The comparisons indicated a high level of confidence in delineation accuracy. Mapping accuracy and systematic error are discussed in section 2.3.1. Field checking and sampling are discussed in in Attachment 6. Potential areal differences in low-lying habitats is discussed in Section 8.2 and in Attachment 3 and represented in Figures 5.7 thorough 5.10 in Attachment 3.

The area mapped is approximately 116,000 acres. Habitat delineation divided this area into twelve structural habitat types. Habitats for each of the five segments in the study area were delineated, and the results for each segment are discussed separately in this document. Delineation procedures and methods are described in Section 2.

The delineation of habitat types, as used to report the extent of emergent sandbar habitat and to assess impacts throughout the EIS. was derived entirely from the aerial imagery utilized. Lower relative elevation habitat types, such as sandbars, wetlands and open water, were recognized as being highly susceptible to rapid change in area with change in river stage. Habitat type areas and shape are not corrected for stage change due to the general lack of detailed low water topographic data for the majority of the combined segments length and the unavailability of multiple imagery sets for a single breeding season. More importantly, meaningful stage correction of particularly ESH acreages would need to be based on a pre-existing agreement concerning the proper stages and flows for each river segment. Section 8.2 discusses this problem using the Gavins Point River Segment; for which there exists recent low-water topographic data. Attachment 3 – Hydrology includes a series of figures at different stages/flows depicting the sensitive effects on ESH acreage at a nesting site; since ESH area if the primary focus of the BiOp RPA and ESH creation and maintenance program.

Changes in areas of habitat types between the two mapping years (1998/1999 and 2005), and explanations of the processes that shaped changes in habitat types are provided in subsequent sections of this appendix. A summary comparison of habitat type acreages among all of the segments was conducted in order to detect similarities and differences and identify trends across the entire study area. Comparisons with earlier delineations performed for select study area segments also are discussed in Section 8.1 of this document.

Results of the habitat delineations were initially used to:

1. establish the total ESH acreage existing in 2005 for each segment of the study area. These acreages were used to form the ESH quantities required under Alternative 4 (Maintain and Create ESH Area as Present in 2005);

[2] For most segments
[3] For the Fort Peck River Segment only
[4] See Attachment 6 for discussions of field sample locations, equipment and methods.

2. derive rates at which ESH eroded within each segment between 1998 and 2005, which was used to develop an estimate of the annual replacement that would be needed to maintain the acreage goals;
3. derive rates of vegetation growth (natural succession) on ESH to develop a basis for the extent of vegetation management that would be needed to maintain ESH as viable habitat for least terns and piping plovers; and
4. identify and map riparian features such as endangered species habitat, wetlands and important cultural resources so as to avoid impacts during ESH construction and maintenance.

It is expected that the conditions depicted by the 2005 delineations will have altered due to natural changes by the time these data begin general usage. Periodic updates and additional site-specific revisions will be necessary on an on-going basis to provide the detail needed for the implementation of construction or maintenance activities.

1.3.2 Spatial Analyses of Nest Data

Habitat delineations provided the framework within which all further analyses described in this document were conducted. Nest data collected by the Corps between 1999 and 2006 were integrated with habitat polygons to conduct analyses within a spatial context. Nest locations were overlaid with estimated habitat polygons, and numerous analyses of nest location, nest success, nest failure, and the absence of nests in ESH polygons[5] were conducted. These analyses were used to:

1. characterize and quantify of the physical features of ESH that correlate with nesting success;
2. analyze nesting patterns and nesting success distributions within each study area segment used to identify locations that could be avoided or preferred for habitat creation;
3. inform construction assumptions used to mechanically build (and maintain) ESH in accordance with the design criteria established in the 2003 BiOp Amendment.

1.4 Organization of the Document

This document is organized into eight sections and six attachments. Section 2 provides a detailed discussion of data sources, delineation procedures and data analysis methods used to conduct analyses that are common to all five study area segments. Some of the procedures used for analyses conducted are not included in Section 2. Procedures used for analyses conducted for only a single segment due to data limitations, are presented only in the discussion of that particular segment.

Sections 3 through 7 provide the results of the investigations for each of the five segments separately, beginning with the most downstream segment (Gavins Point River Segment) and ending with the most upstream segment (Fort Peck River Segment).

Section 8 provides a comparison of the habitats delineated in all five segments in the study area, and a summary of findings from the investigation. In addition, Section 8 provides a comparison between habitat delineations described in this document, discusses comparisons with prior Missouri River habitat delineations and addresses the effects of stage change on low-lying habitat types.. Section 8 concludes with a discussion under the heading of “Sensitive Features Assessment”, which

[5] The term “ESH polygon” is used throughout this document. It is a more precise term than “ESH island”, because an individual island, or sandbar, may include several distinct areas (polygons) of ESH separated by vegetation, wetlands, or other natural features.

defines the most suitable locations for ESH construction and maintenance on a segment-by-segment basis. The discussion focuses on an assessment of the relationships between nesting locations and various natural and anthropogenic features critical to species productivity and the continued protection of other important and legally protected features within the river corridor.

1.4.1 Attachments

Supplemental attachments also are part of this document. The six attachments provide additional details on important calculations, assumptions, and findings.

Attachment 1 provides a summary of constructed ESH efforts by the Corps since 2006, and additional findings from the Corps' ongoing monitoring program.

Attachment 2 provides an analysis on the relationships among indices of production for the least tern and piping plover.

Attachment 3 discusses the high sustained flow hydrologic events of 1996 and 1997, the hydrologic patterns of these study area segments, the methods used for analyses of hydrologic data and the effects.

Attachment 4 provides detailed information on sandbar geometry and composition, and discusses the physical characteristics of nesting habitat. This attachment also includes a summary of findings from a 2006 field survey of nesting habitat and the mechanical sieve analysis of substrate materials.

Attachment 5 provides a thorough characterization of the plant communities, habitats, and associations found in the study area segments. Repetitive plant associations are described as they are distributed along gradients of frequency of inundation, flooding, and topography. Issues of vegetation succession and sandbar colonization are addressed.

Attachment 6 provides details on field data collected, locations of field data collection sites, and equipment used.

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2 Data Sources and Methodology

To assess alternatives across the large geographic scope of the study area, the spatial assessment techniques briefly introduced in Section 1 were used to aggregate and organize data for subsequent analyses. Separate spatial assessments were conducted to evaluate nesting patterns, nesting success, and the character of nesting-habitat in each of the five study area segments. Section 2 provides a discussion of methodologies and data sources common to the analyses performed for each segment. The discussion begins with a description of external and primary data sources used in the analyses presented in Sections 3 through 7.

Methods used to delineate habitats within the study area are discussed in this section. Habitat delineations were conducted using imagery collected at two separate points in time: 1998/1999[6] and 2005. Sections 3, 4, 5, 6, and 7 present segment-specific:

- discussions of delineation results in total acreages and acres per river mile across 12 separate habitat types,
- analysis of ESH acres gained or lost between 1998/1999 and 2005, and
- discussion of the fluvial processes that influence habitat distribution within the segment.

Habitat delineations were used in concert with nesting data in a geographic information system (GIS) framework. Nest presence, nest success, nest failure, and the absence of nests were all analyzed against the background of delineated habitats, and in proximity to one and other in place and over time.

2.1 External Data Sources

Numerous external data sources were used in the analyses. Each of the subsections below provides additional information on:

- Orthographic Image Sets for Study Area Segments
- Missouri River Least Tern and Piping Plover Census Data
- 2005 LiDAR Data for Portions of North and South Dakota
- River Stage and Discharge Data
- Upper Missouri River Bank Stabilization Analysis
- Upper Missouri River Fluvial Geomorphological Analysis
- Previous Habitat Delineations for Study Area Segments

2.1.1 Orthographic Image Sets for Study Area Segments

Digital orthophotographic image sets were used in the preparation of habitat delineations. Rasterized orthophotographs were prepared using high accuracy scanning of conventional aerial platform photogrammetric products. Photogrammetric products were collected and processed using procedures specified in EM-1110-1-1000, which specify ASPRS 1990 Class 1 mapping

[6] Imagery used to delineate the Fort Peck River Segment was taken in 1999, imagery for all other segments was taken in 1998.

standards for target map scale of between 1:2400 and 1:12,000. Primary photographic sets used in the delineation are listed below:

- 1998 false color infrared, scale 1:12,000, 1-foot pixel size for the Gavins Point River Segment, the Lewis and Clark Lake Segment, the Fort Randall River Segment, and the Garrison River Segment.[7]
- 1999 false color infrared, scale 1:12,000, 1-foot pixel size for the Fort Peck River Segment.
- 2005 false color infrared, scale 1:12,000, 1-foot pixel size for all five segments.

Additional digital photographic sets and GIS polygon data prepared from these sets were used in part for comparison and reference. These include photographs captured in years 1976, 1983, 1999, 2000, 2001, and 2005. Imagery (provided by the Omaha District) for these years was prepared by aerial imagery contractors for the Omaha district using the same class 1 accuracy standards used for the 1998 and 2005 imagery.

Orthophotographic sets projected to the Omaha Albers 1929 coordinate system were compiled on a server and networked for multiple workstations and active, on-line, quality supervision. All features were digitized as lines. Once lines closed to form a polygon, a cuncrrently created point was placed in the geographic center to identify the habitat type by number code. Digitizing occurred at a scale of 1:3000. An overlay of the boundaries of USGS 7.5-minute quadrangles of the Missouri River was used to provide an additional geographic reference.

2.1.2 Missouri River Least Tern and Piping Plover Census Data

Nest data from the Missouri River Recovery Program Least Tern and Piping Plover Data Management System (TP DMS) were used to assess the physical conditions, location, and persistence of nesting-habitat in the study area segments. The TP DMS was developed by the Corps' Omaha District to provide a single, centralized system for entry, storage and dissemination of piping plover and least tern survey data from the Missouri River Basin. Different censuses are conducted from April through August to collect data on nest locations and fates, egg incubation and nest initiation dates, chick and fledged juvenile counts, and adult counts.

The TP DMS contains GPS-located nest points collected during entire breeding seasons for 1999 through 2006 for the Gavins Point River Segment, the Lewis and Clark Lake Segment and the Fort Randall River Segment. These data are available only for 2000 through 2006 for the Garrison River Segment and the Fort Peck River Segment.

The original 7,177 nests provided from the TP DMS for this analysis included successful and unsuccessful least tern and piping plover nests for both lake and river segments. GIS was used to select nests by location and assign them to proper segments. This analysis of river segment nests reduced the total number of nests to 4,843 by eliminating nests occurring along reservoir shorelines and selecting only those in the designated segments for additional analyses. Table 2-1 shows the 4,843 nests, distributed by year and segment.

[7] A full 1998 photographic set was not available for the Fort Peck Segment.

Table 2-1
Nest Data Points Used for Analyses

Study Area Segment	1999	2000	2001	2002	2003	2004	2005	2006	Total
Gavins Point River Segment	184	226	198	366	441	439	543	513	2,910
Lewis and Clark Lake Segment	107	63	28	59	43	3	29	4	336
Fort Randall River Segment	None	None	81	101	60	90	87	62	481
Garrison River Segment	None	None	135	160	166	156	200	194	1,011
Fort Peck River Segment	None	None	1	17	19	21	24	23	105
Total	291	289	443	703	729	709	883	796	4,843

2.1.3 2005 LiDAR Data for Portions of North and South Dakota

The South Dakota Department of Game, Fish & Parks provided digital elevation data and digital orthophotographs for portions of the upper Missouri River. These data, while not specifically collected for the PEIS analyses, were extremely useful in producing digital elevation models, TINs,[8] and contour maps with accuracies of approximately 6 inches. The project area for which data were collected encompassed approximately 660 square miles along portions of the Missouri River in South Dakota and North Dakota. This dataset provided coverage of the Fort Randall River Segment, the Lewis and Clark Lake Segment, and the Gavins Point River Segment.

2.1.4 River Stage and Discharge Data

There are over 20 U.S. Geological Survey (USGS)- or Corps-maintained continuous recording stream flow gages located within the subject segments of the Missouri River. Monitoring data from these gages are available from USGS websites, and were used to evaluate the effects of stage on ESH acreage estimates. In addition, these data were used to evaluate the relationship between nest success and maximum river stage during the nesting season, and to characterize the daily effects hydropower dam operations have on habitat.

2.1.5 River Stage and Discharge Relationships

This set of analyses and findings provided stage-discharge interpolation methods and algorithms used by the Omaha District in 2005 to assign discharge to water surface elevations below the Gavins Point Dam and between the three long-term gages on the Gavins Point River Segment. A summary of methods and findings is included in Attachment 3.

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[8] Triangulated Irregular Network (TIN) is a digital data structure used in a GIS for the representation of a surface. A TIN is a vector based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates (x,y, and z) that are arranged in a network of nonoverlapping triangles.

2.1.6 Upper Missouri River Bank Stabilization Analysis

This report[9] is the result of a fluvial geomorphological investigation to estimate changes in the quantity and density of habitat areas that would result from bank stabilization efforts in several reaches of the upper Missouri River. The study analyzed hydraulic, hydrologic and aerial photographic-based spatial data. The study considered the persistence, erosion, reoccurrence, and relative stability of habitats, including ESH. Eroding and accreting reaches were identified, along with discussions of planform stability and flow/feature retention relationships.

Data included in the report were:

- gage records;
- habitat and river bank shapefiles created by the Corps' Engineering Research Development Center (ERDC) using 1983 and 1998 orthophotographs;
- tabular summaries of findings by habitat type per river mile;
- 1991 to 1995 cross-sections and profiles of river reaches;
- HEC-RAS model output using the 1991 through 1995 data; and
- reach geomorphic characterizations.

2.1.7 Upper Missouri River Fluvial Geomorphological Analysis

The objective of this analysis[10] was to evaluate the impacts of bank stabilization on the morphologic processes in the Missouri River as they pertain to the formation and persistence of non-vegetated sandbars. This investigation addressed the same four riverine reaches of the upper Missouri River:

- Fort Peck Dam to vicinity of Yellowstone River;
- Garrison Dam to Lake Oahe;
- Fort Randall Dam to the Niobrara River; and
- Gavins Point Dam to Ponca, NE.

The report was intended to provide an additional tool for designers and managers to use when developing and assessing bank stabilization projects. The report was also intended to support related studies such as Programmatic EISs and Section 10/404 permits.

Datasets provided in the analysis include:

- grain-size analysis of bed, bank, and bar sediments (632 samples);
- summaries of habitat type per river mile for 1976 and 1998;
- tabular summaries of eroding and accreting reaches;

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[9] U.S. Army Corps of Engineers – Omaha District. Dec. 2005. Bank Stabilization Analysis Draft Report. Prepared by HDR Engineering Inc, West Consultants, Mussetter Engineering Inc., and IIHR Hydroscience and Engineering. Omaha NE.

[10] Biedenharn, D.S. et al. 2001. Missouri River – Fort Peck Dam to Ponca State Park Geomorphological Assessment Related to Bank Stabilization. Prepared for the Corps of Engineers Omaha District. ERDEC, Coastal and Hydraulic Laboratory. 3909 Halls Ferry Road, Vicksburg, MS 39180.

- graphed and tabularized historical flows per reach segment;
- sediment redistribution budget; and
- geomorphic classifications.

2.1.8 Previous Habitat Delineations for Study Area Segments

Delineations were conducted previously for the Omaha District's Threatened & Endangered Species Section using aerial imagery from 1996, 1997, 1998, 1999, and 2000. The delineations were completed during 2003 and 2004, and cover the Gavins Point River Segment and portions of the Lewis and Clark Lake Segment. Most of the data were developed using an unspecified, pixel-based, supervised classification system. Shapefiles were attributed by area (acres and hectares), location data, perimeter length, complex number, island status and forested status. Some analyses reside in spreadsheets and appear to correlate certain physical characteristics with nest locations over time. Other analyses were performed in Arc View using the "intersection" routine to compare habitat changes between years and nest use by island. The two major previous delineations are discussed in Section 8.3.

2.2 Primary Data Developed for PEIS Analyses

Many analyses conducted to support the PEIS were based in part on primary research products, which are listed below:

- Riverine habitat delineations for each study area segment
- Topographic data collection and mapping for portions of some study area segments (See Attachment 6) and LiDAR data collected in late 2005 for the Fort Randall and Gavins Point River Segments
- Vegetation sampling and characterization for study area segments (See Attachments 5 and 6)
- Substrate sampling at successful nesting sites (See Attachment 4)

These primary research products are not discussed under separate headings below, but are discussed within the context of the habitat delineation methodology.

2.3 Habitat Mapping Using 1998/1999 and 2005 Imagery

Habitat mapping for the five study area segments was developed to establish baseline conditions and to describe habitat changes that occurred between 1998 and 2005. Habitats were delineated by interpretation of structural characteristics observed on orthophotographs, and verified through field sampling. Structural characteristics were interpreted through textural differences, the presence of shadows, diversity of form, pattern, chroma, hue and matrix density. These characteristics were analyzed in conjunction with topographic changes, the reflective presence of water in soil and the presence of standing water so that a realistic homogenous habitat polygon could be delineated. For example, forests and marshes are structural expressions of plant community differences that can be clearly recognized and delineated without direct knowledge of the plant species composition.

2.3.1 Manual Habitat Digitization

Manual digitization (referred to by GIS analysts as "heads-up digitizing") was used to delineate habitats in the five study area segments. Habitats were identified and delineated using the line drawing tool in ArcEditor, in accordance with a set of rules developed from BiOp text, stereoscopic sampling of available aerial photography, and guidance from Corps and USFWS personnel familiar with the area. Habitat-type coding was assigned as points placed in line-bounded proto-polygons, and converted to polygons once topological[11] corrections were complete.

Minimum mapping scale was generally at a relative fraction scale of approximately 1:3,000. Habitat boundaries were delineated on screen as one millimeter-width line features annotated with points and converted to polygons. A line with a width of one millimeter obscures a 3,000-millimeter wide path (1 meter or 3.28 foot) on the ground. Delineation at a greater or lesser scale changes width of area obscured by the line and ability to visualize habitat edge irregularities. The first step in the delineation was to create a "riverine boundary" - an area defined by the high bank of the main channel and by river mile limits specified in the 2003 BiOp Amendment.

Boundaries of habitats were digitized as lines and label points within a feature dataset in a GIS framework. Digitizing occurred at a scale no greater than 1:3,000, and was executed incrementally, using the 7.5-minute quadrangle as a background segmentation frame for designating delineation assignments and conducting quality control.

Different habitat types were assigned different minimum mapping polygons, depending on the importance of inclusions of other habitat types to the species for which the delineation was conducted. For example, the occurrence of 0.5 acres of barren sand in an otherwise forested habitat unit was ignored because its use by nesting shore birds was considered highly unlikely. Alternatively, a 0.1 acre raised point of sand in the middle of the river was always mapped. Maintenance of proximity to minimum mapping polygon sizes was facilitated by creation of at-scale graphic polygons in various sizes that could be held on the screen and moved with the progress of the delineation.

The relative ease of quality control and the use of topological rule application, error finding, and error correction tools in the Economic and Social Research Institute (ESRI) geodatabase format eliminated polygon overlap and subsequent spatial measurement errors. Once polygons were created and attributed with the point codes, data generated by the geodatabase could be analyzed along numerous metrics, and integrated with additional geo-referenced data for further analysis.

2.3.1.1 Quality Control

The habitat delineation was prepared by a 4-person team linked over a network. A primary issue for quality control was assuring consistency of interpretation of visual signatures in admittedly variable quality aerial imagery. Bias among individual digitization personnel was minimized by the development of rules for the establishment of lines between different habitat types. Quality control included three important elements; the prior preparation of a delineation manual, frequent live team meetings wherein type identification difficulties were discussed and resolved (sometimes resulting in written changes to the prepared delineation manual) and on-screen supervision of all portions of delineation progress. The delineation manual defined the visual

[11] GIS topology is a set of rules that model how points, lines, and polygons share geometry (e.g., rules on how adjacent features share an edge).

signature and the nature of the edge conditions between the 12 defined structural habitat types. Additional delineation rules were added as needed. This manual is presented as Section 2.3.2 of this document.

During the early phases of delineation, frequent QA/QC sessions were held jointly among digitizers to review delineation progress and resolve any uncertainties. Resolution meetings occurred on a near daily basis between delineators and the project supervisor during the first weeks of the delineation, and weekly throughout the 6-week draft delineation process. These meetings included all of the project team, wherein live segments of active delineation on imagery were evaluated to discuss areas of uncertainty. Difficulties were resolved and appropriate changes to methods were codified. Irresolvable problems were marked for resolution by either stereoscopic analysis or for field resolution during subsequent field sampling.

Perpetual on-screen supervision of the habitat classification and mapping was made possible by use of a shared server and project file between all computers used for the project. A draft delineation segment could be pulled up, reviewed at any moment and marked up with notes and changes by both the team leader and by other team members, An active delineation could be supervised in progress to assess accuracy of image interpretation and line quality.

Two topological rules were created in order to easily locate digitizing errors and maintain data integrity. The first rule stated that no lines could have dangles, (i.e., each line has to be snapped to another line thus making undershoots and overshoots easily visible for repair). The second rule stated that each polygon must contain a label point. Polygons were periodically created within the feature dataset in order to view and repair the errors such that each polygon eventually contained attributes from an associated label point. Consistency of data entry and minimization of proto-polygon coding error was ensured by creating a pull down menu for the label points that allowed digitizers to choose habitat types from a list of assigned habitat numbers.

A category was included for "unknown" to direct attention to proto-polygons for which identification problems existed. These locations were then examined on the stereo aerial photographs using a mirror stereoscope, at full-scale, 3X magnification, or 10X magnification. Proto-polygons that could not be resolved by discussion or stereoscopic analysis were marked for field verification.

2.3.1.2 Topography

Topographic expression is not generally available in two-dimensional photographic imagery. However, its effects on moisture regime and plant communities can be clearly observed as color and textural differences. Validation of delineations that relied on these differences required both field sampling and interpretation of the original stereoscopic photographic products.

The contact prints prepared from the original aerial photography were analyzed with stereoscopic equipment to validate delineation choices. Additional topographic data from LiDAR obtained during low discharge in November 2005 were provided for the Gavins Point River Segment, the Lewis and Clark Lake Segment, and the Fort Randall River Segment. These data were used to validate and refine habitat delineations. Topographic conditions and habitat visual "signatures" derived from the delineations and field verification of the 2005 imagery sets were used to improve the understanding of topological features of the 1998/1999 imagery sets.

2.3.1.3 Habitat Classification Software

Habitat classification and delineation was initially attempted using various habitat pattern classification software packages. Unfortunately, high heterogeneity in photography because of varying sunlight angles, water reflection, variable water turbidity, and inconsistent frame-to-frame raster quality required extensive manual correction. Because a high-quality delineation could not be assured by using pattern classification software packages, manual digitization methods were used.

2.3.2 Habitat Classification Types

Habitat classification types were determined through an iterative process that included a review of prior Missouri River delineations, preliminary delineations using the 1998/1999 and 2005 aerial photographs, field sampling, and field verification. Several habitat types were initially defined separately, and later combined[12] for several reasons. Among the reasons were subtle boundaries of certain habitat boundaries, a very high degree of interspersion between habitat types, the potential artificial segregation effects of incident moisture and surface water conditions, and the absence of stereoscopic coverage for the 1998/1999 photographic sets. The confirmation and quality control of habitat delineations were based on four weeks of direct field observations and field sampling conducted in July and August of 2005 and in August 2006. Field observations and field sampling included many miles of in-stream observations and the quantitative collection of vegetation data and topographic data at sampling locations distributed throughout the study area segments.

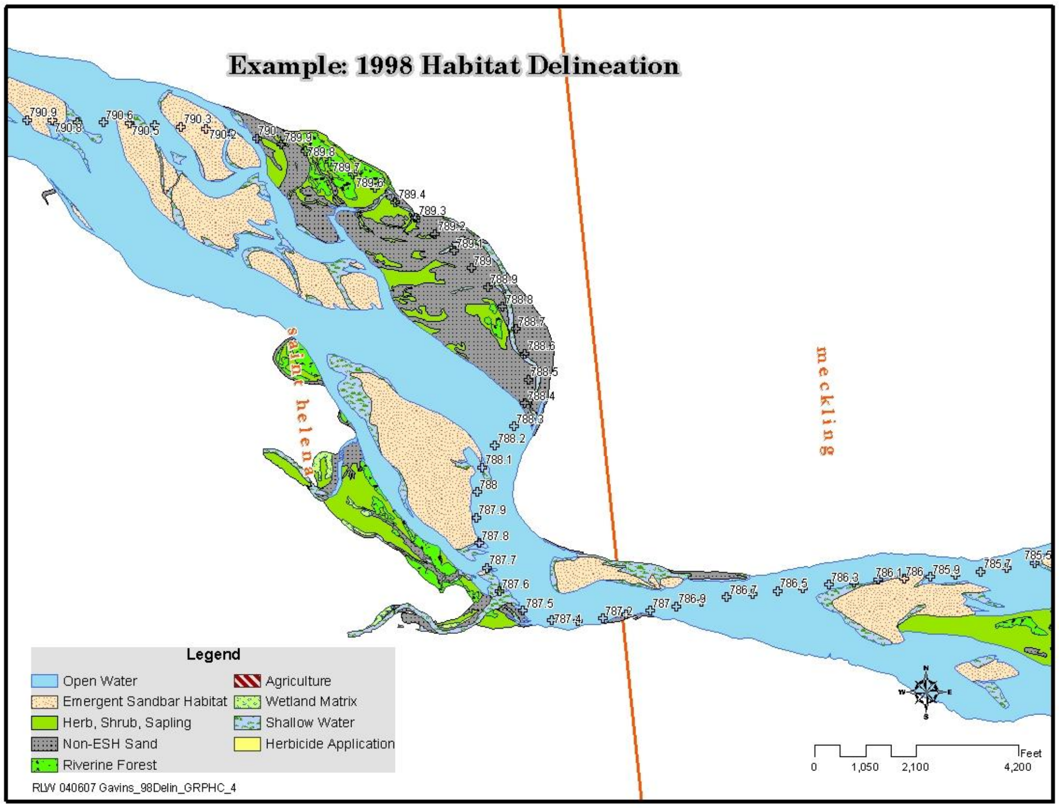
The habitat classifications, including the minimum area mapping unit for the habitat types, are listed in Table 2-2. An example of the composition and boundary conditions is shown by Figure 2-1.

Table 2-2
Habitat Delineation Codes and Descriptions

Type Code	Description	Minimum Area (acres)
1	Open Water	2.5
4	Emergent Sandbar Habitat (islands within the channel only)	0.1
6	Herb-Shrub-Sapling	0.5
7	Non-ESH Sand (including terrestrialized beach)	0.5
9	Riverine Forest	0.5
10	Active Agricultural Row Crop	1.0
11	Wetland Matrix	0.5
12	Shallow Water	1.0
13	ESH Maintenance and Creation Test Areas	1.0
14	Daily-Inundated Sand Plains	0.1
15	Lacustrine Fine Sediments	0.1
16	Anthropogenic Features	0.1

[12] For this reason, the set of habitat classification types are not numbered sequentially.

Figure 2-1
Habitat Delineation Map Example



2.3.2.1 Definition of Emergent Sandbar Habitat

One important objective of this habitat delineation included the comparison of physical features that existed in 1998/1999 with those observed in 2005. Meaningful comparisons of delineated features shown on the 1998/1999 and 2005 imagery sets required an understanding of the methods that were used in previous delineation efforts for the 1998/1999 imagery, which was used as the basis for the 2003 BiOp Amendment acreage goals. Discussions with Corps analysts, review of notes, spreadsheets, and results of the previous delineations showed that the previous delineations were derived through the use of GIS programs using the same aerial imagery for 1998/1999 that was used in this analysis.

Habitat characteristics for least tern and piping plover were discussed in both the 2000 BiOp and the 2003 BiOp Amendment. Language from these documents was used to develop a list of features that describe ESH that would be used in the delineations to measure the extent of ESH in the 2005 imagery. Delineation guidance that emerged from the 2000 BiOp and 2003 BiOp Amendment language is listed below.

- Barren sand located above the water line at the time of imagery capture on islands was the original working definition of ESH at the time the 2000 BiOp was written. Barren sand can be consistently identified on aerial imagery. For the purposes of this PEIS delineation, ESH is defined as barren interchannel sand.

- Areas of open water where the bottom is visible, and areas of water impounded on barren sand islands were classified as shallow water.
- Sparsely to densely vegetated areas near barren sand and shallow water were defined and segregated, rather than included with ESH. From this assumption, wetlands and herb-shrub vegetation were included as habitat mapping types.

2.3.2.2 Habitat Type 1: Open Water

Open Water includes the moderately shallow to deep, non-vegetated main channel water, deep flowing braids, side-channels and deep, non-vegetated ox-bow lakes that remain connected to the river during mean flow conditions. Man-made structures protruding into the flow (groins, jetties, etc.) were not delineated as Open Water, but floating or suspended features such as docks, water intake structures and bridges were delineated as Open Water. In short, all areas within the riparian habitat polygon not delineated as any other habitat type were classified as open water.

The following habitat types typically border Open Water habitats (minimum area: 2.5 acres).

Type	Boundary Appearance	Line Location Placement Guidance
Emergent Sandbar Habitat	Abrupt, moderately dark to very light sand above water level	Draw line at water edge
Herb-Shrub-Sapling Thickets	Abrupt, obvious edge	Draw line at water edge
Non-ESH Sand	Abrupt. Banks and narrow shoreline beaches	Draw line at water edge
Riverine Forest	Abrupt, obvious edge	Draw line at water edge
Shallow Water	Ragged, particulate, declining particles	Draw line where particles are less than 10% water matrix
Wetland Matrix	Ragged to abrupt, particulate, declining particles of dark brown or near black under water	Draw line where vegetation particles are less than 10% in water matrix
Daily Inundated Sand Plain	Abrupt, obvious edge, sharp chroma difference	Draw line at bright/dark sand line-sand edge
Lacustrine Sediments	Wavy, indistinct, gradual	Draw line when brighter color dominates matrix

2.3.2.3 Habitat Type 4: Emergent Sandbar Habitat

Emergent Sandbar Habitat typically occurs as islands, island clusters, and strands near the main channel thalweg and major side channels on islands. These features are composed of fine sand to coarse and pea gravel deposited at elevations about 1.5 feet above annual mean or daily mean (for areas subject to daily power peaking) water elevations. Mapping did not distinguish between wet and dry sand, since this is an incident, ephemeral, characteristic associated either with daily changes in flow (e.g., power peaking), local precipitation near the time of image capture, or substrate moisture from the capillary fringe from the changing water surface elevation.

The following habitat types typically border ESH (minimum area 0.1 acres).

Type	Boundary Appearance	Line Location Placement Guidance
Open Water	Abrupt, moderately dark to very light sand above water level	Draw line at water edge
Herb-Shrub-Sapling	Gradual to abrupt; vegetation color deposes sand as increasing color particles	Vegetation particles become greater than 10% of sand matrix
Wetland Matrix	Abrupt, if at all. Sand at this interface most likely Non-ESH Sand	Draw line at sand edge
Riverine Forest	Abrupt, if at all. Sand at this interface most likely Non-ESH Sand unless new point bar formed against old island	Draw line at sand edge
Daily Inundated Sand Plain	Abrupt, obvious edge, sharp chroma difference, vegetation presence	Draw line at vegetation or bright/dark sand line-sand edge

2.3.2.4 Habitat Type 6: Herb-Shrub-Sapling Thickets

This type is dominated by low to tall herbaceous perennial vegetation growing on moderately well drained to excessively well-drained soils. Shrubs and saplings less than 5 feet tall and not yet supporting distinct canopies may comprise up to 75 percent of the stand. This habitat type also includes areas dominated by saplings of forest trees and larger shrubs with discernible canopies less than 10 feet in diameter. This was the dominant vegetation habitat mapped; representing the successional community development since the 1997 releases.

The following habitat types typically border Herb-Shrub-Sapling Thicket habitats (minimum area 0.5 acres).

Type	Boundary Condition	Line Location Placement Guidance
Open Water	Abrupt, obvious edge	Draw line at water edge
Emergent Sandbar Habitat	Abrupt, obvious edge	Draw line at vegetation-sand edge
Non-ESH Sand	Abrupt, obvious edge	Draw line at vegetation-sand edge
Riverine Forest	Abrupt, obvious edge	Draw line at tree canopy edge
Wetland Matrix	Abrupt, obvious edge	Draw line at wet soil/lushness edge or at canopy edge

2.3.2.5 Habitat Type 7: Non-ESH Sand

Non-ESH Sand includes barren to sparsely vegetated (less than 20 percent) sand not suitable for the nesting of least terns and piping plovers. Non-ESH Sand was chiefly classified as such because of its size and position in the landscape relative to ESH. Typically included are exposed sand connected to riverbank beaches, steep sandy banks along islands, riverbanks, sand blowouts or dunes located in the interior of larger island or separated from ESH by vegetation stands, and sandy near-barrens along channel braids in island complexes. Sand areas on islands that are surrounded by forest trees are also included in this type.

The following habitat types typically border Non-ESH Sand habitats (minimum area 0.5 acres).

Type	Boundary Condition	Line Location Placement Guidance
Open Water	Abrupt, obvious edge	Draw line at water edge
Emergent Sandbar Habitat	Abrupt, obvious edge	Draw line at vegetation-sand edge
Herb-Shrub-Sapling	Abrupt, obvious edge to gradually flowing to ragged canopy size transitions	Draw line where shrub canopies can be discerned
Riverine Forest	Abrupt, obvious edge	Draw line at tree canopy edge
Wetland Matrix	Abrupt, obvious edge	Draw line at wet soil/lushness edge
Daily Inundated Sand Plain	Abrupt, obvious edge, sharp chroma difference, vegetation presence	Draw line at vegetation or bright/dark sand line-sand edge

2.3.2.6 Habitat Type 9: Riverine Forest

Riverine Forest (primarily cottonwood) is composed of single stemmed woody vegetation (trees) in stands, groups, and clusters with measurable leaf canopies greater than 10 feet in diameter. Stand, cluster or group identification ranges from adjacent and overlapping canopies to canopy clusters separated by no more than 50 feet. Isolated trees were not mapped unless larger than the minimum mapping polygon.

Canopies are identified as symmetrical to ragged multi-color masses with discernable dark shadows opposite the solar pathway. Soil moisture conditions within the riverine forest cannot usually be distinguished due to concealment of soil wetness by canopies.

The following habitat types typically border Riverine Forest habitats (minimum acres 0.5 acres).

Type	Boundary Condition	Line Location Placement Guidance
Open Water	Abrupt, obvious edge	Draw line at water edge
Wetland Matrix	Abrupt, obvious edge	Draw line at tree canopy edge
Emergent Sandbar Habitat	Abrupt, obvious edge	Draw line at tree canopy edge
Non-ESH Sand	Abrupt, obvious edge	Draw line at tree canopy edge
Herb-Shrub-Sapling	Abrupt, obvious edge to gradually flowing to ragged canopy size transitions	Draw line where dominant canopy diameter is greater than 3 meters

2.3.2.7 Habitat Type 10: Active Agricultural Row Crop

This type includes areas that have been or apparently are under cultivation and or irrigation. Furrows and irrigation lines are easily discernable. Edges are abrupt and distinct. This type is found on larger island and low floodplain terraces within the high banks of the riparian areas. The minimum area to for Active Agricultural Row Crop polygons is 1 acre.

2.3.2.8 Habitat Type 11: Wetland Matrix

Wetland Matrix habitats include rooted aquatic wetlands and emergent wetlands. Rooted aquatic wetlands include vegetated shallow waters generally less than five feet deep located in low energy positions, such as back channels, ox-bow pools, channel braids, relic channel ponds, deposition bank shallows, zones on the lee side of persistent islands, and protected waters created by groins and jetties. Vegetation occurs as sparse to dense submersed clusters of rooted aquatic plants, floating rooted aquatics and emergent obligate hydrophytes along the shallow fringe. These areas favor high water clarity during a sufficient portion of the growing season to allow rooted aquatic plants to germinate, establish roots and thalli, and to reproduce.

Emergent wetlands include rooted herbaceous and low woody vegetation growing in water or wet soil, composed of species adapted to life in anaerobic conditions, but which generally do not require water to support reproductive processes. This type occurs along back-channel fringes, oxbow ponds, in-land relict channels, and poorly drained depressions in sandy uplands. The dominant vegetation is herbaceous perennial, but hydrophytic woody saplings and shrubs may be dominant. These features are generally not discernible from remote sensing data.

Wetlands Matrix habitats also include regions of high wetland/upland interspersion; where wetlands make up more than 60 percent of the landscape. Edges between habitat types are abrupt to highly diffuse and gradual. Apparent soil moisture and a frequency of interspersed small stand water bodies are used to assess the presence of this type.

The following habitat types typically border Wetlands Matrix habitats (minimum area 0.5 acres).

Type	Boundary Condition	Line Location Placement Guidance
Open Water	Ragged to abrupt, particulate, declining particles of dark brown or near black under water	Draw line where particles are less than 10% in water matrix
Emergent Sandbar Habitat	Abrupt, obvious edge	Draw line at vegetation-sand edge
Non-ESH Sand	Abrupt. Outboard edges of narrow beaches and steep sand banks along protected channel reaches	Draw line at vegetation-sand edge
Herb-Shrub-Sapling	Abrupt to gradual edge. Soil saturation (darkening) and relative vigor of wetland versus drier vegetation is discernible	Draw line at wet soil and/or density fringe
Riverine Forest	Abrupt, obvious edge	Draw line at canopy edge

2.3.2.9 Habitat Type 12: Shallow Water

Shallow Water includes all landlocked water bodies such as lakes and ponds not dominated by emergent or submersed vegetation. Also included are non-vegetated shallow backwaters and relict channels where the channel bottom can be seen. These are habitats that occur along gradients between active depositional zones (incipient sand bars) and vegetated wetlands. Many Shallow Water habitats are the products of recent deposition or braid blockage when there has been insufficient time for colonization by vegetation. Habitats that appear to be "incipient sandbars" were delineated as Shallow Water habitats because it was not possible to determine whether incipient sandbars were accruing or ablating at the moment the image was captured. In addition, the gradual change between "incipient sandbar" and Shallow Water could not be consistently discerned.

Shallow Water edges are abrupt between upland and ragged and diffuse between ESH and between Wetland Matrix habitats. The minimum area for Shallow Water habitat polygons is 1 acre.

2.3.2.10 Habitat Type 13: ESH Test Area Constructed Prior to 1996

Constructed ESH Test Areas are generally rectilinear in form and greater than 5 acres. A muted or dark brown vegetation color, along with a widened row appearance (as compared to agricultural areas) is used to identify this type. Applying herbicides, tilling, blade ripping or a combination of mechanical and chemical practices applied in a linear fashion have created this type. Edges of Constructed ESH are always abrupt and distinct. These types are found most frequently for the 1998/1999 photo sets in the Garrison River Segment and the Fort Peck River Segment. The minimum area for Constructed ESH habitat polygons is 1 acre.

2.3.2.11 Habitat Type 14: Daily Inundated Sand Plain

Daily Inundated Sand Plain was defined after field observations and review of gage data, because gage data helped to describe the effects of daily power peaking at Fort Peck Dam, Garrison Dam, and Fort Randall Dam. Each dam's electrical output changes daily. Increasing the flow of water through turbines to generate more power increases the volume of flow discharged to the downstream river, and raises the water surface elevation in the river channel. During the nesting season, this daily high discharge and associated water surface elevation takes place in late afternoon.

Daily Inundated Sand Plain is composed of medium sand to relatively coarse gravel plains that are inundated by a few inches to more than 3 feet on a daily basis during the nesting season. Specific timing and duration of inundation vary, but the lowest flow-induced stages typically occur in the morning and the highest stages in the late afternoon. This phenomenon occurs throughout the nesting season, rendering ephemerally emergent sand area subject to daily inundation and desiccation.

This type of habitat appears differently when submerged than when exposed. It is critical that the time of the photograph used for habitat delineation is compared to the stage data from continually recording gages for the same period. Characteristics of this type have been validated by review of gage data for 1998, 1999, and 2005; stereoscopic interpretation of the 2005 low altitude photographs prepared for production of the orthophotographs; and through field verification in the summer of 2005. Key indicators for the identification of this type at low stage using orthophotographs include:

- Low range of color difference. The combination of a local uniformity of grain size (a function of localized fluvial energy gradients) and very low surface relief (materials are distributed in relatively level plains) create a uniform visual signature that contrasts sharply with areas not subject to daily inundation and desiccation.
- A higher chroma in general than for continually emergent sandbars. The daily "washing" removes fine sediments, particularly darker organic matter, which is also lower in specific gravity.
- A near absence of vegetation (particularly in the 2005 photo set), as daily stage fluctuations inhibits the germination and survival of most plant species.

Identification during high daily stage includes:

- The presence of dark, water-covered, relatively uniformly textured plains outside of the thalweg and adjacent or confluent with emergent bars, beaches and islands.
- A smooth, regular and abrupt edge, as may be produced by the low scarps between daily submerged and perennially emergent areas.

The following habitat types typically border Daily Inundated Sand Plain (minimum area 0.1 acres).

Type	Boundary Condition	Line Location Placement Guidance
Open Water	Abrupt, obvious edge	Draw line at waterline or distinct submerged plateau edge

Wetland Matrix	Abrupt, obvious edge	Draw line at wet soil/lushness edge
Emergent Sandbar Habitat	Abrupt, obvious edge	Draw line sand color difference or vegetation occurrence edge
Non-ESH Sand	Abrupt, obvious edge	Draw line sand color difference or vegetation occurrence edge
Lacustrine Fine Sediments	Gradual, not obvious	Most polygons in lower Fort Peck River Segment near Yellowstone confluence

2.3.2.12 Habitat Type 15: Lacustrine Fine Sediments

Lacustrine Fine Sediments include areas generally above water at the time of image capture that are exposed because of lowered lake levels or very slight daily power peaking stage fluctuations. These habitats occur in the headwaters of reservoirs and are most spatially important near the confluence of the Yellowstone River in the Fort Peck River Segment as it enters the Missouri River. This habitat type is composed of barren sediments comprised of clay, silt, and fine sand accumulations exposed by lowering of lake levels, and have not been colonized by wetland vegetation. These areas remain saturated to the surface, appear to be level, and rise only a few centimeters above water levels.

The following habitats typically border Lacustrine Fine Sediments (minimum area 0.1 acres).

Type	**Boundary Condition**	**Line Location Placement Guidance**
Open Water	Gradual wavy edge	Draw line when brighter color dominates matrix
Wetland Matrix	Abrupt, obvious edge	Draw line at vegetation edge
Daily Inundated Sand Plain	Gradual, not obvious	Identify this type in apparent lake backwater conditions and in free flowing reaches

2.3.2.13 Habitat Type 16: Anthropogenic Features

Anthropogenic Features are man-made. Included are buildings, paved areas, large highways, urbanized areas, farmyards, and any non-natural feature larger than 0.1 acres. Boundaries are distinct and abrupt with all other natural habitat types. The minimum polygon size for Anthropogenic Features is 0.1 acre.

2.3.3 Emergent Sandbar Habitat Change from 1998/1999 to 2005

Sections 3 through 7 also show the results of a GIS intersection[13] of ESH delineated in the 1998/1999 imagery with ESH delineated in the 2005 imagery. The analysis of the intersection identifies habitats that replaced ESH delineated in the 1998/1999 imagery, and lists a probable reason for the change. Graphs are provided to demonstrate redistribution of habitats between the two delineation years. Explanations for the change to those habitats that replace ESH are provided below.

[13] The GIS "clip" procedure was used to perform this step of the analysis. The procedure generates a new polygon from the geometric intersection of the two separate clipped polygon features.

2.3.3.1 ESH Lost to Erosion and Carried Down River

Elevated, high-flow-deposited sands become susceptible to erosion as high flows end. Some erosion occurs as result of precipitation runoff, as sheet and rill erosion. However, the majority of erosion occurs at the exposed sand - water interface, which varies as water stage changes, and is most pronounced along portions of bars nearest the deepest primary flow channel (thalweg) or an active chute. An area mapped in 2005 as "open water" that had been mapped as sandbar or another elevated habitat from the 1998/1999 imagery is assumed to have been lost to erosion and the materials re-deposited downstream.

2.3.3.2 ESH Retained in Original Position

Portions of the ESH delineated in the 1998/1999 imagery remained in place, and was delineated in the 2005 imagery.[14]

2.3.3.3 ESH Lost to Erosion and Redistributed Locally

An area mapped as a Shallow Water habitat in 2005 imagery that overlaid ESH delineated from the 1998/1999 imagery, may or may not contain sediments from 1998/1999 ESH. It does indicate that former elevated habitats have eroded to a lower elevation.

2.3.3.4 ESH Natural Succession to Uplands

Much of the areas mapped as elevated, barren sandbar from the 1998/1999 imagery remain in originally accumulated locations but have been fully colonized by upland plant species.

2.3.3.5 ESH Natural Succession to Wetlands

Portions of lower elevation ESH (subject to more frequent contact with moisture) sometimes became densely vegetated with wetland vegetation. These include areas originally accumulated after 1997, and areas of shallow water where obligate hydrophytes have become established on accumulated sediments.

2.4 Field Verification and Quality Control

After completion of draft habitat delineations, field verification sampling was conducted during 2005 and 2006. Data collected in the field provided ecological characterization information and linkages for orthophotographic image interpreters to compare remotely observed data to actual field sampling information. Sample locations were selected in GIS from the 1998/1999 orthophotographs, from which coordinates were extracted and exported as waypoints for GPS equipment. Samples were selected to resolve uncertainties during delineation and to verify lines drawn. A large number of potential sample locations were initially identified and created as coordinate points throughout the project area, with recognition that all would not be available due to highly limited access and travel distances during the generally non-navigable, low-water summer field season. All data sampling and feature locations located using survey-grade GPS equipment. Field data were collected electronically using GPS data recording equipment and/or recorded on sampling forms developed for this field assessment.

Summaries of field data and findings are used throughout this appendix, and additional field sampling data are provided in Attachments 4, 5 and 6. Attachment 6 provides a comprehensive

[14] In later numerical analyses, areas of "persistent ESH" were shown to serve as the most heavily used and productive nesting sites for the period since the 1997 releases.

discussion of the field sampling extent, timing, locations, equipment and procedures, including listings of the locations of actual sample sites.

2.4.1 Delineation Error, Accuracy and Reporting Precision Considerations

Error occurs during delineation between habitat types. The use of mapping data for planning and regulatory compliance purposes relies on an understanding of the accuracy of the mapping approximation. The fundamental question is the degree to which a given mapping product accurately defines a real world condition. The answer to this question is entirely premised on whether the imagery and field-collected spatial data describe real world conditions. This question cannot be separated from considerations for the duration of time that the identification may represent real world conditions.

This delineation is structural in approach, that is; based on such elements as the height and density (or absence) of vegetation, rather than its compositions, using a single set of annual imagery collected during a relatively brief period. The imagery used (or any single frame imagery) fixes potential habitat polygon edges for an instant. Accuracy can be judged by either the degree to which a polygon defines the shape observable on the image, and or by whether the image represents the true nature and extent of the habitat as defined.

Field sampling demonstrated (See Attachments 5 and 6) that riparian vegetation in the Missouri River valley is composed of repetitive structural groupings occurring at approximately equal local elevations relative to local flow and stage change frequency. Forests composed of large trees well defined by canopy shadows and adjacent lower vegetation are generally unaffected by normal flow events. They are however subject to shape change, therefore delineation boundary and area variability, due to wind (which cannot be easily accounted). Low-lying habitats such as ESH, daily-inundated sand, and of course, the area of water as a habitat type, are strongly affected by stage change. Stage change is not only an issue between years but also important during the collection of any photographic data set. This problem is most notable in segments subject to daily power generation peaking.

The method used for this delineation is based entirely on visual acuity and practiced hand control during delineation. The true composition of the habitat unit being delineated was assumed to be known from field-examined textural and color differences in the image, through stereoscopic photogrammetric methods and from field sampling. If a difference in imagery texture or reflectance can be seen, it can be drawn. There may be hand wiggle but there is also real world high irregularity of vegetation edges and water/non-water interfaces, and variations do to the influence of time and events. Irregularities of borders along tree canopies and water edges must be smoothed to a high degree. At the delineation scale of 1:3000, edge irregularities of less than 3-10 feet could not be observed.

For the more elevated densely vegetated habitats, edge-definition issues can be somewhat accounted within the realm of drawing line thickness, relative to scale and error may be estimated as a percentage of area in declining importance as polygon size increases. The error in estimation of error would also be both highly uncertain and statistically meaningless, ranging from a potential of 50% for a generated 0.1-acre polygon, approximately 1% for a 1-acre polygon and 0.1% for a 10-acre regular circular polygon. Smaller polygons are likely somewhat over estimated because the line would follow the outer edge of the smaller polygon at the expense of the large surrounding polygon.

Imagery pixel size is 1 meter. This translates to approximately 80 pixels per inch of screen at 1:3000 (1"=250'). At this scale, one is able to see crisp edges for vegetation and sand edges and define them with lines. On-screen line width (1 mm, 254 mm/inch) at this relative fraction is close to one pixel in width. This is the limit of the technology and appropriate for the scale. The error for what can be seen at this scale is approximately 7-feet (~3.5 feet either way). For example, the error range in a 1-acre circular polygon is approximately +/- 1%. As a polygon becomes smaller or more irregular, this error ratio gets larger. As a polygon becomes larger, the relative error, as the length of the perimeter to total polygon error becomes much smaller.

Once lines are drawn, the geometry checked, fixed, finalized and polygons created, the calculation of areas is extremely precise using the strict Euclidian algorithms in the ESRI software (default = 9 decimal places). The resulting polygons have no line width problems. It is like cutting out a piece of material; it becomes a real, discrete object that can be measured and summed with other pieces to any level of accuracy. Polygon size summaries presented in all tables was rounded down to 0.1 acres. The 0.1 acre threshold for accuracy has at least one real world application; wetlands impacts are usually denominated in 10ths of acres for regulatory purposes.

Giving full consideration for the short-term dynamism of the riverine corridor, the methods used and the accuracy of the base imagery accuracy is estimated to range for elevated habitat types from approximately +/-50% in individual polygons nearing the 1/10th acre threshold to much less than 1 percent for polygons =/> 5 acres. The accuracy of mapping of low lying habitats is potentially more variable. Since power surge stage change affects the upper (near dam) portions of power generation river segments, representation of actual habitat conditions delineated on any particularly image may range from 100% (at extreme low or high water) to 1-50% at average flow conditions (depending like elevated types on polygon size). For ESH measurement, an historic knowledge of actual use of a site for nesting and recent topographic data are needed to define the true extent of this type of habitat for the imagery used (or any image) for a period of interest. All evidence suggest that the 1998 imagery mapping of ESH represented just bare sand at the observed stage. The 2005 imagery, supported by nest point data and sometimes detailed topographic data, allowed close approximation of the residual nesting habitat portion of ESH The effects of stage change on low-lying habitats is discussed in Attachment 3, Hydrology.

2.5 Analyses of Nests, Nest Success, and Nest Habitats

This set of analyses investigated the significance of locations and distributions of GPS-recorded least tern and piping plover nests. The analyses identified characteristics, patterns, and relationships between nesting and habitat that assist in the development and quantitative assessment of alternatives in the PEIS. Analyses included, but were not limited to:

- Distributions of nests by river mile;
- Distribution of NestAreas;
- Identification of highly successful natural ESH islands;
- Identification of highly successful constructed ESH islands;

- Identification of ESH not used for nesting; and
- Development of Internest distances and nesting acreage occupied.

The discussion provided in this section provides details on analyses that are common to each of the five segments in the study area. It is important to note that some analyses were not conducted for all five of the segments in the study area because of limitations in available data. As such, only analyses common to all five segments are discussed in this section of the document; procedures used to conduct additional analyses that were unique to a particular segment (e.g., the Gavins Point River Segment) are explained within the discussion of that segment.

2.5.1 Distribution of Nests and Nesting Success by River Mile

This analysis was undertaken as a first step in the characterization of nests and nesting success within the study area segments. Clusters of total nests, successful nests, and failed nests were grouped and analyzed by their location within each river mile of a segment.

Because this analysis served as the starting point for the evaluation of nesting data along spatial parameters, its description uses the Gavins Point River Segment as an example. There are several reasons for showing the analysis of nesting-habitat by river mile within the framework of a general methodology discussion. Findings from the analysis revealed that more detailed analyses of nest data and habitat delineations would be required to understand nesting patterns. For this reason, this basic analysis was not repeated for all segments in the study area – its findings led to the development of more robust and meaningful analyses. Nevertheless, it is important in communicating methods used in further analyses. The discussion below is intended to provide a more thorough understanding of the detailed spatial analyses of habitat and nest data discussed later in this section.

2.5.1.1 Gavins Point River Segment Example

River miles were used as sectioning points for a GIS feature layer that sliced the Gavins Point River Segment into polygons of equal length, but unequal area because of extensive variability in channel width and alignment. The river mile polygons were used to select all nests from the TP DMS Gavins Point River Segment nest layer for the years 1999 through 2006 – nest counts and successful nests[15] were obtained.

Tables 2-3 and 2-4 present these data by river mile and year, sorted by total number of nests. Table 2-3 lists all nests (least tern and piping plover) for the Gavins Point River Segment. Table 2-4 shows only successful nests. Each of the tables also provide percentages of total counts, cumulative percentages by river mile, and the number of years that nests were established within a particular river mile. Gray shading designates river mile locations with sandbars mechanically constructed by the Corps in 2004 and 2005.

During the period of data analysis (1999-2006), 39 out of a total of 58 river mile locations (shown in Tables 2-3 and 2-4) had nests established in the Gavins Point River Segment. The following observations can be made from the tables:

- the cumulative percent column of Table 2-3, shows that more than 95 percent of all nests were established within 25 river miles of the 58 river-mile segments;

[15] A successful nest is defined as a nest within which at least one egg hatched.

- the cumulative percent column of Table 2-4 shows that 95 percent of successful nests were established within 21 river miles of the 58 river-mile segments;
- the top-ranked 15 river mile segments supported 85 percent of all nests in the Gavins Point River Segment between 1999 and 2005;

As shown in the tables, nesting in the Gavins Point River Segment was consistently clustered in a relative few locations. This is depicted in Figure 2-2. The habitat delineations prepared for this analysis showed that sandbars created by the 1997 releases were substantially eroded in 1998 and 1999. The observed clustering suggests that, during the period of analysis, nesting-habitat was concentrated in several discrete areas, with a few of those areas being of higher importance to population size and reproductive effort (nesting).

Nest Failure[16] was also clustered in the Gavins Point River Segment, as shown in Figure 2-3. The average failure rate in Gavins Point River Segment was approximately 35 percent, and the statistical correlation between total nests and total failed nests was 0.96. For 14 of the 18 river-mile segments with failure rates greater than average, their locations are upstream of RM 785[17]. RM 797 through RM 804 presented contiguous high failure rate segments with the highest overall reach failure rates occurring at RM 799 through RM 800.

[16] A failed nest is defined as a nest within which zero eggs hatched.
[17] RM will be used in place of river mile when specific river miles are listed.

Table 2-3
Gavins Point Nest Distribution by Year and River Mile: Sorted by Total Number of Nests

River Mile	1999	2000	2001	2002	2003	2004	2005	2006	Total	% of Total	Cuml. %	Count Years
788	25	20	20	59	56	69	42	17	308	10.6%	10.6%	8
756	29	38	14	45	83	61	12	5	287	9.9%	20.4%	8
770		5		21	25	7	44	121	223	7.7%	28.1%	6
781	34	35	21	10	13	35	41	11	200	6.9%	35.0%	8
795	1	27	29	25	18	39	24	26	189	6.5%	41.5%	8
761					14		66	82	162	5.6%	47.0%	3
801		7	10	27	48	22	27	9	150	5.2%	52.2%	7
754						63	52	34	149	5.1%	57.3%	3
769	12	5	1		1	2	64	62	147	5.1%	62.4%	7
793		1	6	38	46	25	16	12	144	4.9%	67.3%	7
778	3		9	45	41	21		2	121	4.2%	71.5%	6
777	7	23	25	24	8		31		118	4.1%	75.5%	6
804	9	4	2	7	14	10	17	32	95	3.3%	78.8%	8
802				1	7	34	32	11	85	2.9%	81.7%	5
759			16	24	16	9	5	1	71	2.4%	84.2%	6
790	44	14		1	2				61	2.1%	86.3%	4
767	4	11	7		12	10			44	1.5%	87.8%	5
758				3	11	11	8	4	37	1.3%	89.0%	5
791							16	19	35	1.2%	90.2%	2
798	3	18	9	2	1			1	34	1.2%	91.4%	6
789	1		1	3	5	4	6	8	28	1.0%	92.4%	7
803	1	1		3	5	8	4	2	24	0.8%	93.2%	7
757	3	8	6	4	2				23	0.8%	94.0%	5
766			1	19	3				23	0.8%	94.8%	3
808						1	15	7	23	0.8%	95.6%	3
800	2	1				1		16	20	0.7%	96.3%	4
797			2		1		6	8	17	0.6%	96.8%	4
787					2	4	3	5	14	0.5%	97.3%	4
796	3	1	2	1	3	2	2		14	0.5%	97.8%	7
782					3		1	9	13	0.4%	98.2%	3
807	2						3	7	12	0.4%	98.7%	3
799	1	7	2	1					11	0.4%	99.0%	4
764			7	1					8	0.3%	99.3%	2
768			6	1					7	0.2%	99.6%	2
786					1	1	2		4	0.1%	99.7%	3
755							1	2	3	0.1%	99.8%	2
774							3		3	0.1%	99.9%	1
772			2						2	0.1%	100.0%	1
765				1					1	0.0%	100.0%	1
Total	184	226	198	366	441	439	543	513	2,910			
Count Years	18	18	22	24	27	22	27	26				

Table 2-4
Gavins Point Successful Nest Distribution by Year and River Mile
Sorted by Total Number of Nests

River Mile	1999	2000	2001	2002	2003	2004	2005	2006	Total	% of Total	Cuml. %	Count Years
788	16	17	16	54	53	54	15	8	233	12.2%	12.2%	8
756	24	35	8	32	54	30	8	2	193	10.1%	22.3%	8
781	28	28	20	5	10	19	30	4	144	7.5%	29.8%	8
770		3		11	9		34	75	132	6.9%	36.7%	5
795		24	23	23	12	18	18	13	131	6.9%	43.6%	7
761					6		52	50	108	5.6%	49.2%	3
769	6	5	1				48	41	101	5.3%	54.5%	5
778	1		9	39	36	13			98	5.1%	59.6%	5
754						57	20	19	96	5.0%	64.6%	3
793		1	6	16	33	13	9	2	80	4.2%	68.8%	7
801		3	9	15	39	5	6		77	4.0%	72.9%	6
777	5	18	20	21	8		2		74	3.9%	76.7%	6
804	1	2	2	7	10	3	15	16	56	2.9%	79.7%	8
759			15	15	8	9	2		49	2.6%	82.2%	5
802				1	6	21	12	5	45	2.4%	84.6%	5
790	26	10		1	1				38	2.0%	86.6%	4
767	2	10	5		10	2			29	1.5%	88.1%	5
757	3	8	6	4	2				23	1.2%	89.3%	5
798		11	8	2				1	22	1.2%	90.4%	4
789	1		1	2	4	4	5	4	21	1.1%	91.5%	7
758				3	5	8	5		21	1.1%	92.6%	4
808							15	4	19	1.0%	93.6%	2
791							13	5	18	0.9%	94.6%	2
803				3	5	3	3	1	15	0.8%	95.3%	5
766			1	14					15	0.8%	96.1%	2
797			1		1		6	3	11	0.6%	96.7%	4
796	3		1	1	3	1	1		10	0.5%	97.2%	6
782					3			7	10	0.5%	97.8%	2
800		1				1		5	7	0.4%	98.1%	3
764			6	1					7	0.4%	98.5%	2
807							2	4	6	0.3%	98.8%	2
768			6						6	0.3%	99.1%	1
787					1	3		1	5	0.3%	99.4%	3
799		1	2	1					4	0.2%	99.6%	3
755							1	1	2	0.1%	99.7%	2
786					1	1			2	0.1%	99.8%	2
772			2						2	0.1%	99.9%	1
765				1					1	0.1%	99.9%	1
774							1		1	0.1%	100.0%	1
Total	116	177	168	272	320	265	323	271	1,912			
Count Years	12	16	22	23	24	19	24	22				

Figure 2-2
Total Nest Density per River Mile

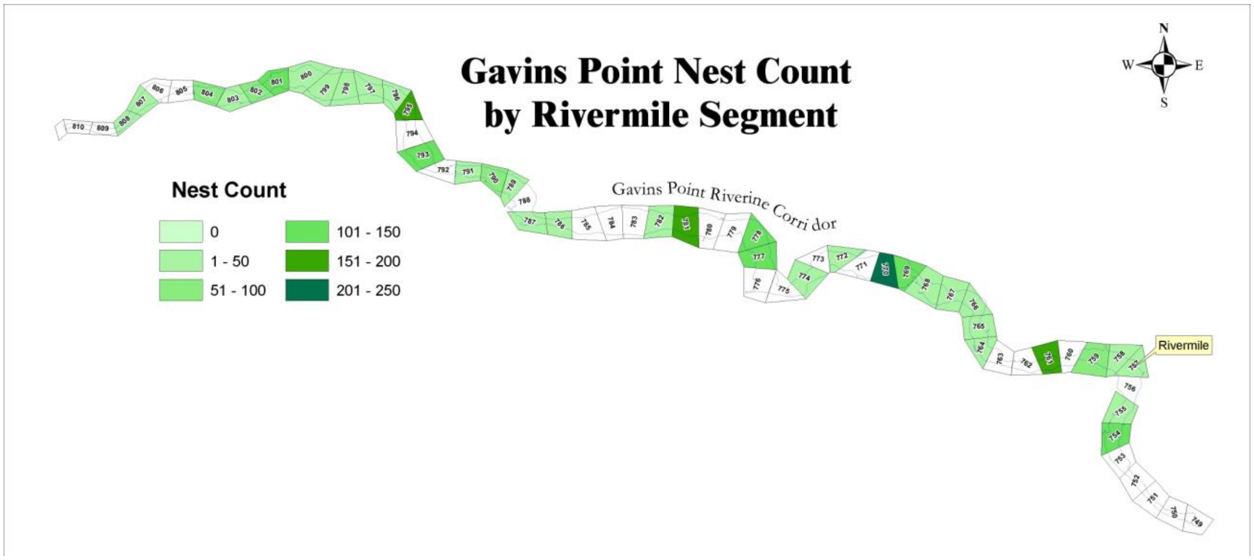
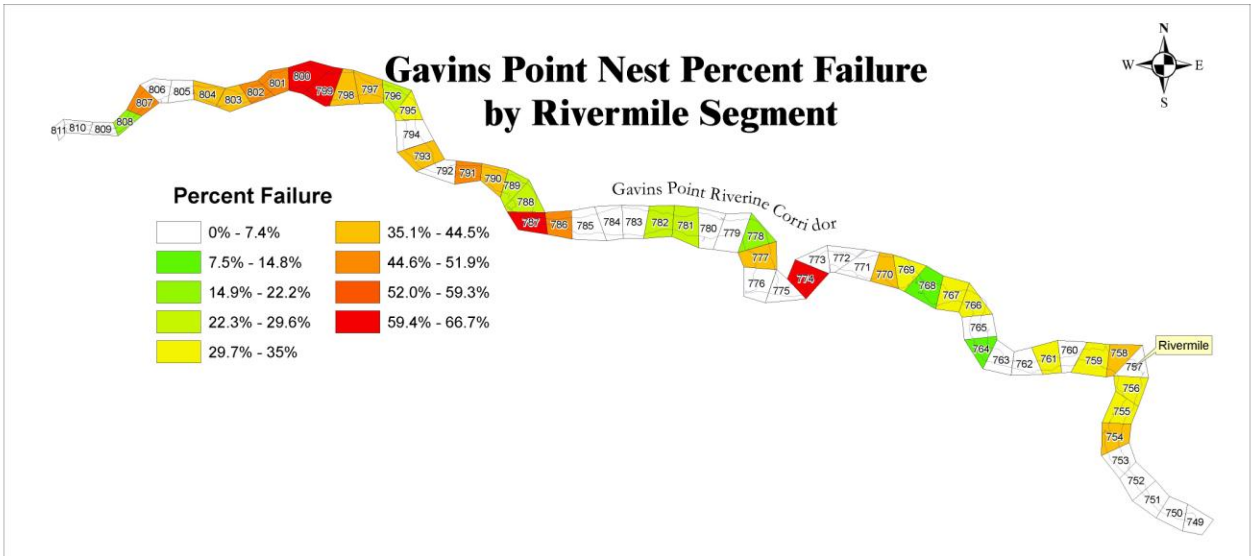


Figure 2-3
Nest Percent Failure by River Mile



The nine river mile segments with 50 or more nest failures are shown in Table 2-5. Most, including three segments with constructed sandbars, had failure rates at or below the mean.

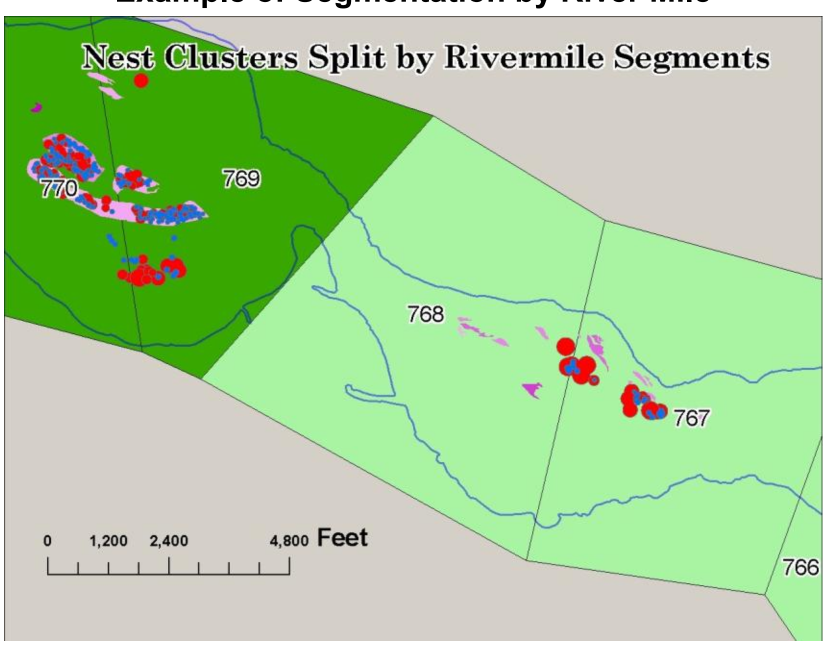
Table 2-5
River Mile Segments with 50 or More Nest Failures

River Mile	Total Nest Failures	Percent Failed	Origin
801	73	48.7%	Natural
793	64	44.4%	Natural
770	91	40.8%	Created
754	53	35.6%	Created
761	54	33.3%	Created
756	94	32.8%	Natural
795	58	30.7%	Natural
781	56	28.0%	Natural
788	75	24.4%	Natural

2.5.2 Distribution of Nests and Nest Success by NestArea

The initial examination of nesting-habitat by river mile served as a preliminary tool to segregate riverine habitat that does not support any nesting from areas that support nesting, and successful nesting. However, analyses based on river mile classifications alone obscure important ecological conditions and artificially divide natural clusters of nests (see Figure 2-4). Additional evaluations conducted as part of the analysis of nests by river mile revealed that there was no significant correlation between river mile location, area in acres or position in the reach with nest numbers, nest density, or nest success.

Figure 2-4
Example of Segmentation by River Mile



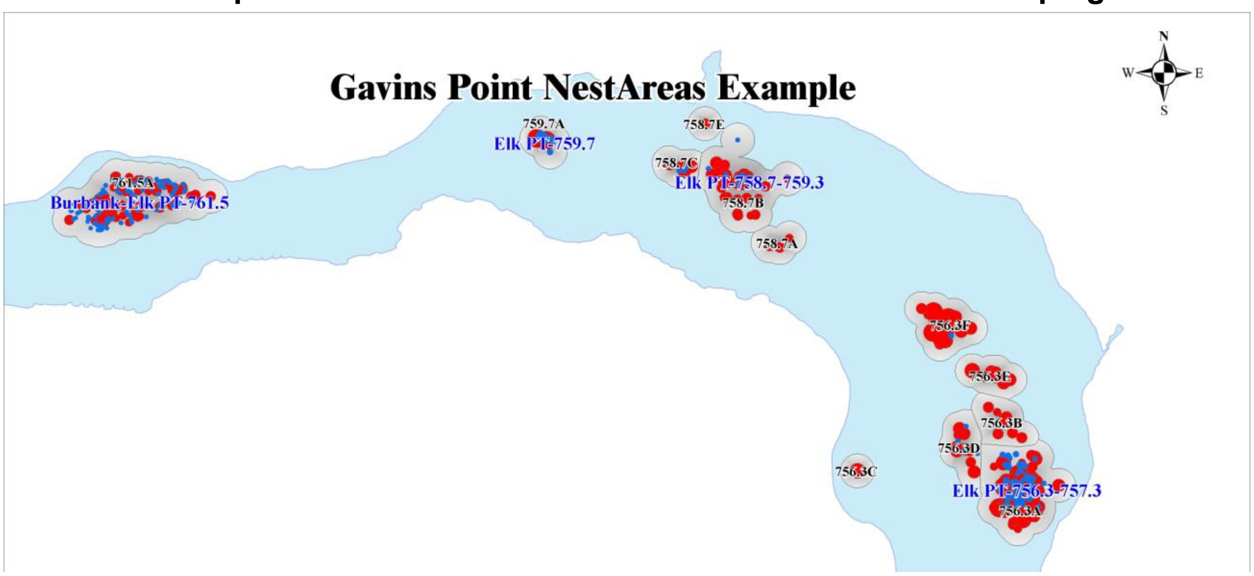
NestArea is a descriptive term used throughout this analysis. The term was created to refine spatial understanding of nest clustering and to avoid the artificial segmentation of data by river mile. NestAreas were defined by selecting clusters of individual nests, and NestArea polygons were created by buffering selected nest groupings with a 100-meter radius. NestArea polygons were named by combining the USGS quadrangle name and river mile spread into a single name (e.g., St. Helena: 787.9-788.2). An example of the grouping of nests, and the assignment of NestArea names is provided in Figure 2-5.

Because some of the identified NestAreas were composed of different islands that were active during different years, a subunit representing a single island sandbar was added to the NestArea name whenever appropriate. Many NestAreas were composed of distinct and separate nest clusters, which were given an additional naming attribute of an ordinal letter (A, B, C, etc.).

The construct of the NestArea was the grouping of nests by annual activity (conceptually equal to the "site" in the TP-DMS) and inter-annually, to assess trends in location usage.

The results of this analysis are discussed within Sections 3 through 7 of this appendix. The discussions provide study area segment-specific distributions of total nests and successful nests by NestArea for each of the five study area segments. In addition, the analysis includes further investigations of highly successful NestAreas for select study area segments.

Figure 2-5
Example of NestArea Nomenclature and Nest Cluster Grouping



2.5.3 Analyses of Productive Emergent Sandbar Habitat Characteristics

Distributions of nest establishment and nest success by NestArea were used to identify sites that serve as highly productive nesting areas. However, the NestArea distributions alone do not describe the *characteristics* of ESH upon which successful or unsuccessful nesting occurs. Also, the NestArea distributions do not identify ESH islands that are *not* selected for nesting.

The analyses investigated nest establishment and nest success within individual ESH polygons delineated from the 2005 imagery, and identified characteristics of ESH successful ESH, unsuccessful ESH islands, and ESH islands upon which nesting did not occur.

Analyses relied on the integration of the GIS data from the *Emergent Sandbar Habitat Change from 1998 to 2005* assessment (described above). That analysis had been initially conducted to describe the fate of 1998/1999 ESH, but a finding emerged when a number of ESH polygons defined from the 1998/1999 delineation were again delineated as ESH based on the 2005 imagery.

All available years of nesting data for each study area segment were used in the analyses. Nesting data were plotted against the background of the 1998/1999 and 2005 habitat delineation polygons to identify characteristics of ESH that explain nesting use, nesting success or failure, and the lack of nests on ESH polygons. Structural and spatial characteristics of individual ESH polygons were investigated to develop an understanding of topography, shape, location within the channel, elevation above the waterline, vegetation coverage, and substrate composition.

Extensive analyses were conducted for the Gavins Point River Segment to identify similarities and *differences* among successful, unsuccessful, and unused ESH. Findings from the analyses were applied to the other four study area segments. The following were analyzed in detail:

- nest density, measured in nests per acre;
- highly successful nests;
- ESH with limited or no successful nests;
- mapped ESH not used for nesting-habitat;
- relative elevation / flood risk;
- relative size; and
- predation risk.

2.5.4 Establish ESH Acreage Goals for PEIS Alternative 5

Alternative 5 of the PEIS was described in the Notice of Intent as, "*Manipulate Sufficient Habitat to Maintain Fledge Ratios*." The premise being that, based on the measured nesting and fledgling productivity from mechanically created ESH, there would be some measurable area of mechanically-created and maintained ESH that, if constructed and maintained, would be sufficient to meet the fledge ratio goals for both species. This analysis establishes the area of nesting-habitat occupied by least tern and piping plover in each segment of the study area.

It is important to note that this analysis does not compute fledge ratios, i.e., the number of fledglings per adult pair. *Rather, this analysis assumes that, since current fledge ratios have met the BiOp goals, the number of acres of suitable habitat that have produced those ratios will be sufficient to maintain those ratios in the future.* Estimates of ESH acreages needed are based on the assumption that the acreage of ESH *used* by a successful population can also be used to establish a target for the area of ESH needed to *sustain* a desired population level.

Procedures used to measure the area of nesting-habitat used are described below,[18] and it is important to note that the acreage estimates are conservative. This is because the final acreage goals that are represented under PEIS Alternative 5 are not based on estimates of nesting-habitat occupied for any single year. Rather, the final acreage goals are based on estimates of the nesting-habitat occupied over the entire period of analysis, which results in a larger acreage requirement because multi-year data is more geographically dispersed. Eight years of occupied nesting area data were used to derive ESH acreage goals for the Gavins Point River Segment and the Lewis and Clark Lake Segment, and six years of occupied nesting area data were used to derive ESH acreage goals for the other three segments.

Nesting-habitat is defined in this analysis as the areas of barren sand occurring on interchannel sandbars that remain exposed above water levels for periods sufficient for least tern and piping plover to establish nests. Nesting-habitat is (by definition of usability for nesting) stable for periods of at least 30 days and usually longer than 60 days during the breeding season.[19]

For the purpose of this analysis, the following fundamental notions were established:

- the presence of a nest was taken as evidence that the conditions suitable for nest establishment existed at a specific location;
- nest establishment represents a choice by the species of one area over others;
- establishment of a successful nest (one within which an egg hatches) demonstrates that suitable nesting conditions persisted for at least the period of nest establishment and egg incubation;
- establishment of numerous nests with multiple occurrences of success over the span of one or more years in proximate location to one another defines those areas that possess the characteristics most favorable for nesting;
- the recording of a successful nest and group of successful nests demonstrates that nesting-habitat existed at a location, even if that habitat is absent during a later observation; and
- areas that do not support nests in an area supporting an available nesting population are not considered nesting-habitat (although such areas may support some other critical survival need for least tern and piping plover)

Steps involved in the analysis are described below.

2.5.4.1 Step 1: Separate the Data.

Nest data was separated by study area segment, species, year, and NestArea as the first step in the analysis. Both successful and unsuccessful nests were used in this analysis, and all nests recorded at a site were used without regard to timing of nest establishment during the breeding season.

[18] Several different GIS-based methods were tested to measure the area used by individual nests and the total areas used within recurrent nesting clusters (e.g., Total Nest Cluster and Time Slice Distances, Minimum Convex Polygon Assessment, Thiessen polygons, Delaunay triangulations, etc.) All were unsuitable for this analysis.
[19] It is assumed that inundation, even by a single event, is fatal to an established clutch and to unfledged chicks.

2.5.4.2 Step 2: Measure Distances between Nests

GIS procedures were used to measure the distances between nests in each separate data set, and to determine the nearest-neighbor for each nest. For example, NestArea A shows 100 least tern nests for the year 2000. The GPS-located point that represents Nest 1 of NestArea A is 0.5 meters from the GPS-located point that represents Nest 37 of NestArea A. Distances between Nest 1 and the remaining 99 nests located in NestArea A in the year 2000 are all greater than 0.5 meters. The nearest-neighbor measurement for Nest 1 would be 0.5 meters. Procedures that measured the nearest-neighbor distance for Nest 1 were repeated for all 100 nests located in NestArea A during the year 2000, which yielded a data set of 100 nearest-neighbor measurements for least terns in NestArea A during the year 2000.

2.5.4.3 Step 3: Establish the Radius of Nesting Habitat Circles

Nesting-habitat circles were used to estimate the acreage used for nesting-habitat, and nearest-neighbor measurements were used to establish the radius of the habitat circle for each nest. Given the example in Step 2, the 100 nearest-neighbor measurements for NestArea A form a distribution of 100 least tern data points. In Step 3, statistics that describe the distribution of nearest-neighbor distances (e.g., minimum, maximum, mean, and quartile values) were calculated, and a nesting-habitat circle radius was derived from the statistics. While the mean and the median of a distribution describe the expected value, the third quartile value of the nearest-neighbor measurement distribution was used in this analysis to conservatively estimate the area measured as nesting-habitat. In the example of the 100 nearest-neighbor measurements for NestArea A in the year 2000, the third quartile value would be higher than 74 of the other nearest-neighbor measurements. The third quartile nearest-neighbor value represented the diameter of the habitat circles for NestArea A, and the radius of the circle was represented by half of the diameter.

Nearest-neighbor distance measurements sometimes resulted in measurements in excess of hundreds of feet. These were assumed to be single, isolated nesters using small patches on larger islands or single bare sand patches on smaller islands. Accounting for the area used by all birds required that these distant nests be assigned a reasonable buffer distance. Since much trial and error produced no consistent test for reasonability, a common statistical test for identifying outliers in datasets was used.

Most methods for statistical outlier identification would identify a nearest-neighbor distance of, for example, 389 feet as belonging to a different group than a group with nearest-neighbor distance numbers with a range from 30 to 50 feet. The objective, however, was to assign a reasonable buffer radius to obtain an area commanded by each nest and for all nests. Lacking multiple nearest-neighbor measurements, the habitat circle radius assigned to the outliers was set at the calculated Upper Inner Fence outlier distance. The equation for this statistical value is:

Upper Inner Fence Distance = Third Quarter Value + 1.5 x IQR, where

IQR = Third Quarter Value – First Quartile Value

Nesting-habitat circle radii for distant nests on the same island as a NestArea cluster were set at the third quartile value for that island, which included the nearest-neighbor distance of the most distant nest. For cases in which the Upper Inner Fence Distance was less than the third quartile value, the third quartile value was used. Nesting-habitat circle radii for widely separated distant nests established on sandbars separated by hundreds to thousands of feet were assigned a habitat circle radius equal to the Upper Inner Fence Distance for the entire annual cohort for the study area segment.

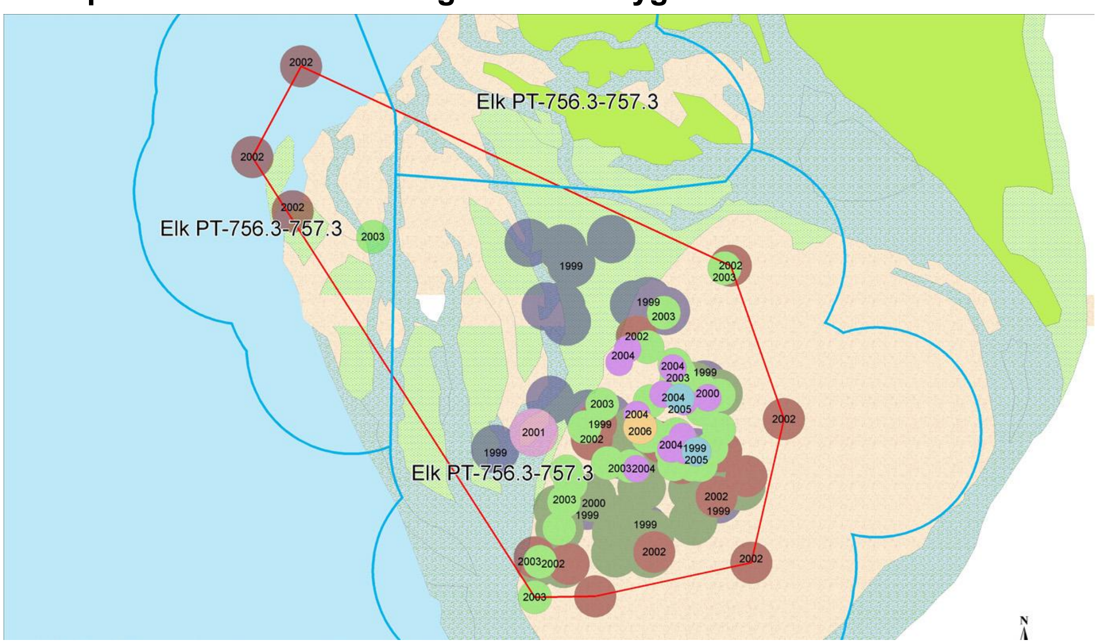
2.5.4.4 Step 4: Establish Nesting Habitat Polygons

Radii established in Step 3 were used to establish circles around each nest that represent acres of territory surrounding each nest. Again, it is important to reiterate that the radius of each circle was calculated separately for each species, each NestArea, and each year of the period of analysis.

Each nesting territory circle was plotted in the GIS model, with overlapping areas of circles counted only once in the calculation of the polygon's total acreage. This procedure was repeated for each species, each NestArea, and each year of the period of analysis.

Figure 2-6 provides a graphic representation of the results for least terns at a single NestArea. Each circle in the figure represents the nesting-habitat territory assigned to each nest, and the figure shows circles with different colors along with a nesting year designation. For example, the areas within the gray circles represent the acreage of habitat used by least terns at the NestArea designated as Elk PT 756.3-757.3 during 1999.

Figure 2-6
Example of Measured Nesting Habitat Polygons: Least Tern 1999 - 2006



2.5.4.5 Step 5: Calculate Combined Area of Nesting Habitat Polygons

After Steps 1 through 4 were completed, habitat circles for both species and for all years in the period of analysis were combined for each NestArea.[20] It is important to note that each circle in the combined set *retained* its radius that was established in Step 3. As can be seen in Figure 2-6 above, the total combined area for all years is not represented by the sum of the area occupied

[20] The GIS procedure "dissolve" was used to combine habitat circles into irregularly shaped polygons. The procedure removes boundaries between adjacent polygons.

during each year from 1999 through 2006. Overlapping areas of the habitat circles on each NestArea were again counted only once in the calculation of total acreage represented by combined nest territory circles.

It is recognized that the method used to measure nesting-habitat likely overestimates the actual area used in any year (i.e., use of the 75^{th} percentile for nearest-neighbor distance measurements as the habitat circle radii, and the use of widely distributed multi-year data). However, it was imperative that the ESH acreage goals established for PEIS Alternative 5 would reliably support the largest adult population of least tern and piping plover present during the period of analysis.

2.6 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defines those areas most suitable for ESH construction and maintenance, as well as those areas that if used would result in potentially significant impacts to either the natural or manmade environment. It identifies the conditions and locations that cannot be practically considered for inclusion in the ESH program. The conservation or protection of designated sensitive features is assumed to have a real and definable spatial expression – i.e., an area of land and water that they cover or occupy. The area associated with each sensitive feature is the sum of its physical area and the area around it considered necessary to conserve or protect its essential quality.

This process of eliminating areas that should be avoided leaves the remaining areas as the most suitable for ESH construction and maintenance on a segment-by-segment basis. The basis for this evaluation assumes the existence of man-made and natural features that should be conserved or protected from the land use changes that would occur from ESH program implementation. These include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment. Included in this group are special habitats such as Clean Water Act Section 404 Jurisdictional Wetlands, and cultural and historical resources. The location of historical sites within the subject segments was incorporated into the overall exclusion area to avoid public disclosure of site locations.

In addition to sensitive resources that should be avoided, a number of physical constraints limit the locations where ESH sites can be constructed. There are many high-energy or sediment-starved reaches where the placement of substrate to construct sandbars would be nearly impossible. Construction and maintenance of ESH in these areas would not be feasible because of high costs, increases in occupational risks, and only brief persistence.

2.6.1 Sensitive Resource Buffers and Exclusion Zones

An initial list of sensitive resources to be avoided was developed and circulated to the USFWS, National Park Service (NPS), and the affected states with a request to review and comment. Specifically, agencies were formally requested to review the Corps' suggested list and provide:

1. any additional features or resources to be avoided,
2. minimum buffer distance for the resources already listed as well as any additional resources recommended for avoidance, and
3. a reference or justification for each of the buffer distances provided.

Affected states and agencies were asked to indicate if the resources and associated buffer distances provided were a regulatory limit, published in the scientific literature, or based on best professional judgment (USACE, 2005b). The following list was sent to various agencies and intuitions on May 26, 2005 and again on March 2, 2006.

Sensitive Resource Features

- Areas with Scenic Viewsheds/Vistas
- Boat Ramps
- Bridges
- Cold Water Reaches
- Confluences with Uncontrolled Tributaries
- Cultural/Historic Resources
- HTRW Sites
- Islands/Sandbars with Trees >4-inch DBH
- Mining Sites
- Missouri Recreational River Reaches for 2005 and 2006.
- Municipalities
- Mussel Beds
- Native American Lands
- NPDES-permitted Outfalls and Waste Water Discharge Points
- Other State-Listed Species populations or designated critical habitats
- Recreation Areas
- Submersed Cable and Pipeline Crossings
- Submersed Historical Archeology Sites
- Tailraces
- Thalweg
- Water Intakes for Agricultural, Municipal, or Industrial Water Use
- NWI-Mapped Wetlands

The agency and institutional responses to this information request are presented in Tables 2-6 through 2-14. Table 2-15 provides a summary of the responses used in the analysis.

Table 2-6
Montana-Dakota Utilities Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer (ft)	Downstream Buffer (ft)
R.M. Heskett Station Cooling Water Intake	Lat. 46" 52' 3.86" N Long. 100"52' 56.57" W	12,500	6,000
R.M. Heskett Cooling Water Discharge Outfall (winter)	Lat. 52' 4.67" N Long. 100' 52'57.39" W	12,500	6,000
R.M. Heskett Station Cooling Water Discharge Outfall (summer)	Lat. 46 52' 2.50" N Long. 100' 52' 55.32" W	12,500	6,000
West End Point of Natural Gas Pipeline Crossing (Pierre, SD)	Lat. 44 22' 14.26" N Long. 100' 22' 20.48" W	12,500	6,000
East End Point of Natural Gas Crossing (Pierre, SD)	Lat. 44" 22' 21.44" Long. 100' 21' 58.36" W	12,500	6,000

Table 2-7
Montana Water Center Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer (ft)	Downstream Buffer (ft)
Cold Water Reaches	Below Fort Peck Reservoir	1,000	250
Mussel Beds		1,500	250
State Listed species or designated habitats		1,500	1,500
Municipal Water Intakes		1,500	500
NWI - Mapped Wetlands		1,000	500

Table 2-8
North Dakota Game and Fish Department
Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer (ft)	Downstream Buffer (ft)
Paddlefish and other Native Rare Fish Habitat to Avoid	Yellowstone River Confluence with Missouri		
Paddlefish and other Native Rare Fish Habitat to Avoid	Erickson Island near Williston		
Paddlefish and other Native Rare Fish Habitat to Avoid	Missouri River between RM 1130 - 1331		
Boat Ramps (River)		600	600
Boat Ramps (Lakes)		1,200	1,200
Lake Shoreline Access Routes on Sakakawea	Corps Riverdale Office has Locations	1,200	1,200
Municipalities	Various		
Bismarck		Burnt Boat Ramp	Heart River Confluence
Cabin or Cottage Areas (Recreation Areas)	Various	1,200	1,200

Table 2-9
South Dakota Dept. of Environment and Natural Resources
Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer (ft)	Downstream Buffer (ft)
Water Quality	Downstream of Garrison Dam	n/a	n/a

Table 2-10
Nebraska Game and Parks Commission
Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer	Downstream Buffer
Bald Eagle Nests	Various – Survey 1 mi up and downstream of desired project location.	0.5 mi or line of sight	0.5 mi or line of sight
Least Tern and Piping Plover Nest Sites	Various	0.25 mi of active nests	0.25 mi of active nests
Blue Sucker Riffle Complexes	Various	Do not disturb riffle	Do not disturb riffle.
Mussel Beds	Various		
Wetlands	Various		
Sicklefin/Sturgeon Chub	Unknown		
Other Nesting Birds	On Existing Sandbars or any area of Disturbance		
Threatened or Endangered Fish Species	Various		

Table 2-11
U.S, Fish and Wildlife Service
Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer (ft)	Downstream Buffer (ft)
Active Bald Eagle Nests	Various - pre-construction survey required	0.5 mi	0.5 mi
Mussels	Various - pre-construction survey required		
Least Tern and Piping Plover Nesting Colonies	Various - pre-construction survey required	0.25 mi	0.25 mi
Pallid Sturgeon Habitat	Various - pre-construction survey required	tbd	tbd
Boat Ramps	Various - known locations	case-by-case	case-by-case

Table 2-12
U.S. National Park Service
Sensitive Features and Protective Buffers

Sensitive Resource Feature	Location	Upstream Buffer (ft)	Downstream Buffer (ft)
Entire MNRR	All Aspects of the MNRR	None - avoid all	None - avoid all

Table 2-13
South Dakota Game Fish & Parks
Sensitive Features and Protective Buffers

Location	Species	Date	Site Use by Turtles
Below Lake Yankton (outlet is locally known as the bubble), RM 810-809.72, SD side	Smooth softshell	3/19/99	Over 100 smooth softshells on bottom, in clam bed, wintering site
Upper end of sandbar at RM 807.1-807.4	Smooth softshell False-map turtle, Possibly other species.	8/24/99	Many nests on island, one live smooth softshell and one live false-map turtle captured and released.
Large sandbar just upstream of the island at the mouth of the James River, RM 800.8	Smooth softshell	8/24/99	Nest site and nursery for smooth softshells; 24 YOY smooth softshells and one adult male captured and released.
1st sandbar in channel between Elk Island and mouth of James River, RM 800.4	Smooth softshell, Possibly other species	8/24/99	30-40 turtle nests, YOY smooth softshells found and much sign of smooth softshells
1st small sandbar between Elk Island and SD shore, RM 800.3	Smooth softshell	8/24/99	Much evidence of smooth softshells
North side of Goat Island, RM 783.0 to 783.2	Unknown, probably both smooth softshell and false-map turtle	8/12/99	Hundreds of nests on open sandy area, bank erosion is gradually making this site inaccessible to turtles
2 bars just below mouth of the Vermillion River, RM 770.8	Smooth softshell	8/4/99	Three nests
Oxbow in the Elk Point sand dunes area, RM 767	Smooth softshell, False-map turtle	9/11/99	Two adult smooth softshells; 12 YOY false-map turtles, from 3.5 to 8 cm carapace length.

Table 2-14
Summary of Agency Responses

Resource	Location/Segment	Upstream Buffer (ft)	Downstream Buffer (ft)
Physical Feature/Infrastructure			
R.M. Heskett Station Cooling Water Intake	Garrison	12,500	6,000
R.M. Heskett Cooling Water Discharge Outfall	Garrison	12,500	6,000
R.M. Heskett Station Cooling Water Discharge Outfall	Garrison	12,500	6,000
West End Point of Natural Gas Pipeline Crossing (Pierre, SD)	Garrison	12,500	6,000
East End Point of Natural Gas Crossing (Pierre, SD)	Garrison	12,500	6,000
Cold Water Reaches	Fort Peck Dam to Milk River	1,000	250
Entire MNRR	Randall and Gavins Point		
Cabin or Cottage Areas (Recreation Areas)	Garrison	1,200	1,200
Bismarck	Garrison	Burnt Boat Ramp	Heart River Confluence
Boat Ramps	Garrison	600	600
Municipal Water Intakes	Fort Peck	1,500	500
Biological			
`	Fort Peck	1,500	250
Bald Eagle Nest	all	2,640	2,640
Least Tern and Piping Plover Nest Sites	all	1,320	1,320
State Listed species or designated habitats	Fort Peck	1,500	1,500
NWI - Mapped Wetlands	Fort Peck	1,000	500
Blue Sucker Riffle Complexes	NE - Gavins Point Reach and Ft. Randall	Do not disturb riffle	Do not disturb riffle.
Paddlefish and other Native Rare Fish Habitat to Avoid	Fort Peck-Yellowstone River Confluence with Missouri		
Paddlefish and other Native Rare Fish Habitat to Avoid	Fort Peck-Erickson Island near Williston		
Paddlefish and other Native Rare Fish Habitat to Avoid	Fort Peck-Missouri River between RM 1330 - 1331		
Sicklefin /Sturgeon Chub	NE - Gavins Point Reach and Ft. Randall		
Pallid Sturgeon Habitat	all		

The locations and avoidance distances provided in Table 2-17 were used to create GIS polygon shapefiles of restrictive and exclusionary zones.

2.6.2 Measured Minimum Separation Distance Buffers

The TP-DMS was used to measure the minimum nesting distances observed from various anthropogenic features and sensitive resources. The dataset included all nests initiated between 1999 and 2006 for all study area segments. These nest locations were compared to a feature dataset created in geodatabase format that included a point file, a line file, and polygon files representing the anthropogenic features located along the upper Missouri River.

This anthropogenic feature dataset was created by manual digitization of observable features on the 1998/1999, and 2005 aerial imagery used for riverine corridor habitat delineation. Features that could not be identified from the orthophotographic imagery were marked and checked, using stereoscopic interpretation. This developed dataset included 3,633 point features, 67 line features, and the polygons created from them. Separately, gallery cottonwood forest edges were identified as potentially restrictive natural features. Personal communications with Casey Kruse and Greg Pavelka of the Corps' Threatened & Endangered Species Section (2004-2006) advised that forests located within several hundred feet of ESH may be used by raptors as observation posts for finding and predating nesting colonies. The gallery forest boundary was delineated to create polygons from the 2005 imagery. The objects identified in the feature dataset are listed below.

- domiciles;
- boat ramps (both private and public);
- boat docks (both public and private);
- designated recreation sites/areas;
- large water intake and outfall structures;
- industrial features/areas;
- highly urbanized areas;
- bridges;
- overhead transmissions lines;
- transmission lines under channel;
- transmission pipe lines under channel; and
- gallery forest edges.

The GIS procedure "spatial join" was used to measure the distances from all nests to the nearest anthropogenic feature point. This procedure creates a new shapefile that maintains all attributes of the nest dataset, while creating new attribute fields for feature type and the distance from the nearest feature to the nest. The measured distances were compiled to evaluate minimum nesting distances.

Minimum nesting distance was defined as the linear distance beyond which more than 95 percent of the nests were located. Minimum nesting distances were separately determined by species and study area segment, and by successful and unsuccessful nests. Derived minimum separation distances were then used to create buffer features in GIS format. These buffers were intersected with the riverine habitat polygons, to reveal areas that would not be unfavorable for construction and maintenance sites. The minimum linear separation distances are listed by reach, species, and feature type in the Table 2-15. The larger of the minimum separation distances for each features was used to establish buffer zones.

Table 2-15
All Reaches Combined: Point Feature Distances

	95% Separation Distance (Feet)		Full Data Set (Feet)	
Feature Type	**Least Tern**	**Piping Plover**	**Average**	**Minimum**
Domiciles	850	850	2,236	690
Boat Ramps	750	700	2,437	363
Recreation Areas	700	700	1,306	213
Boat Docks	550	450	1,777	341
Miscellaneous Feature	650	750	2,087	455
Irrigation Pumps	750	850	2,340	726
Industrial Facilities	550	500	671	525
Gallery Forest Edges	550	550	950	290

2.6.3 Flow Regime Restriction Buffer

There are recognized relationships between channel size, flow, erosive energy gradients, and the degradation and aggradation zones in any controlled river system (Biedenharn et al, 2001). In order to avoid significant changes to river hydrology, ESH construction and maintenance would need to be restricted from areas that could impose geometric channel alterations and induce significant hydrologic changes. Three areas within each study area segment present physical limitations restricting the ability to create ESH: the primary channel flow area needed to convey the water volumes (i.e., the thalweg), narrow channel reaches unsuited to island formation and retention, and a 200-foot buffer from the existing shoreline necessary as a predator moat. These three area types were excluded from consideration.

2.6.3.1 Minimum Flow Channel

The entire river channel would not be available for the creation and maintenance of ESH – some areas are not suitable for construction. The width of area needed for flowage is controlled in part by the depth of the primary flow-way in the river (the thalweg). Lacking comprehensive bathymetric data for all five reaches, the location of the thalweg was estimated and digitized in GIS from the 2005 imagery. The width for buffering the line was developed by measuring the channel width at the most narrow sections along an entire study area segment and generating the average width of the flow-way. Using the line digitized thalweg centerline, a buffer was created for each study area segment based on multiple averaged segment-specific channel measurements. This area, designated as the thalweg, was considered unavailable for ESH construction and maintenance. The effect of excluding the thalweg reduces the overall riverine corridor acreage available for the ESH program.

2.6.3.2 Channel Width Restrictions

A comprehensive examination of the upper Missouri River identified areas that were able to accumulate and sustain persistent sandbars (Biedenharn, 2001). Sandbar formation and retention is controlled by the planform of the river channel (Biedenharn et al, 2001) and the channel width and the associated flow velocity dictate the sediment particle size that can be carried by the flow. These relationships, developed for each of the subject segments, are presented in Table 2-16.

Table 2-16
Channel Width and Sandbar Formation

Segment[21]	Mean Channel Width With no Bars (ft)	Lower Threshold Channel Width for Bar Formation and Retention (ft)	Mean Width of Channel with Sustained Bars (ft)	Mean Width of Channel With Bars and Islands (ft)
Gavins Point	1,360	1,625	2,900	4,375
Fort Randall	2,046	2,171	2,300	3,470
Garrison	1,751	2,069	2,273	2,821
Fort Peck	750	836	1,073	1,512

Source: Biedenharn et al 2001.

The lower threshold channel width for bar formation and retention was described in the Biedenharn analysis as the channel width below which 75% of the reaches in a segment had no bars present. These width estimates were used in the GIS to create buffered lines following the centerline of the riverine habitat delineation polygons for each reach. This allowed segmentation of the river into two categories:

1. suitable for ESH – above minimum width threshold for sandbar retention,
2. unsuited for ESH – below to well below minimum channel width for sandbar retention.

Riverine corridor portions identified as category 2 were buffered and excluded from the area available for construction.

2.6.3.3 Predator Moat

Least tern and piping plovers rarely utilize sandbars connected to the riverbanks (i.e., terrestrialized sandbars). Kruse (2004), Pavelka (2005, 2006) and others assert high predation rates for birds using sandbars attached to the riverbank. Bird avoidance of riverbank sandbars was supported by GIS analysis of the TP-DMS. Intersection of nest points with the habitat layers revealed that less than 0.1 percent of nests were located on terrestrialized sandbar habitat between 1999 and 2006. Kruse (pers com, 2005) recommends "a minimum 200-foot wide, deep channel separates constructed or maintained ESH from the shoreline." For the exclusion, a 200-foot wide inner buffer along the edge of the riverine habitat boundary was generated in GIS to define lands and waters unsuited for ESH construction to leave room for a moat to restrict predator access.

[21] No analysis was performed for the Lewis and Clark Lake Segment.

2.6.4 Residual Areas for Construction and Maintenance

Various features, habitats, engineering considerations, and activities present in the Missouri River channel limit the actual areal extent upon which ESH can be constructed. The foregoing elements discussed represent spatial restrictions that categorize the riverine corridor acreage into three categories. These categories are listed below.

1. **Exclusion Areas** are locations at which ESH could not be constructed because intrusion into these locations could cause significant geomorphic alterations to the river corridor. Such an intrusion would risk physical and economic damages to public and private infrastructure or land uses. Exclusion areas include the estimated minimum flow way for normal flowage (i.e., the thalweg), narrow channel reaches, and areas needed to provide a predator moat.
2. **Restrictive Areas** are locations at which ESH could be constructed and maintained at relatively low physical risk, but could put nesting habitat in areas at risk from predation, recreation encroachment, or locations otherwise limited for nesting use and productivity. Areas of limited usability are those areas defined by analysis of distances from features that have shown to be restrictive to nest establishment or nest success.
3. **Available Areas** are locations that are most suitable for the construction and maintenance of ESH. However, it is important to note that any construction activities would need to ensure that other high-interest features (e.g., archeological and cultural resources, or other protected species) would be avoided.

The various features and restrictions defined in the previous sections are categorized and summarized in Table 2-17. The spatial expressions of features in categories 1 and 2 have been used to create riverine habitat program use classification GIS polygons applied to predict the actual acreage available for category 3 activities. Exclusion areas are shaded gray in Table 2-17, and restrictive areas are not shaded.

Table 2-17
Summary of Restrictions and Exclusions for Construction and Maintenance of Emergent Sandbar Habitat

Feature	Restriction	Source or Basis	Distance	Extent	Impact of Failure to Observe
Minimum Thalweg Width/ Actual Active Thalweg	Engineering Challenge	Practical Construction Consideration	Varies	Actual Area	May enhance channel erosion, alter alignment, shorten life of created sandbar
Narrow Channel Width, High Erosion Potential	Engineering Challenge	USACE Engineering Reports	Varies	River Width	May enhance channel erosion, alter alignment, shorten life of created sandbar
Electrical Power Station Cooling Intakes	Exclusion	Infrastructure Protection	18,500	River Width	Public or Private Property Damage
Electrical Power Station Cooling Water Discharge	Exclusion	Infrastructure Protection	18,500	River Width	Public or Private Property Damage
Elevated Electric Power line Crossing	Exclusion	Infrastructure Protection	2,000	River Width	Public or Private Property Damage

Feature	Restriction	Source or Basis	Distance	Extent	Impact of Failure to Observe
Municipal Water Intakes	Exclusion	Agency Instruction	2,000	River Width	Public or Private Property Damage
Natural Gas Pipeline Crossing	Exclusion	Infrastructure Protection	18,500	River Width	Public or Private Property Damage
New Construction Near active ILT and PPL nests	Seasonal Exclusion	Agency Instruction	2,640	River Width	May inhibit use, productivity or enhance predation
Cultural, Historical, Archaeological Features	Protected Cultural Resource	Agency Instruction	Variable	Buffered Area	Regulatory Violation
Bald Eagle Nest	Protected Natural Feature	Agency Instruction	5,280	River Width	Regulatory Violation
Pallid Sturgeon Habitat	Protected Natural Feature	Agency Instruction	Variable	Actual Area	Regulatory Violation
Sicklefin/Sturgeon Chub	Protected Natural Feature	Agency Instruction	Variable	Actual Area	Regulatory Violation
Wetland	Protected Natural Feature	Agency Instruction	Variable	Actual Area	Regulatory Violation
Predator Moat	Protective of Birds	Expert Advice	200	From River Bank	May inhibit use, productivity or enhance predation
Blue Sucker Riffle Complexes	Protected Natural Feature	Agency Instruction	Variable	Actual Area	Regulatory Violation
Paddlefish and other Native Rare Fish Habitat to Avoid	Protected Natural Feature	Agency Instruction	Variable	Actual Area	Regulatory Violation
State Listed Species/ Protected Habitats	Protected Natural Feature	Agency Instruction	Variable	Actual Area	Regulatory Violation
Boat Docks	Protective of Birds	Calculated Minimum	550	From Point	May inhibit use, productivity or enhance predation
Boat Ramps	Protective of Birds	Agency Instruction	1,200	River Width	May inhibit use, productivity or enhance predation
Boat Ramps	Protective of Birds	Calculated Minimum	750	From Point	May inhibit use, productivity or enhance predation
Domiciles	Protective of Birds	Calculated Minimum	850	From Point	May inhibit use, productivity or enhance predation
Gallery Forest Edges	Protective of Birds	Calculated Minimum	550	From Point	May inhibit use, productivity or enhance predation

Feature	Restriction	Source or Basis	Distance	Extent	Impact of Failure to Observe
Industrial Facilities	Protective of Birds	Calculated Minimum	550	From Point	May inhibit use, productivity or enhance predation
Cabin or Cottage Areas (Recreation Areas)	Protective of Birds	Agency Instruction	2,400	River Width	May inhibit use, productivity or enhance predation
Cold Water Reaches (Dam to first major tributary)	Protective of Birds	Expert Advice	Variable +1,250	River Width	May inhibit use, productivity or enhance predation
Irrigation Pump	Protective of Birds	Calculated Minimum	850	From Point	May inhibit use, productivity or enhance predation
Miscellaneous Man-made Structure	Protective of Birds	Calculated Minimum	750	From Point	May inhibit use, productivity or enhance predation
Municipal River Frontages	Protective of Birds	General Observation	All	River Width	May inhibit use, productivity or enhance predation
Recreation Areas	Protective of Birds	Calculated Minimum	700	From Point	May inhibit use, productivity or enhance predation
Mussel Beds	Protected Natural Feature	Agency Instruction	1,750	River Width	Regulatory Violation
Turtle Habitat	Protected Natural Feature	Agency Instruction	Variable	Actual Site	Regulatory Violation

This assessment was performed for each of the study area segments using the results of the 2005 habitat delineations. The GIS process used for estimation of available acreages for each river segment included the following:

Polygons were created using the available features' areas and distances specified in Table 2-20. These polygons were categorized as either exclusionary or restrictive and combined into single polygons for each study area segment. The total combined polygon created from exclusionary areas was used to overlay and erase the 2005 habitat map for each segment. The result was the first available area per segment outside of exclusionary areas; the "exclusion residual" map.

The restrictive area combined map was then used to erase the "exclusion residual" map, the result of which is the "restrictive residual" map, also describable as the "available areas." The available area map presents both the location and the measurable acreage for the areas in which the ESH construction and maintenance actions could be implemented with the least impacts to other riverine resources.

Other restrictions (e.g., land ownership) may also apply to these areas from the existence of protected and high interest features that were unknown at the time of this analysis. Legal, state, and local jurisdictional controls and real estate issues have not been considered in this assessment.

Comprehensive mapping to display the results of this analysis for all five segments would not be practical in a printed document. Examples of GIS outcomes from the Fort Peck River Segment are presented as Figures 2-7 and 2-8. Data, metadata, shapefiles, feature data sets, and project files used for this assessment are available in digital format from the Corps of Engineers, Omaha District.

Figure 2-7
Example of a the Application of Exclusion Areas

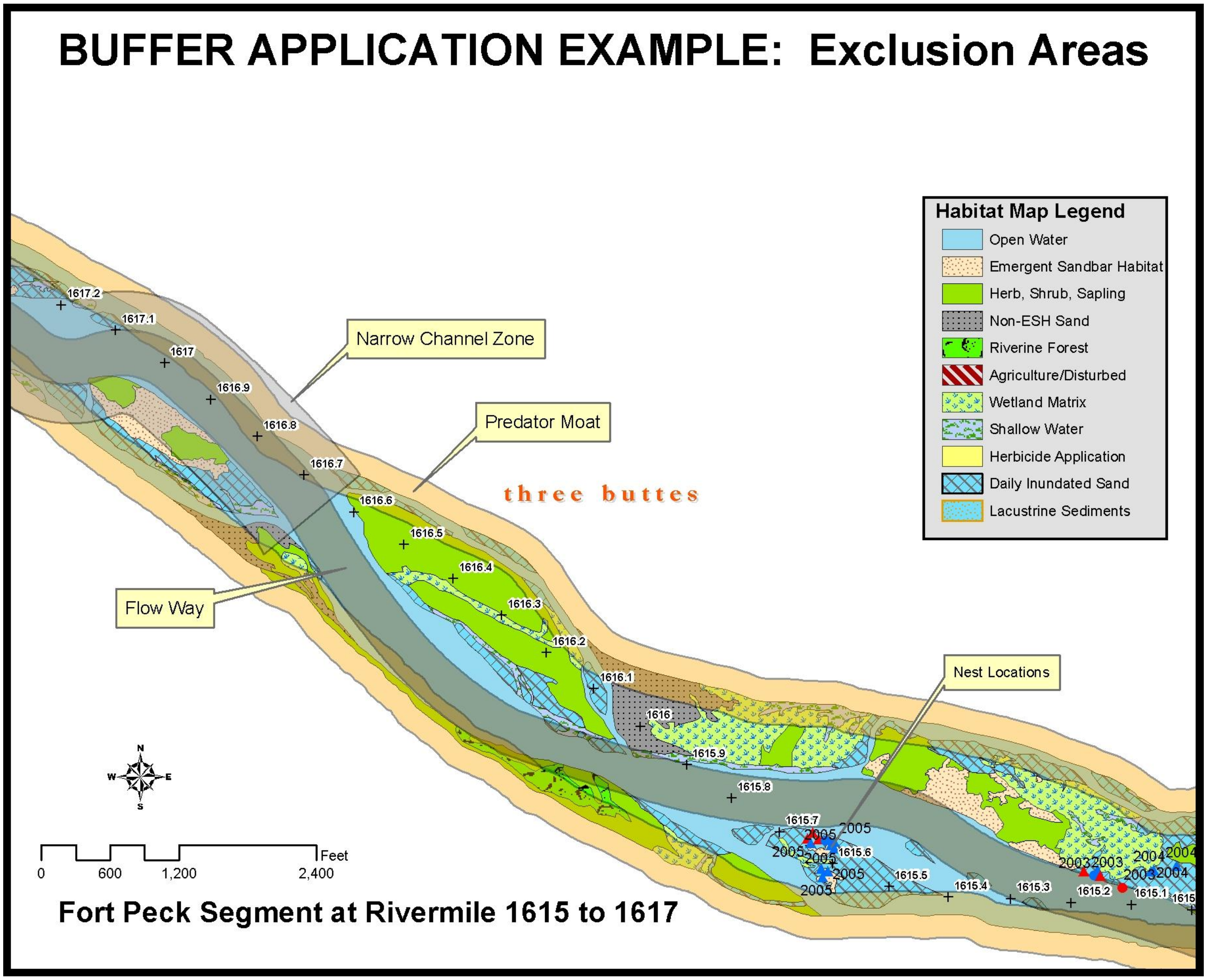
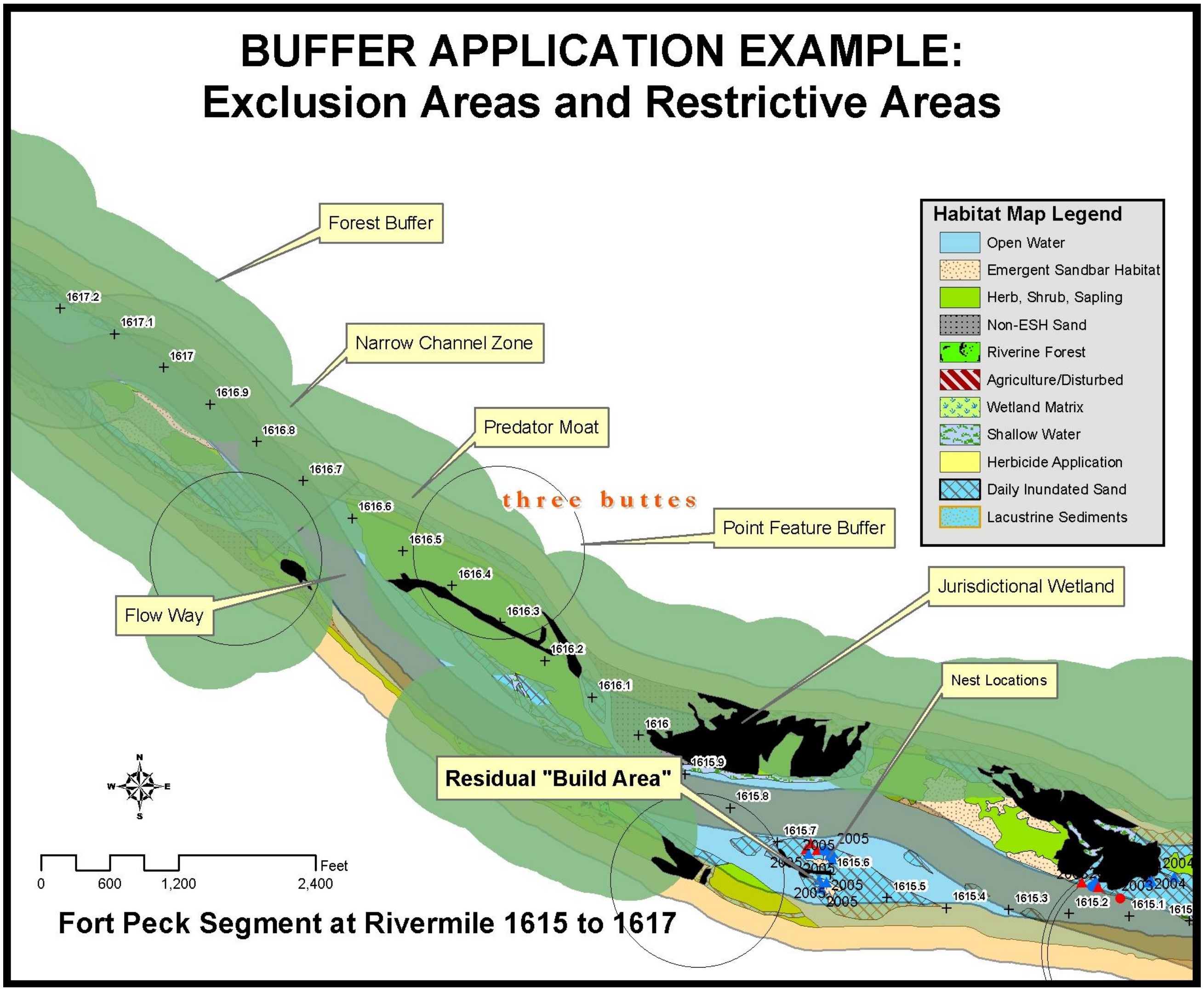


Figure 2-8
Example Application of Exclusion Areas and Restrictive Areas to Generate Unencumbered Available Areas



3 Gavins Point River Segment

The Gavins Point River Segment extends from the Ponca State Park boat ramp at RM 753.0 to the tailrace of Gavins Point Dam at RM 811.1 (see Figures 3-1 and 3-2 below). This segment is the farthest down river, lowest in elevation, and most southern of the designated free-flowing segments. The total area within the upstream and downstream limits between the high banks is approximately 23,000 acres.

Figure 3-1
Regional Overview of the Study Area

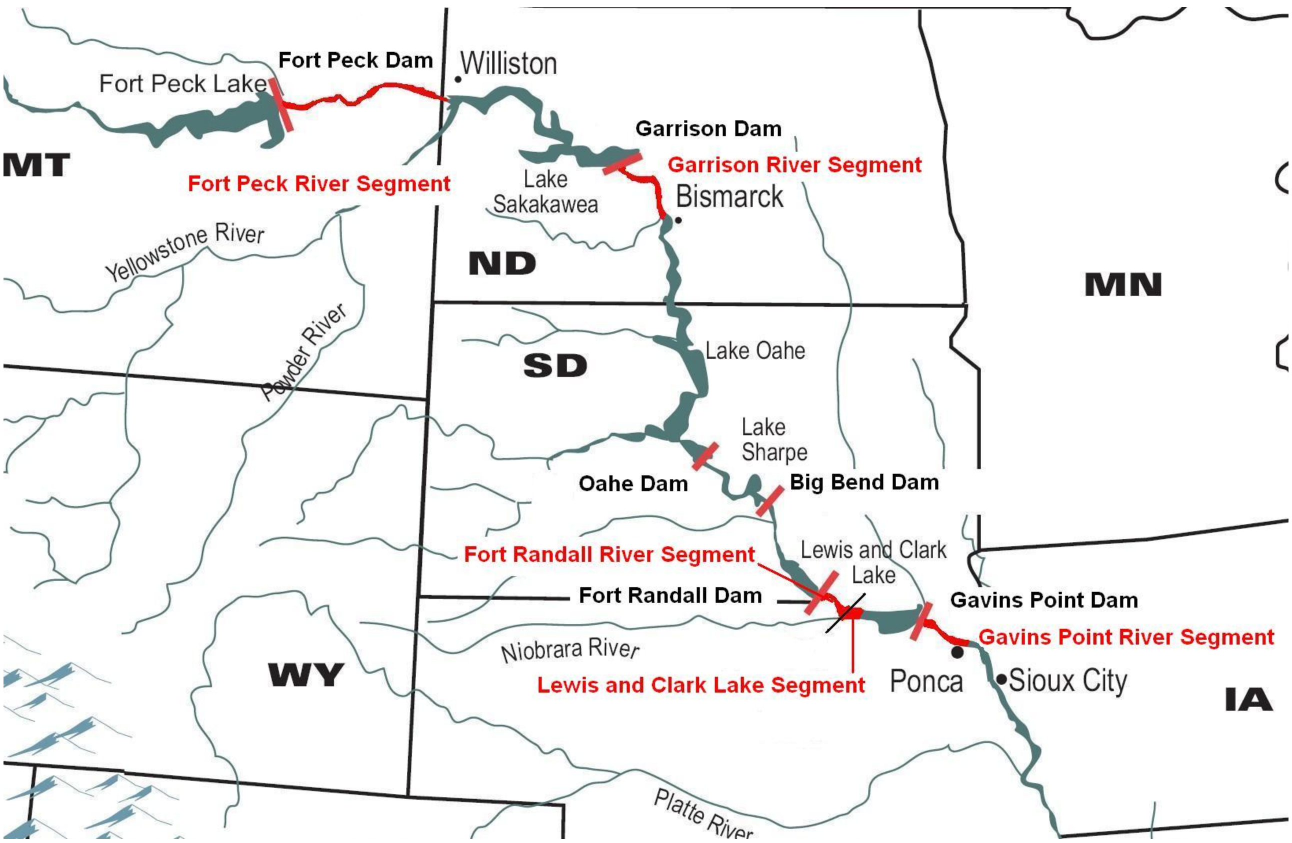
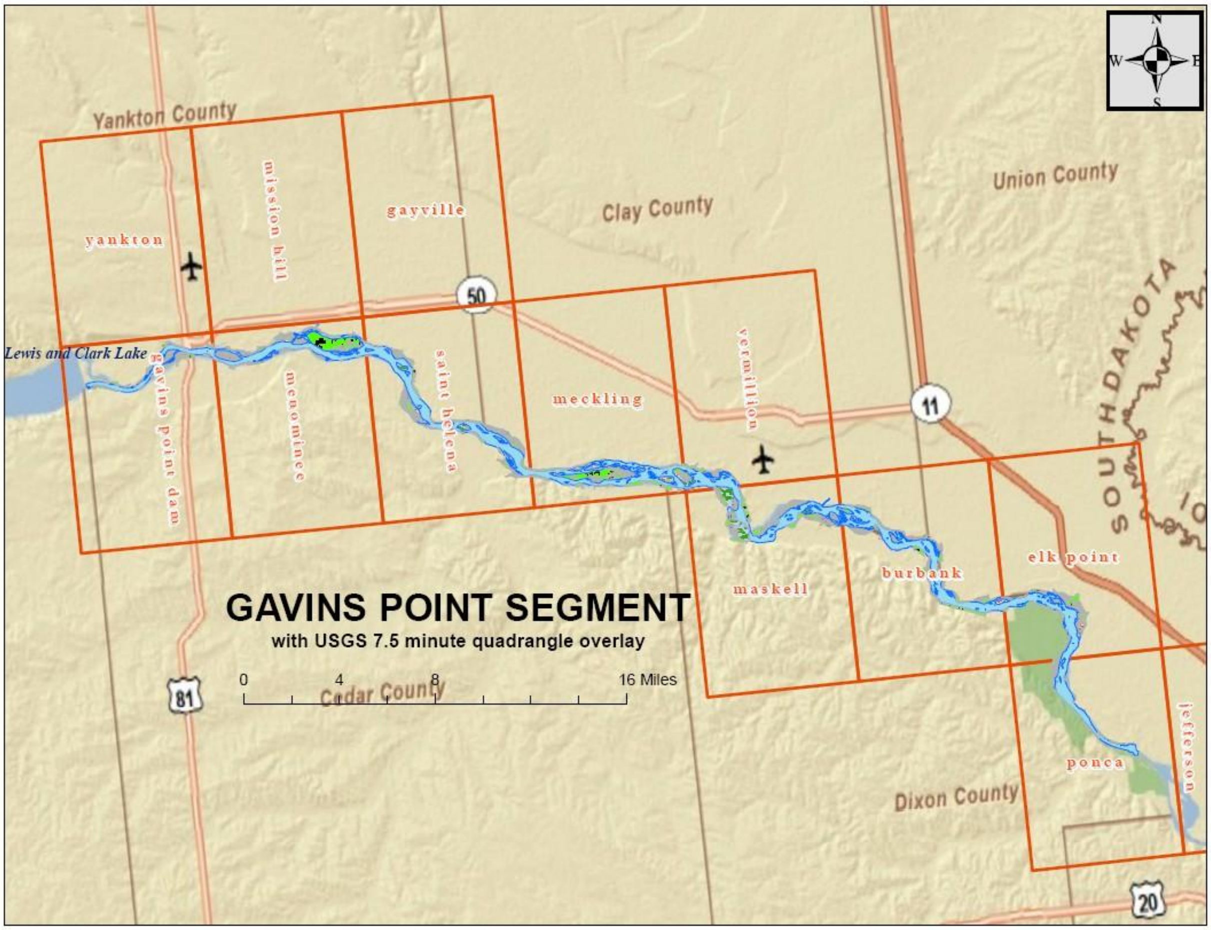


Figure 3-2
Overview of the Gavins Point River Segment with USGS Quadrangles



3.1 Habitat Delineation

Table 3-1 summarizes the change in acres for all habitat types between 1998 and 2005. Table 3-2 depicts the changes in ESH acreage between 1998 and 2005. Figure 3-3 displays the changes in acres per river mile of each habitat type between 1998 and 2005. Eight of the 12 habitat types defined in Section 2 are present in the Gavins Point River Segment.

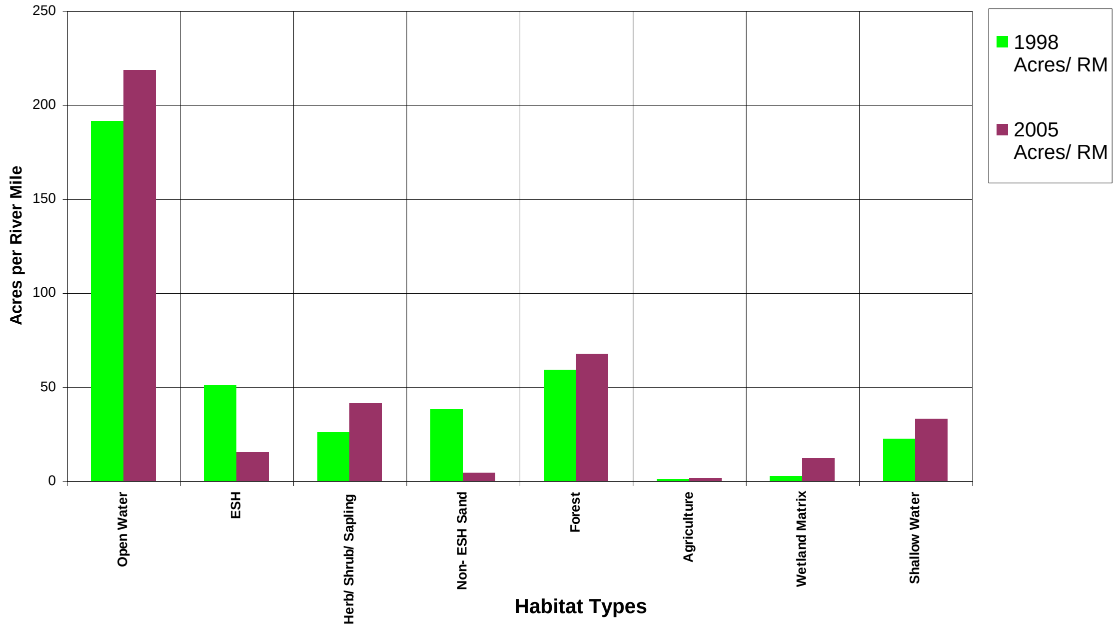
It is important to note that the 2005 aerial imagery used in the habitat delineation was captured during a Gavins Point Dam discharge of 21,000 cubic feet per second (cfs). Had the photographs been collected when releases were more typical (about 26,000 cfs), ESH polygon counts and total acreage delineated would have both been considerably lower because a higher river stage would have concealed the ESH. The low flows and low stage revealed 387 ESH polygons, which comprised 880 acres of ESH in 2005. These 880 acres represent the quantity of ESH required for the Gavins Point River Segment under PEIS Alternative 4: Maintain and Create ESH Area As Present in 2005.

Table 3-1 shows that the average total habitat area for the Gavins Point River Segment is 402 acres per river mile. The average riverine habitat area width is 3,316 feet. Approximately 50 percent of the total area is Open Water habitat with flows between 20,000 and 30,000 cfs from Gavins Point Dam. There are a few large forested islands that, given their elevated positions and dominance of large old trees, are most likely carved-off slivers of the ancient high bank floodplain, rather than sandbar created by recent fluvial processes. The remaining area is occupied by sandbar deposits at various elevations that range from barren sand to heavily vegetated sandbar. Table 3-1 also shows that the area of ESH mapped for 1998 was established at 2,944 acres, and was reduced to 880 acres (a 70 percent reduction) in the seven years between 1998 and 2005. These 2,944 acres delineated from the 1998 imagery represent the quantity of ESH required for the Gavins Point River Segment under PEIS Alternative 3: Create and Maintain ESH Area as Present in 1998/1999.

Table 3-1
Habitat Acreage Summary: Gavins Point River Segment 1998 and 2005

Habitat Name	1998 Acres	2005 Acres	Change Acres	1998 Acres/ RM	2005 Acres/ RM	Change Acres/ RM	1998 Pct of Total	2005 Pct of Total
Open Water	11,095	12,679	1,584	191	219	27	49.0%	55.5%
ESH	**2,944**	**880**	**-2,064**	51	15	**-36**	**13.0%**	**3.9%**
Herb/ Shrub/ Sapling	1,498	2,396	898	26	41	15	6.6%	10.5%
Non-ESH Sand	2,208	260	-1,948	38	4	-34	9.7%	1.1%
Forest	3,425	3,923	497	59	68	9	15.1%	17.2%
Agriculture	54	77	23	1	1	0	0.2%	0.3%
Wetland Matrix	144	697	553	2	12	10	0.6%	3.1%
Shallow Water	1,296	1,924	628	22	33	11	5.7%	8.4%
Total	22,664	22,837						

Figure 3-3
Change in Riparian Habitat Composition – Gavins Point River Segment



3.1.1 Emergent Sandbar Habitat Lost Between 1998 and 2005

Table 3-2 summarizes the habitat changes of ESH delineated in 1998 for the Gavins Point River Segment. As shown in the table, the majority of ESH was lost to erosion – sediments were either swept from or redistributed throughout the segment. Natural succession to vegetated upland or wetland habitats claimed 491 acres of ESH that was present in 1998, and 490.4 acres of the 1998 ESH remained in place through 2005.

Table 3-2
Disposition of ESH Lost from 1998 to 2005: Gavins Point River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	1551	53%	ESH lost to erosion and carried down river
ESH	490	17%	ESH retained from 1998
Herb/Shrub/Sapling	345	12%	Natural succession of well-drained sand bar to upland shrubs and herbs
Shallow Water	354	12%	ESH lost to erosion and redistributed in local backwater shallows
Wetland Matrix	146	5%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Non-ESH Sand	29	1%	ESH became terrestrialized or surrounded by forest
Forest	28	1%	Natural growth of shrubs into forest-sized trees
Total	2944		

3.1.2 Origin of 2005 Emergent Sandbar Habitat

Table 3-3 shows the results of an analysis to determine the origin of ESH mapped for 2005. The table shows that approximately 490 acres of ESH were in the same location during both delineation years. It was initially assumed likely that the balance of ESH (390 acres) either was constructed by the Corps in 2004 and 2005, or had accrued since 1998 through sandbar formation at other locations. Seven constructed ESH islands with a total area of approximately 119 acres were delineated near RMs 754, 761, and 770. The addition of constructed ESH brings the total area to 609 acres (490 + 119), leaving 271 acres of ESH potentially created through fluvial processes (redistribution of sediments) between 1998 and 2005.

The evaluation determined that 490 acres delineated from the 1998 images continued to exist as ESH in 2005. These areas include ESH that remained sufficiently vegetation-free to be identified as ESH during both years; resisting natural succession or subject to natural, mechanical or chemical manipulation prior to 2005 imagery acquisition. Conversion of 31 acres of terrestrialized sandbar to ESH was a consequence of the development of a chute through a former beach, resulting in island creation.

ESH delineated from 2005 imagery in areas that existed as shallow water in 1998 (80 acres) have two flow-related explanations:

1) the 1998 aerial imagery was acquired at a flow 4,000 cfs greater than in 2005 (25,000 cfs vs. 21,000 cfs), thus greater areas of sandbar were marginally above the water surface and visible in the 2005 photoset, and

2) releases from the Gavins Point Dam redistributed sand to create new ESH since the high releases of 1997.

Both explanations are valid. The remaining 2 acres represent conversion of vegetated areas to barren sand.

Table 3-3
Origins of ESH Delineated for 2005

1998 Habitat Type	Acres	Explanation
Open Water	277	Open Water area that became ESH by 2005
ESH	490	Area that remained ESH between 1998 and 2005
Herb/Shrub/Sapling	2	Area of Herb/Shrub/Sapling in 1998 that became ESH by 2005, possibly through scouring
Non-ESH Sand	31	Area of terrestrialized sand bar in 1998 that became ESH by 2005
Shallow Water	80	Area of shallow water in 1998 was mapped as ESH in 2005 because of lower flows in the Gavins Point River Segment

3.1.3 Impact of Fluvial Processes – Gavins Point River Segment

Bruce Vander Lee, a contractor with the Omaha District, performed least tern and piping plover database management and habitat delineations of the Gavins Point River Segment. Delineations were performed using imagery collected in 1996, 1998, 1999, and 2000. The Vander Lee 1998 habitat delineations were conducted using the same imagery that was used for the PEIS 1998 delineation of the Gavins Point River Segment, and a comparison was made between the two delineations. The Vander Lee 1998 delineation was virtually identical to the PEIS delineation of 1998 imagery for the Gavins Point River Segment, with a measured difference of less than 0.2 percent.

The consistency between the two delineations provide confidence that the 1996, 1999, and 2000 Vander Lee delineations may be used for analyses. The ESH acreages for these years, included with the acreage of ESH delineated from 2005 imagery, are shown in Table 3-4. The data show a substantial decrease of ESH acreage occurred between 1998 to 1999, followed by an increase in 2000, followed by a decline to 2005. ESH acreage in 1999 were relatively equal to 1996 levels.

Table 3-4
Comparison of Mapped Sandbar Areas for Various Years

Year	Interchannel Sandbar Acres	Flow (cfs)	Stage (ft)
1996	1,261	39,000	24.2
1998	2,983	26,000	22.5
1999	1,242	36,200	23.9
2000	1,760	31,500	23.3
2005	*880	21,000	21.6

* PEIS delineated acreage

The increase in ESH acreage for 2000 is noteworthy. An important sediment redistribution event was discovered in an assessment of island and sandbar elevations using LIDAR, gage data and field survey data (see Attachment 3 – Hydrological Data Analysis). Upon commencement of this investigation, the assumed origin of all sandbar was the 1996-1997 high controlled release event. While most sandbars can be connected through elevation to the 1997 event, a few small bars were found that demonstrated the persistent occurrence of a lower level release following 1997. A review of the Gavins Point Dam flow data and the gage data from Yankton and Maskell, two additional high-flow events were identified. The first occurred between November 9 and November 30 1998 at a consistent 40,000 cubic feet per second (cfs). The second occurred from August 30 through December 2, 1999 at between 43,000 and 45,000 cfs. These events may have eroded approximately 1,200 acres of 2,900 acres of interchannel sandbar mapped from the 1998 imagery.

The 2000 aerial imagery depicts an apparent resurgence of nearly 500 acres of ESH. The increase was the result of re-deposition farther downstream as low-lying bars, which later served as nesting-habitat during the dry, lower releases of the 2001 and 2002 nesting seasons. The majority of the apparent increase in ESH for 2000 was subsequently attributed to stage differences in the imagery.

Table 3-5 presents the flow and stage for the imagery used for habitat delineation in the Gavins Point River Segment since 1996. Stage figures used for comparison are the daily means from the Maskell USGS gage near RM 775.0. Flows are the daily means from Gavins Point Dam records. The 2.3 feet of difference is significant for low gradient topography common for features near water elevation[22]. Assessment of this effect was investigated using the 2005 LIDAR data.

Table 3-5
Aerial Imagery Characteristics: Gavins Point River Segment

Year	Date	Flow (CFS)	Stage (ft)
1996	06/04/1996	39,000	24.2
1998	05/04/1998	26,000	22.5
1999	06/16/2000	34,000	23.6
1999	07/07/1999	38,400	24.2
2000	08/09/2000	31,500	23.3
2005	06/15/2005	21,000	21.6
2005	06/17/2005	21,000	21.6

Assessment of the effects of stage on acreage for low-lying, frequently flooded sandbar habitats was conducted to demonstrate the difficulty for planning and ESH management stemming from the use of instant photographic imagery for quantification of low-lying habitat area in the dynamic fluvial event of river flow. ArcMap GIS was used to match concurrent flow data from Gavins Point Dam, gage data from Yankton and Maskell USGS continuously recording stream gages with the 2005 LiDAR and the 1998 and 2005 imagery. Stage at various flows was interpolated to all ESH islands based on distance and river fall calculated from the LiDAR. LiDAR points were used to create contours for each island, and contours were converted to polygons for area calculation. An area at stage model was prepared to summarize exposed sandbar at various stages and correct for the stage differences in the existing imagery sets (Table 3-6). The derived estimates presented in Table 3-6 normalize incident stage differences. They reveal the magnitude of error that may occur from attempts to measure areas of features in a highly variable riverine habitat using incident remote-sensing data. While this assessment highlights the uncertainties associated with the use of instant imagery, the habitat mapping using the available imagery as described in Section 2 was however not adjusted because a target river management stage or flow had not been established.

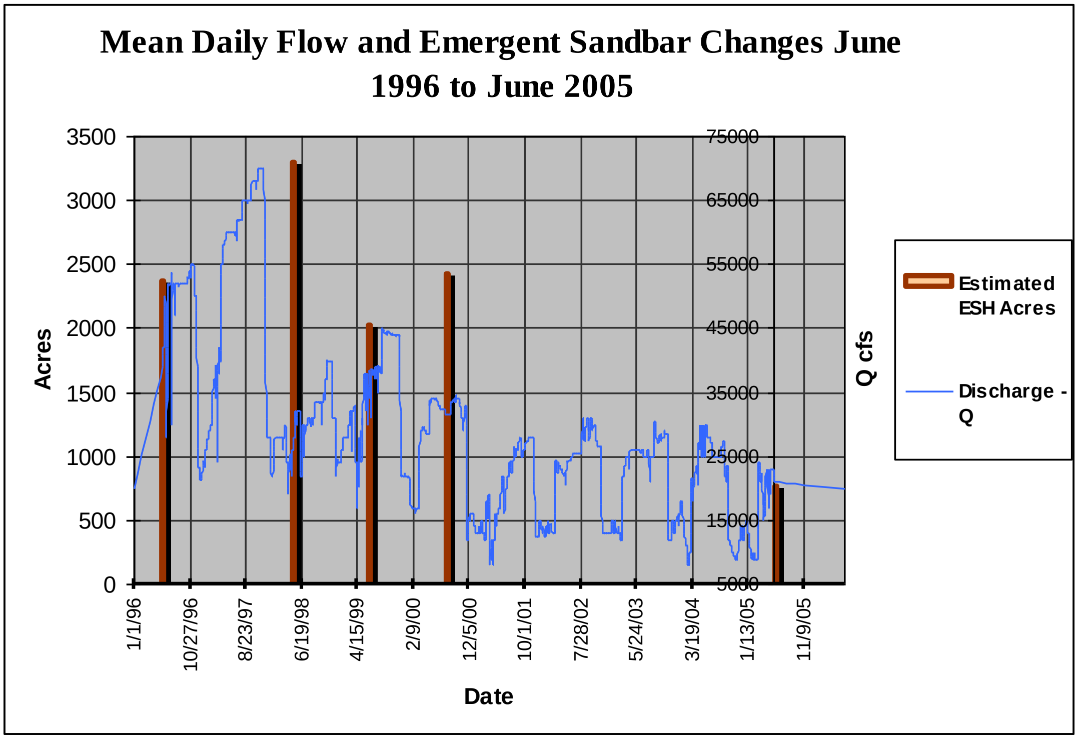
[22] If slopes were as steep as 1% (often much flatter on the depositional side of islands and bars), this vertical distance would result in a 230-foot wide band around every sandbar, adding one additional acre for every 200 linear feet of shoreline.

Table 3-6
Comparisons of Estimated Sandbar Area at Different Stages in Gavins Point

Year	Flow (CFS)	Stage (ft)	Stage Corrected Acreage	Estimated Area 15 Kcfs	Estimated Area 25 Kcfs	Estimated Area 35 Kcfs	Estimated Area 45 Kcfs
1996	39,000	24.2	1,261	3,821	2,362	1,432	893
1998	26,000	22.5	2,983	5,327	3,293	1,997	1,245
1999	36,200	23.9	1,242	3,269	2,020	1,225	764
2000	31,500	23.3	1,760	3,911	2,417	1,466	914
2005	21,000	21.6	880	1,223	756	458	286

Figure 3-4 shows mean daily flow from the Gavins Point Dam for January 1, 1996 through October 21, 2006. The figure also shows an estimate of ESH acreage corresponding to flows of 25,000 cfs.

Figure 3-4
Flows from Gavins Point Dam and ESH Estimates at 25,000 cfs



The foregoing normalization of area/stage relationships indicates that sandbars have been rapidly reformed by fluvial processes. Normalized for 35 Kcfs, approximately 39 percent of 1998 sandbar was lost before the 1999 breeding season. A rebound of approximately 200 acres was observed in the 2000 imagery, as the area of sandbar returned to approximate 1996 levels. The total loss of sandbar acreage by 2005 increased to approximately 70 percent of 1998 levels. This represents a subsequent annual proportional loss of less than 15 percent per year after 2000.

Winter pool lowering discharges in 1998 and in December 1999 of up to 45,000 cfs appear to have eroded hundreds acres of sandbar. Sediments were redistributed throughout the segment at relative elevations visible in 2000 but at local elevations frequently below subsequent breeding season water levels. High water during 1999 reduced usable habitat to approximately 1,200 acres. The 2003 amended BiOp language recognized the decline of suitable nesting-habitat to 260 acres, a figure consistent with other findings in this document.

This discussion highlights the problems associated with the use of single-instant aerial imagery to measure low elevation features in a river channel. Not only do fluvial processes reconfigure sandbars on a continual basis, but changes in stage can result in large differences in the observable expanse of these features.

3.2 Summary of Nest Data

The TP-DMS data set analyzed for the Gavins Point River Segment contained a total of 2,910 nests established between 1999 and 2006. Of those nests, 1,912 were successful – a success rate of over 65 percent. Nesting success and nesting failure were both clustered in discrete areas.

3.3 Distribution of Nesting Habitat by NestArea

The NestArea segmentation of the database grouped nests by location to show trends over breeding seasons. Table 3-7 shows the distribution of successful nests for both species combined over 39 NestAreas sorted in descending order by total successful nest count. Also shown on the table is the number of years in which nesting occurred on the NestArea. Constructed NestAreas are designated by gray shading in the table.

Table 3-7 shows that 50 percent of all successful nests over the eight-year period of analysis were established at five NestAreas. Figure 3-5 shows the general location of these five NestAreas.

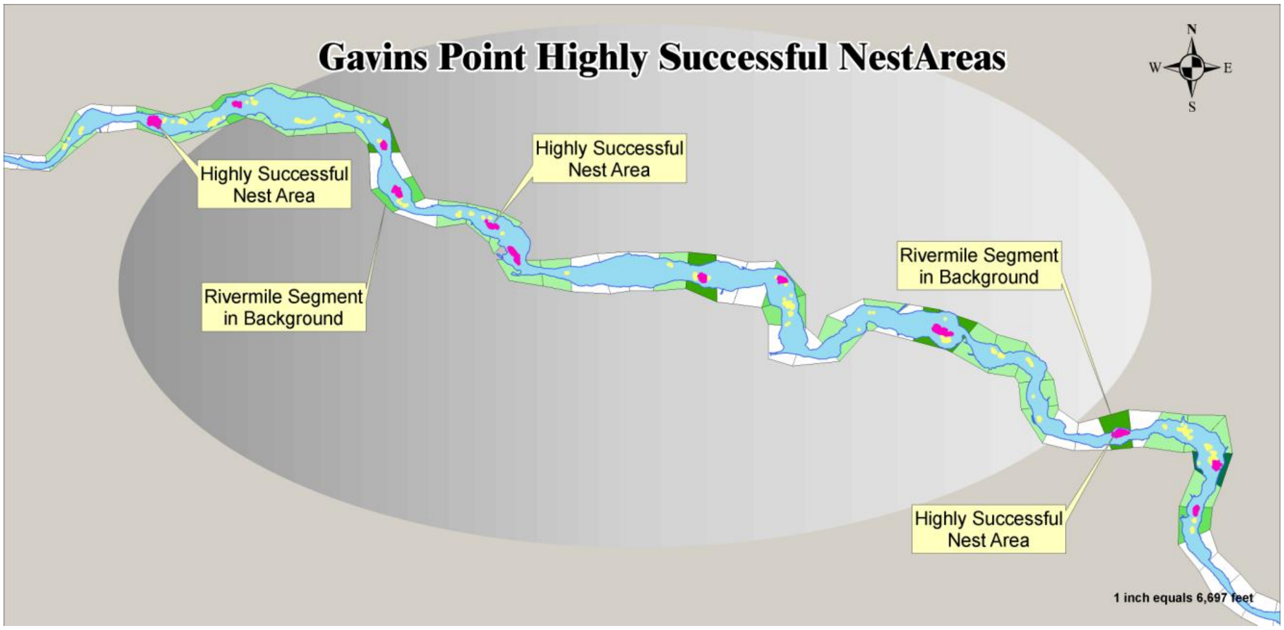
In addition, the table shows that over 90 percent of successful nests were established at 18 NestAreas, with only 10 percent of successful nests established at 21 NestAreas.

Table 3-7
Distribution of Successful Nests by NestArea and Years

NESTAREA	Nest Counts for Years Active								Total	Years	% Total	Cuml %
	1999	2000	2001	2002	2003	2004	2005	2006				
St.Helena: 787.9-788.2	16	17	16	54	54	57	15	9	238	1	12.4%	12.4%
Burbank: 769.4-770.4	6	8	1	11	9		82	116	233	3	12.2%	24.6%
Elk PT: 756.3-757.3	27	42	13	36	57	31	8	2	216	5	11.3%	35.9%
St.Helena: 795.1-795.4	1	24	22	23	13	17	18	13	131	2	6.9%	42.8%
Meckling: 781.5	25	23	15	2	10	19	30	4	128	2	6.7%	49.5%
Burbank-Elk PT: 761.5					6		52	50	108	1	5.6%	55.1%
Vermillion: 778.5-778.9	1		9	39	35	14			98	3	5.1%	60.3%
Ponca3: 754.8						48	11	18	77	1	4.0%	64.3%
Menomine: 801.3-801.5		3	9	15	39	5	5		76	1	4.0%	68.3%
Maskell: 777.0-778.1	5	18	19	21	9		2		74	3	3.9%	72.1%
St.Helena: 793.4-793.8			4	15	31	8	3	2	63	1	3.3%	75.4%
Menomine: 804.3-804.6	1	2	2	7	10	3	15	17	57	3	3.0%	78.4%
Elk PT: 758.7-759.3				17	13	17	7		54	4	2.8%	81.2%
St.Helena: 789.8-790.4	26	9		1	4	4	4	4	52	3	2.7%	83.9%
Menomine: 802.0-802.5				1	6	21	13	5	46	2	2.4%	86.3%
Burbank: 767.6-768.1	2	10	11		9	3			35	2	1.8%	88.2%
Menomine: 798.3-799.0		12	7	3	3			1	26	1	1.4%	89.5%
Gavins PT: 807.8-808.2							15	5	20	2	1.0%	90.6%
St.Helena: 791.3							13	5	18	1	0.9%	91.5%
St.Helena: 793.1-793.4		1	2	1	2	5	6		17	2	0.9%	92.4%
Elk PT: 759.7			15		1				16	1	0.8%	93.3%
Meckling: 781.7	3	5	5	3					16	1	0.8%	94.1%
Burbank: 766.5-766.8			1	14					15	1	0.8%	94.9%
Menomine: 803.3-803.5				3	5	3	3		14	1	0.7%	95.6%
Ponca1: 754.2							10	2	12	1	0.6%	96.2%
St.Helena: 797.4-797.6			1		1		6	3	11	2	0.6%	96.8%
Meckling: 782.6					3			7	10	1	0.5%	97.3%
St.Helena: 796.7-796.9	3		1	1	3	1	1		10	1	0.5%	97.9%
Ponca2: 754.4						9			9	1	0.5%	98.3%
Burbank: 764.5			6	1					7	1	0.4%	98.7%
Menomine: 800.6-800.9		1				1		5	7	2	0.4%	99.1%
Gavins PT: 807.3-807.5							2	3	5	2	0.3%	99.3%
St.Helena: 790.8	1	1		1	1				4	1	0.2%	99.5%
St.Helena: 789.5			1	1			1		3	1	0.2%	99.7%
Maskell: 772.7			2						2	1	0.1%	99.8%
Meckling: 786.1					1	1			2	1	0.1%	99.9%
Burbank: 765.6				1					1	1	0.1%	99.9%
Maskell: 773.2							1		1	1	0.1%	100.0%
St.Helena: 796.4	16	17	16	54	54	57	15	9	0	1	0.0%	100.0%
Total	117	176	162	271	325	267	323	271	1,912	65		
Active Subunits	13	15	21	23	24	19	24	19	65			
% of Successful Nests	6%	9%	9%	14%	17%	14%	17%	14%				
Cumulative %	6%	15%	24%	38%	55%	69%	86%	100%				

Note: Shaded rows are constructed ESH Sites

Figure 3-5
Highly Successful NestAreas of the Gavins Point River Segment



3.4 Productive Emergent Sandbar Habitat Characteristics

The following analyses were conducted to develop acreage estimates for Alternative 5 which seeks to create and replace ESH area that represents the amount of habitat used by the two species during the period of analysis. In conducting these analyses, the assumption was made that successful nesting, corresponding with Nest Success in the tern and plover census and productivity survey data, was representative of adequate nest site conditions, while fledge success further complicates the relationship to nest site quality by including factors tied to the quality of foraging and brood-rearing habitat at a nest site as well as external factors such as predation and agonism.

Over 2,100 acres of ESH visible in the 1998 imagery were lost to various natural processes between 1998 and 2005. This occurred while only 172 additional acres of ESH were accrued, a 12:1 lost to gained ESH ratio. The overall ESH losses (2,996 acres down to 880 acres) represent a 70 percent reduction.

However, these ESH losses were not matched by a reduction in nest counts in the Gavins Point River Segment over roughly the same time period. Data from the TP-DMS show that over 2,900 nests were established in the segment between 1999 and 2006. Nest counts rose from just under 200 nests in 1999 to over 500 by 2005. Given this disparity between nest counts and ESH acreages, an analysis was conducted to identify the characteristics of ESH selected as nesting-habitat, and the characteristics of ESH that led to nest success.

To identify the characteristics, analyses were conducted to:

- identify 2005 ESH polygons that support nests;
- identify nests located within 2005 ESH polygon boundaries;

- identify highly successful ESH islands;

In exploring this phenomenon, the areas that were used for nesting were analyzed and compared with population, nest numbers, and productivity metrics.

3.4.1 Identification of 2005 Habitat Polygons Supporting Nests

A spatial join was performed between the 2005 habitat polygons and the Gavins Point River Segment 1999-2006 nest dataset point features to assess nest distribution over time. Both least tern and piping plover nests were used and the initial findings are presented in Table 3-8.

Table 3-8
Count of Nests by Habitat Type Mapped in 2005

TYPE	Total Nests	Successful Nests	% Success	% Total in Type	% Success in Type
4	2,168	1,372	63.3%	74.5%	71.8%
1	508	380	74.8%	17.5%	19.9%
12	120	85	70.8%	4.1%	4.4%
6	59	38	64.4%	2.0%	2.0%
11	38	27	71.1%	1.3%	1.4%
7	16	9	56.3%	0.5%	0.5%
9	1	1	100.0%	0.0%	0.1%
Totals	2,910	1,912	65.7%		

A statistical comparison of the data in Tables 3-8 and 3-2 (above) shows that ESH loss and nest site loss were not correlated (adjusted R^2 for ESH acres and nest count is -0.104). Nearly 75 percent of all nests and 72 percent of successful nests identified between 1999 and 2006 (2,168 nests) occurred on the 490 acres of sandbar exposed in 1998 and found to be still in existence and mapped in 2005. Types 1 and 12 polygons (open water and shallow water) collected approximately 22 percent of all nest sites in Table 3-8 and 88 percent of the 742 nest sites not on Type 4 (ESH). These nest sites appear to have been lost to erosion. The remaining loss of nest sites accounted by other habitat types amount to less than 4 percent of total nests. That roughly 75 percent of nests over the period of 1999-2006 occurred on areas that were still classified as ESH as late as 2005 suggests that the majority of nesting birds selected these sites early in the period following the 1997 releases and continued to use them successfully. A noteworthy finding is that non-ESH sand (habitat Type 7) was selected by less than 0.5 percent of nesting birds, and supported the lowest success rate for all habitat types. It is also noteworthy that while mapped ESH declined by 70 percent, sites used for nesting may have declined as little as 25 percent when the total island area is considered.

3.4.2 Identify 1999-2006 Nests within 2005 ESH Polygon Boundaries

ESH polygons describe discrete units of habitat on interchannel sandbars. Vegetation occupation and erosion since 1997 dissected the extensive sandbars mapped from the 1998 imagery. As a result, delineations of the 2005 imagery showed a reduction in ESH polygon size and an increase in the number of separate ESH polygons (see Table 3-9).

Table 3-9
Comparison of ESH Polygons Delineated from 1998 and 2005 Imagery

Statistic	1998 ESH Polygons	2005 ESH Polygons
Sandbar Count	185	387
Minimum Acres	0.04	0.01
Maximum Acres	218	59
Total Acres	2,896	880
Mean Acres	15.6	2.27

Each of the 387 ESH polygons from 2005 was assigned a unique identifier composed of the NestArea name and the polygon record identification number. For example, the identifier for ESH polygons located within NestArea Menominee: 804.3-804.6[23] would be assigned the identifier Menominee: 804.3-804.6-*X*, where *X* represented the ESH polygon's record identification number.

The results of plotting the nest data from the TP-DMS against the background of the 2005 habitat delineation is shown in Table 3-10[24], which lists nest counts for 1999 through 2006. Since both annual nest counts and repeated use are desirable characteristics for a constructed ESH site, numbers that represent these factors were combined to establish a site importance value (IV). The site IV was calculated as the product of the number of nests and the number of years in which a site supported at least one nest, and Table 3-10 presents the sites sorted in descending order by IV.

The table shows that <u>71 out of 387</u> ESH polygons delineated in 2005 had supported 2,167 (74 percent) of all nests established by both species during the 1999-2006 period.

[23] It is important to note that the NestArea construct was created to group nests according to their general location within the segment, and that a NestArea could contain several distinct ESH polygons.
[24] On this table, the column designated as "Nests" represents total nests, regardless of success, failure, or species.

Table 3-10
1999-2006 Nests and Gavins Point River Segment 2005 ESH Polygons

Rank	ISLAND	YEAR											
		1999	2000	2001	2002	2003	2004	2005	2006	Nests	YRS	IV	AC
1	St.Helena: 787.9-788.2-273	19	20	17	46	50	71	45	22	290	8	2,320	39.01
2	Elk PT: 756.3-757.3-139	16	38	10	33	72	58	11	5	243	8	1,944	37.57
3	Meckling: 781.5-233	26	24	13	6	12	35	40	1	157	8	1,256	33.02
4	Menomine: 801.3-801.5-347		6	8	20	45	22	25	9	135	7	945	19.04
5	St.Helena: 795.1-795.4-292	1	14	13	9	7	30	12	22	108	8	864	5.14
6	Burbank: 769.4-770.4-178				8	5		72	106	191	4	764	29.19
7	Burbank: 769.4-770.4-193				8	11	1	20	65	105	5	525	14.24
8	Burbank-Elk PT: 761.5-156					13		66	82	161	3	483	51.94
9	St.Helena: 793.1-793.4-289				25	37	17	5	2	85	5	425	24.57
10	Menomine: 802.0-802.5-324				1	5	34	29	11	80	5	400	21.09
11	Ponca3: 754.8-138						33	39	32	104	3	312	12.49
12	Elk PT: 758.7-759.3-167				16	14	15	2		47	4	188	6.04
13	Menomine: 803.3-803.5-327	1	1		3	5	8	4		22	6	132	10.40
14	Menomine: 804.3-804.6-307		1	2	1	6	8	1		19	6	114	12.70
15	St.Helena: 789.8-790.4-280				1	5	4	4	7	21	5	105	6.86
16	St.Helena: 793.1-793.4-286						7	7	10	24	3	72	0.87
17	Menomine: 804.3-804.6-326	7	2			3	1		1	14	5	70	24.23
18	Gavins PT: 807.8-808.2-291						1	15	6	22	3	66	5.40
19	Burbank: 769.4-770.4-177							15	12	27	2	54	6.73
20	Menomine: 798.3-799.0-322		11	2		3				16	3	48	2.98
21	Menomine: 804.3-804.6-308							4	19	23	2	46	2.29
22	Menomine: 804.3-804.6-335							11	12	23	2	46	19.93
23	Meckling: 782.6-255					3		1	9	13	3	39	7.33
24	Ponca1: 754.2-132							13	4	17	2	34	4.37
25	St.Helena: 791.3-281							15	2	17	2	34	2.03
26	Maskell: 777.0-778.1-199			8	2	1				11	3	33	1.04
27	Maskell: 777.0-778.1-194							30		30	1	30	8.18
28	St.Helena: 791.3-285							1	14	15	2	30	5.01
29	St.Helena: 795.1-795.4-294							11	4	15	2	30	0.48
30	Menomine: 798.3-799.0-311	3	5		1					9	3	27	1.39
31	Meckling: 781.7-202			2	2	1		1		6	4	24	2.31
32	Gavins PT: 807.3-807.5-298							3	6	9	2	18	2.01
33	St.Helena: 797.4-797.6-338							6	2	8	2	16	0.29
34	Elk PT: 758.7-759.3-150						1	3	1	5	3	15	2.72
35	Burbank: 767.6-768.1-175					3	4			7	2	14	1.28
36	Menomine: 800.6-800.9								14	14	1	14	5.04
37	Maskell: 777.0-778.1-200		1	1	2					4	3	12	2.61
38	Meckling: 786.1-234					1	1	2		4	3	12	13.23
39	Menomine: 801.3-801.5-346		1	2	1					4	3	12	2.09

Rank	ISLAND	YEAR 1999	2000	2001	2002	2003	2004	2005	2006	Nests	YRS	IV	AC
40	St.Helena: 796.7-796.9-329					1	2	1		4	3	12	2.55
41	Elk PT: 758.7-759.3-152						1	4		5	2	10	4.32
42	Menomine: 804.3-804.6-309		1				1	1		3	3	9	1.89
43	St.Helena: 789.5-275				1			1	1	3	3	9	1.31
44	St.Helena: 793.1-793.4-288		1		1	1				3	3	9	4.80
45	Menomine: 798.3-799.0-323	1	3							4	2	8	0.50
46	Elk PT: 756.3-757.3-148				2	1				3	2	6	0.98
47	Menomine: 801.3-801.5-343				2	1				3	2	6	0.52
48	Elk PT: 758.7-759.3-164							1	1	2	2	4	5.23
49	Menomine: 798.3-799.0-310			1					1	2	2	4	0.51
50	Menomine: 804.3-804.6-334				1	1				2	2	4	4.90
51	St.Helena: 790.8-284		1			1				2	2	4	1.94
52	St.Helena: 797.4-797.6-342			1		1				2	2	4	0.87
53	Vermillion: 778.5-778.9-205				1				1	2	2	4	1.15
54	Maskell: 773.2-176							3		3	1	3	2.13
55	Gavins PT: 807.3-807.5-296	2								2	1	2	4.00
56	Menomine: 802.0-802.5-333							2		2	1	2	1.49
57	Elk PT: 756.3-757.3-147					1				1	1	1	1.25
58	Elk PT: 758.7-759.3-149							1		1	1	1	0.05
59	Elk PT: 758.7-759.3-154								1	1	1	1	0.40
60	Elk PT: 758.7-759.3-155							1		1	1	1	0.64
61	Elk PT: 758.7-759.3-169								1	1	1	1	0.11
62	Elk PT: 758.7-759.3-170							1		1	1	1	1.78
63	Maskell: 777.0-778.1-198				1					1	1	1	0.58
64	Maskell: 777.0-778.1-201							1		1	1	1	2.07
65	Menomine: 798.3-799.0-325		1							1	1	1	0.84
66	Menomine: 800.6-800.9-355						1			1	1	1	7.40
67	Menomine: 800.6-800.9-361		1							1	1	1	3.42
68	St.Helena: 789.8-790.4-279							1		1	1	1	0.35
69	St.Helena: 793.1-793.4-287				1					1	1	1	0.80
70	St.Helena: 795.1-795.4-293							1		1	1	1	0.11
71	St.Helena: 796.4-317							1		1	1	1	0.57
	Total	76	132	80	195	310	356	533	486	2,167			506.6
	Percent of Total Nests in Annual Dataset	41%	58%	42%	53%	69%	81%	98%	95%	74%			58%

Table 3-11[25] lists the 63 islands that supported successful nests. The table is sorted in descending order by IV, and shows nest count by year, the number of years in which a successful

[25] On this table, the column designated as "Nests" represents total successful nests.

nest was located within the ESH polygon, and the ESH polygon acres based on the 2005 habitat delineation.

As shown in Table 3-11, 39 islands supported five or fewer total nests and 37 ESH polygons supported 5 or fewer successful nests during the eight-year period. Only 13 islands supported 30 or more total nests during the period. Twelve islands supported more than 30 successful nests.

Table 3-11
Gavins Point River Segment Islands with Successful Nests 1999-2005

Rank	ISLAND	YEAR 1999	2000	2001	2002	2003	2004	2005	2006	Nests	YRS	IV	ACRES
1	St.Helena: 787.9-788.2-273	14	17	14	42	46	55	15	9	212	8	1696	39.01
2	Elk PT: 756.3-757.3-139	15	35	6	24	49	30	7	2	168	8	1344	37.57
3	Meckling: 781.5-233	22	19	13	2	10	19	30	1	116	8	928	33.02
4	Burbank: 769.4-770.4-178				2	1		55	72	130	4	520	29.19
5	St.Helena: 795.1-795.4-292		12	11	9	4	13	9	13	71	7	497	5.14
6	Menomine: 801.3-801.5-347		3	7	11	36	5	5		67	6	402	19.04
7	Burbank-Elk PT: 761.5-156					5		52	50	107	3	321	51.94
8	Burbank: 769.4-770.4-193				6	3		14	40	63	4	252	14.24
9	St.Helena: 793.4-793.4-289				9	26	7	3	2	46	5	230	24.57
10	Menomine: 802.0-802.5-324				1	4	21	9	5	40	5	200	21.09
11	Ponca3: 754.8-138						32	11	18	61	3	183	12.49
12	Elk PT: 758.7-759.3-167				8	8	13	1		30	4	120	6.04
13	St.Helena: 789.8-790.4-280					4	4	3	4	15	4	60	6.86
14	Menomine: 803.3-803.5-327				3	5	3	3		14	4	56	10.40
15	Menomine: 804.3-804.6-307			2	1	4	3	1		11	5	55	12.70
16	Gavins PT: 807.8-808.2-291							15	4	19	2	38	5.40
17	Burbank: 769.4-770.4-177							12	4	16	2	32	6.73
18	Menomine: 804.3-804.6-308							3	13	16	2	32	2.29
19	Maskell: 777.0-778.1-199			7	1	1				9	3	27	1.04
20	Menomine: 798.3-799.0-322		5	2		2				9	3	27	2.98
21	Menomine: 804.3-804.6-335							10	3	13	2	26	19.93
22	Ponca1: 754.2-132							10	2	12	2	24	4.37
23	St.Helena: 793.1-793.4-286						5	6		11	2	22	0.87
24	Meckling: 782.6-255					3			7	10	2	20	7.33
25	St.Helena: 797.4-797.6-338							6	1	7	2	14	0.29
26	Menomine: 804.3-804.6-326		1			2			1	4	3	12	24.23
27	St.Helena: 791.3-281							12		12	1	12	2.03
28	Gavins PT: 807.3-807.5-298							2	3	5	2	10	2.01
29	Menomine: 798.3-799.0-311		4		1					5	2	10	1.39
30	St.Helena: 791.3-285							1	4	5	2	10	5.01

Rank	ISLAND	YEAR 1999	2000	2001	2002	2003	2004	2005	2006	Nests	YRS	IV	ACRES
31	St.Helena: 796.7-796.9-329					1	1	1		3	3	9	2.55
32	Meckling: 781.7-202			2	2					4	2	8	2.31
33	St.Helena: 795.1-795.4-294							8		8	1	8	0.48
34	Elk PT: 758.7-759.3-150						1	2		3	2	6	2.72
35	Menomine: 801.3-801.5-346			2	1					3	2	6	2.09
36	Menomine: 800.6-800.9								5	5	1	5	5.04
37	Elk PT: 758.7-759.3-152						1	1		2	2	4	4.32
38	Maskell: 777.0-778.1-200		1	1						2	2	4	2.61
39	Meckling: 786.1-234					1	1			2	2	4	13.23
40	Menomine: 798.3-799.0-310			1					1	2	2	4	0.51
41	Menomine: 801.3-801.5-343				1	1				2	2	4	0.52
42	Menomine: 804.3-804.6-309		1					1		2	2	4	1.89
43	Menomine: 804.3-804.6-334				1	1				2	2	4	4.90
44	St.Helena: 789.5-275				1			1		2	2	4	1.31
45	St.Helena: 793.1-793.4-288		1			1				2	2	4	4.80
46	St.Helena: 797.4-797.6-342			1		1				2	2	4	0.87
47	Burbank: 767.6-768.1-175					3				3	1	3	1.28
48	Elk PT: 756.3-757.3-148				2					2	1	2	0.98
49	Maskell: 777.0-778.1-194							2		2	1	2	8.18
50	Elk PT: 758.7-759.3-149							1		1	1	1	0.05
51	Elk PT: 758.7-759.3-155							1		1	1	1	0.64
52	Elk PT: 758.7-759.3-164							1		1	1	1	5.23
53	Maskell: 773.2-176							1		1	1	1	2.13
54	Maskell: 777.0-778.1-198				1					1	1	1	0.58
55	Menomine: 798.3-799.0-323		1							1	1	1	0.50
56	Menomine: 802.0-802.5-333							1		1	1	1	1.49
57	Menomine: 800.6-800.9-355						1			1	1	1	7.40
58	Menomine: 800.6-800.9-361		1							1	1	1	3.42
59	St.Helena: 789.8-790.4-279							1		1	1	1	0.35
60	St.Helena: 790.8-284		1							1	1	1	1.94
61	St.Helena: 793.1-793.4-287				1					1	1	1	0.80
62	St.Helena: 795.1-795.4-293							1		1	1	1	0.11
63	Vermillion: 778.5-778.9-205				1					1	1	1	1.15
	Total	51	102	69	131	222	215	318	264	1,371			495.6
	Percent of Total Successful Nests in Annual Dataset	44%	58%	43%	48%	68%	81%	98%	97%	72%			56%

3.4.3 Highly Successful ESH Polygons

The total area for all 387 ESH polygons mapped from the 2005 imagery is 880 acres. When all ESH polygons from the 2005 delineation are intersected with all nests (1999-2006) only 71 ESH polygons with a total area of 507 acres ever contained nests (58 percent of the total mapped ESH in 2005). Successful nests are restricted to 60 of 387 ESH polygons, comprising 496 acres or approximately 56 percent of the mapped ESH. The top-ranked most productive and highly successful sites, which have supported more than 58 percent of the successful nests during the period assessed, occupy only 12 ESH polygons, comprising 293 acres (about 33 percent of the mapped ESH for 2005).

Table 3-12 shows the 12 top ranked sites with an IV higher than 100, which establishes a threshold as a site with 30 or more successful nests for the eight-year period. The IV rank of 100 is a notable and natural break in the dataset. The next lower site had an IV of only 60 and a successful nest count of 15 over the entire 8-year period.

As shown in the table, four of the most highly successful sites were mechanically constructed ESH (shaded lines in the above tables), suggesting that many of the characteristics of recently constructed ESH sites provide habitat suitable for nesting. The fourth- and eighth-ranked sites, Burbank: 769.4-770.4-178 and Burbank: 769.4-770.4-193, were constructed in 2004/2005 at the location of a small sandbar that previously supported 12 nests, thus the IV is somewhat skewed compared to other constructed sites.

Three natural sites, accounting for approximately 30 percent of the acreage, have supported the highest nest numbers for eight years. The average density for these three sites is 4.7 nests per acre; which is slightly above the mean for highly successful sites, but well below the most productive site, St.Helena-795.1-795.4-292, which demonstrates a mean nesting density of nearly 14 nests per acre.[26]

Table 3-12
ESH Polygons Supporting Successful Nests – IV Higher than 100

Rank	ESH Polygon	S-Nest	Active Yrs	IV	Acres	Density: nest/acre
1	St.Helena: 787.9-788.2-273	212	8	1,696	39.0	5.4
2	Elk PT: 756.3-757.3-139	168	8	1,344	37.6	4.5
3	Meckling: 781.5-233	116	8	928	33.0	3.5
4	Burbank: 769.4-770.4-178	130	4	520	29.2	4.5
5	St.Helena: 795.1-795.4-292	71	7	497	5.1	13.8
6	Menomine: 801.3-801.5-347	67	6	402	19.0	3.5
7	Burbank-Elk PT: 761.5-156	107	3	321	51.9	2.1
8	Burbank: 769.4-770.4-193	63	4	252	14.2	4.4
9	St.Helena: 793.4-793.4-289	46	5	230	24.6	1.9
10	Menomine: 802.0-802.5-324	40	5	200	21.1	1.9
11	Ponca3: 754.8-138	61	3	183	12.5	4.9
12	Elk PT: 758.7-759.3-167	30	4	120	6.0	5
	Totals / Average IV	1,111		558	293.3	4.6
	Percent of Total Successful Nests and Total 2005 Mapped ESH Acres	58%			33%	

[26] All densities are based on 2005 habitat delineation acreages.

3.4.3.1 Most Productive Natural ESH Polygons

The eight most productive natural site polygons are shown in Table 3-13. These sites each support 30 or more successful nests, and together produced 750 successful nests during the eight-year period of analysis. These eight sites alone produced 39 percent of all successful nests in the Gavins Point River Segment. The total combined area of these ESH polygons was approximately 238 acres, only 21 percent of the area mapped from the 2005 imagery.

The importance of these nesting sites is more significant if the nests and site acreages for mechanically created sites are removed from the analysis. For the eight-year period, these eight sites support 79 percent of all natural site nests, 81 percent of the successful nests, and comprise 63 percent of the total 2005-mapped ESH area.

Seven of the eight natural sites mapped in 2005 existed in total or in part of the ESH polygons mapped from the 1998 imagery. A single site (Elk PT: 758.7-759.3-167) comprising 6 acres appears to be composed of redistributed sediments.[27] It is likely that this site and several other small sites were deposited as a result of the high-flow period of August to December 1999, when discharge from Gavins Point Dam exceeded 45,000 cfs. Review of the 1999 CIR orthophotographs and prior Gavins Point River Segment delineations by Bruce Vander Lee (2003) supports this supposition.

Over the period studied, certain sites showed increased persistence and use for nesting that results in greater than average nesting of these particular areas. As such, the characteristics of these highly successful sites were analyzed to inform site selection, design, and construction for the ESH implementation program. The physical characteristics of lost sites, rarely used sites, abandoned sites, and sites with very high nest failure were also evaluated to identify features that may be detrimental to nest success or undesirable as a nesting site.

Table 3-13
Most Productive Natural ESH Polygons 1999-2006

Rank	ESH Polygon	S-Nest	Count Yrs	IV	Acres	Density: nest/acre
1	St.Helena: 787.9-788.2-273	212	8	1696	39.0	5.4
2	Elk PT: 756.3-757.3-139	168	8	1344	37.6	4.5
3	Meckling: 781.5-233	116	8	928	33.0	3.5
4	St.Helena: 795.1-795.4-292	71	7	497	5.1	13.8
5	Menomine: 801.3-801.5-347	67	6	402	19.0	3.5
6	St.Helena: 793.4-793.4-289	46	5	230	24.6	1.9
7	Menomine: 802.0-802.5-324	40	5	200	21.1	1.9
8	Elk PT: 758.7-759.3-167	30	4	120	6.0	5.0
	Totals, Average IV and Average Density	750		677	185.5	4.9
	Percent of Total Successful Nests and Percentage of 2005 Mapped ESH	39%			21%	

[27] Review of Gavins Point Dam discharge records and several USGS river gages along the Gavins Point Segment suggest that flows sufficiently high to create new sites above subsequent navigation flow stages occurred in the fall of 1999

3.4.3.2 Most Productive Constructed Islands

The five constructed ESH sites are shown in Table 3-14. Highly successful created ESH sites vary from natural sites in IV (because the difference in active years) and in nest density. The 1-nest per acre density difference (4.9 for the natural sites versus 3.9 for the constructed sites), however, is removed if the very highly productive single site, St.Helena: 795.1-795.4-292, is dropped from the calculation of the mean for natural sites in Table 3-13. This suggests that constructed sites are performing as nearly well as natural sites.

Table 3-14
Most Productive Constructed Islands: 1999-2006

Rank	ISLAND	S-Nest	Count Yrs	IV	Acres	Density: nest/acre
4	Burbank: 769.4-770.4-178	130	2	520	29.2	4.5
6	Menomine: 801.3-801.5-347	67	2	402	19.0	3.5
7	Burbank-Elk PT: 761.5-156	107	2	321	51.9	2.1
8	Burbank: 769.4-770.4-193	63	2	252	14.2	4.4
11	Ponca3: 754.8-138	61	3	183	12.5	4.9
	Totals, Average IV and Average Density	428		336	126.9	3.9
	Percent of Total Successful Nests and Percentage of 2005 Mapped ESH	22%			14%	

3.4.3.3 Nest Density Analyses

Nest densities were compared for total nest sites, successful nest sites, and highly successful sites using 2005 ESH acreages. The total set of nesting sites supported an average of approximately 5 nests per acre. The successful nest sites supported only 3.6 nests per acre, and highly successful sites supported 3.8 nests per acre. An explanation for higher density of the total nest sites was found in the occurrence of many sites smaller than one acre that supported very dense least tern colonies.

Regressions were used to evaluate relationships between acres of mapped ESH and numbers of nests for the different nest site groupings. Results of the regressions are shown below.

Total nest islands	Adjusted $R^2 = 0.723$
Successful nest islands	Adjusted $R^2 = 0.698$
Highly successful nest islands	Adjusted $R^2 = 0.432$
Natural highly successful nest islands	Adjusted $R^2 = 0.576$ (0.721)[28]
Constructed nest sites	Adjusted $R^2 = 0.328$

[28] R2 obtained if the very highly productive site St.Helena-795.1-795.4-292 is dropped from the analysis.

The total area of mapped ESH selected by birds for nesting was moderately well correlated with nest numbers, suggesting the existence of a threshold condition for nesting selection not met by 316 other sites by 2005-mapped ESH islands. The reduced correlation between mapped ESH area supporting successful nests and nest numbers suggests changes in site conditions following nest selection, which is recognized to include (primarily) inundation, saturation, precipitation, and predation. The further reduction in correlation between mapped area and nest counts for highly successful sites suggests that other factors are more important than total area; for example, site longevity, surface uniformity, and relative elevation above the water surface.

The increased positive correlation between nest count and acreage for natural sites (particularly once the outlier site is removed) suggests that area is predictive of nest numbers. The lower correlation for constructed sites is also noteworthy. While the constructed sites supported a high degree of successful nesting, the efficiency is irregular. Constructed ESH does not reliably predict nest density from the current data based on mapped ESH.

The data indicate that created sites may be increasingly important in terms of numbers of nests from 2003 forward.

Total nest counts and successful nest counts generally increased for natural nesting sites from 1999 through 2003. Both began declining in 2004 and continued to decline through 2006. The Ponca islands created in 2004 began to reverse the declining nest count trends on the Gavins Point River Segment. Response to the construction of sites at RM 761 and RM 770 continued the upward trend for total and successful nests through 2005. However, the use of natural nesting-habitat appears to be declining in terms of both total nest establishment and successful nesting. Figures 3-6 and 3-7 show total nests and successful nest counts, respectively, for natural and created sites by year. Figure 3-6 shows that ESH constructed in 2004 and 2005 largely mitigated the declining trend in natural site nest counts. Figure 3-6 also shows trends for nest initiations. Both total nest numbers and total numbers of successful nests declined in 2006 (Figures 3-6 and 3-7). This trend will likely continue unless ESH acreage for the segment is supplemented with new or restored ESH.

Figure 3-6
Gavins Point River Segment Total Nest Establishment Trends

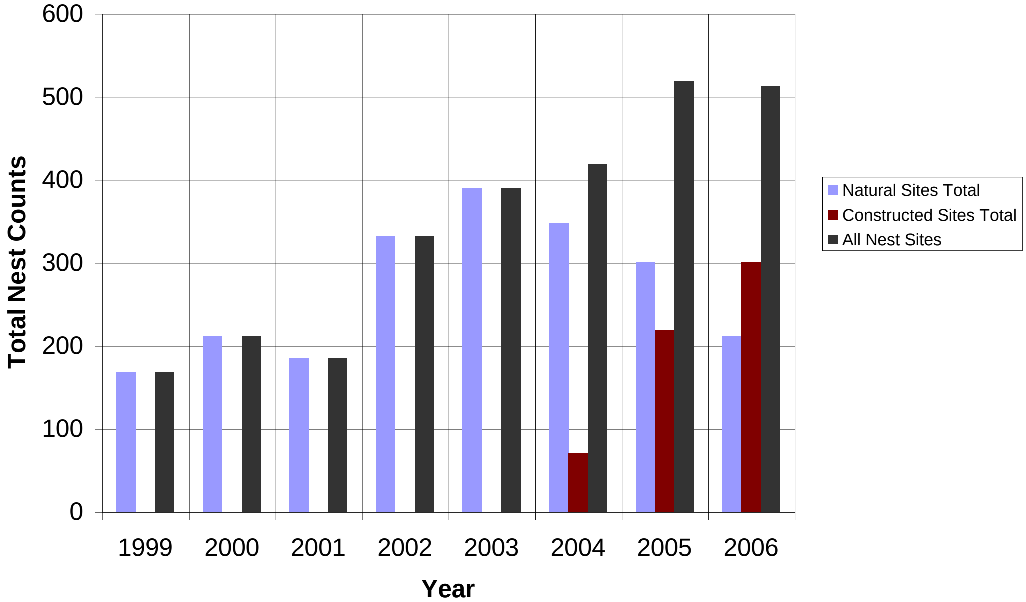
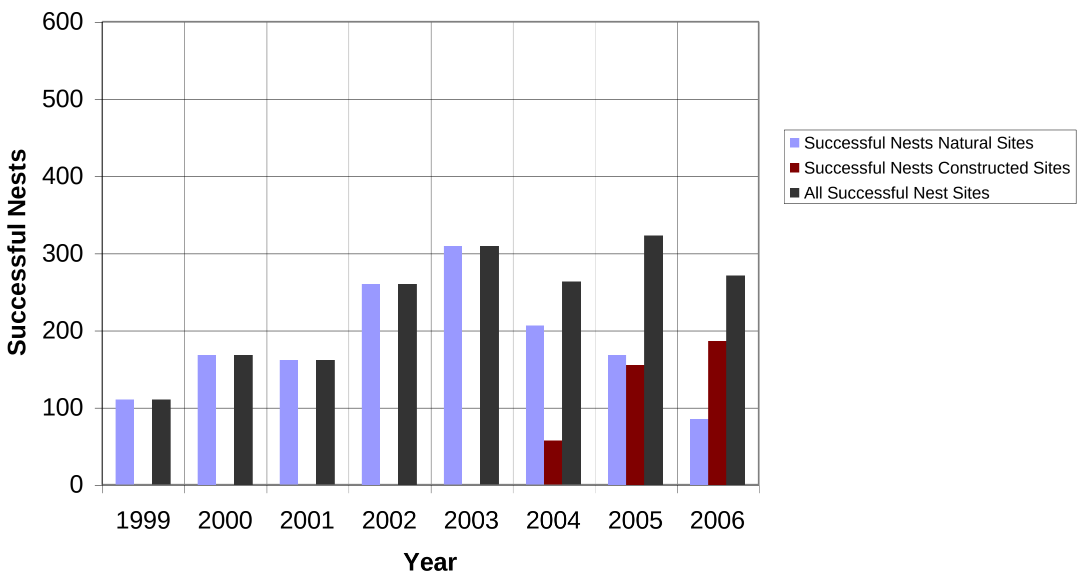


Figure 3-7
Gavins Point River Segment Successful Nest Establishment Trends



3.4.4 ESH Polygons with Limited or No Successful Nests

A review of the spatial characteristics of the ESH polygons with limited or no successful nests was conducted. These ESH polygons include 51 of the 2005-delineated ESH polygons (see Table 3-11 above) that produced 20 or fewer successful nests in the 8-year period of analysis.

These sites, which comprise 220 acres, supported 441 total nests and 260 successful nests during the eight-year period – a success rate of 59 percent (4 to 6 percentage points below highly productive sites). The sites summarized over the eight year period in Table 3-15 are grouped by:

- sites with 11 to 19 successful nests,
- sites with 2 to 10 successful nests,
- sites with only one successful nest, and
- sites at which no nests were successful, though at least one nest was established.

Each of these sites appeared to be limited in its capability to serve as consistent nesting-habitat due to some combination of poor habitat quality, insufficient area, low elevation/frequent flooding, loss of site due to erosion or natural succession (low persistence), frequent disturbance by human activities, or predation. Nevertheless, some other factor likely prevented successful re-use of a site. It was noted that some of these sites were located in areas in which small-scale ESH enhancement activities were undertaken (i.e., herbicide application or vegetation mowing) that were intended to stimulate increased nesting.

Table 3-15
ESH Polygons with Limited or No Successful Nests: 1999 - 2006

Minimally Producing Sites	Count	Mean Years	Total Acres	Average Acres	Successful Nests	Percent of Total Successful Nests[29]
Sites with 11 to 19 Nests	10	2.6	71.6	7.2	139	7%
Sites with 2 to 10 nests	27	2	105	3.8	107	6%
Sites with 1 nest	14	1.4	32.5	2.2	14	1%
Sites with no Successful Nests	8	1	11	1.4	0	0%
Totals/ Means/ Percentages	59	1.75	220.1	3.65	260	14%

These sites may be located in less than ideal areas where birds can succeed when system releases are lower, but characteristically fail under typical flow regimes. Several islands upstream from RM 804, for example, have supported early breeding season nest establishment in 2005 and 2006 at relatively low, fringe elevations around more persistent islands and sandbars, only to be inundated by a subsequent water level rise.

3.4.5 Mapped ESH Polygons Not Used for Nesting Habitat.

The previous discussions have addressed the 71 sites upon which at least one nest had been established between 1999 and 2006 on a total of 507 acres. There were an additional 366 sites mapped as ESH in 2005 with a total area of 373 acres that did not support any nests during the period of analysis. While many habitat characteristics or incident events may be involved in use

[29] This is for the entire Gavins Point nest dataset.

or non-use of a mapped ESH polygon as nest habitat, three characteristics were identified during the analysis that suggest reasons for the distribution of nesting use. These factors include:

- relative elevation, as local freeboard translated to a flood risk category,
- relative area of the ESH polygon, and
- proximity to a forest edge.

3.4.5.1 Flood Risk

Nest Point elevations were determined using topographic data generated from LiDAR data collected during a low-flow period of approximately 11,000 cfs discharge from Gavins Point Dam. ESH polygon elevation was calculated using additional randomly generated points (1 point/100 square feet of ESH area) for the 2005 ESH-mapped polygons. The elevation for water surrounding the island was determined for each island by averaging the elevations of multiple random points generated in a 200-foot polygon perimeter buffer. Average nest elevation minus average water elevation was computed to determine average freeboard for the ESH polygon.

Average freeboards for natural islands were binned using freeboard-based flood risk categories as noted in Table 3-16. These categories are based on the local water surface elevation to mean island elevation during a low-flow period. Actual freeboard during seasonally maintained flows[30] and during higher navigation flows (33,000 cfs) is reduced 1 to 3 feet, depending on location in the reach. The occurrence of multiple year nesting cluster elevations was used to define bin boundaries. Table 3-16 also lists flood risk zones developed to assess nest selection.

Table 3-16
Gavins Point River Segment Flood Risk Zones

Flood Risk Category	Comment – Interpretation
Zone 0 >8.01 Feet	Highest islands; sites pre-date 1997 releases. Support mature cottonwood stands. Height above water and vertical banks preclude use by piping plover chicks. Not usually nesting habitat. (Example: Goat Island)
Zone 1 4.66-8.00 Feet	High elevation persistent islands created or highly modified by 1997 releases. Sites in this class contained the majority of nests. (Example: St.Helena-787.9-788.2-273)
Zone 2 3.01-4.65 Feet	Middle elevation islands created by 1997 releases, usually on downstream end of reach. This is the elevation of most Corps constructed sites. Fair nesting habitat. (Example: Elk PT-756.3-757.3-139)
Zone 3 1.85-3.00 Feet	Low elevation periodically exposed islands created by 1999 high-flow event. In addition, elevation of a Corps constructed site; inundated during navigation stage water levels. Opportunistically used nesting habitat. (Example: Burbank-769.4-770.4-178).
Zone 4 0.81-1.85 Feet	Islands inundated or saturated to the surface during annual navigation flows. Annual opportunistic nesting areas. Rarely used for nesting habitat. (Example: Maskell-777.0-778.1-198).
Zone 5 <0.80 Feet	Areas below normal flow elevations most years. Never nesting habitat

[30] The most frequently occurring flow during the breeding seasons for the period of record of this assessment has been from 20,000 cfs to 28,000 cfs.

Tables 3-17, 3-18, 3-19, 3-20, and 3-21 compare various aspects of ESH polygons and nesting characteristics to flood risk zones. Figures 3-8, 3-9, 3-10, and 3-11 show the distributions of site characteristics by flood risk zone. These assessments include only natural sites, since constructed sites (particularly island Burbank-769.4-770.4) at artificially established elevations do not represent habitat created by normal fluvial geomorphic events.

Table 3-17 and Figure 3-8 show the distribution of all unique ESH islands by flood risk zone and distinguish between those islands supporting nests from those with no nest occurrences in the data analyzed. Figure 3-8 converts counts in Table 3-17 to percentages to normalize magnitude differences between nested and non-nested islands. Percentages for the total number of island polygons and those islands without nests are nearly normally distributed around the median flood risk zone; zone 3, although both also show a more rapid decline toward flood zone 5. Islands supporting the most nesting are skewed toward the lower flood risk zone, zone 2.

Table 3-18 and Figure 3-9 show flood risk zone distribution by acreage. The distribution by acreage is strongly skewed toward the flood risk zones 1 and 2; the less frequently flooded islands. These findings support the assumption that most ESH islands are residuals from the 1996/1997 high-flow event. These sites are expected to be more elevated than sandbar formations resulting from smaller subsequent high-flow events.

Tables 3-19, 3-20, and Figure 3-10 show the distribution of total nests and successful nests by flood risk zone. The distribution of both is skewed to flood zones 1 and, primarily, 2; suggesting the existence of a flood-risk based threshold for nest establishment. Successful nest count drops to nearly zero at flood risk zone 3. It is worth noting that this may not be an entirely natural phenomenon, as controlled high flows in the Gavins Point River Segment are used early in the nesting season to deter birds from nesting on low elevation bars. This is done to allow for greater operating flexibility later in the season.

Table 3-21 and Figure 3-11 show and compare the numbers of all ESH islands supporting nest establishment and those supporting only successful nests. The distribution is similar around flood risk zone 2. However, sites supporting successful nests showed a greater proportion closer to flood risk zone 2 than in 3. This suggests flooding as a reason for the difference between successful and unsuccessful nest sites.

There were 20 sites with few successful nests, comprising 45.4 acres, found to be in flood risk zone 3 or below, suggesting that flooding and saturation risk may be linked to low nest success. There were 39 sites with few successful nests, comprising 174.1 acres, that are not explained by flooding. There were also 215 sites in flood risk zone 3 or below, comprising 152.1 acres, that did not support nests in the period of analysis. The remaining 151 non-nesting ESH islands comprising 121.3 acres that are not fully explained by freeboard, elevation and flood risk zone considerations.

Figure 3-12 provides an example of flood risk zones in the Gavins Point River Segment.

Table 3-17
ESH Polygon Counts for Various Flood Risk Zones

	Nest EVER		
Flood Risk Zone	NO	YES	Total
1	23	20	43
2	78	25	103
3	116	16	132
4	58	2	60
5	41	2	43
Total	316	65	381

Figure 3-8
Gavins Point River Segment 2005 ESH Polygon Distribution by Flood Risk Zone

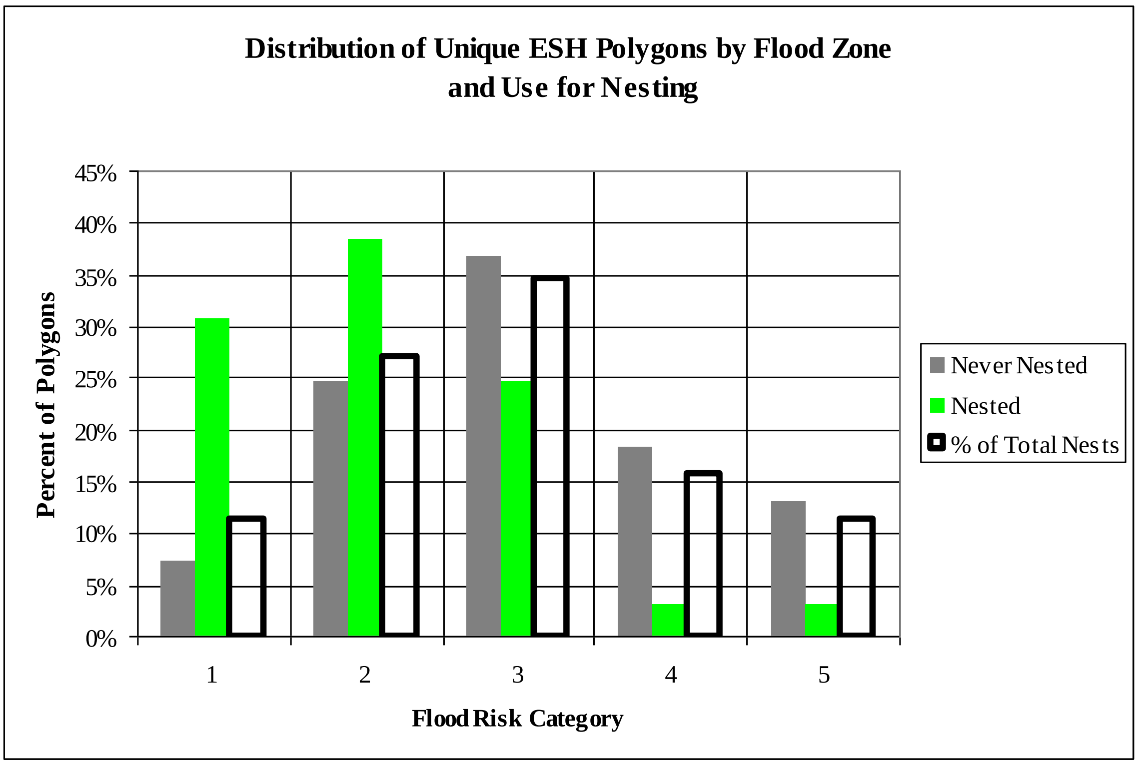


Table 3-18
Acres of ESH in Various Flood Risk Zones

Sum of Acres	Nest EVER		
Flood Risk Zone	NO	YES	Total
1	112.1	184.0	296.1
2	108.4	158.3	266.7
3	86.7	34.8	121.5
4	45.3	8.5	53.7
5	21.1	2.1	23.2
Total	373.6	387.7	761.2

Figure 3-9
Gavins Point River Segment 2005 ESH Acreage Distribution by Flood Risk Zone

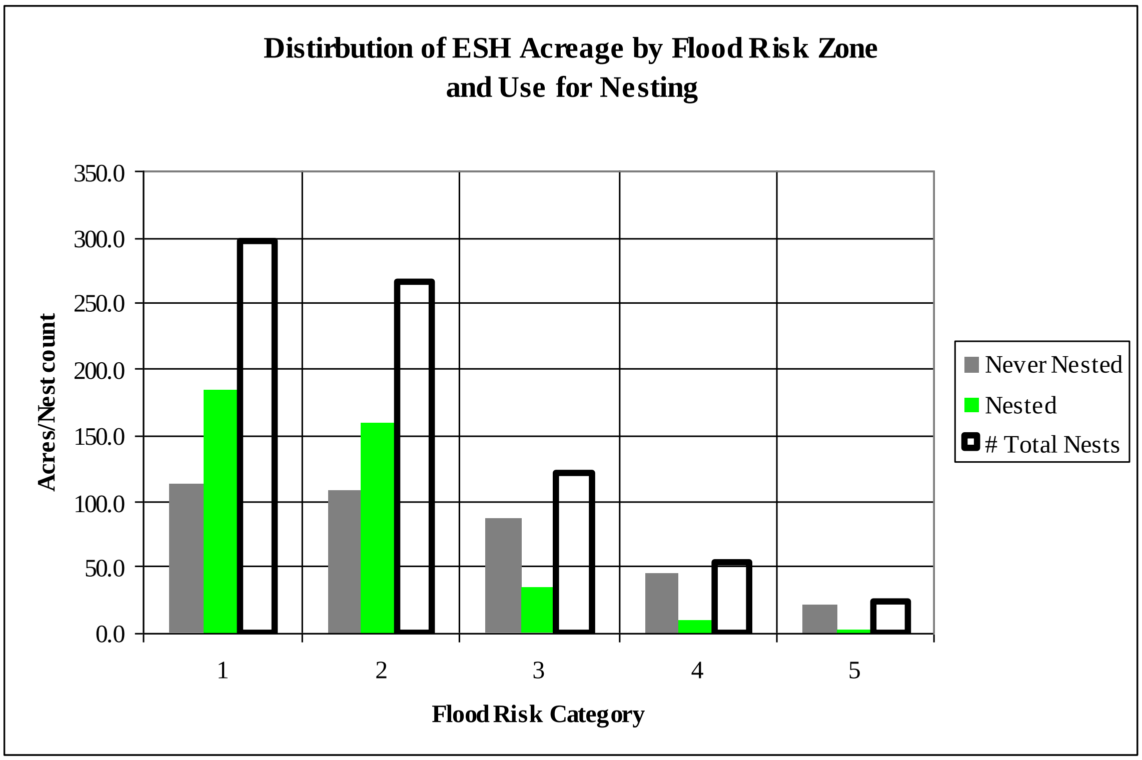


Table 3-19
Total Nests in
Various Flood Risk Zones

All Nests	
Flood Risk Zone	Total
1	678
2	669
3	91
4	37
5	2
Total	1477

Table 3-20
Successful Nests in
Various Flood Risk Zones

Successful Nests	
Flood Risk Zone	Total
1	438
2	448
3	22
4	9
5	1
Total	918

Figure 3-10
Gavins Point River Segment 2005 Nest Distribution by Flood Risk Zone

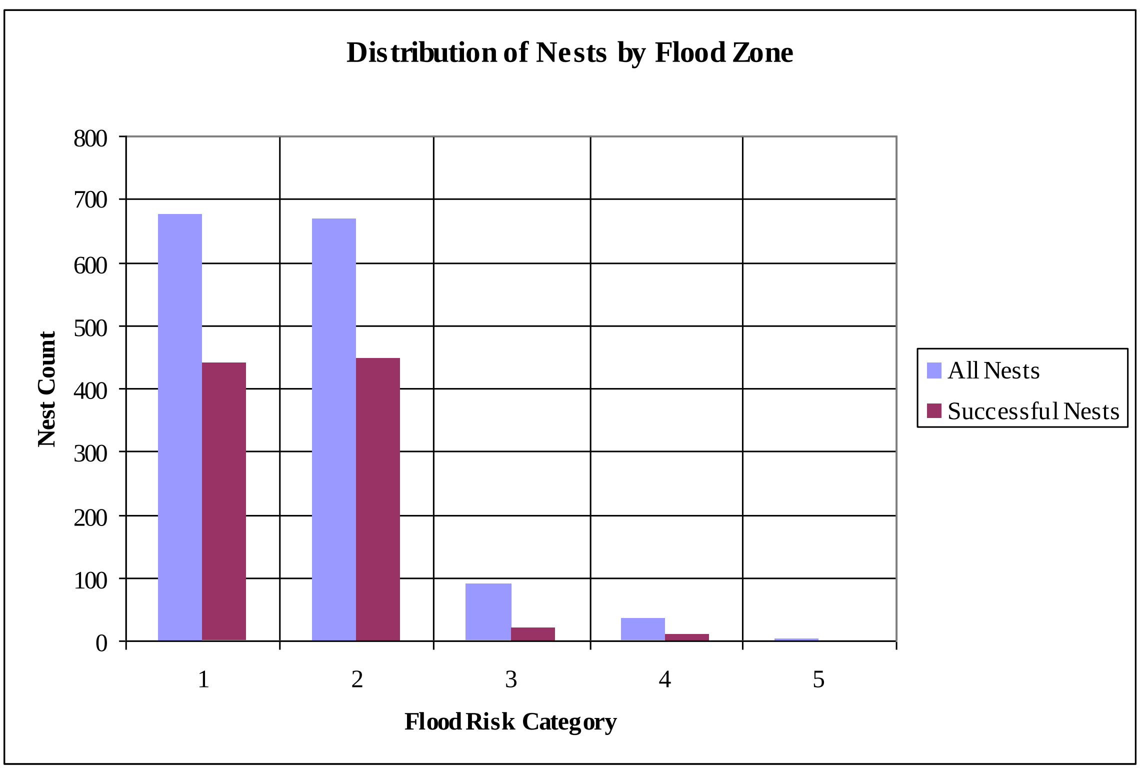


Table 3-21
Nest Polygons within Various Flood Risk Zones

Count of Nest Polygons		
Flood Risk Zone	T-Nest	S-Nest
1	20	15
2	25	23
3	16	10
4	2	2
5	2	1
Total	65	51

Figure 3-11
Gavins Point River Segment 2005 Nest Island Distribution by Flood Risk Zone

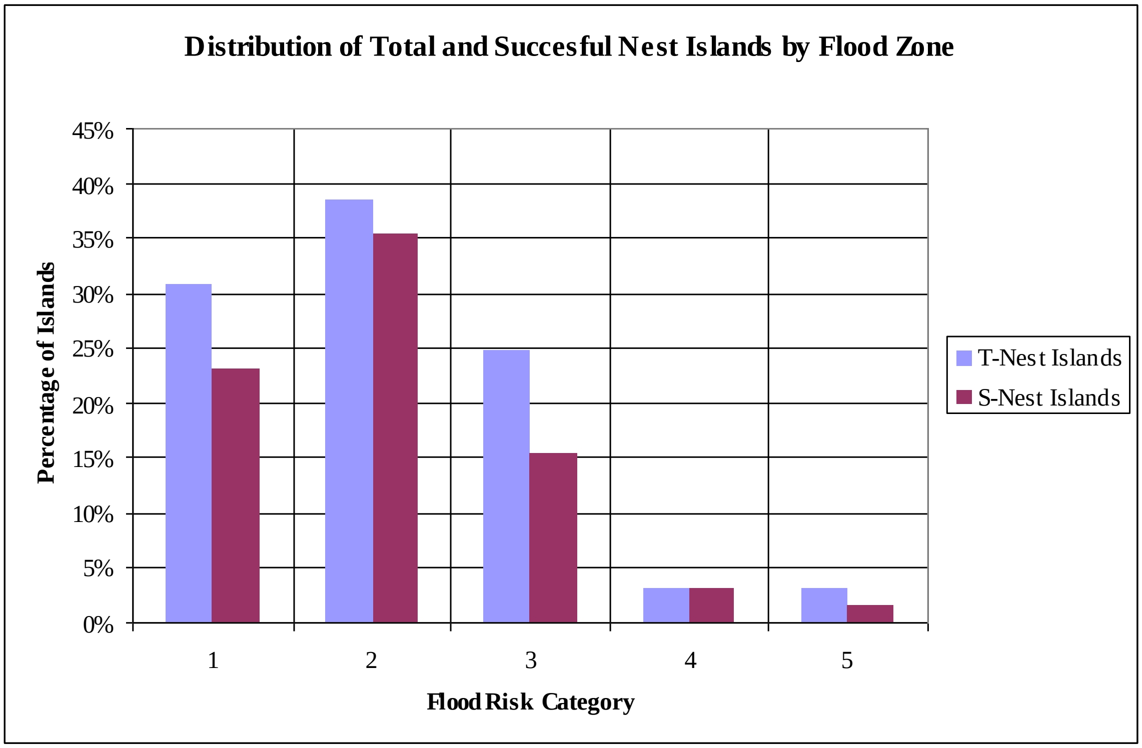
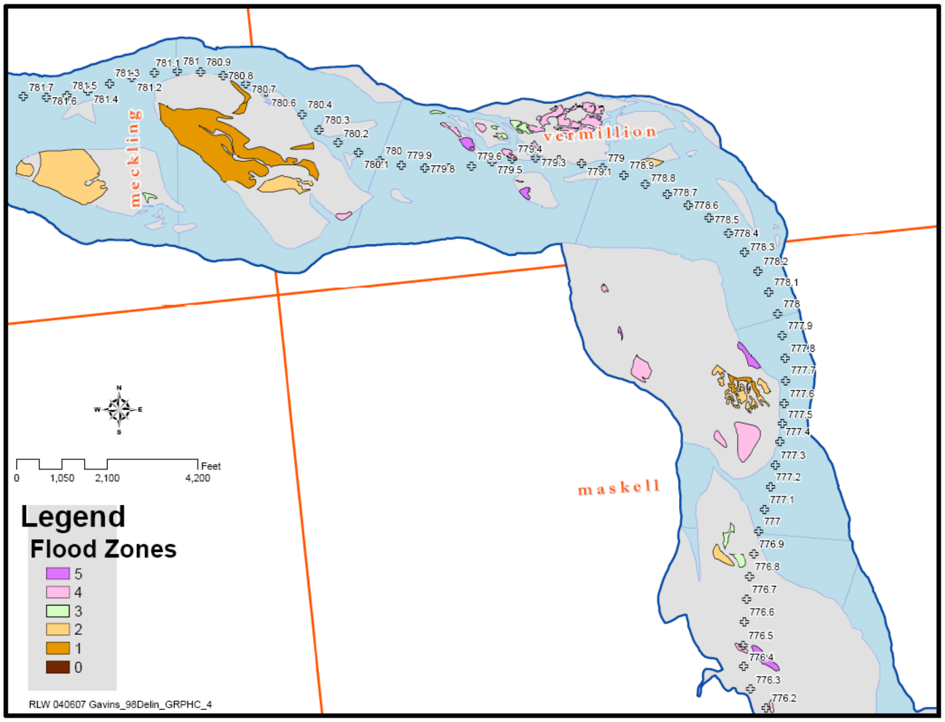


Figure 3-12
Gavins Point River Segment Example of Flood Risk Zones



3.4.5.2 Nest Establishment Limitations Due to Small Habitat Area Acreage

Least tern and piping plover are believed to successfully nest less frequently on smaller islands (personal com. Kruse, 2005). Mapped ESH habitat was assessed for relationships between absolute area and nesting frequency of occurrence using the 2005 ESH habitat polygons. The number of ESH individual polygon areas mapped for 2005, is strongly skewed towards small acreages. The frequency distribution shown in Table 3-22 shows that polygons 1-acre or less account for nearly 65 percent of all mapped polygons.

Table 3-22
ESH Island Polygon Area Frequency Distribution

Bin (acres)	Frequency	Cumulative %
1	231	64.71%
5	98	92.16%
10	13	95.80%
15	5	97.20%
20	2	97.76%
25	3	98.60%
30	1	98.88%
35	1	99.16%
40	2	99.72%
45	0	99.72%
50	1	100.00%

The acreage size categories listed in Table 3-22 were used to compare other characteristics of various sized sandbars to evaluate the importance of ESH patch size in nesting usage, and to establish function-based lower thresholds for future ESH construction. Small ESH polygons may be separate islands or may be fragments of what was once extensive ESH on islands that have eroded or have become occupied by vegetation. It is important to note that constructed ESH sites are excluded from this assessment.

Tables 3-23 through 3-27 and Figures 3-13 through 3-15 show distributions of various ESH characteristics separated into acreage categories. The categories are less than or equal to one acre, greater than one to five acres, greater than five but less than ten acres, etc.

Table 3-23, Table 3-24 and Figure 3-13 demonstrate the relationship between acreage distribution by size category and the nesting use of islands in each size category. More than 50 percent of the 2005 ESH acreage is represented by habitat patches less than 10 acres in area and nearly 15 percent is represented by patches of less than 1 acre. More than 92 percent (233/251) of 2005-mapped habitat patches smaller than 1 acre had not supported nesting. Significant nest usage peaks with sites equaling 5 acres or smaller.

Table 3-25 and Figure 3-14 address the distribution of smaller sites across acreage bin categories. The presence of nearly all flood risk zone 4 and 5 sites in 1-acre to 5-acre bins shows that smaller islands occur most often lower in elevation groupings. They may be the residual elevated sandbars from 1997, the high points deposited by a post-1997 minor high-flow event, or the higher protrusions of expansive sediment accumulations just below the water surface.

Table 3-26 and Figure 3-15 show the distribution of nest count from ESH islands in selected acreage bin categories. A major portion of nests (25 percent) occurred on sites between 5 and 15 acres in area. The majority of nests were on the few sites larger than 35 acres in area. Less than 5 percent of both total nests and successful nests were located on habitat patches less than 5 acres in area.

Table 3-27 shows the distribution of acreage size categories by flood risk zone. There were 18 sites one acre or less in area, representing less than 5 percent of ESH acreage and supporting less than 3 percent (70) of total nests for the assessment period. Only 18 of sites less than 1-acre in area supported nest establishment, and 233 were not used for nesting.

It is not clear whether island size or flood risk zone is more restrictive to nest usage. However, both of these characteristics are linked to geomorphologic processes. Smaller, lower elevation islands are created by more frequently occurring, lower flow events. Larger, more elevated sandbars are created by higher magnitude, less frequent flow events. Based on usage data, a five-acre lower limit may be an appropriate criterion for constructed ESH in the Gavins Point River Segment. Upper acreage limits should bounded by site-specific conditions and cost considerations.

Table 3-23
ESH Acres by Category

Acre Size Category	Total Acres
1	111.5
5	207.2
10	80.0
15	59.6
20	39.0
25	69.9
30	25.9
35	33.0
40	76.6
50	58.5
Total	761.2

Table 3-24
Use of Acre-Category For Nesting

Count of ISLAND	Nest EVER		
Acre Size Category	NO	YES	Percent Used for Nesting
1	233	18	7.2%
5	76	26	25.4%
10	3	10	76%
15	2	3	60%
20		2	100%
25		3	100%
30	1		100%
35		1	0%
40		2	100%
50	1		0%
Totals	316	65	

Figure 3-13
Gavins Point River Segment 2005 Nest Island and Site Nest Use Distribution by Acreage Bin

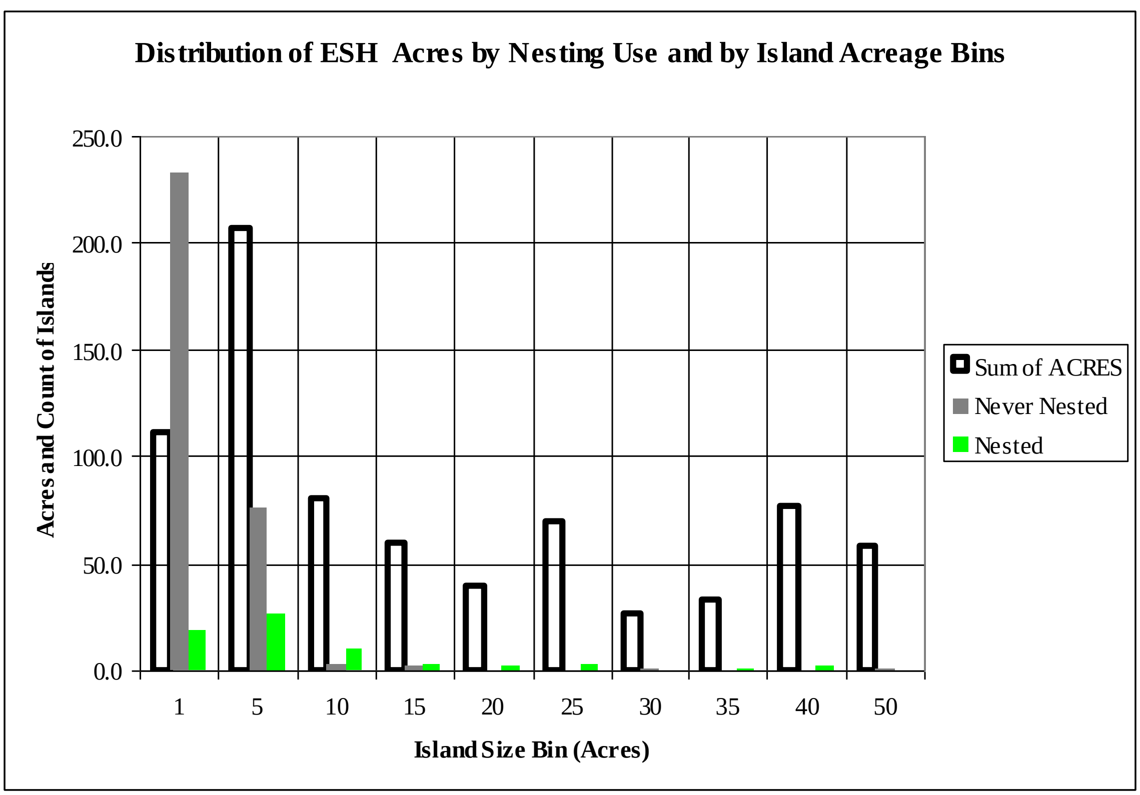


Table 3-25
Flood Risk by ESH Island Size Category

Count of ISLAND	Flood Risk					
Size Category	1	2	3	4	5	Total
1	7	67	94	47	36	251
5	22	26	35	12	7	102
10	5	4	3	1		13
15	4	1				5
20	1	1				2
25	2	1				3
30		1				1
35		1				1
40	1	1				2
50	1					1
Total	43	103	132	60	43	381

Figure 3-14
Nest Island Acreage Size Category Distribution by Flood Risk Zone

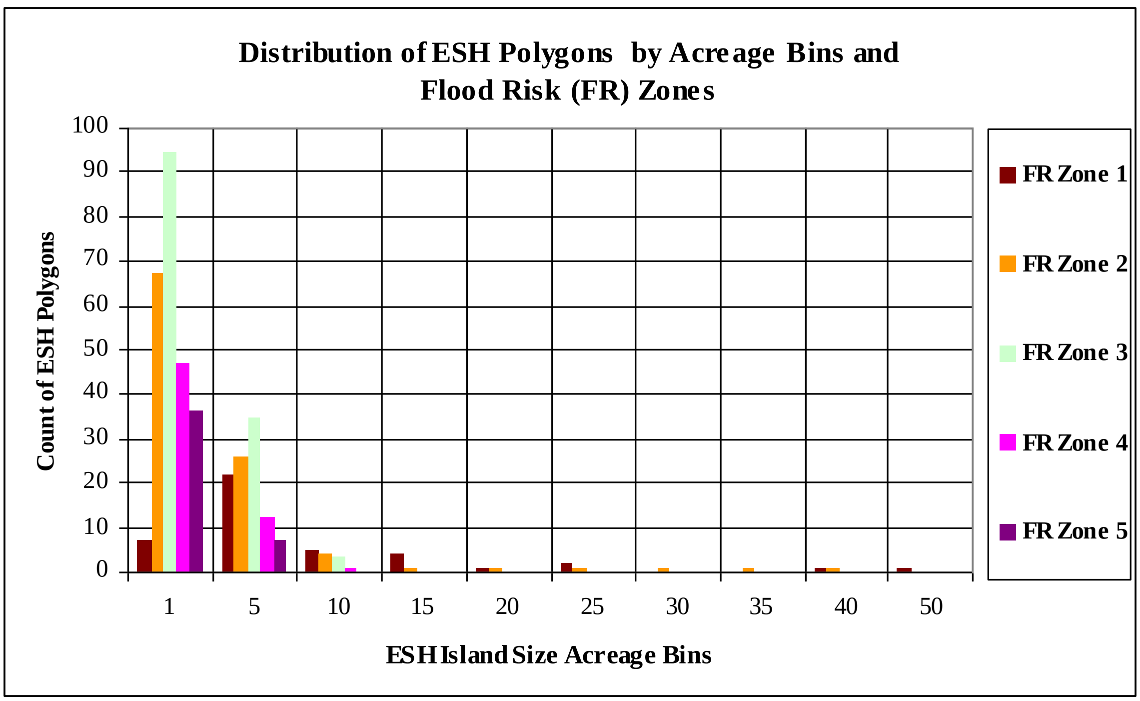


Table 3-26
Total and Successful Nests by Island Size Category

All Nests COUNT						
Size Category	**T-Nest Count**	**Percent Total**	**Cuml Percent**	**S-Nest Count**	**Percent Total**	**Cuml Percent**
1	70	5%	5%	41	4%	4%
5	138	9%	14%	87	9%	14%
10	251	17%	31%	124	14%	27%
15	34	2%	33%	16	2%	29%
20	151	10%	44%	67	7%	36%
25	163	11%	55%	87	9%	46%
35	152	10%	65%	116	13%	59%
40	518	35%	100%	380	41%	100%
Total	1477			918		

Figure 3-15
Gavins Point River Segment 2005 Nest Distribution by Acreage Bin

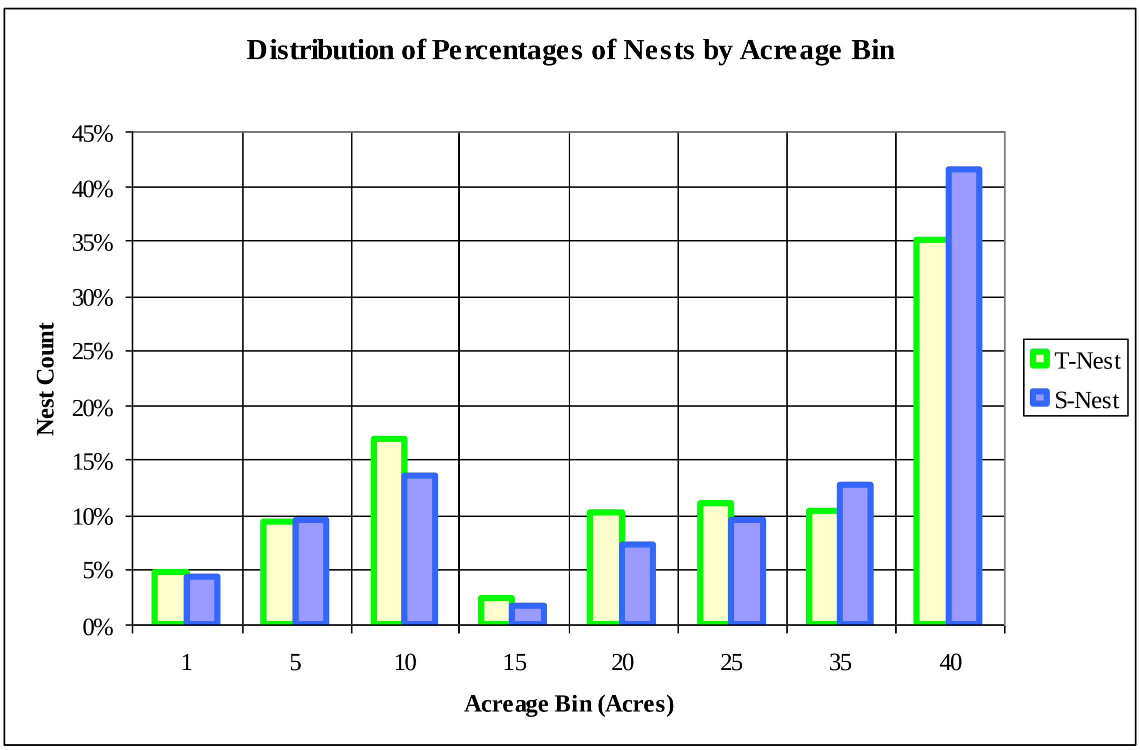


Table 3-27
ESH Polygon Acreage Size Categories by Flood Risk Zone

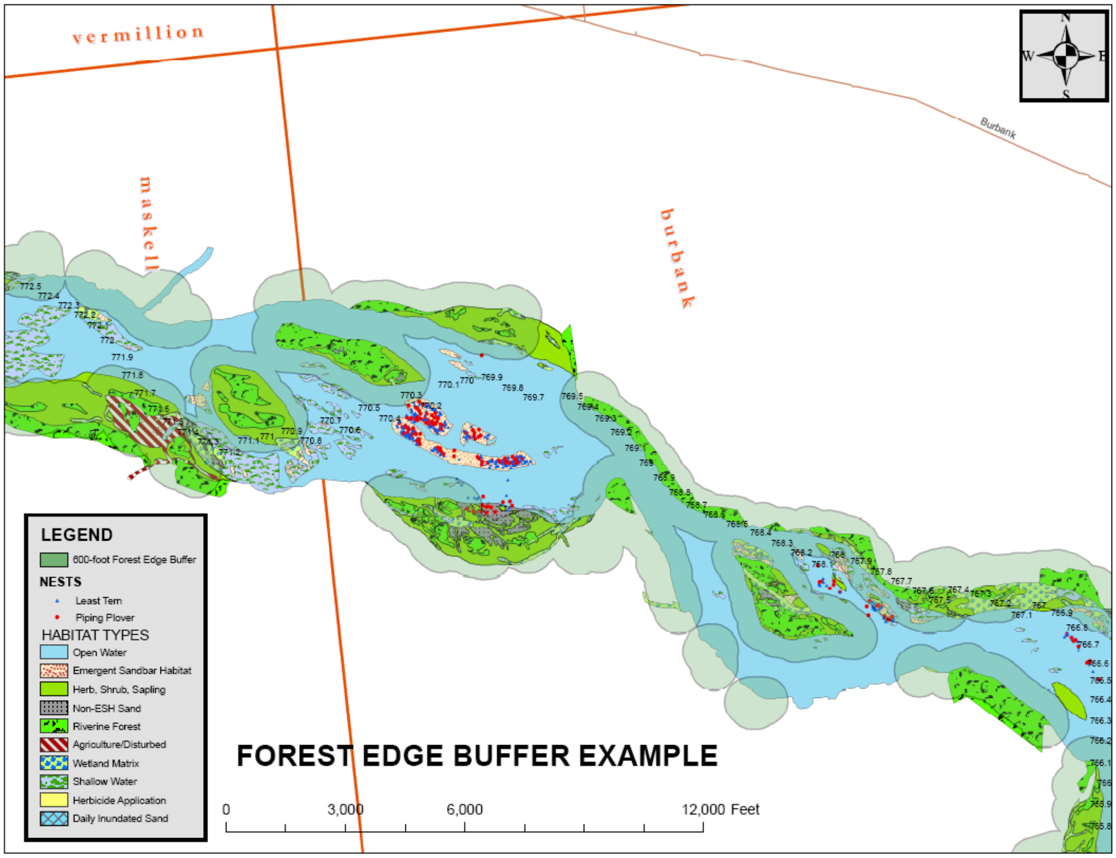
Count of All Nest Sites	Flood Risk Zone					
Acreage Size Category	**1**	**2**	**3**	**4**	**5**	**Total**
1	2	8	6	1	1	18
5	7	11	7		1	26
10	4	2	3	1		10
15	3					3
20	1	1				2
25	2	1				3
30						
35		1				1
40	1	1				2
50						
Total	20	25	16	2	2	65

3.4.5.3 Avian Predator Perch-Restricted Sites: Forest Buffers

Gallery cottonwood forest edges have been identified as natural features potentially restrictive to nest use of a sandbar by terns and plovers. Personal communications with Casey Kruse and Greg Pavelka of the USACE Gavins Point Project Office (2004-2006) advised that forests located within several hundred feet of a sandbar potentially used for tern and plover nesting, may be used by raptors as observation posts; improving the raptors ability for finding and predating nesting colonies. Figure 3-16 shows an example of forest edge buffers in proximity to nesting sites for the Gavins Point River Segment

Forest edge-related restrictions to nest site selection may partially explain the presence of several hundred acres mapped as ESH in 2005 that were not used for nesting during the period of analysis. For the purpose of this analysis it was assumed that little change in forest edge had occurred over the data collection period and that forest habitat edges delineated from 2005 imagery would be appropriate for the evaluation of nest data from several years. An analysis of the distribution of distances of least tern and piping plover nests from forest edges in the Gavins Point River Segment showed no discernable difference between least tern and piping plover minimum distances from forest edges. Several nests were established as close as 200 feet, but 95 percent of least tern and piping plover nests were established 600 feet or more from forest edges. Nearly 52 percent of least tern and piping plover nests were established at distances exceeding 1,200 feet. Beyond 1,200 feet, piping plover nests tend to be established slightly closer to forest edges than least tern nests. The demonstrated ability of least terns to nest on smaller islands near the middle of the river may account for some of the difference.

Figure 3-16
Example of Forest Buffers



A second approach was used to assess the influence of forest edge distance on use of ESH for nesting. Forest buffer polygons were created using the forest edge lines with a 600-foot radius, which represent the approximate distance maintained from forest edges by 95 percent of nesting least terns and piping plovers. Forest proximity buffers (FPB) were spatially joined with 2005 ESH polygons and area of the intersection[31] (in square feet and as a percentage) was calculated. The percentage of an ESH polygon within an FPB was used to assign bins for ESH polygons. The 11 bins represent 10 percent FPB coverage increments, with "0" equal to no FPB, and "10" equal 100 percent FPB coverage.

Table 3-28 shows ESH polygon acres, counts, total nests, and successful nests separated by bin value. The numbers shown in the table apply to the entire ESH polygon, so a site with a high FPB bin still may have all or some portion of nests at that site clustered outside of the FPB. As shown in the table, more than 90 percent of both total nests and successful nests were located on ESH with less than 40 percent FPB coverage. The nests shown to be located on ESH with 70 percent FPB coverage are particularly noteworthy. Upon review of the data, the majority of these nests were established during the 1999 through 2003 breeding seasons, and the nests may not have been located within forest buffers. Since effective tree height needed to inhibit nest site selection was not addressed in this assessment, some growth height-boundary affects might

[31] The area in which the 600-foot forest edge buffer overlapped a mapped ESH polygon.

participate when 2005 forest edge features are used for restrictive buffer creation. A growing percentage of nests were established within forest buffers for 2005 and 2006. The occurrences of these suggest that bird populations may be selecting sub-optimal sites as habitat availability declines. Table 3-29 demonstrates this occurrence.

Table 3-28
Distribution of Acreage, ESH Sites, and Nests in Forest Proximity Bins

% FPB Cover	Acres	Poly CNT	T-Nests	S-Nests
0	311.0	194	1,019	660
10	42.3	14	115	66
20	76.5	10	367	261
30	98.9	13	283	168
40	21.1	1	78	40
50	30.9	6	1	0
60	73.8	4	9	0
70	28.6	5	27	17
80	35.7	10	152	87
90	65.8	16	2	0
100	95.6	114	15	8
Total	880.2	387	2,068	1,307

Table 3-29
Nests in Forest Buffer Zones by Year

T-Nests				**YEAR**					
Nests in FB	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
No	177	207	187	355	412	341	267	179	2,125
Yes	7	19	5	11	35	35	48	33	193
Total	184	226	192	366	447	376	315	212	2318
Percent of Total	4%	9%	3%	3%	8%	10%	18%	18%	9%
S-Nests				**YEAR**					
Nests in FB	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
No	113	164	158	266	296	196	143	74	1,410
Yes	3	13	4	6	30	12	25	11	104
Total	116	177	162	272	326	208	168	85	1,514
Percent of Total	3%	8%	3%	2%	10%	6%	17%	15%	8%

Review of the GIS mapping revealed that much of the apparent increase in use of nesting sites within forest buffers was strongly affected by the use of a constructed site at RM 761.5. This site is within a forest edge along its northwestern shoreline. While the area within the forest edge was sparsely used for nesting, the remaining island (selected by the buffer-island intersection) was heavily utilized.

3.4.5.4 Summary of Non-Use

Three primary rationales for non-use or non-suitability for nesting were analyzed, including flooding risk, small island size, and proximity to gallery cottonwood forest. Many sites included two or more of these factors, here called “defects” that may have deterred nesting. Tables 3-30 and 3-31 summarize cross-referencing of defect intersection by number of separate ESH polygons and, separately, by acreage. The lack of least tern and piping plover nesting at certain ESH sites can be preliminarily explained for 94 percent of the separate sandbars and 92 percent of total used acres by forest edge effects, small patch size, and risk of flooding.

Table 3-30
Rationales for 316 ESH Sites Not Supporting Nests in the Period of Analysis

Code	Technical Defect	Explanation	Count
1	Flood Risk Zone =<3	Too Low	31
2	Forest Proximity Buffer =>5	Too Close to Forest Edge	27
3	Acreage Bin 1	Too small	25
4	Both 1 and 2	Too Low an Too Close to Forest	14
5	Both 1 and 3	Too Low and Too Small	111
6	Both 2 and 3	Too Close to Trees and Too Small	38
7	1, 2 and 3	All Defects	59
8	Unknown	No Rationale	11
	TOTAL		316

Table 3-31
Rationales for 374 ESH Acres Not Supporting Nests in the Period of Analysis

Code	Technical Defect	Explanation	Acres
1	Flood Risk Zone =<3	Too Low	60
2	Forest Proximity Buffer =>5	Too Close to Forest Edge	159
3	Acreage Bin 1	Too small	14
4	Both 1 and 2	Too Low an Too Close to Forest	22
5	Both 1 and 3	Too Low and Too Small	44
6	Both 2 and 3	Too Close to Trees and Too Small	18
7	1, 2 and 3	All Defects	28
8	Unknown	No Rationale	30
	TOTAL		374

There are 11 ESH polygons that comprise a total of 30 acres for which no clear explanation of non-use could be derived from the data. The most puzzling site is Meckling 781.5, the largest natural ESH site remaining (58 aces). Less than half of the acreage is within a tree proximity buffer and the site is mostly within flood risk zones 1 and 2. The next ESH site; upstream only a few thousand feet, was one of the most highly productive sites during the period of analysis. Located mid river and protected from erosion by other islands and shallows, the site at RM 781.5 would seem to offer a prime location for ESH restoration if the defects can be resolved. Nonetheless, there appeared to be little unused, suitable ESH in the Gavins Point River Segment during the period of analysis.

3.4.6 Lost Nest Sites

There were 716 nests within the Gavins Point River Segment not selected by the 2005 ESH polygons, and grouped here as “lost nest sites.” Lost nest sites supported nests at least one year between 1999 and 2005, but their GPS locations were not within any of the existing 2005 ESH polygons – that is, locations where nests were located using GPS were not found within ESH polygons mapped from the 2005 imagery. Lost nest sites were grouped into seven categories:

1. Lost to erosion (the sandbar no longer exists),
2. Lost to upland natural succession (vegetated areas that were once barren sand),
3. Lost to wetland natural succession (wetland areas that were once barren sand),
4. Exposed during annual low water events[32] (sandbar typically submerged),
5. Initiated on sites only briefly exposed during a breeding season,
6. Nest established in non-ESH habitats (e.g., terrestrialized sand), and
7. Unknown.

[32] For example, in 2001 and 2002.

Category fitting was performed by visual assessment using the following GIS feature layers:

- Riverine habitat delineations for 1998 and 2005,
- ESH delineations by Vander Lee for 1998, 1999, and 2000,
- CIR orthophotographs for 1998, 1999, 2000, 2001, and 2005, and
- Island elevation polygons generated from the 2005 LiDAR.

Findings in previous sections of this document were also used for this assessment. Table 3-32 shows an accounting of the lost nest sites, by location, and loss category.

Table 3-32
Summary of Gavins Point River Segment Lost Nest Sites

	Loss Categories							
NestArea	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
Burbank: 764.5	1			7				8
Burbank: 765.6	1							1
Burbank: 766.5-766.8	22							22
Burbank: 767.6-768.1	40							40
Burbank: 769.4-770.4	46							46
Burbank: Elk PT-761.5	1							1
Elk PT: 756.3-757.3	34	7	20					61
Elk PT: 758.7-759.3	11	13			2			26
Elk PT: 759.7				17				17
Gavins Pt: 807.8-808.2					1	1		2
Maskell: 772.7	1			1				2
Maskell: 777.0-778.1	18	52		1				71
Meckling: 781.5	12				7		3	22
Meckling: 781.7	15							15
Menomine: 798.3-799.0	5	4		3				12
Menomine: 801.3-801.5	2					4		6
Menomine: 802.0-802.5	2					3		5
Menomine: 803.3-803.5					1			1
Menomine: 804.3-804.6		6		5	1			12
Menomine: 800.6-800.9		4						4
Ponca1: 754.2	1							1
Ponca2: 754.4	10							10
Ponca3: 754.8	20							20
St.Helena: 787.9-788.2	28			3				31
St.Helena: 789.5	1							1
St.Helena: 789.8-790.4	53	3						56
St.Helena: 790.8	3							3
St.Helena: 791.3					2		1	3
St.Helena: 793.1-793.4				2	2			4
St.Helena: 793.4-793.8	19			4				23
St.Helena: 795.1-795.4	44		3	11		2		60
St.Helena: 796.7-796.9	9							9
St.Helena: 797.4-797.6	1				6			7
Vermillion: 778.5-778.9	113						1	114
Total	513	89	23	54	22	10	5	716

Table 3-33 shows the distribution of nesting sites within various loss categories by year for the period of analysis. Erosion appears to be the major reason for loss of ESH nesting sites, followed by natural succession. The decline of sites lost to erosion in the years following 2002 may indicate that erosion rates slowed over time. A more streamlined shape was noted for the 2005 imagery for most residual sandbars and islands than for the same sites in the 1998 imagery.

The numbers of nests in loss categories 4 and 5 is also noteworthy. The majority of category 4 nest losses occurred in the dry year 2001. The highest loss of nests (and their sites) occurred in 2003-2004 as mean seasonal stages were restored. Category 5 nest losses occurred principally in 2006. Category 6 losses represent the loss of non-ESH sand habitat; that is, sandy barrens attached to the shoreline or in small patches between forest stands.

Table 3-33
Nesting Site Loss by Category and Year

Site Habitat Change	1999	2000	2001	2002	2003	2004	2005	2006	Total
1. Lost to erosion	81	67	63	132	98	70	2		513
2. Lost to upland natural succession	13	23	6	22	19	4		2	89
3. Lost to wetland natural succession	11		2	4	2	3	1		23
4. Sites supporting nests exposed during annual low water			36	8	8	2			54
5. Sites supporting briefly exposed during a breeding season					1		2	19	22
6. Nest established in non-ESH habitats		2		2	2		3	1	10
7. Unknown.								5	5
Total	105	92	107	168	130	79	8	27	716

3.5 Establish ESH Acreage Goals for PEIS Alternative 5

This analysis defines the area of measured nesting-habitat for least tern and piping plover in the Gavins Point River Segment. The results of the analysis were used to provide ESH acreage goals for this segment under Alternative 5 of the PEIS. The methodology described in Section 2 of this document was used to measure nesting-habitat on an annual and total basis for the Gavins Point River Segment. Steps in the analysis are briefly reviewed below.

1. Separate the nest point data by year, species, and NestArea.
2. Measure distances between nests, and identify the nearest-neighbor distance for each nest.
3. Calculate the radius of nesting-habitat circles for each NestArea, species, and year.
4. Create GIS nesting-habitat polygons for each NestArea, species, and year as the area within habitat circles, counting overlapping areas only once.
5. Combine species and year habitat circles for each Nest Area, counting overlapping areas only once. Establish acreage goals for the Gavins Point River Segment under PEIS Alternative 5 by adding the acreage for each NestArea in the segment.

3.5.1 Least Tern Measured Nesting Habitat

Table 3-34 shows measured nesting-habitat acreages for least tern by year and NestArea, sorted by IV. As shown in the table, total measured nesting-habitat increased by 300 percent between 1999 and 2005. The average measured nesting-habitat for least terns was less than 23 acres per year in the Gavins Point River Segment for the 8-year period of analysis. The highest measured nesting area occurred in 2005 and 2006, which coincided with the 2005 construction of ESH sandbars at RM 770, RM 761 and RM 754. The lowest nesting area usage was during the earliest years in the data set 1999 through 2001.

Measured nesting-habitat, the number of nesting areas, and the number of nests were all strongly and positively correlated with one another. These findings would seem to demonstrate a progressive colonization of new sites and slight increase of nesting density over the analysis period. Nest densities for least tern vary from 8 per acre in 1999 to 12 per acre in 2004. A density reduction to nine per acre correlates with the availability and utilization of new constructed habitat in 2005. The adjusted R-square (0.931) from the regression of measured nesting habitat with nest counts suggests that the area of measured nesting-habitat can predict the number of established least tern nests. Predictions suggest that approximately 9.5 least tern nests per nesting-habitat acre would be a reasonable management prediction for ESH constructed in the Gavins Point River Segment.

Table 3-34
Measured Nesting Habitat Acres by NestArea and Year - Least Tern

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Mean Acres**	**Active Years**	**IV**
St. Helena: 787.9-788.2	1.1	1.0	0.9	3.6	4.8	5.8	0.6	0.4	2.3	8	18.1
Burbank-Elk PT: 761.5					0.7		8.5	13.7	7.6	2	15.3
Elk PT: 756.3-757.3	3.4	4.2		2.4	3.2	1.5			2.9	5	14.7
Vermillion: 778.5-778.9			1.1	5.1	5.7	2.0			3.5	4	13.9
Ponca3: 754.8						5.6	4.1	4.2	4.6	3	13.9
Menomine: 801.3-801.5			0.9	2.2	4.4	3.1	1.2	1.5	2.2	6	13.3
Menomine: 802.0-802.5					4.0	0.7	3.5	1.8	2.5	4	10.0
St. Helena: 789.8-790.4	6.8	1.0					0.1	0.1	2.0	4	8.0
Burbank: 769.4-770.4	0.6	0.1		1.7	1.4	0.2	13.1	10.2	3.9	2	7.8
St. Helena: 795.1-795.4		1.2	1.6	0.7	0.5	1.3	0.3	1.0	1.0	7	6.7
Maskell: 777.0-778.1	0.0	0.6	0.6	1.2	0.5		2.2		0.9	6	5.2
St. Helena: 793.4-793.8				2.3	1.6	1.3			1.7	3	5.2
Meckling: 781.5	0.8	0.7	0.1		0.3	0.5	1.3	0.01	0.5	7	3.6
Menomine: 798.3-799.0		2.8							2.8	1	2.8
Ponca1: 754.2							1.5	0.1	0.8	3	2.4
Elk PT-758.7-759.3				0.5	1.3	0.4			0.8	3	2.3
Burbank: 767.6-768.1		0.5	0.4		0.6	0.3			0.5	4	1.9
Burbank: 764.5			1.7						1.7	1	1.7
Ponca2: 754.4						1.4			1.4	1	1.4
Elk PT: 759.7			1.3						1.3	1	1.3
Menomine: 800.6-800.9								1.2	1.2	1	1.2
Gavins Pt.: 807.8-808.2							0.7		0.7	1	0.7
Menomine: 804.3-804.6							0.1	0.6	0.3	2	0.7
Burbank: 766.5-766.8				0.5					0.5	1	0.5
St. Helena: 791.3							0.4	0.1	0.2	2	0.5
St. Helena: 793.1-793.4						0.1	0.1	0.1	0.1	3	0.3
Meckling: 782.6								0.2	0.2	1	0.2
St. Helena: 797.4-797.6							0.05	0.1	0.1	2	0.1
Gavins Pt.: 807.3-807.5								0.01	0.01	1	0.01
Total Acres	12.7	12.1	8.7	20.2	28.9	24.0	37.6	35.4	22.5		
Active NestAreas	6	9	9	10	13	14	16	17	12		
Active NestAreas Count	102	119	103	216	254	276	346	318	1416		

3.5.2 Piping Plover Measured Nesting Habitat

Table 3-35 shows measured nesting-habitat acreages for piping plover by year and NestArea, sorted by IV. As shown in the table, the average measured nesting-habitat for piping plovers was just over 100 acres per year for the 8-year period of analysis. Total annual nesting area was highly variable, ranging above 100 acres. Piping plover nest densities vary from less than 1 per measured nesting-habitat acre in 1999 to approximately 3 per measured nesting-habitat acre in 2004 and in 2006. Relationships between nesting density and the construction of ESH in 2004 and 2005 are not apparent, but the total number of nests increased by more than 10 percent in these years as a result of increased nests established on these new sites.

The highest measurement of nesting-habitat occurred in 2001, a year noted for below normal flows during the breeding season that led to a concurrent increase in ESH acreage. The lowest measurement of nesting-habitat (53 acres) occurred in 2004. A correlation matrix was prepared to evaluate whether any significant relationships exist between flows and nesting measurements. Descriptive statistics were developed for flows recorded at Gavins Point Dam for the period of April 1 through August 31 for 1999 through 2006 and correlated with measured nesting-habitat acres, the count of active nest areas, and the number of nests for each year.

Table 3-36 shows the correlation matrix. As shown in the table, flows were all negatively correlated with nesting values, indicating that as flow increases, nesting activity declines. Acres of measured nesting-habitat were most strongly negatively correlated with mean flow during the breeding season. The number of nesting areas and total nest count were most strongly negatively correlated with maximum flow during the breeding season. Nest numbers and the number of nest sites were very strongly, positively correlated. Nesting acreage is not strongly correlated with either nest numbers or the number of nesting areas. Since piping plover nearest-neighbor distances[33] are so highly variable, site selection by piping plovers appears to drive nesting acreage. Site selection seems to respond to annual maximum flows, but the mechanism of selection is unknown.

These findings are indicative of progressive colonization of new sites, and nest density increases as habitat becomes colonized by the growing population. However, these data suggest that the number of nests cannot be directly predicted from the calculated acreage of nesting-habitat, but seem to respond to the number of selectable sites above annual maximum flow elevations. Together, these observations argue that the construction of more elevated ESH sites may facilitate more frequent piping plover nesting.

[33] See Section 2 for a discussion on the nearest-neighbor measurement.

Table 3-35
Measured Nesting Habitat Acres by NestArea and Year – Piping Plover

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Mean Acres**	**Active Years**	**IV**
Elk PT: 756.3-757.3	14.0	11.7	25.2	26.9	25.2	11.2	5.4	1.8	15.2	8	121
St. Helena: 787.9-788.2	8.6	6.3	13.1	8.3	11.9	8.4	10.1	3.9	8.8	8	71
Menomine: 804.3-804.6	11.5	3.0	4.7	7.5	10.3	3.6	8.3	7.4	7.0	8	56
Meckling: 781.5	9.1	10.8	17.0	6.4	2.4	0.9	5.9	1.4	6.7	8	54
Maskell: 777.0-778.1	8.1	3.6	13.6	7.5	2.4		2.1		6.2	6	37
St. Helena: 795.1-795.4	1.6	4.3	8.0	8.5	5.7	3.5	2.9	1.8	4.5	8	36
St. Helena: 793.4-793.8			7.0	9.4	10.1	3.5	2.8	0.4	5.5	6	33
Menomine: 801.3-801.5		2.9	7.3	8.7	5.3	2.8	4.4	0.9	4.6	7	32
Menomine: 798.3-799.0	5.0	6.5	14.1	3.4	2.4			0.4	5.3	6	32
Elk PT-758.7-759.3				10.2	6.6	2.7	7.5	1.8	5.7	5	29
St. Helena: 789.8-790.4	17.1	3.5		2.2	2.6	0.9	1.4	0.4	4.0	7	28
Vermillion: 778.5-778.9	1.6		4.7	7.2	6.4	1.9		0.4	3.7	6	22
Burbank-767.6-768.1	5.5	1.7	11.3		1.6	0.9			4.2	5	21
Burbank-Elk PT: 761.5					1.8		12.2	15.0	9.7	2	19
Burbank: 769.4-770.4	8.1	2.2	2.3	5.8	4.8	0.9	18.6	17.0	7.5	2	15
Meckling: 781.7	4.7	2.0	3.9	3.0			0.7		2.8	5	14
Menomine: 802.0-802.5				1.1	0.8	3.0	6.9	1.6	2.7	5	13
St. Helena: 796.7-796.9	3.5	0.7	4.0	1.1	2.4	0.9	0.7		1.9	7	13
Menomine: 803.3-803.5	1.6	0.7		3.2	2.8	2.4	2.1	0.4	1.9	7	13
St. Helena: 793.1-793.4		0.7	4.7	2.2	1.6	0.4	2.0	0.8	1.8	7	13
Ponca3: 754.8						3.1	6.2	2.5	4.0	3	12
Burbank: 766.5-766.8				4.9	1.6				3.3	2	6.5
St. Helena: 797.4-797.6			4.7		0.8			0.4	2.0	3	5.9
Burbank: 764.5			4.7	1.1					2.9	2	5.8
Menomine: 800.6-800.9	2.5	0.7				0.4		1.6	1.3	4	5.3
Gavins Pt.: 807.8-808.2						0.4	2.0	2.7	1.7	3	5.1
Gavins Pt.: 807.3-807.5	2.2						1.3	1.3	1.6	3	4.9
Maskell: 772.7			4.7						4.7	1	4.7
St. Helena: 789.5			2.3	1.1			0.7	0.4	1.2	4	4.6
Ponca1-754.2							2.4	0.4	1.4	3	4.3
St. Helena: 790.8	1.6	0.7		1.1	0.8				1.1	4	4.2
St. Helena: 791.3							2.1	2.1	2.1	2	4.2
Elk PT-759.7			3.8						3.8	1	3.8
Meckling: 786.1					0.8	0.4	1.4		0.9	3	2.6
Meckling: 782.6					1.1		0.7	0.4	0.7	3	2.2
Maskell: 773.2							0.7		0.7	1	0.7
St. Helena: 796.4							0.7		0.7	1	0.7
Ponca2-754.4						0.7			0.7	1	0.7
Total Acres	106.4	62.2	161.2	131.0	112.0	53.0	112.2	67.8	100.7		
Active NestAreas Count	17	17	20	22	24	21	27	25	38		
Total Nest Count	82	107	89	150	193	163	196	195	1175		

Table 3-36
Correlations Between Flow and Piping Plover Nesting Metrics

	Acres	Nest Areas	Nest Count
Acres	1.00		
Nest Areas	0.08	1.00	
Nest Count	-0.28	0.90	1.00
Max	-0.38	-0.75	-0.59
Mean	-0.48	-0.72	-0.46
Mode	-0.46	-0.61	-0.36
Median	-0.46	-0.71	-0.46
Min	-0.42	-0.61	-0.32
Range	0.09	-0.08	-0.24

3.5.3 Combined Nesting Habitat Acreage

Table 3-37 shows the measured nesting-habitat by year for both species combined. It is important to note that Table 3-37, like tables 3-34 and 3-35, is sorted by IV. For this reason, the ESH islands do not appear in the same order as Table 3-34 or Table 3-35, and a row-by-row comparison of the three tables cannot be made. It is also important to note that the combined measured nesting-habitat shown in Table 3-37 for specific ESH islands could be less than would be calculated by adding the measured nesting-habitat for the same island from Tables 3-34 and 3-35. This is because any overlapping areas counted toward measured nesting-habitat in Tables 3-34 and 3-35 when least tern and piping plover are combined are only counted once.

Measured nesting-habitat polygons for each species overlap considerably. Least tern nesting-habitat polygons were 70 percent overlapped by piping plover habitat polygons. The mean combined annual measured nesting-habitat area acres for the Gavins Point River Segment was 113 acres. Acreage ranged from 167 acres in 2001 (approximately 30 acres of which may have been the result of the low-flow regime that year) to less than 69 acres in 2004. This was a 59 percent reduction in measured nesting-habitat used for a period that experienced a contrary 239 percent increase in the number of nests.

Constructed sites in place by 2005 supported a 20 percent increase in nest counts. In addition to gains in nesting attributable to constructed ESH, annual increases in measured nesting-habitat were influenced by progressive colonization and flow. Reductions in nesting acreage were attributed to erosion and vegetation encroachment. However, annual differences were also affected by the seasonal discharge and resulting river stage.

Total measured nesting-habitat area is most strongly influenced by piping plover nesting. Therefore, it is not surprising that correlations between total measured nesting-habitat area and river flows are similar to the correlations derived for piping plovers alone. Nest count and the number of nesting sites are both most strongly negatively correlated with annual breeding season maximum flow rates. Measured nesting-habitat acreage is most strongly negatively correlated with the mean flow during the breeding season. Table 3-38 shows the correlation matrix.

Table 3-37
Measured Nesting Habitat Acres by NestArea and Year – Both Species

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Mean Acres**	**Active Years**	**IV**
Elk PT-756.3-757.3	16.7	12.6	25.2	27.8	25.5	11.2	5.4	1.8	15.8	8	126.3
St.Helena-787.9-788.2	9.0	7.0	13.5	11.8	13.8	11.7	11.0	5.2	10.6	8	84.6
Meckling-781.5	10.4	11.6	17.0	6.4	3.0	2.0	7.3	1.7	7.4	8	59.5
Menomine804.3-804.6	11.5	3.0	4.7	7.5	10.3	3.6	8.7	7.6	7.1	8	56.9
St.Helena-795.1-795.4	1.6	6.2	9.3	10.2	5.9	4.7	3.5	3.0	5.5	8	44.3
Maskell-777.0-778.1	8.1	4.0	14.3	8.4	2.9		2.9		6.8	6	40.5
Menomine801.3-801.5		3.2	7.7	9.7	7.6	3.8	5.0	1.7	5.5	7	38.7
St.Helena-793.4-793.8			7.2	11.5	10.6	4.2	2.8	0.6	6.1	6	36.8
Menomine798.3-799.0	5.0	6.7	14.3	3.4	2.4			0.4	5.4	6	32.2
St.Helena-789.8-790.4	18.3	3.9		2.2	2.8	1.1	1.6	0.7	4.4	7	30.6
Elk PT-758.7-759.3				10.4	6.6	2.8	7.5	1.9	5.8	5	29.2
Vermillion-778.5-778.9	1.6		5.6	8.7	7.8	3.1		0.5	4.5	6	27.3
Burbank-Elk PT-761.5					2.0		15.6	18.7	12.1	2	24.2
Burbank-767.6-768.1	5.5	2.4	11.3		2.1	1.2			4.5	5	22.5
Ponca3-754.8						7.3	7.3	4.5	6.4	3	19.1
Burbank-769.4-770.4	8.7	3.6	2.3	6.2	5.2	1.2	23.3	23.0	9.2	2	18.4
Menomine802.0-802.5				1.1	1.5	4.3	7.8	2.1	3.4	5	16.9
Meckling-781.7	4.7	2.2	4.1	3.0			0.7		2.9	5	14.7
St.Helena-796.7-796.9	3.5	0.7	4.0	1.1	2.4	0.9	0.7		1.9	7	13.4
Menomine803.3-803.5	1.6	0.7		3.2	2.8	2.5	2.1	0.4	1.9	7	13.3
St.Helena-793.1-793.4		0.7	4.7	2.2	1.6	0.7	2.0	1.1	1.9	7	13.0
Burbank-766.5-766.8			0.3	5.2	1.6				2.3	3	7.0
St.Helena-797.4-797.6			4.7		0.8		0.4	1.1	1.7	4	6.9
Burbank-764.5			5.2	1.1					3.2	2	6.4
Mnmne800.6-800.9Duck	2.5	0.7				0.4		2.4	1.5	4	6.2
Ponca1-754.2							3.1	0.8	1.9	3	5.8
GavinsPt.-807.8-808.2						0.4	2.6	2.7	1.9	3	5.7
GavinsPt.-807.3-807.5	2.2						1.5	1.6	1.8	3	5.3
St.Helena-791.3							2.6	2.1	2.4	2	4.7
Maskell-772.7			4.7						4.7	1	4.7
St.Helena-789.5			2.3	1.1			0.7	0.4	1.2	4	4.6
Elk PT-759.7			4.1		0.1				2.1	2	4.2
St.Helena-790.8	1.6	0.7		1.1	0.8				1.1	4	4.2
Meckling-782.6					1.1		0.7	1.2	1.0	3	3.0
Meckling-786.1					0.8	0.4	1.4		0.9	3	2.6
Ponca2-754.4						1.5			1.5	1	1.5
Maskell-773.2							0.7		0.7	1	0.7
St.Helena-796.4							0.7		0.7	1	0.7
Burbank-765.6				0.2					0.2	1	0.2
Totals	113.7	70.5	166.6	143.6	121.9	68.8	129.6	87.5	112.8		
Active NestAreas Count	17	17	21	23	25	21	28	25	39		
Total Nest Count	184	226	192	366	447	439	542	513	2909		

Table 3-38
Correlations Between Flow and Total Nesting Metrics

Correlations between Flows and Total Nesting Values			
	Acres	**Nest Areas**	**Nest Count**
Acres	1.00		
Nest Areas	0.29	1.00	
Nest Count	-0.19	0.87	1.00
Mean	-0.56	-0.76	-0.48
Mode	-0.53	-0.65	-0.38
Median	-0.54	-0.75	-0.48
Max	-0.44	-0.80	-0.57
Min	-0.50	-0.62	-0.37
Range	0.11	-0.12	-0.16

Table 3-39 was generated by combining all least tern and piping plover measured nesting-habitat areas for all years by NestArea. It is important to note that the numbers shown in the table represent a consolidation by NestArea over all years, and overlapping areas between years and among species have been counted once in the area calculation. In addition, the total numbers shown on the table cannot be derived from numbers shown in any of the preceding tables. Table 3-39 shows the total measured nesting-habitat of 570 acres when species and years are combined from each NestArea. The 570 acres establishes the ESH Acreage Goals for the Gavins Point River Segment under PEIS Alternative 5.

Approximately 88 acres are accounted by constructed ESH, leaving 482 acres of natural habitat measured as nesting-habitat in the Gavins Point River Segment. This acreage number compares favorably with findings for the 481 natural sandbar acres existing in 2005 that supported nesting during the period of analysis (see habitat delineation summary charts in this section). This is reflective of increased nest numbers and nest densities for both species on the portion of habitat that remained substantially unchanged from 1998-2005.

Table 3-37 above showed that 10 sites, comprising 74 acres of estimated nesting-habitat had been lost before 2005. Subtracting 74 acres from 483 estimated natural acres leaves 412 acres, a figure that lies between the measured acres of ESH existing in 2005 that supported nests (481 acres) and the 2005 measured acres of ESH supporting successful nests (383 acres). While it is recognized that the method used to measure nesting-habitat is conservatively high (see discussion in Section 2), the similarities between acres of ESH retained throughout the period of record and these findings provide an important part of the explanation for the increase in nest numbers throughout a period of significant emergent sandbar loss. Decreases in nest spacing allowed for a growing population to utilize a small number of persistent sites during the period analyzed.

Table 3-39
Measured Nesting Habitat Acres – All Years Combined

NestArea	Least Tern	Piping Plover	Total Combined Acres	IV
Elk PT: 756.3-757.3	11.2	59.1	60.5	126.3
St. Helena: 787.9-788.2	16.9	36.3	39.2	84.6
Meckling: 781.5	10.2	27.7	28.8	59.5
Menomine: 804.3-804.6	1.3	41.4	41.7	56.9
St. Helena: 795.1-795.4	10.2	15.6	17.2	44.3
Maskell: 777.0-778.1	8.5	29.8	31.3	40.5
Menomine: 801.3-801.5	7.6	15.2	15.7	38.7
St. Helena: 793.4-793.8	6.3	25.2	26.5	36.8
Menomine: 798.3-799.0	2.4	24.7	24.8	32.2
St. Helena: 789.8-790.4	7.0	23.2	24.4	30.6
Elk PT: 758.7-759.3	2.9	20.3	20.7	29.2
Vermillion: 778.5-778.9	8.3	17.2	19.4	27.3
Burbank-Elk PT: 761.5	11.1	23.6	28.1	24.2
Burbank: 767.6-768.1	3.4	18.1	18.4	22.5
Ponca3: 754.8	8.2	9.7	12.8	19.1
Burbank: 769.4-770.4	22.1	42.2	49.9	18.4
Menomine: 802.0-802.5	4.2	10.1	11.7	16.9
Meckling: 781.7	1.7	10.4	10.4	14.7
St. Helena: 796.7-796.9	0.0	9.9	9.9	13.4
Menomine: 803.3-803.5	0.3	8.9	8.9	13.3
St. Helena: 793.1-793.4	0.8	8.5	8.5	13.0
Burbank: 766.5-766.8	2.1	5.8	6.1	7.0
St. Helena: 797.4-797.6	1.0	5.1	5.6	6.9
Burbank-764.5	1.3	5.6	6.2	6.4
Menomine 800.6-800.9	1.5	4.9	5.7	6.2
Ponca1: 754.2	1.5	2.6	3.5	5.8
Gavins Pt.: 807.8-808.2	1.2	4.1	4.2	5.7
Gavins Pt.: 807.3-807.5	0.5	4.5	4.6	5.3
St. Helena: 791.3	1.4	3.4	3.6	4.7
Maskell: 772.7	0.0	4.7	4.7	4.7
St. Helena: 789.5	0.0	2.8	2.8	4.6
Elk PT: 759.7	1.9	3.8	4.1	4.2
St. Helena: 790.8	0.0	3.2	3.2	4.2
Meckling: 782.6	0.8	2.0	2.3	3.0
Meckling: 786.1	0.0	2.0	2.0	2.6
Ponca2: 754.4	1.0	0.7	1.5	1.5
Maskell: 773.2	0.0	0.7	0.7	0.7
St. Helena: 796.4	0.0	0.7	0.7	0.7
Burbank: 765.6	0.2	0.0	0.2	0.2
Total	158.8	533.5	570.4	

3.6 Identification of Nesting Habitat Area by River Stage Estimates

The singular characteristic of nesting-habitat in the Gavins Point River Segment that distinguishes it from other habitats is its elevated position – the majority of nesting-habitat in the segment has not been inundated since the end of high releases in 1997.

This analysis provides estimates the area of potential nesting-habitat for the Gavins Point River Segment using detailed topographic data derived from the 2005 LiDAR dataset. These estimates were compared with the measured nesting-habitat acreages used to estimate nesting area and the areas delineated from aerial imagery. The LiDAR was used to derive triangulated integrated topographic networks for each NestArea existing in 2005. Topographic data were used to analyze the effects of flow, and to estimate the residual acreage of exposed ESH at different flows for each NestArea.

The LIDAR, upon which flow/stage/area estimations are based, was obtained at a flow of 11,000 cfs. The 2005 imagery, upon which the 2005 habitat delineation was based, was collected at 21,000 cfs. The mean flow for 2005 was 21,400 cfs and the maximum flow during the breeding season was 23,500 cfs, which was 2,000 cfs below the mean flow for the period, and nearly 7,000 cfs below the mean high flow during the breeding season. Full service navigation flow in the Gavins Point River Segment is approximately 33,000 cfs. The high flow during the period assessed was sustained above 45,000 cfs for more than 120 days, which occurred in the fall of 1999.

River stages were estimated at each NestArea in 5,000 cfs flow increments. The area of exposed ESH at each flow increment was calculated by using the derived water stage elevation as a lower-bounding polygon perimeter. Figure 3-17 and Table 3-40 show the results of the analysis. Table 3-40 shows the acres for each of the 29 active NestAreas in 2005, and the ESH acres exposed above flows ranging from 15,000 cfs to 50,000 cfs. NestAreas are sorted in descending order by acres exposed at for each nest-supporting sandbar 50,000 cfs. This sorting aids in defining the probable origin of the different NestAreas. Created sites are shown throughout the distribution.

The label “Existing” in Table 3-40 describes a NestArea that may have been the locale of significant sand deposits on an existing elevated island during the 1997 high-flow event. NestAreas identified as “1997 Relic” were likely created by the 1997 event, and NestAreas identified as “1999 Relic” were created by the 1999 fall high-flow event. The 1999 relic sites are relatively lower in elevation, and contribute significantly to nesting-habitat only during sustained flows below 30,000 cfs. (Note: the constructed site Burbank-769.4-770.4, a highly productive site in 2005, also sorts with the 1999 Relics.)

Figure 3-17
Gavins Point River Segment 2005 Active NestArea Acreages at Increasing Flow

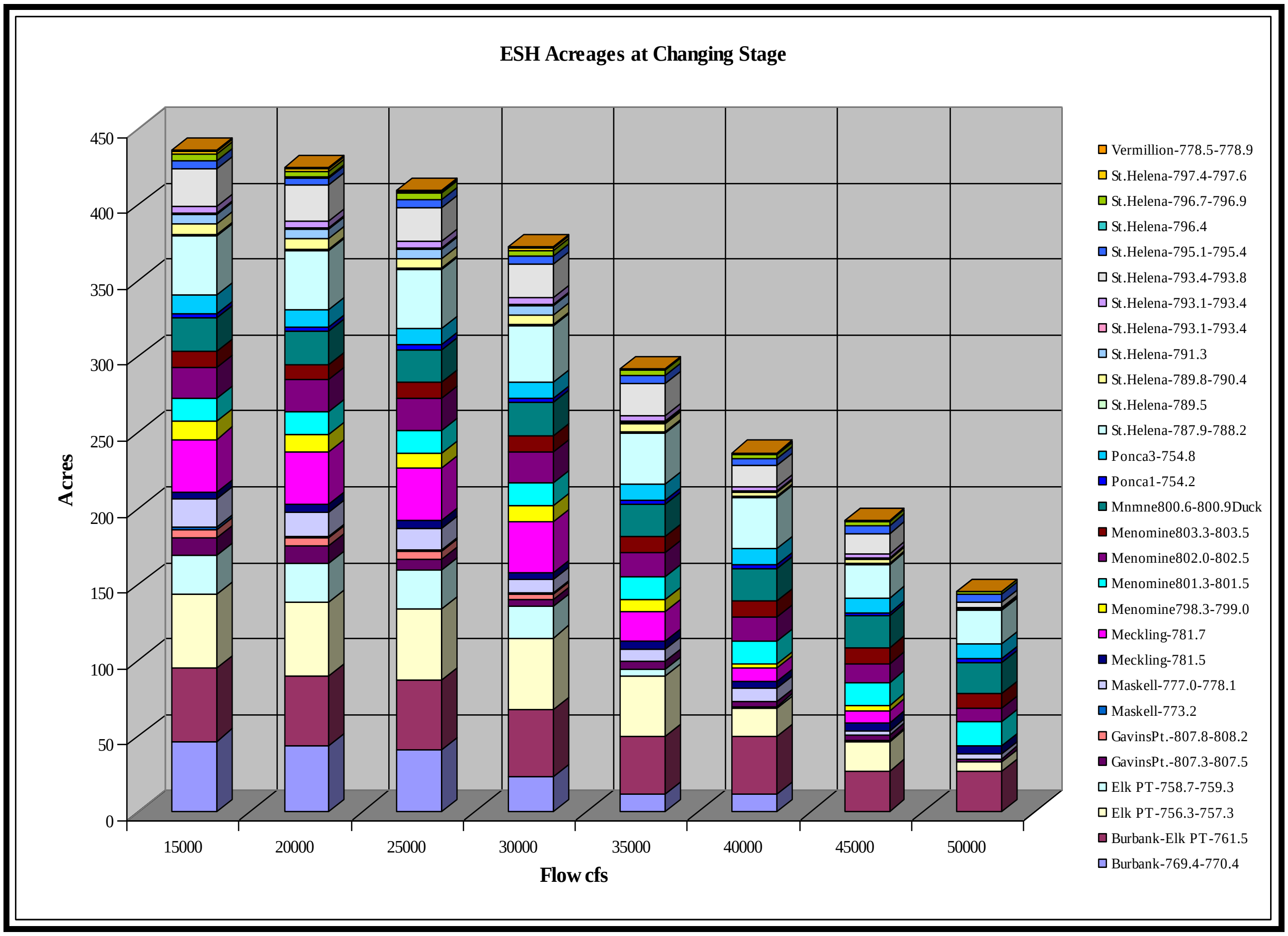


Table 3-40
ESH Acres Above Water at Various Flows for NestAreas Active in 2005

NestArea	15,000 Acres	20,000 Acres	25,000 Acres	30,000 Acres	35,000 Acres	40,000 Acres	45,000 Acres	50,000 Acres	Probable Origin	Acres
Burbank-Elk PT-761.5	47.8	46.1	45.8	44.6	37.8	37.8	26.8	26.8	Constructed	15.6
St.Helena-787.9-788.2	38.9	38.6	38.3	37.0	33.9	33.9	21.9	21.9	Existing	11.0
Menomine 800.6-800.9	21.7	21.7	21.7	21.7	21.4	21.3	21.3	20.4	Existing	0.0
Menomine 801.3-801.5	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	Existing	5.0
Menomine 803.3-803.5	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	Existing	2.1
Ponca3-754.8	11.9	11.5	11.1	10.9	10.6	10.6	9.9	9.9	Constructed	7.3
Menomine 802.0-802.5	20.9	20.9	20.9	20.6	15.7	15.7	12.4	8.9	Existing	7.8
Elk PT-756.3-757.3	48.8	48.1	47.2	47.2	39.8	19.2	19.2	6.1	Existing	5.4
Meckling-781.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	Existing	7.3
St.Helena-795.1-795.4	5.1	5.1	5.1	5.0	4.9	4.9	4.7	4.7	1997 Relic	3.5
St.Helena-793.4-793.8	24.5	23.5	22.3	22.2	21.2	13.7	13.7	3.6	1997 Relic	2.8
Maskell-777.0-778.1	18.5	15.6	14.1	8.7	8.4	8.4	3.3	3.3	1997 Relic	2.9
Gavins Pt.-807.3-807.5	11.1	11.1	7.2	4.6	4.6	3.1	3.1	2.1	1997 Relic	1.5
Ponca1-754.2	3.2	2.9	2.8	2.7	2.6	2.3	1.9	1.9	Constructed	3.1
St.Helena-796.7-796.9	4.0	3.9	3.8	3.8	3.4	2.4	2.4	1.7	1997 Relic	0.7
St.Helena-789.5	1.3	1.3	1.1	1.1	1.0	1.0	0.9	0.9	1997 Relic	0.7
St.Helena-789.8-790.4	6.4	6.4	6.3	6.0	5.3	2.6	2.6	0.7	1997 Relic	1.6
St.Helena-793.1-793.4	0.9	0.9	0.8	0.8	0.7	0.7	0.5	0.5	1997 Relic	2.0
Meckling-781.7	34.6	34.6	34.5	33.6	19.4	8.3	8.3	0.2	1997 Relic	0.7
Menomine 798.3-799.0	11.5	11.3	10.3	10.3	8.0	3.0	3.0	0.2	1997 Relic	0.0
St.Helena-793.1-793.4	4.3	4.3	4.3	4.2	3.6	2.8	2.8	0.2	1997 Relic	2.0
St.Helena-797.4-797.6	1.7	1.5	1.1	1.1	0.9	0.8	0.8	0.2	1997 Relic	0.4
Elk PT-758.7-759.3	25.9	25.9	25.7	20.7	5.1	1.1	1.1	0.1	1999 Relic	7.5
Burbank-769.4-770.4	46.6	43.7	40.7	22.7	11.5	11.5	0.0	0.0	Constructed	23.3
Gavins Pt.-807.8-808.2	5.4	5.4	5.4	3.5	0.2	0.2	0.0	0.0	1999 Relic	2.6
Maskell-773.2	1.7	1.4	0.6	0.6	0.0	0.0	0.0	0.0	1999 Relic	0.7
St.Helena-791.3	6.7	6.7	6.3	6.3	0.9	0.3	0.3	0.0	1999 Relic	2.6
St.Helena-796.4	0.6	0.5	0.2	0.2	0.1	0.0	0.0	0.0	1999 Relic	0.7
Vermillion-778.5-778.9	1.1	1.0	1.0	0.9	0.3	0.3	0.1	0.0	1999 Relic	0.0
Totals	436	424	409	372	292	236	192	145		120.8
Average Lost Rates at Stage increase	0.0	2.6%	6.1%	14.7%	33.0%	45.7%	56.0%	66.8%		

Table 3-40 also shows measured nesting habitat acres. These are compared to acres exposed at various flow events in Table 3-41. The right-hand column of Table 3-41 shows the ratio of total measured nesting habitat acres to the total acres of ESH exposed in 10,000 cfs flow increments. Note that the acreage (and resulting measured nesting habitat area ratios) for sites designated as "1999 Relics" drop rapidly at flows exceeding 25,000 cfs. The large reduction in "Constructed" sites at flows exceeding 25,000 cfs is because of the complete inundation of the site at Burbank 770, which becomes inundated at flows between 25,000 and 30,000 cfs. The majority of these lower elevation areas are inundated at the end of each annual breeding season, when flows are increased for navigation.[34]

The analysis indicates that the measured nesting habitat area, NestArea acres, and the majority of nests were within ESH sites that remain exposed above 25,000 cfs – NestArea acreages were present at low flows. Relics from 1999 provided significantly less acreage above a flow of 25,000 cfs, and constructed sites provided less acreage above 35,000 cfs. The 1997 Relic sites and the Existing Islands were the only sites that provided nesting habitat above 45,000 cfs. The ratios of measured nesting habitat to total exposed area of ESH remains at 2.5:1 for 1997 Relics and 2.7:1 for Existing Islands. These sites supported more than 75% of all nesting between 1999 and 2006. This acreage did not decline significantly until 2004, and was augmented by new constructed sites in 2004 and 2005. The rate of vegetation encroachment on existing acreage of nesting area appears to be the critical factor for continued high nest number support.

Table 3-41
Residual ESH Acres by Site Origin and Stage
Compared Measured Nesting Habitat Acreages

Data	1999 Relic	1997 Relic	Constructed Site	Existing Island	Total	Total Measured Nesting Habitat Acres / Total Acres Ratio
Measured Nesting Habitat Acres	14.0	18.7	49.4	38.7	120.8	1.0:1
25,000 cfs	39.1	110.9	100.4	158.6	409.1	3.4:1
35,000 cfs	6.6	81.5	62.4	141.5	292.0	2.4:1
45,000 cfs	1.5	46.1	38.6	105.3	191.5	1.6:1

3.7 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defines those areas most suitable for ESH construction and maintenance, as well as those areas that if used would result in potentially significant impacts to either the natural or manmade environment. This process of eliminating areas that should be avoided leaves the remaining areas as the most suitable for ESH construction and maintenance for the Gavins Point River Segment. These areas include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment. The steps involved in conducting this analysis are explained in detail in Section 2 of this document, and are outlined below.

1. Solicit input on sensitive resources and buffer distances from affected states and agencies;
2. Create an anthropogenic features dataset from aerial imagery;
3. Establish the separation distance between nesting habitat and anthropogenic features; and

[34] These areas are rather prime reproduction sites for cottonwood and sandbar willow.

4. Establish the minimum flow channel, channel width restrictions, and define the predator moat area;

The result of the analysis is a set of spatial restrictions that categorize the riverine corridor acreage into three categories. These categories are listed below.

1. **Exclusion Areas** are locations at which ESH could not be constructed because intrusion into these locations could cause significant geomorphic alterations to the river corridor. Such an intrusion would risk physical and economic damages to public and private infrastructure or land uses. Exclusion areas include the estimated minimum flow way for normal flowage (i.e., the thalweg), narrow channel reaches, and areas needed to provide a predator moat.
2. **Restrictive Areas** are locations at which ESH could be constructed and maintained at relatively low physical risk, but could put nesting habitat in areas at risk from predation, recreation encroachment, or locations otherwise limited for nesting use and productivity. Areas of limited usability are those areas defined by analysis of distances from features that have shown to be restrictive to nest establishment or nest success.
3. **Available Areas** are locations that are most suitable for the construction and maintenance of ESH. However, it is important to note that any construction activities would need to ensure that other high-interest features (e.g., archeological and cultural resources, or other protected species) would be avoided.

The acreage for Exclusion Areas, Restrictive Areas, and Available Areas is summarized by habitat type for the Gavins Point River Segment in Table 3-42. It is important to note that Available Area acres is a subset of Restrictive Area acres.

Table 3-42
Residual Available Area for ESH Construction: Gavins Point River Segment

Habitat Type	2005 Acres	Restrictive Area Acres	Available Area Acres
Open Water	12,678	3,911	2,050
Emergent Sandbar Habitat	880	737	456
Herb-Shrub-Sapling	2,391	1,664	314
Non-ESH Sand	256	137	49
Riverine Forest	4,325	1,575	15
Active Agricultural Row Crop	77	58	8
Wetland Matrix	688	446	0
Shallow Water	1,932	1,352	989
Daily Inundated Sand Plains	0	0	0
Lacustrine Fine Sediments	0	0	0
Total	**23,227**	**9,880**	**3,881**
Percent		**43%**	**17%**

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4 Lewis and Clark Lake Segment

The Lewis and Clark Lake Segment extends from RM 828.1, to just upstream of the Niobrara River confluence at RM 845.0, a distance of 16.9 river miles (see Figures 4-1 and 4-2 below). The entire reach is within the upper half of the length of the pool behind Gavins Point Dam. Total acreage of the segment is approximately 17,000 acres within the high banks. Average total acres of habitat per river mile are 1,000 acres, resulting in an average width of 8,250 feet. A difference of approximately 450 acres was noted between the 1998 area and the 2005 area of the reach. The explanation for the difference is not an increase in habitat area, but the result of missing imagery for the 1998 orthophotographs in the Springville Quadrangle. Considering the location of the missing imagery, the difference was primarily accounted for as Open Water and Wetlands Matrix habitat types.

Figure 4-1
Regional Overview of the Study Area

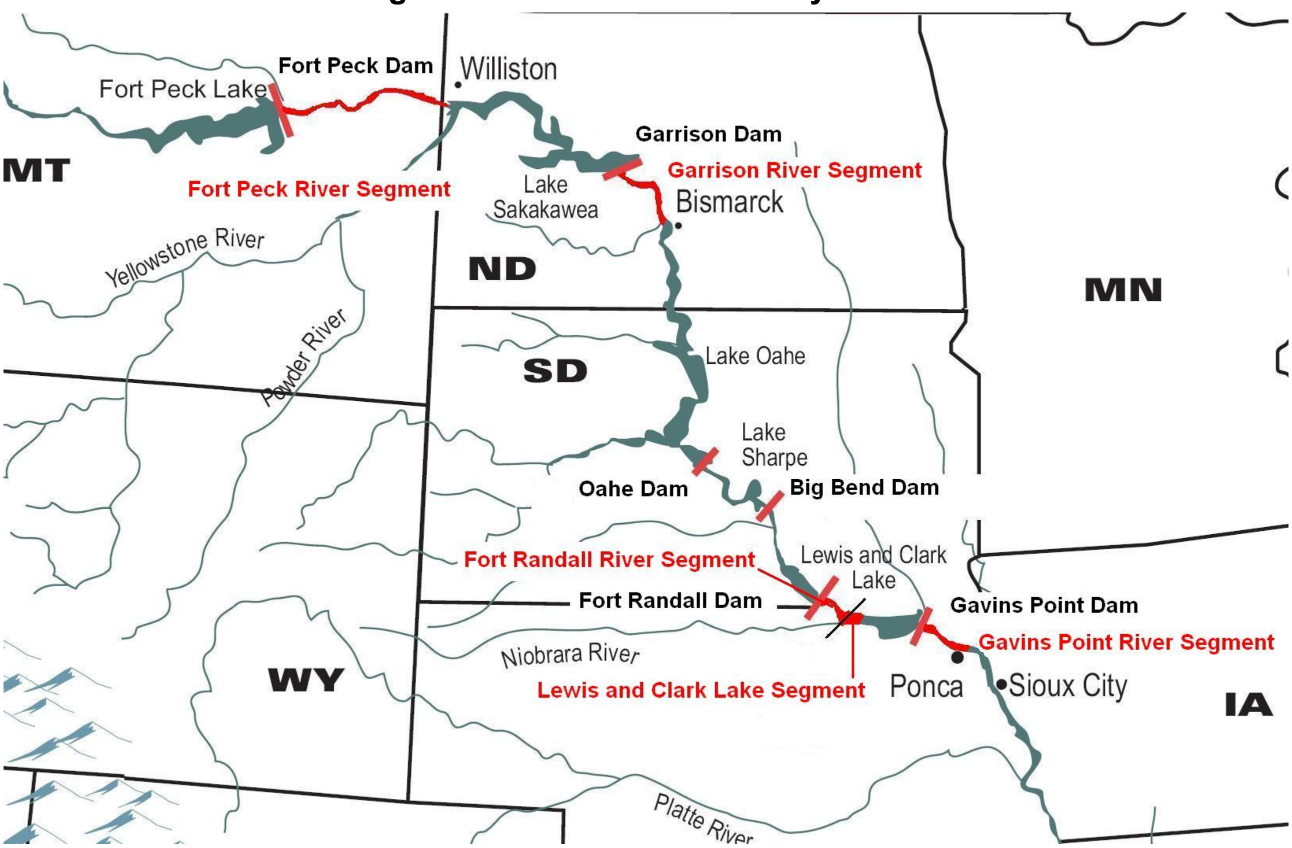
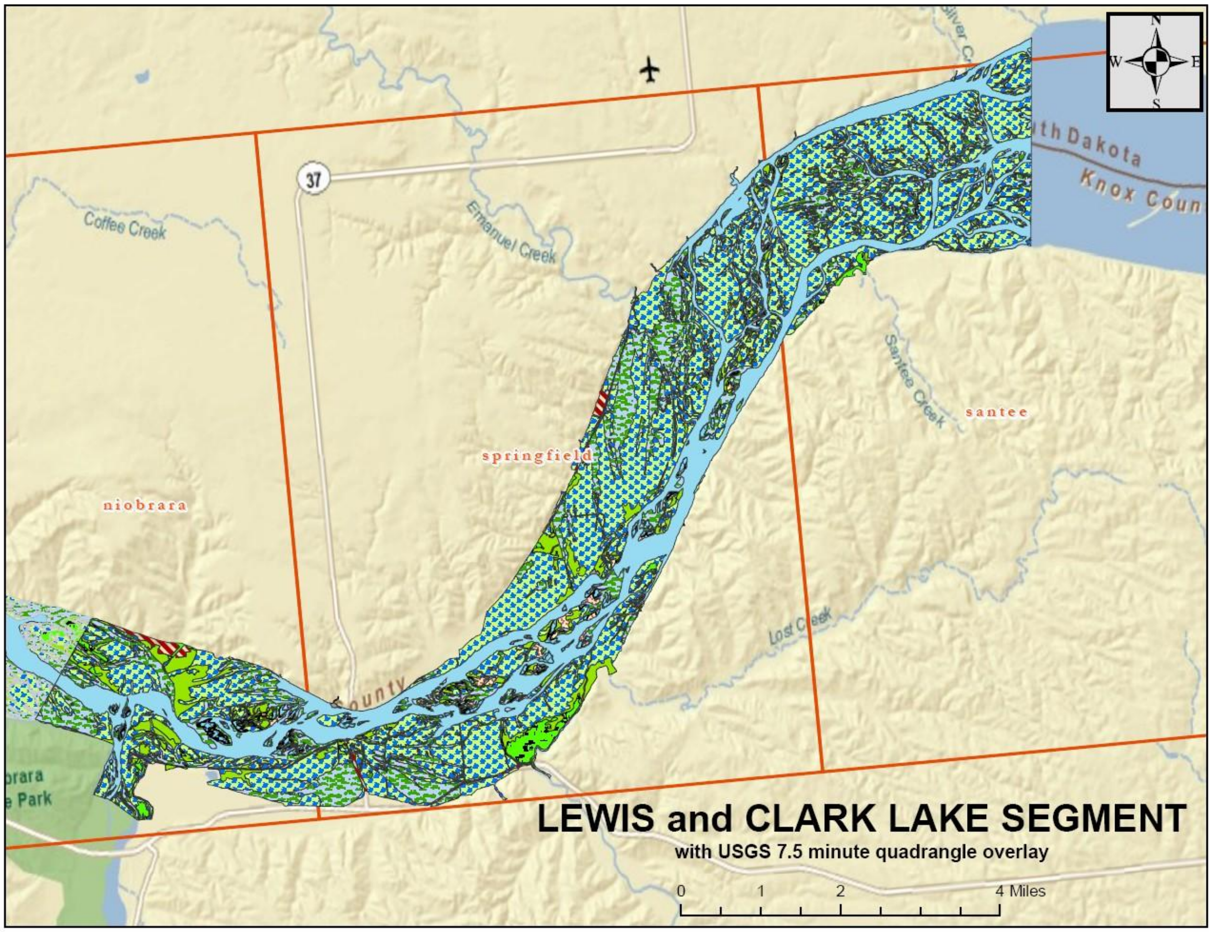


Figure 4-2
Overview of the Lewis and Clark Lake Segment with USGS Quadrangles



4.1 Habitat Delineation

Table 4-1 summarizes the change in acres for all habitat types between 1998 and 2005. Table 4-2 depicts the changes in ESH acreage between 1998 and 2005. Figure 4-3 displays the changes in acres per river mile of each habitat type between 1998 and 2005. Nine of the 12 habitat types defined in Section 2 are present in the Lewis and Clark Lake Segment.

Pool elevation in this segment is maintained at approximately 1,207 feet, but power-peaking discharges from the Fort Randall Dam result in daily elevation changes in the upper part of the reach of approximately 0.5 feet.[35] .

As shown in Table 4-1, the dominant habitats in the Lewis and Clark Lake Segment are Open Water, Wetlands Matrix, and Shallow Water, which together comprise 86.8 percent and 89.2 percent of the habitat acres using the 1998 and 2005 imagery, respectively. The last row of Table 4-1 includes acreage for Daily Inundated Sand Plain, a habitat type resulting from power generation peaking surges[36]. Daily Inundated Sand Plain habitat does not always border suitable

[35] Measured at the Niobrara USGS gage.
[36] This habitat type was not identified in the Gavins Point River Segment.

nesting-habitat. However, in situations where this habitat type is adjacent to an area suitable for nesting, it is likely to provide foraging opportunities for piping plovers when exposed. Daily Inundated Sand and low-lying Non-ESH Sand accounted for 4.2 percent of total habitat acres in 1998 and 2.3 percent in 2005.

ESH accounts for less than 3.5 percent of the habitat in the period since the 1997 high releases. The majority of ESH seems to have been created in the delta just downstream of the Niobrara confluence during the 1997 high releases. This location is likely comprised of coarse sediments that are released as flow energy dissipates at the lake pool. Downstream, substrate materials distribute themselves by declining grain size, offering less suitability for use in creation of sandbars.

Table 4-1 shows that acreage of the ESH dropped by 75 percent from 1998 (566 acres) to 2005 (142 acres). The few sandy openings comprising the 142 acres remaining in 2005 were poorly used for nesting; out of 23 nest initiations, only two piping plover nests were successful. In 2006 there were only four piping plover nest initiations (with two successful), suggesting that most marginally usable ESH in 1998 had become too small for nesting and overcome by plant growth by 2006. Field observations in August 2006 confirmed this conclusion.

Table 4-1
Habitat Acreage Summary: Lewis and Clark Lake Segment 1998 and 2005

Habitat Name	1998 Acres	2005 Acres	Change Acres	1998 Acres/ RM	2005 Acres/ RM	Change Acres/ RM	1998 % of Total	2005 % of Total
Open Water	3,270	3,684	414	192	217	24	19.6%	21.5%
ESH	566	142	-424	33	8	-25	3.4%	0.8%
Herb/Shrub/Sapling	599	919	320	35	54	19	3.6%	5.4%
Non-ESH Sand	259	20	-239	15	1	-14	1.6%	0.1%
Forest	254	247	-7	15	15	0	1.5%	1.4%
Agriculture	91	147	56	5	9	3	0.5%	0.9%
Wetland Matrix	7,570	8,397	827	445	494	49	45.3%	48.9%
Shallow Water	3,666	3,222	-444	216	190	-26	21.9%	18.8%
Daily Inundated Sand Plain	431	380	-51	25	22	-3	2.6%	2.2%
Total	16,706	17,158						

Table 4-2 shows that only 46.1 acres remained as ESH between 1998 and 2005. The remaining 95.9 acres of ESH mapped in 2005 within this segment represent new ESH that changed from other 1998 habitat types over the intervening period.

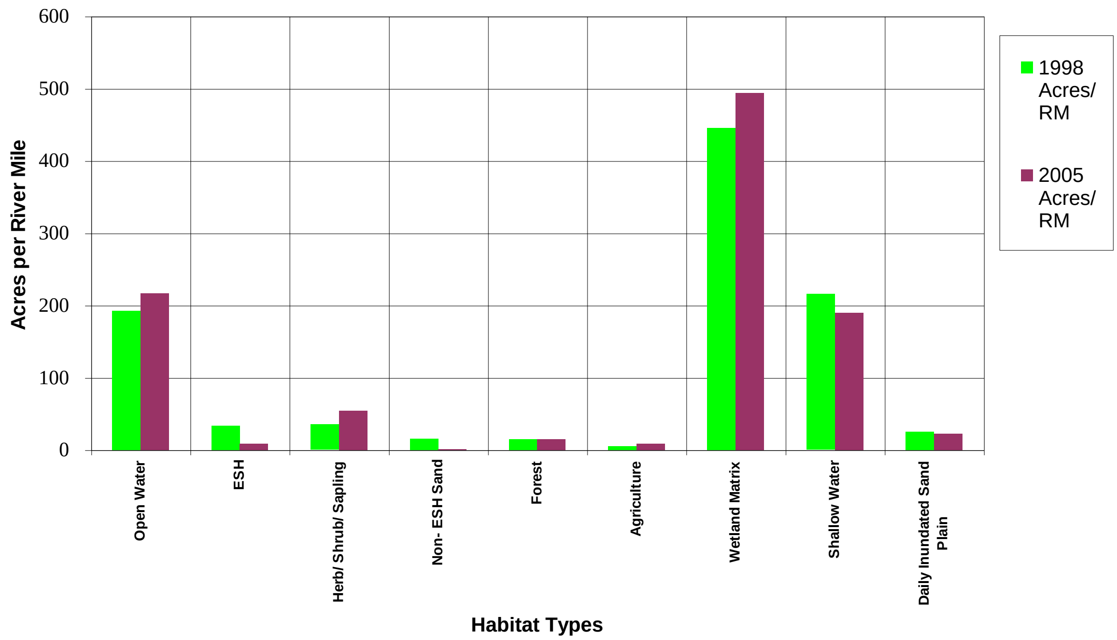
As shown in Table 4-2, the majority (62 percent) of ESH delineated for the Lewis and Clark Lake Segment from the 1998 imagery succumbed to natural succession of both wetlands (Wetland Matrix) and upland (Herb/Shrub/Sapling) habitats. Taken together, these successional habitat types increased by more than 1,100 acres from 1998 to 2005 (see Table 4-1). Erosion and redistribution to Open Water, Shallow Water, and Daily-inundated Sand Plain makes up another 29 percent of the loss of ESH from 1998 to 2005.

Table 4-2
Disposition of ESH Lost from 1998 to 2005: Lewis and Clark Lake Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	100.2	18%	ESH lost to erosion with sediments carried down stream
ESH	46.1	8%	ESH retained from original 1998 area
Herb/Shrub/Sapling	118.8	21%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	1.6	0%	Became terrestrialized or surrounded by forest
Forest	5.7	1%	Forest canopy growth into/around ESH
Wetland Matrix	231.2	41%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	37.9	7%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand	23.9	4%	ESH redistributed to low plateaus by daily high flows from power peaking at Fort Randall Dam
Total	565.5		

Figure 4-3 graphs the changes in habitat acres per river mile for the Lewis and Clark Lake Segment between 1998 and 2005.

Figure 4-3
Change in Habitat Composition – Lewis and Clark Lake Segment



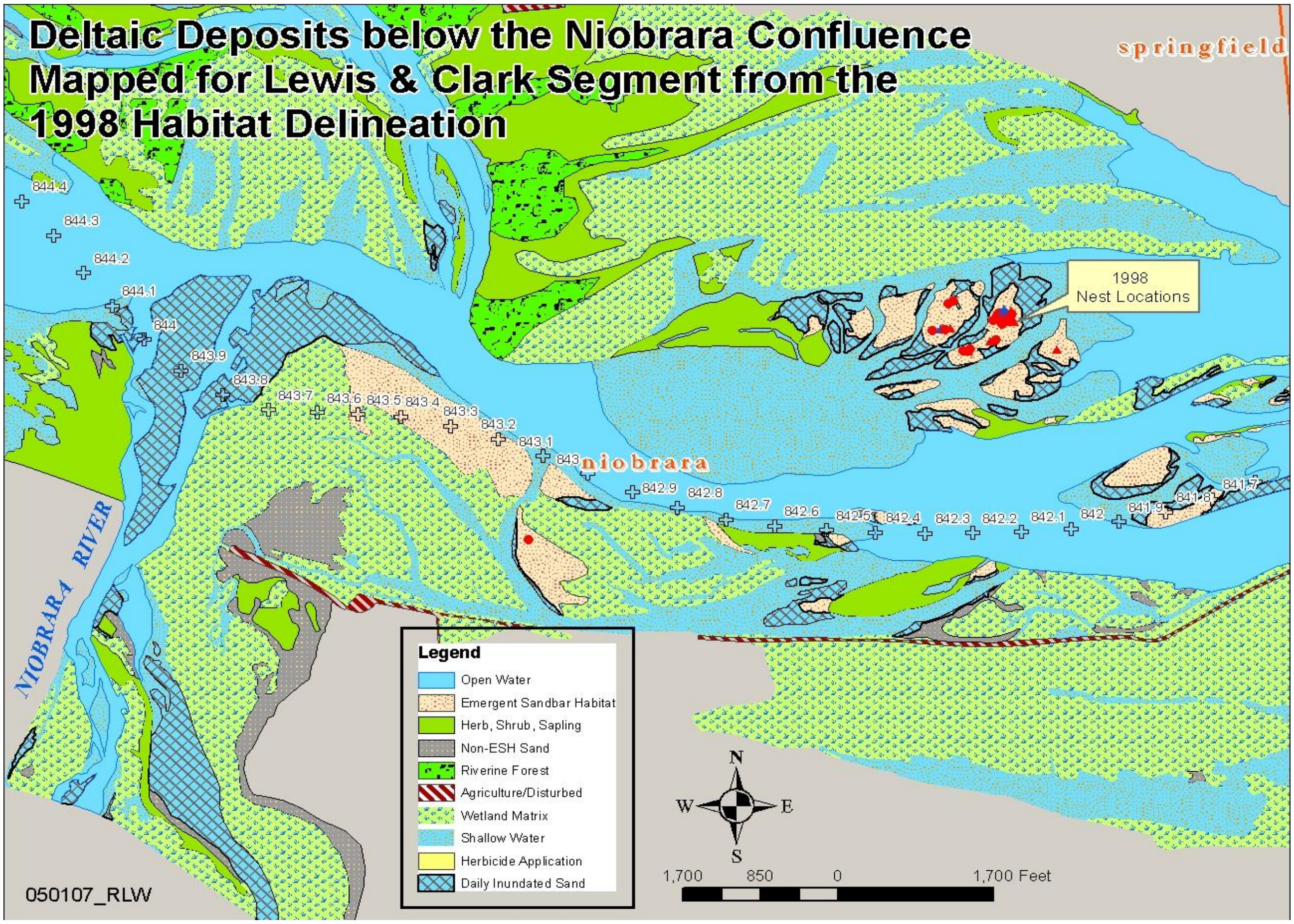
4.1.1 Impact of Fluvial Processes – Lewis and Clark Lake Segment

The high volume flow events during 1996 and 1997 that created so much barren sandbar in the Gavins Point River Segment were far less effective in creating sandbar in the Lewis and Clark Lake Segment. Water elevations in Lewis and Clark Lake during 1996-1997 did not result in sustained elevations that were significantly higher than normal pool elevations. For this reason, sandbar-building sediments arriving from the Missouri River main stem and the Niobrara River appear to have been largely deposited at the upstream portion of this segment where the backwater effects from the lake begin.

A deltaic deposit near the mouth of the Niobrara (RM 842) resulted in the creation of several low elevation sandbars used for nesting activity by both least tern and piping plover until 2000. Figure 4-4 shows these features from the 1998 habitat delineation for the Lewis and Clark Lake Segment. Similar deposits, perhaps the result of flow surges, were initially used for nesting near RM 839 and RM 838.

Low elevation sediment deposits (relative to the normal pool) are more susceptible to both erosion, as a result of power peaking flows, and rapid natural succession by vegetation. Lower sandbar elevation also results in a higher relative water table. These sites are more susceptible to the germination and growth of vegetation than are the relatively highly elevated and desiccated sandbars in Gavins Point River Segment. Vegetation encroachment, primarily by wetland vegetation, was the major cause of loss for the majority of sandbars, as discussed above. Island subsidence into the lake pool and erosion (particularly in the Niobrara delta area) were also important in the rapid loss of ESH.

Figure 4-4
Deltaic Deposits Below the Missouri-Niobrara Confluence in 1998



4.2 Summary of Nest Data

The nest data set analyzed for the Lewis and Clark Lake Segment includes 195 least tern nests and 119 piping plover nests - a total of 314 nest data points. The dataset spans 1999 through 2006, although most nesting activity peaked in 1999 and had been significantly reduced by 2003. The nest failure rate was nearly 70 percent, which is considerably higher than observed in the Gavins Point River Segment (30-35 percent).

4.3 Distribution of Nesting Habitat by NestArea

The NestArea segmentation of the nest database grouped nests by location to show trends over breeding seasons. Tables 4-3 and 4-4 show the distribution of total nests and successful nests, respectively, for both species combined. Tables 4-5 and 4-6 show the distribution of total and successful nests for least terns (ILT), and Tables 4-7 and 4-8 show the data for piping plovers (PPL). Each of the tables show nest counts by location and year for the 38 NestAreas where nests were established over the period of 1999 through 2006. Each of the tables are sorted by importance value (IV), which is the product of the number of nests and the number of years used for nesting at each location.

As shown in Table 4-3, nesting-habitat was concentrated in what are later defined as depositional areas. Twelve NestAreas were used for nesting for more than one year; eight of which supported nesting for only 2 years. Three sites supported nesting for 3 years, while a single NestArea (Springfield: 838.0) supported nesting for 6 of the 8 years. None of these sites would be classified as "highly successful" when compared to the Gavins Point River Segment NestAreas. Total nest numbers peaked in 1999, when acreages of barren sand would have been at the highest levels of the 1998 to 2005 period. Nest numbers in every year following 1999 are substantially lower - the highest of which is only about 60 percent of 1999 nest numbers. This suggests that habitat quality was being degraded faster than would allow for increases in colonization and nesting by the birds.

Table 4-3
Total Nest Distribution by Year and NestArea

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total Nests**	**Years Active**	**IV**
Springfield: 838.0	29	1		1		2	1	1	35	6	210
Niobrara: 841.8A					30		1	1	32	3	96
Springfield: 839.2	25	2						1	28	3	84
Niobrara: 842.2A	22	7							29	2	58
UP Niobrara: 1		9	5	1					15	3	45
Springfield: 834.3				40					40	1	40
Niobrara: 842.3A	5	13							18	2	36
Niobrara: 842.2B	2	5	1						8	3	24
Niobrara: 841.9					8	1			9	2	18
Niobrara: 842.1B		15							15	1	15
Santee: 827				14					14	1	14
Niobrara: 841.8B							10		10	1	10
Niobrara: 842.2C	3	2							5	2	10
Niobrara: 842.1A			9						9	1	9
Springfield: 838.2A	3						1		4	2	8
Springfield: 839.5	7								7	1	7
Niobrara: 842.6B			5						5	1	5
Niobrara: 842.0B	1	1							2	2	4
Springfield: 839.9			1				1		2	2	4
Niobrara: 842.0A			3						3	1	3
Springfield: 841.6							3		3	1	3
Niobrara: 841.6A							2		2	1	2
Niobrara: 841.8C							2		2	1	2
Niobrara: 842.3B	2								2	1	2
Springfield: 840.0							2		2	1	2
Niobrara: 841.6B			1						1	1	1
Niobrara: 842.3C			1						1	1	1
Niobrara: 842.6A			1						1	1	1
Niobrara: 843.1	1								1	1	1
Springfield: 835.9	1								1	1	1
Springfield: 837.1		1							1	1	1
Springfield: 837.3	1								1	1	1
Springfield: 837.4		1							1	1	1
Springfield: 837.7				1					1	1	1
Springfield: 838.2B			1						1	1	1
Springfield: 838.7					1				1	1	1
Springfield: 839.1								1	1	1	1
UP Niobrara: 2				1					1	1	1
Total	102	57	28	58	39	3	23	4	314		
Sites Active	13	11	10	6	3	2	9	4			

Table 4-4 shows that only 19 of the 38 NestAreas supported successful sites. The table also shows that only three sites supported more than 10 successful nests over the 8-year data period, and eight sites supported only one successful nest. The overall nest success rate (total successful nests / total nests) for the Lewis and Clark Lake Segment was roughly 30 percent (95 of 314 nests).

Table 4-4
Total Successful Nest Distribution by Year and NestArea

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total Nests**	**Years Active**	**IV**
Springfield: 839.2	9	1						1	11	3	33
Springfield: 834.3				24					24	1	24
UP Niobrara: 1		4	4						8	2	16
Niobrara: 841.8A					13				13	1	13
Niobrara: 842.3A	1	5							6	2	12
Niobrara: 842.2A	3	2							5	2	10
Niobrara: 842.1B		9							9	1	9
Springfield: 838.0		1		1				1	3	3	9
Niobrara: 842.2B		1	1						2	2	4
Santee: 827				3					3	1	3
Springfield: 839.5	3								3	1	3
Niobrara: 841.6A							1		1	1	1
Niobrara: 841.6B			1						1	1	1
Niobrara: 842.2C		1							1	1	1
Niobrara: 842.3C			1						1	1	1
Springfield: 837.7				1					1	1	1
Springfield: 838.2B			1						1	1	1
Springfield: 839.9			1						1	1	1
Springfield: 841.6							1		1	1	1
Total	16	24	9	29	13	0	2	2	95		
Sites Active	4	8	6	4	1	0	2	2	19		
Percent Successful	16	42	32	50	33	0	9	50			

Table 4-5
Least Tern Total Nest Distribution by Year and NestArea

	YEAR								
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2005**	**Total Nests**	**Years Active**	**IV**
Niobrara: 842.2A	15	4					19	2	38
Springfield: 839.2	15	1					16	2	32
Niobrara: 841.8A					26		26	1	26
Niobrara: 842.3A	3	9					12	2	24
UP Niobrara: 1		8	3				11	2	22
Springfield: 834.3				20			20	1	20
Springfield: 838.0	15						15	1	15
Santee: 827				13			13	1	13
Niobrara: 841.8B						10	10	1	10
Niobrara: 842.1B		10					10	1	10
Niobrara: 842.2B	1	4					5	2	10
Niobrara: 841.9					7		7	1	7
Niobrara: 842.1A			6				6	1	6
Niobrara: 842.0B	1	1					2	2	4
Niobrara: 842.2C	1	1					2	2	4
Niobrara: 842.6B			4				4	1	4
Springfield: 839.5	4						4	1	4
Niobrara: 841.8C						2	2	1	2
Niobrara: 842.0A			2				2	1	2
Springfield: 838.2A	2						2	1	2
Springfield: 841.6						2	2	1	2
Niobrara: 841.6A						1	1	1	1
Niobrara: 842.6A			1				1	1	1
Springfield: 838.7					1		1	1	1
Springfield: 839.9			1				1	1	1
UP Niobrara: 2				1			1	1	1
Total	57	38	17	34	34	15	195		
Sites Active	9	8	6	3	3	4			

Table 4-6
Least Tern Successful Nest Distribution by Year and NestArea

	YEAR								
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2005**	**Total Nests**	**Years Active**	**IV**
UP Niobrara: 1		4	2				6	2	12
Niobrara: 841.8A					10		10	1	10
Niobrara: 842.3A	1	4					5	2	10
Springfield: 834.3				10			10	1	10
Springfield: 839.2	9						9	1	9
Niobrara: 842.1B		7					7	1	7
Niobrara: 842.2A	3						3	1	3
Springfield: 839.5	3						3	1	3
Santee: 827				2			2	1	2
Springfield: 839.9			1				1	1	1
Total	16	15	3	12	10	0	56		
Sites Active	4	3	2	2	1	0			

Table 4-7
Piping Plover Nest Distribution by Year and Nest Area

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total Nests**	**Years Active**	**IV**
Springfield: 838.0	14	1		1		2	1	1	20	6	120
Springfield: 839.2	10	1						1	12	3	36
Niobrara: 842.2A	7	3							10	2	20
Springfield: 834.3				20					20	1	20
Niobrara: 841.8A					4		1	1	6	3	18
Niobrara: 842.3A	2	4							6	2	12
UP Niobrara: 1		1	2	1					4	3	12
Niobrara: 842.2B	1	1	1						3	3	9
Niobrara: 842.2C	2	1							3	2	6
Niobrara: 842.1B		5							5	1	5
Niobrara: 841.9					1	1			2	2	4
Springfield: 838.2A	1						1		2	2	4
Niobrara: 842.1A			3						3	1	3
Springfield: 839.5	3								3	1	3
Niobrara: 842.3B	2								2	1	2
Springfield: 840.0							2		2	1	2
Niobrara: 841.6A							1		1	1	1
Niobrara: 841.6B			1						1	1	1
Niobrara: 842.0A			1						1	1	1
Niobrara: 842.3C			1						1	1	1
Niobrara: 842.6B			1						1	1	1
Niobrara: 843.1	1								1	1	1
Santee: 827				1					1	1	1
Springfield: 835.9	1								1	1	1
Springfield: 837.1		1							1	1	1
Springfield: 837.3	1								1	1	1
Springfield: 837.4		1							1	1	1
Springfield: 837.7				1					1	1	1
Springfield: 838.2B			1						1	1	1
Springfield: 839.1								1	1	1	1
Springfield: 839.9							1		1	1	1
Springfield: 841.6							1		1	1	1
Total	45	19	11	24	5	3	8	4	119		
Sites Active	13	11	9	6	3	3	8	5			

Table 4-8
Piping Plover Successful Nest Distribution by Year and Nest Area

	YEAR										
NestArea	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Total Nests**	**Years Active**	**IV**
Springfield: 834.3				14					14	1	14
Springfield: 838.0		1		1				1	3	3	9
Niobrara: 842.2B		1	1						2	2	4
Springfield: 839.2		1						1	2	2	4
Niobrara: 841.8A					3				3	1	3
Niobrara: 842.1B		2							2	1	2
Niobrara: 842.2A		2							2	1	2
UP Niobrara: 1			2						2	1	2
Niobrara: 841.6A							1		1	1	1
Niobrara: 841.6B			1						1	1	1
Niobrara: 842.2C		1							1	1	1
Niobrara: 842.3A		1							1	1	1
Niobrara: 842.3C			1						1	1	1
Santee: 827				1					1	1	1
Springfield: 837.7				1					1	1	1
Springfield: 838.2B			1						1	1	1
Springfield: 841.6							1		1	1	1
Total	0	9	6	17	3	0	2	2	39		
Sites Active	0	7	5	4	1	0	2	2			

4.4 Distribution of Nests and ESH For All Years

Mapped ESH in the Lewis and Clark Lake Segment declined by roughly 75 percent from 1998 to 2005 (566 to 142 acres). The 142 acres of ESH mapped for 2005 were contained in 115 separate polygons representing islands or habitat patches.

There were 46 acres mapped as ESH in 2005 in the same location as in 1998. When the spatial data and the nesting data were intersected, only 29 of the 115 ESH polygons from 2005 contained nests. These polygons, totaling 48.1 acres, captured 157 (50 percent) of all nests established in the Lewis and Clark Lake Segment over the 8-year period of analysis. The remaining nesting sites were located in non-ESH polygons delineated from the 2005 imagery, which indicates an ESH loss of 50 percent over the eight-year period. Nest losses (and the former nesting-habitat they represent) were distributed among other habitat types as shown as in Table 4-9.[37]

[37] Note that the sum of nests in Table 4-9 is 31 nests short of the total shown for the Lewis and Clark Lake Segment in tables shown earlier in this section. These 31 nests were located outside the habitat mapping area, either on

The remaining 86 of the 115 ESH polygons that did not contain nests in 2005 (totaling 94 acres) probably did not provide suitable conditions for nesting-habitat. Most of the ESH polygon areas not used for nesting were unused because of individual or multiple habitat flaws. Some of these ESH polygons were located within 600-foot gallery forest buffers. Others were less than 0.1 acres and surrounded by dense herbaceous and shrubby vegetation, while some appeared to be too low in elevation.

Table 4-9 shows the distribution of nest points over the sampling period, the habitat type polygons from the 2005 imagery delineation, and the flood risk zones. Certain inferences were drawn from using habitat types as surrogates for elevation differences and ranked by assumed frequency of annual flooding from rarely (1) to nearly always (6). This ranking correlates with the mapping methods and a general elevation-based differentiation between habitat types.

Table 4-9 shows that, during 1999 and 2000, nests were distributed throughout six habitat types. Lower flood-risk habitat types showed nest establishment throughout the period of analysis. Higher flood-risk habitat types showed nest establishment through the 2001 breeding season – the lowest flow year in the Gavins Point River Segment datasets (see Section 3 of this document). These non-ESH sites (as delineated from 2005 imagery) may have provided preferred fresh, barren sand during the 2001 breeding season, but were lost to erosion and inundation in subsequent years. It is interesting to note that no nests were established on areas mapped as 2005 ESH for the 2001 breeding season. Nest establishment in the area mapped as Herb-Shrub showed a declining trend after the 2000 breeding season that is consistent with the processes of vegetation encroachment.

Table 4-9
Nest Points by Flood Risk Zone, Habitat Type, and Year of Nest Establishment

		Year Nest Established								
Flood Risk Zone	Habitat	1999	2000	2001	2002	2003	2004	2005	2006	Total Nests
1	Herb-Shrub (upland)	15	23		10	5				53
2	Emergent Sandbar	28	7		31	12	3	20	56	157
3	Emergent Wetland		4			20				24
4	Daily-inundated Sand	4	3	10						17
5	Shallow Water	2	15	3						20
6	Open Water			13						13
		49	52	26	41	37	3	20	56	284

temporary islands in the Lewis and Clark Lake proper, or up the Niobrara River beyond coverage the imagery used for habitat delineations.

4.5 Establish ESH Acreage Goal for PEIS Alternative 5

The ESH acreage goal for PEIS Alternative 5 was established based on measurement of nesting-habitat for least tern and piping plover in the Lewis and Clark Lake Segment. The methodology described in Section 2 of this document was used to measure nesting-habitat on an annual and total basis for the Lewis and Clark Lake Segment. Steps in the analysis are briefly reviewed below.

1. Separate the data by year, species, and NestArea.
2. Measure distances between nests, and identify the nearest-neighbor distance for each nest.
3. Establish the radius of nesting-habitat circles for each NestArea, species, and year.
4. Establish nesting-habitat polygons for each NestArea, species, and year as the area within habitat circles, counting overlapping areas only once.
5. Combine species and year habitat circles for each Nest Area, counting overlapping areas only once.
6. Establish acreage goals for the Lewis and Clark Lake Segment under PEIS Alternative 5 by adding the acreage for each NestArea in the segment.

Data generated during implementation of the steps listed above are shown in Tables 4-10 through 4-12. Table 4-10 shows nesting acreages for least tern and piping plover, by year and by NestArea. As shown in the table, nesting acreage declined for both species between 1999 and 2006. The maximum annual nesting acreage occupied for least tern occurred in 2001, which amounted to 14 acres for the entire Lewis and Clark Lake Segment. The maximum annual nesting acreage occupied for piping plover occurred in 1999, which amounted to 26.1 acres for the entire Lewis and Clark Lake Segment.

Table 4-11 shows nesting-habitat acreage occupied by NestArea and year when the acreages used by least tern and piping plover were combined. The table shows that only three moderately important sites were greater than one acre in size and used for more than one year.

Summaries shown in Table 4-11 indicate that the highest acreage of measured nesting-habitat and the highest numbers of nests were established near the end of the high water period of 1996-1997. The highest total nest density occurred in 2000, with nearly five nests per acre. The highest density of successful nests was recorded in 2003. Natural ESH in the Lewis and Clark Lake Segment had degraded significantly by 2004.

Table 4-12 shows the results derived from combining the nesting acreage polygons for both species and for all years by NestArea to estimate the entire area used for nesting during the period of analysis. As shown in the table, the entire estimated area used for nesting in the Lewis and Clark Lake Segment for the 1999 through 2006 period of analysis was 81.9 acres.

Table 4-10
Measured Nesting Habitat Acres by NestArea, Year, and Species

	1999		2000		2001		2002		2003		2004		2005		2006	
NestArea	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**
Springfield: 838.0	5.9	8.6		1.0				0.8				0.5		0.3		0.3
Springfield: 834.3							2.3	6.0								
Springfield: 839.2	1.5	3.9	0.3	1.0												1.2
UP Niobrara: -1			0.4	1.0	3.4	1.9		0.8								
Niobrara: 842.6B					5.7	1.0										
Springfield: 839.5	0.4	4.6														
Springfield: 838.2A	1.2	1.6												1.2		
Santee: 827							3.0	0.8								
Springfield: 839.9					2.4									1.2		
Niobrara: 842.2A	0.5	0.8	0.6	1.5												
Niobrara: 842.2B	0.5	0.7	0.3	1.0		1.0										
Niobrara: 841.8A									0.7	1.8				0.3		0.3
Niobrara: 842.3A	0.2	0.8	0.7	0.9												
Niobrara: 842.6A					2.1											
Niobrara: 842.2C	0.5	0.2	0.3	1.0												
Niobrara: 842.1B			0.6	1.3												
Niobrara: 842.1A					0.4	1.5										
Niobrara: 843.1		1.6														
Springfield: 835.9		1.6														
Springfield: 837.3		1.6														
Niobrara: 841.6A													0.3	1.2		
Springfield: 841.6													0.0	1.2		
Springfield: 839.1																1.2
UP Niobrara: -2							1.0									
Niobrara: 842.0A					0.0	1.0										
Niobrara: 841.6B						1.0										
Niobrara: 842.3C						1.0										
Springfield: 837.1				1.0												
Springfield: 837.4				1.0												
Springfield: 838.2B						1.0										
Springfield: 837.7								0.8								
Niobrara: 842.0B	0.5		0.3													
Niobrara: 841.9									0.1	0.3		0.3				
Springfield: 840.0														0.5		
Springfield: 838.7									0.3							
Niobrara: 842.3B		0.2														
Niobrara: 841.8B													0.1			
Niobrara: 841.8C													0.0			
Total	**11.3**	**26.1**	**3.6**	**10.4**	**14.0**	**9.1**	**6.2**	**9.4**	**1.1**	**2.0**	**0.0**	**0.8**	**0.4**	**6.0**	**0.0**	**3.0**

Table 4-11
Nesting Habitat Acreage by Year, Both Species

NestArea	1999	2000	2001	2002	2003	2004	2005	2006	Mean Acres	Active Years	IV
Springfield: 838.0	11.8	1.0		0.8		0.5	0.3	0.3	2.4	6	14.6
Springfield: 839.2	4.0	1.1						1.2	2.1	3	6.4
UP Niobrara: -1		1.2	4.1	0.8					2.1	3	6.2
Springfield: 834.3				5.8					5.8	1	5.8
Niobrara: 842.6B			5.7						5.7	1	5.7
Springfield: 839.5	4.6								4.6	1	4.6
Springfield: 839.9			2.4				1.2		1.8	2	3.7
Santee: 827				3.1					3.1	1	3.1
Springfield: 838.2A	1.9						1.2		1.6	2	3.1
Niobrara: 842.2B	0.9	1.0	1.0						0.9	3	2.8
Niobrara: 842.2A	1.0	1.6							1.3	2	2.6
Niobrara: 841.8A					1.8		0.3	0.3	0.8	3	2.3
Niobrara: 842.6A			2.1						2.1	1	2.1
Niobrara: 842.3A	0.8	1.1							0.9	2	1.9
Niobrara: 842.1A			1.8						1.8	1	1.8
Niobrara: 843.1	1.6								1.6	1	1.6
Springfield: 835.9	1.6								1.6	1	1.6
Springfield: 837.3	1.6								1.6	1	1.6
Niobrara: 842.2C	0.5	1.0							0.7	2	1.4
Niobrara: 842.1B		1.3							1.3	1	1.3
Springfield: 839.1								1.2	1.2	1	1.2
Niobrara: 841.6A							1.2		1.2	1	1.2
Springfield: 841.6							1.2		1.2	1	1.2
UP Niobrara: -2				1.0					1.0	1	1.0
Niobrara: 841.6B			1.0						1.0	1	1.0
Niobrara: 842.3C			1.0						1.0	1	1.0
Springfield: 837.1		1.0							1.0	1	1.0
Springfield: 837.4		1.0							1.0	1	1.0
Springfield: 838.2B			1.0						1.0	1	1.0
Niobrara: 842.0A			1.0						1.0	1	1.0
Springfield: 837.7				0.8					0.8	1	0.8
Niobrara: 842.0B	0.5	0.3							0.4	2	0.8
Niobrara: 841.9					0.3	0.3			0.3	2	0.5
Springfield: 840.0							0.5		0.5	1	0.5
Springfield: 838.7					0.3				0.3	1	0.3
Niobrara: 842.3B	0.2								0.2	1	0.2
Niobrara: 841.8B							0.1		0.1	1	0.1
Niobrara: 841.8C							0.0		0.0	1	0.0
Total Acres	30.8	11.5	20.9	12.5	2.4	0.8	6.0	3.0	10.99		
Active Sites	13	11	10	6	3	2	9	4			
Total Nests	102	57	28	58	39	3	23	4			
Successful Nests	16	24	9	29	13	0	2	2			
T-Nest/Acre	3.31	4.97	1.34	4.66	16	4	3.8	1.3			
S-Nest/Acre	0.52	2.09	0.43	2.33	5.5	0	0.3	0.7			

Table 4-12
Measured Nesting Habitat Acres by NestArea

NestArea	Acres	NestArea	Acres
Niobrara: 841.6A	1.24	Santee: 827	3.13
Niobrara: 841.6B	0.95	Springfield: 834.3	5.78
Niobrara: 841.8A	2.10	Springfield: 835.9	1.57
Niobrara: 841.8B	0.06	Springfield: 837.1	0.95
Niobrara: 841.8C	0.00	Springfield: 837.3	1.57
Niobrara: 841.9	0.49	Springfield: 837.4	0.95
Niobrara: 842.0A	0.95	Springfield: 837.7	0.85
Niobrara: 842.0B	0.76	Springfield: 838.0	12.81
Niobrara: 842.1A	1.79	Springfield: 838.2A	3.09
Niobrara: 842.1B	1.32	Springfield: 838.2B	0.95
Niobrara: 842.2A	2.25	Springfield: 838.7	0.31
Niobrara: 842.2B	2.06	Springfield: 839.1	1.24
Niobrara: 842.2C	1.38	Springfield: 839.2	4.89
Niobrara: 842.3A	1.62	Springfield: 839.5	4.63
Niobrara: 842.3B	0.16	Springfield: 839.9	3.17
Niobrara: 842.3C	0.95	Springfield: 840.0	0.50
Niobrara: 842.6A	2.10	Springfield: 841.6	1.24
Niobrara: 842.6B	5.66	UP Niobrara: -1	5.86
Niobrara: 843.1	1.57	UP Niobrara: -2	1.01
Total Acreage used for Nesting 1999-2006			81.9

The acreage of ESH mapped by remote imagery for the Lewis and Clark Lake Segment was found to relate poorly to nest numbers. The strongest relationships for both nest establishment and nest success were between acreages of elevated barren sand and measured nesting-habitat acreage. If relative elevation (above local seasonal high water stage) was an important selection criteria for birds nesting in the Lewis and Clark Lake Segment, there should be a positive relationship between ESH mapped in 2005 (particularly that portion residual from 1998) and the measured acreage estimates for the NestAreas.

Table 4-13 compares ESH mapped from 2005 imagery with the 1999 acres and the total measured habitat acreages for sites not lost to vegetation encroachment or to erosion. Both the total acreage and several of the acreages for these sites were very similar to the measured habitat acreages. These acreages were derived by different methods, and the 46-acre figure also emerges as the intersection of ESH acreage mapped in 1998 and 2005.

Given the hydrologic and available sediment quality conditions, ESH in this segment may persist only briefly. Due to reach-specific conditions, continual maintenance to control vegetation and continued dredging to accommodate subsidence may be necessary to increase the longevity of ESH in the Lewis and Clark Lake Segment.

Table 4-13
Estimated Nesting Acreage and Mapped 2005 ESH

NestArea	1999 Acres	Total Measured Nesting-Habitat Acres	Measured 2006 Acres	Mapped 2005 ESH
Springfield: 839.1		1.2		7.6
Springfield: 837.7		0.8		4.5
Springfield: 840.0		0.5	0.5	4.0
Springfield: 838.2A	1.9	3.1	1.2	5.1
Niobrara: 841.8B		0.1	0.1	0.3
Niobrara: 841.8C		0.002		0.3
Niobrara: 842.0B	0.5	0.8		0.7
Niobrara: 842.1B		1.3		1.3
Niobrara: 841.9		0.5		0.2
Springfield: 838.0	11.8	12.8	0.3	12.2
Niobrara: 842.3A	0.8	1.6		0.7
Springfield: 841.6		1.2	1.2	0.3
Niobrara: 841.6A		1.2	1.2	0.3
Niobrara: 841.8A		2.1	0.3	1.1
Niobrara: 842.2C	0.5	1.4		0.4
Niobrara: 842.2A	1.0	2.2		0.8
Springfield: 839.9		3.2	1.2	1.6
Niobrara: 842.2B	0.9	2.1		0.3
Springfield: 834.3		5.8		3.7
Springfield: 839.5	4.6	4.6		1.5
Sum		46.6		46.9

4.6 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defines those areas most suitable for ESH construction and maintenance, as well as those areas that if used would result in potentially significant impacts to either the natural or manmade environment. This process of eliminating areas that should be avoided leaves the remaining areas as the most suitable for ESH construction and maintenance for the Lewis and Clark Lake Segment. These areas include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment. The steps involved in conducting this analysis are explained in detail in Section 2 of this document, and are outlined below.

1. Solicit input on sensitive resources and buffer distances from affected states and agencies;

2. Create an anthropogenic features dataset from aerial imagery;
3. Establish the separation distance between nesting habitat and anthropogenic features; and
4. Establish the minimum flow channel, channel width restrictions, and define the predator moat area;

The result of the analysis is a set of spatial restrictions that categorize the riverine corridor acreage into three categories. These categories are listed below.

1. **Exclusion Areas** are locations at which ESH could not be constructed because intrusion into these locations could cause significant geomorphic alterations to the river corridor. Such an intrusion would risk physical and economic damages to public and private infrastructure or land uses. Exclusion areas include the estimated minimum flow way for normal flowage (i.e., the thalweg), narrow channel reaches, and areas needed to provide a predator moat.
2. **Restrictive Areas** are locations at which ESH could be constructed and maintained at relatively low physical risk, but could put nesting habitat in areas at risk from predation, recreation encroachment, or locations otherwise limited for nesting use and productivity. Areas of limited usability are those areas defined by analysis of distances from features that have shown to be restrictive to nest establishment or nest success.
3. **Available Areas** are locations that are most suitable for the construction and maintenance of ESH. However, it is important to note that any construction activities would need to ensure that other high-interest features (e.g., archeological and cultural resources, or other protected species) would be avoided.

The acreage for Restrictive Areas, and Available Areas is summarized by habitat type for the Lewis and Clark Lake Segment in Table 4-14. It is important to note that Available Area acres is a subset of Restrictive Area acres.

Table 4-14
Residual Available Area for ESH Construction: Lewis and Clark Lake Segment

Habitat Type	Acres 2005	Restrictive Area Acres	Available Area Acres
Open Water	3,684	1,935	1,490
Emergent Sandbar Habitat	142	127	111
Herb-Shrub-Sapling	919	843	568
Non-ESH Sand	20	13	11
Riverine Forest	247	175	7
Active Agricultural Row Crop	147	97	23
Wetland Matrix	8,397	7,670	0
Shallow Water	3,222	2,805	2,238
Daily-Inundated Sand Plains	380	305	263
Lacustrine Fine Sediments	0		0
Total	**17,157**	**13,969**	**4,711**
Percent		**39%**	**18%**

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5 Fort Randall River Segment

The Fort Randall River Segment begins at the upstream end of the Lewis and Clark Lake Segment at RM 845.0, and extends to Fort Randall Dam at RM 880.0, a distance of 35.0 river miles (see Figures 5-1 and 5-2 below). The habitat area within the high banks is approximately 13,800 acres, which translates to 384 acres per river mile, and an average width of 3,168 feet. Riverine habitat area increased by 177 acres between 1998 and 2005. Review of 1998 and 2005 orthophotographs indicates that the additional habitat area has resulted from bank erosion. The Fort Randall River Segment is in the backwater of Lewis and Clark Lake to approximately RM 854.0 (the lower 9 miles of the segment). This point correlates with a reduction in average riverine corridor width less than 2,200 feet, which is the approximate lower threshold channel width for sandbar formation and retention (Biedenharn et al ERDC, 2001).

Figure 5-1
Regional Overview of the Study Area

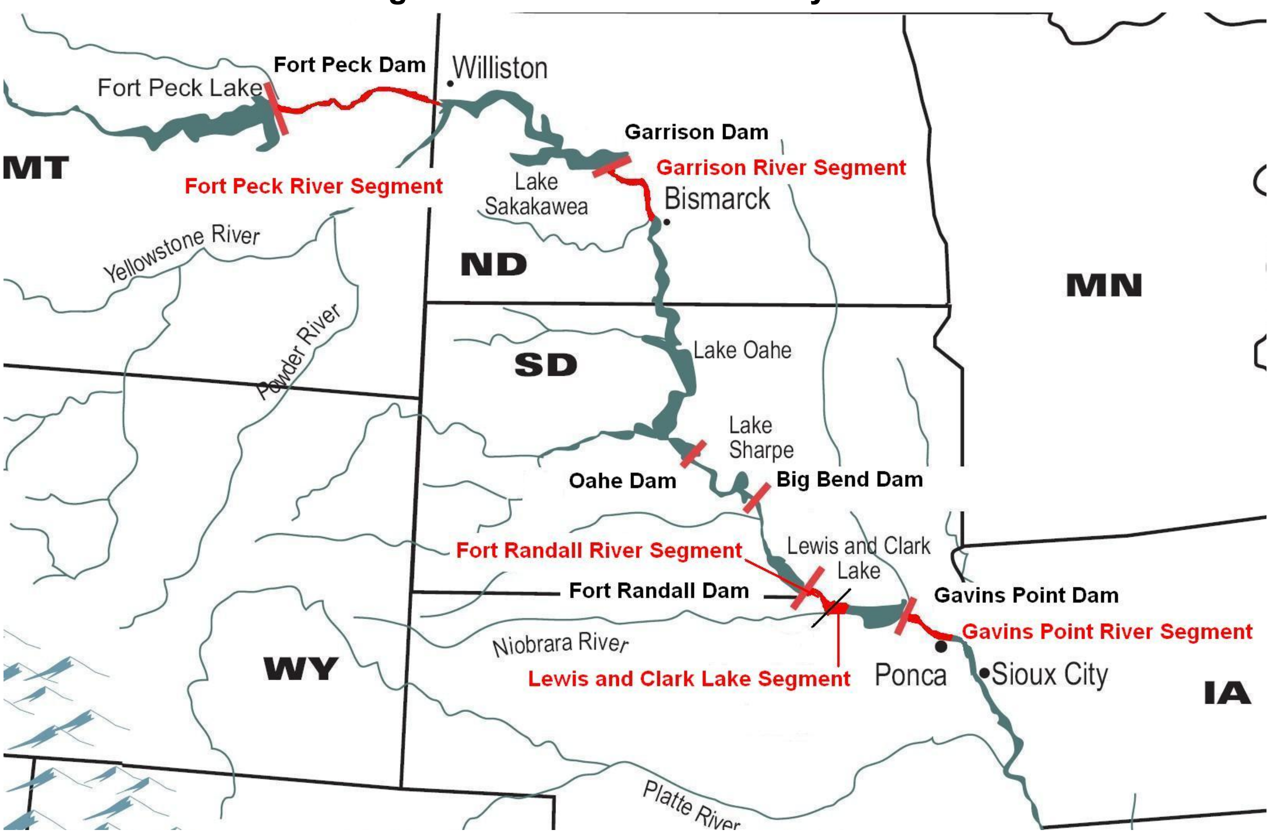
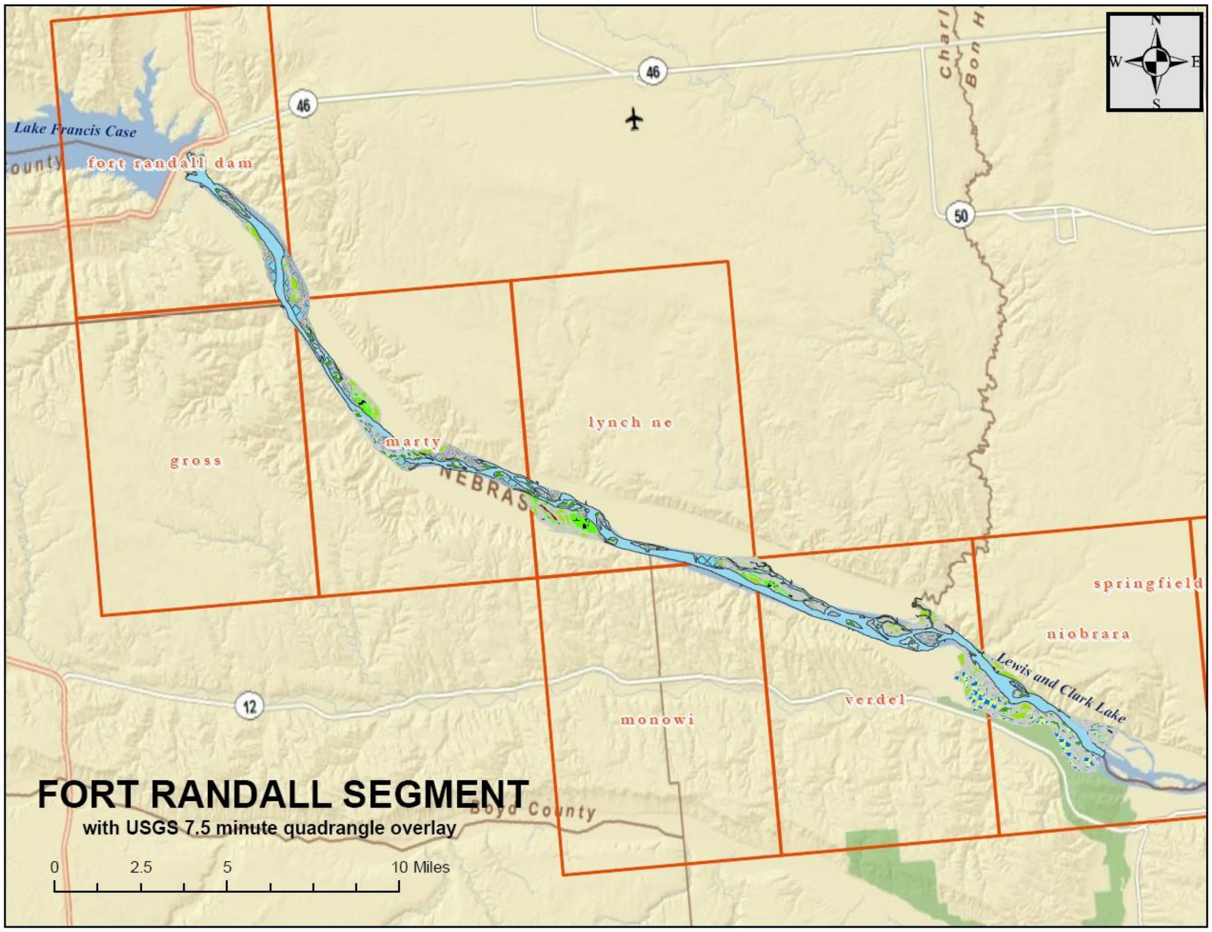


Figure 5-2
Overview of the Fort Randall River Segment with USGS Quadrangles



5.1 Habitat Delineation

Table 5-1 summarizes the change in acres for all habitat types between 1998 and 2005. Table 5-2 depicts the changes in ESH acreage between 1998 and 2005. Figure 5-3 displays the changes in acres per river mile of each habitat type between 1998 and 2005. Ten of the 12 habitat types defined in Section 2 are present in the Fort Randall River Segment.

Table 5-1 shows that ESH habitat has declined by 57 percent (295 to 128 acres) in the Fort Randall River Segment, even though riverine habitat increased in total by 177 acres. Major acreage losses also occurred in the following habitat types: Open Water, Non-ESH Sand, Forest, and Shallow Water. The loss of Open Water suggests that the Fort Randall River Segment may not be sediment deficient, which would follow from its shallow slope and low energy gradient. Habitat types showing significant gains over the 1998 to 2005 period include: Herb/Shrub/Sapling, Wetland Matrix, and Daily-Inundated Sand Plain. While Non-ESH Sand and Shallow Water (visible submersed sand) habitats decreased, when combined with Daily Inundated Sand habitat, the combination of the three exceeds 1998 levels by 225 acres. This indicates that source materials for construction of ESH may be ample in this reach. Those sediments, occurring in elevated positions (as observed during August 2006), appear to contain a suitable coarse material fraction that indicate their suitability for mechanical ESH construction.

Table 5-1
Habitat Acreage Summary: Fort Randall River Segment 1998 and 2005

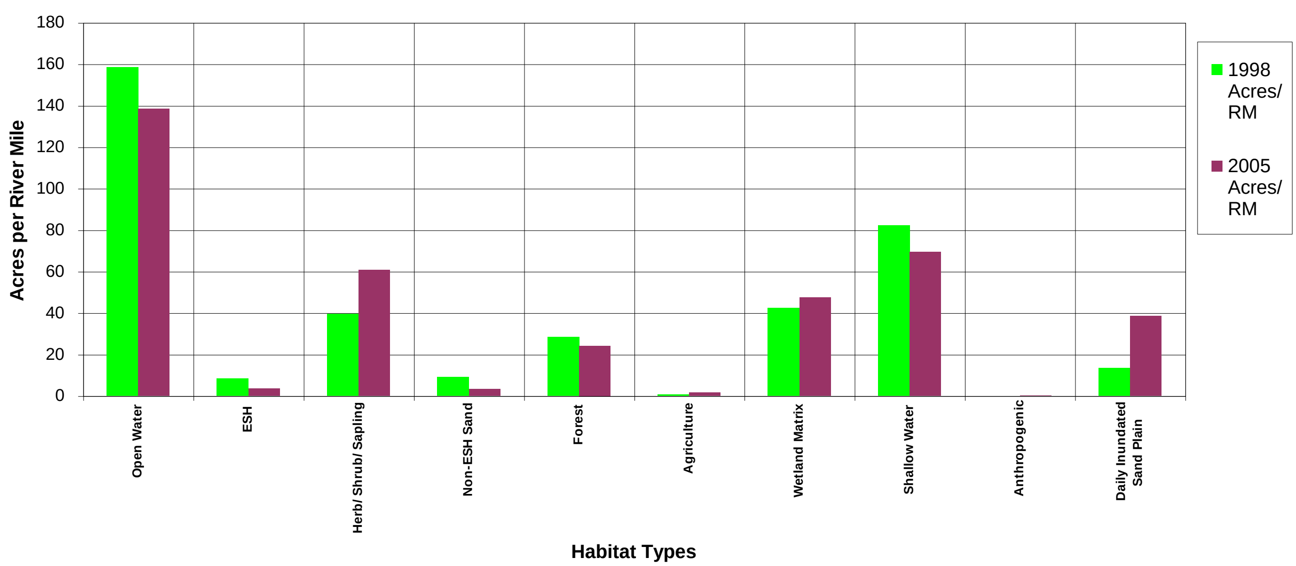
Habitat Name	1998 Acres	2005 Acres	Change Acres	1998 Acres/ RM	2005 Acres/ RM	Change Acres/ RM	1998 Pct of Total	2005 Pct of Total
Open Water	5,639	4,926	-713	158	138	-20	41.4%	35.7%
ESH	295	128	-168	8	4	-5	2.2%	0.9%
Herb/Shrub/Sapling	1,405	2,164	758	39	61	21	10.3%	15.7%
Non-ESH Sand	327	120	-207	9	3	-6	2.4%	0.9%
Forest	1,014	859	-155	28	24	-4	7.4%	6.2%
Agriculture	20	60	39	1	2	1	0.1%	0.4%
Wetland Matrix	1,505	1,684	179	42	47	5	11.1%	12.2%
Shallow Water	2,931	2,470	-461	82	69	-13	21.5%	17.9%
Anthropogenic	0	10	10	0	0	0	0.0%	0.1%
Daily Inundated Sand Plain	478	1,370	893	13	38	25	3.5%	9.9%
Total	13,614	13,791						

Table 5-2 shows that only 56.2 acres of the 295 acres of ESH identified in 1998 were still mapped as ESH in 2005. The remaining 71.8 acres of ESH mapped in 2005 within this segment represent new ESH that changed from other 1998 habitat types over the intervening period. As shown in Table 5-2, 44 percent of ESH delineated for the Fort Randall River Segment from the 1998 imagery has been lost to natural succession of lower areas into Wetlands Matrix and, on better drained sites, to herb and shrub communities. Sixteen percent has become Daily Inundated Sand. Twenty percent has become either Open Water or Shallow Water.

Table 5-2
Disposition of ESH Lost from 1998 to 2005: Fort Randall River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	36.7	12%	ESH lost to erosion and carried down river
ESH	56.2	19%	ESH retained from original 1998 area
Herb/Shrub/Sapling	96.2	33%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	0.9	0%	Became terrestrialized or surrounded by forest
Forest	0.6	0%	Natural growth of shrubs into forest-sized trees
Wetland Matrix	33.2	11%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	23.3	8%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand Plain	48.2	16%	ESH redistributed to low plateaus by daily high flows from power peaking at Fort Randall Dam
Total	295.2		

Figure 5-3
Change in Habitat Composition – Fort Randall River Segment



5.1.1 Impact of Fluvial Processes – Fort Randall River Segment

The Fort Randall River Segment is subject to significant daily changes in water surface elevation because of variations in Fort Randall Dam discharges. Variations in discharge are made in response to daily electricity generation peaks, which begin in the late morning each day[38]. The stage change is noticeable in the river from afternoon to early evening. The magnitude of the effect on stage generally declines from upstream to downstream. The Verdel USGS stream gage located near the lower end of the Fort Randall River Segment, indicates a daily fluctuation of approximately 0.75 feet. While no gage data were available to confirm upstream stage fluctuations, the daily stage change near the dam may approach 1.5 feet or more, based on field observations of upper island shorelines.

Power-peaking creates the Daily Inundated Sand Plain habitat type. This habitat type comprised 10 percent of the total riverine habitat acreage in the Fort Randall River Segment in 2005, which is nearly triple the acres of Daily-Inundated Sand Plain habitat observed in 1998. Each day during power-peaking, volume, stage and flow velocity increase, and re-mobilize fine sediments. Later, as discharges are reduced, entrained sediments are re-deposited, with coarse sediments carried only a short distance. Comparison of the 1998 and 2005 sandbar polygons suggest that much of this deposition is occurring on the upstream end of sandbars formed in 1998. The enlarging upstream sandbars protect the originally deposited material, which provides an explanation for the observed increase in ESH polygon size. The source of this sediment may be channel erosion immediately downstream of the dam (Biedenharn 2001) and bank erosion, as might be suggested by the decline in Non-ESH Sand and forest habitat. Sandbars tend toward simple round to oval forms; such as might be expected when water levels rise and lower frequently.

The same process of habitat conversion due to power peaking is notable in the lower part of the segment; however, a second surge-related effect has apparently occurred. Sandbars and ESH lower in the segment have decreased in area due to significant erosion of upstream protrusions, which are notably ragged. The backwater effect that begins in the lower section may participate in allowing surge waters to pile up against and erode island faces. The Daily Inundation Sand Plain habitat deposits are smaller and lower in relative elevation, allowing rising, higher-energy waters to soften and erode materials. Daily Inundation Sand Plain and Shallow Water habitat types occur more frequently on the trailing than the leading end of bars in the lower portion of the reach.

The flow event in the Gavins Point River Segment during 1997[39] was mirrored in time by a longer than normal high-stage event in the Fort Randall River Segment, but it was of lesser magnitude. The Gavins Point River Segment experienced elevated stages of as much as 5 to 8 feet[40] above normal for more than 200 days that eroded islands, scoured vegetation, and redistributed sand. The Fort Randall River Segment experienced only minor sustained stage elevations of approximately 1.7 feet above the mean stage, which appear to be approximately 0.4 feet less than the mean monthly high stage during the April through August least tern and piping plover breeding season for the period of gage record since 1997.[41] The Verdel Gage recorded an

[38] The 2006 power production schedule included a daily flow increase for Fort Randall Dam from 25,000 cfs to 41,000 cfs from 11:00 AM to 4:00 PM (B. Doan, USACE, pers com 2007).
[39] Approximately for 220 days between April 25, 1997 through December 18, 1997.
[40] Based on the USGS Maskell Gage 06000005 near Vermillion, SD.
[41] Based on the USGS Verdel Gage 06453600.

average monthly stage fluctuation during the April through August nesting season of greater than 4 feet. Most sandbars that are used for nesting in this reach are inundated at least annually, which may account for both the irregular trend in nesting usage and the higher nest failure rates for this segment. Based on gage data, it is likely that little suitable nesting-habitat was created during the 1997 event. The amount that was created was probably of lower relative elevation and more susceptible to flooding and surface saturation losses.

The low energy nature of the 1997 flow event in the Fort Randall River Segment probably did not scour the more highly elevated islands, however it could have drown successional vegetation on low-lying sandbars and islands, leaving behind barren sand that would have quickly returned to wetlands and shallow water.

Daily stage changes due to power-peaking surges from Fort Randall Dam occur annually during the least tern and piping plover breeding season. These daily stage fluctuations add a greater degree of uncertainty to ESH spatial measurement (particularly in the upper part of the Fort Randall River Segment) than exists for the Gavins Point River Segment. The habitat mapping category, Daily Inundated Sand Plain, which is adjacent to most of the mapped ESH represents much of the 1998-mapped ESH that has been lost to erosion. Increase in the Daily-inundated Sand habitat type is the physical result of bank sloughing due to destabilization by frequent wetting cycles. A relatively low-flow-energy regime, ineffective for transporting larger sediment sizes, results in level plateaus of clean coarse sand and fine gravel surrounding most nesting-habitat and non-nesting vegetated islands.

The major ESH loss factor in the Fort Randall River Segment can be attributed to encroachment by vegetation. Loss of ESH to the upland natural succession by herbs and shrubs and wetland occupation by successional hydrophytes represents 44 percent of the loss. Differing somewhat from conditions in the Gavins Point River Segment, much ESH might be restored in the Fort Randall River Segment by timely vegetation management.

5.2 Summary of Nest Data

The Fort Randall River Segment dataset includes 122 piping plover nests and 297 least tern nests - a total of 419 nest data points. The dataset spans breeding seasons 2001 through 2006. This dataset does not contain nest information for the immediate period following the 1996-97 high-flow events.

5.3 Distribution of Nesting Habitat by NestArea

The dataset was spatially reclassified using the “NestArea” concept and methods employed for the Gavins Point River Segment. Similar to the Lewis and Clark Lake Segment, NestAreas in the Fort Randall River Segment mostly represented single contiguous sandbar islands or local high points connected by the Daily Inundated Sand Plain habitat type. Analyses conducted for this segment were distribution of nests by NestArea, distribution of Nesting Habitat by Interchannel Sandbar, estimation of nesting-habitat, and an estimation of nesting areas by elevation.

Table 5-3 shows statistics for the subset of Fort Randall River Segment NestAreas (17 of 21) that supported successful nests at some period between 2001 through 2006. Average success was 54 percent, below that of the Gavins Point River Segment (66 percent), but well above the Lewis and Clark Lake Segment (30 percent). Only two NestAreas supported nesting activity for all six years of the dataset. Importance values (IVs), the product of the number of active years and the number of nests, were used to rank NestAreas. Using a break point of 80, the top six sites supported 304, or 73 percent of total nest establishments, and contained 188 (82 percent) of all successful nests. The remaining 11 sites supported nesting for only one or two years. The number of active sites in any given year ranged from 7 to 14, with no clear trend of increase or decline. Nest establishment numbers also show no clear trend, ranging from a low of 52 in 2003 to a high of 85 in 2002. The percentage of successful nests ranged from a low of 31 in 2006 to a high of 49 in 2005.

Table 5-3
Total Nest Distribution by Year and NestArea

NestArea	2001	2002	2003	2004	2005	2006	Total Nests	Years Active	IV	Percent Success
Marty: 869-5	7	39	24	21	4	3	98	6	588	61%
Marty: 870-2	9	1	22	20	10	8	70	6	420	76%
Verdel: 854-3		12			18	24	54	3	162	69%
Niobrara: 848-3	17	14	1	1			33	4	132	33%
Marty: 867-1	23	1			1	2	27	4	108	48%
Verdel: 854-7		8	1	12	1		22	4	88	64%
Verdel: 851-8C	2				12	3	17	3	51	18%
Marty: 866-6A					15	10	25	2	50	52%
Verdel: 851-8B	8	4			3		15	3	45	20%
Lynch: 863.8		1	2	1	2	2	8	5	40	75%
Ft-Randall Dam: 874-8			1	2	4	1	8	4	32	38%
Marty: 867	1	1		6			8	3	24	25%
Marty: 866.6-C					3	8	11	2	22	36%
Verdel: 851-8A	5			1			6	2	12	33%
Marty: 870-1			1		4		5	2	10	20%
Marty: 866.6-B					3	1	4	2	8	0%
Verdel: 855-5				1	1		2	2	4	100%
Marty: 866.6-D		3					3	1	3	0%
Ft-Randall Dam: 874-5				1			1	1	1	0%
Marty: 869-4	1						1	1	1	100%
Verdel: 851-8D		1					1	1	1	0%
Total Nests per Year	73	85	52	66	81	62	419			
Active Sites	9	11	7	10	14	10				
Successful Nests	39	33	39	37	49	31	228			
% Success	53%	39%	75%	56%	60%	50%				

Tables 5-4 through 5-7 provide total nest and successful nest distributions for piping plover and least tern separately. Piping plover used all 21 NestAreas (Table 5-4), but only 16 supported successful nests (Table 5-5). Least terns established nests in 16 NestAreas (Table 5-6) but produced successful nests at only 12 sites (Table 5-7). Each of the tables are sorted by importance value (IV), which is the product of the number of nests and the number of years used for nesting at each location.

Table 5-4 indicates that 69 percent of piping plovers nesting efforts occurred in the 6 top-ranked NestAreas, with nearly 39 percent of nesting occurring at just two sites, Marty: 869-5 and Marty: 870-2. Most other active sites supporting nests included only one or two nests per NestArea in any given year. Table 5-5 indicates even higher consolidation among successful NestAreas, with 77 percent of successful piping plovers nesting efforts occurring in the 6 top-ranked NestAreas, and nearly 54 percent of successful nesting occurring at just two sites, Marty: 869-5 and Marty: 870-2. All other active sites supporting successful nests included only one or two nests per NestArea in any given year. This suggests that plovers used smaller patches of barren sand that varied in size and location in the Fort Randall River Segment. This may have been due to river stage variation and the distribution of annual versus perennial vegetation during the nest establishment period.

Table 5-4
Piping Plover Nest Distribution by Year and NestArea

NestArea	2001	2002	2003	2004	2005	2006	Total	Years Active	IV
Marty: 869-5	1	7	7	9	4	3	31	6	186
Marty: 870-2	1	1	5	4	2	3	16	6	96
Marty: 867-1	7	1			1	2	11	4	44
Lynch: 863.8		1	2	1	2	2	8	5	40
Niobrara: 848-3	3	5	1	1			10	4	40
Verdel: 851-8B	4	2			2		8	3	24
Verdel: 854-7		2	1	1	1		5	4	20
Verdel: 854-3		3			1	2	6	3	18
Verdel: 851-8C	1				3	2	6	3	18
Marty: 867	1	1		3			5	3	15
Ft-Randall Dam: 874-8			1	1		1	3	3	9
Verdel: 851-8A	3			1			4	2	8
Verdel: 855-5				1	1		2	2	4
Marty: 866.6-C						2	2	1	2
Ft-Randall Dam: 874-5				1			1	1	1
Marty: 866-6A					1		1	1	1
Marty: 869-4	1						1	1	1
Marty: 870-1					1		1	1	1
Verdel: 851-8D		1					1	1	1
Total	22	24	17	23	19	17	122		
Active Sites	9	10	6	10	11	8	19		

Table 5-5
Piping Plover Successful Nest Distribution by Year and NestArea

NestArea	2001	2002	2003	2004	2005	2006	Total	Years Active	IV
Marty: 869-5	1	5	5	5	3	2	21	6	126
Marty: 870-2	1	1	4	4	2	2	14	6	84
Lynch: 863.8		1	2	1	1	1	6	5	30
Niobrara: 848-3	2		1	1			4	3	12
Marty: 867-1	2				1		3	2	6
Marty: 867	1			1			2	2	4
Verdel: 854-3					1	1	2	2	4
Verdel: 854-7				1	1		2	2	4
Verdel: 851-8A	1			1			2	2	4
Verdel: 855-5				1	1		2	2	4
Verdel: 851-8B					2		2	1	2
Ft-Randall-Dam: 874-8				1			1	1	1
Marty: 866.6-C						1	1	1	1
Marty: 866-6A					1		1	1	1
Marty: 869-4	1						1	1	1
Verdel: 851-8C					1		1	1	1
Total	9	7	12	16	14	7	65		
Active Sites	7	3	4	9	10	5	16		
% Success	41%	29%	71%	70%	74%	41%	53%		

Tables 5-6 and 5-7 indicate that least tern used the same top-ranked sites as piping plovers, with five NestAreas containing 73 percent of nests. These five NestAreas also supported 87 percent of successful least tern nests. Other active sites typically supported three or more successful nests, although only two other sites supported nesting for more than two breeding seasons. There were four least tern nesting sites active for only a single season, and seven that produced successful nests for a single season. The conclusion drawn is that, similar to the Gavins Point River Segment, nesting activity in the Fort Randall River Segment was highly concentrated at relatively few nesting sites.

Table 5-6
Least Tern Total Nest Distribution by Year and NestArea

NestArea	2001	2002	2003	2004	2005	2006	Total	Years Active	IV
Marty: 870-2	8		17	16	8	5	54	5	270
Marty: 869-5	6	32	17	12			67	4	268
Verdel: 854-3		9			17	22	48	3	144
Marty: 866-6A					14	10	24	2	48
Niobrara: 848-3	14	9					23	2	46
Verdel: 854-7		6		11			17	2	34
Verdel: 851-8C	1				9	1	11	3	33
Verdel: 851-8B	4	2			1		7	3	21
Marty: 866.6-C					3	6	9	2	18
Marty: 867-1	16						16	1	16
Ft-Randall Dam: 874-8				1	4		5	2	10
Marty: 866.6-B					3	1	4	2	8
Marty: 870-1			1		3		4	2	8
Marty: 866.6-D		3					3	1	3
Marty: 867				3			3	1	3
Verdel: 851-8A	2						2	1	2
Nest per Year	51	61	35	43	62	45	297		
Active Sites	7	6	3	5	9	6	16		

Table 5-7
Least Tern Successful Nest Distribution by Year and NestArea

NestArea	2001	2002	2003	2004	2005	2006	Total	Years Active	IV
Marty: 870-2	7		16	8	5	3	39	5	195
Marty: 869-5	5	19	1	5			30	4	120
Verdel: 854-3		3			12	2	17	3	51
Verdel: 854-7		4		8			12	2	24
Marty: 866-6A					12		12	1	12
Niobrara: 848-3	7						7	1	7
Verdel: 851-8C					1	1	2	2	4
Marty: 866.6-C					3		3	1	3
Ft-Randall Dam: 874-8					2		2	1	2
Marty: 867-1	1						1	1	1
Marty: 870-1			1				1	1	1
Verdel: 851-8B	1						1	1	1
Nests per Year	30	26	27	21	35	24	163		
Active Sites	5	3	3	3	6	3	12		
% Success	59%	43%	77%	49%	56%	53%	55%		

5.4 Distribution of Nests and ESH For All Years

As stated previously, ESH in the Fort Randall River Segment declined by 57 percent from 1998 to 2005 (296 to 128 acres). The 128 acres of ESH mapped in 2005 were contained in 60 separate polygons representing islands or habitat patches. Only 29 polygons (49 percent), comprising 68.6 acres (54 percent) of the mapped ESH, selected at least one nest point. The total number of historic nests selected was 324 (78 percent) of the total nests (414) in the nest database for the period of analysis.

Table 5-8 shows 2005 ESH polygons grouped into the 15 NestAreas in which they were located, the nest count, the NestArea acres and the nests per acre density.

Table 5-8
Nest Counts, Acreage, and Nests/Acre by NestArea

NestArea	Nest Count	Acres	Nests/Acre
Marty: 869-5	79	18.6	4.2
Marty: 870-2	75	8.9	8.5
Verdel: 854-3	49	1.4	34.3
Marty: 866-6A	25	0.8	33
Verdel: 854-7	20	3.8	5.3
Marty: 866.6-C	15	8.4	1.8
Verdel: 851-8C	14	0.4	31.2
Marty: 867-1	12	5.2	2.3
Verdel: 851-8B	9	1.9	4.8
Ft-Randall Dam: 874-8	8	7.4	1.1
Lynch: 863.8	8	3.5	2.3
Marty: 867	6	1.6	3.7
Verdel: 855-5	2	4	0.5
Niobrara: 848-3	1	0.9	1.1
Verdel: 851-8A	1	1.9	0.5
Total Nests	**324**		
Total Acres		**68.7**	
Total Nests/Total Acres			**4.7**

5.5 Establish ESH Acreage Goal for PEIS Alternative 5

The ESH acreage goal for PEIS Alternative 5 was established based on measurement of nesting-habitat for least tern and piping plover in the Fort Randall River Segment. The methodology described in Section 2 of this document was used to measure nesting-habitat on an annual and total basis for the Fort Randall River Segment. Steps in the analysis are briefly reviewed below.

1. Separate the data by year, species, and NestArea.
2. Measure distances between nests, and identify the nearest-neighbor distance for each nest.
3. Establish the radius of nesting-habitat circles for each NestArea, species, and year.
4. Establish nesting-habitat polygons for each NestArea, species, and year as the area within habitat circles, counting overlapping areas only once.
5. Combine species and year habitat circles for each Nest Area, counting overlapping areas only once.
6. Establish acreage goals for the Fort Randall River Segment under PEIS Alternative 5 by adding the acreage for each NestArea in the segment.

Data generated during implementation of these steps are shown in Tables 5-9 through 5-12.

Table 5-9 is ranked in descending order by importance value (IV) and shows estimated nesting-habitat acreage for piping plover for each NestArea by year. Mean acreage for each NestArea was calculated for all years and is presented with the number of years the NestArea was active. Total average annual nest acreage was 32.8 acres. The estimated total NestArea for piping plover was greatest in 2001 (63.5 acres) and least in 2003 (9.3 acres). The trend in total acreage shows a precipitous decline after 2001 and resurgence, beginning in 2004, to more than 37 acres in 2006. This resurgence was initially thought to be linked to vegetation management tests in the segment. A field investigation in August 2005 revealed that management activities had not sustained or significantly increased the area of barren sand, particularly for larger expanses, but may have increased the frequency of smaller habitat patch sizes used by single nesting pairs. It was also noted that a very high density of herbaceous vegetation had occupied most sites between rows of herbicide-treated cottonwoods.

Table 5-9
Piping Plover Measured Nesting Habitat Acreage by NestArea

NestArea	2001	2002	2003	2004	2005	2006	Mean Acres	Active Years	IV
Marty: 869-5	5.2	8.5	2.9	8.5	5.5	10.2	6.8	6	40.8
Verdel: 851-8B	15.7	4.0			5.5		8.4	3	25.2
Marty: 867-1	8.6	2.0			2.9	7.2	5.2	4	20.8
Niobrara: 848-3	11.1	2.4	1.0	1.9			4.1	4	16.4
Verdel: 851-8C	5.2				3.5	7.6	5.4	3	16.3
Marty: 870-2	5.2	2.0	1.7	0.7	0.8	2.4	2.1	6	12.8
Marty: 867	5.2	2.0		2.1			3.1	3	9.3
Verdel: 854-7		3.4	1.0	1.9	2.9		2.3	4	9.3
Lynch: 863.8		2.0	1.8	1.9	0.7	1.5	1.6	5	7.9
Ft-Randall Dam: 874-8			1.0	1.9		3.8	2.3	3	6.8
Verdel: 854-3		0.4			2.9	2.2	1.9	3	5.6
Marty: 869-4	5.2						5.2	1	5.2
Verdel: 855-5				1.9	2.9		2.4	2	4.8
Verdel: 851-8A	2.1			1.9			2.0	2	4.0
Marty: 866-6A					2.9		2.9	1	2.9
Marty: 870-1					2.9		2.9	1	2.9
Marty: 866.6-C						2.2	2.2	1	2.2
Verdel: 851-8D		2.0					2.0	1	2.0
Ft-Randall Dam: 874-5				1.9			1.9	1	1.9
Marty: 866.6-B							0.0	0	0.0
Marty: 866.6-D							0.0	0	0.0
Total Acres	63.5	28.8	9.3	24.9	33.3	37.2	32.8		

Table 5-10 is ranked in descending order by importance value (IV) and shows estimated nesting-habitat acreage for least tern for each NestArea by year. The estimated total NestArea for least tern was greatest in 2001 (28.0 acres) and least in 2006 (1.3 acres). The drop in nesting-habitat area noted for piping plover also occurred for least tern after the 2001 breeding season, but there has been no similar resurgence.

Table 5-10
Least Tern Measured Nesting Habitat Acreage by NestArea

NestArea	2001	2002	2003	2004	2005	2006	Mean Acres	Active Years	IV
Marty: 869-5	7.5	6.1	3.8	8.2			6.4	4	25.6
Verdel: 851-8B	4.7	3.6			0.4		2.9	3	8.7
Marty: 867-1	8.2						8.2	1	8.2
Marty: 870-2	1.8		2.2	1.2	1.4	0.3	1.4	5	6.9
Verdel: 854-3		1.2			2.0	0.8	1.3	3	4.0
Niobrara: 848-3	2.9	0.7					1.8	2	3.6
Verdel: 851-8C	1.8				0.4	0.1	0.8	3	2.3
Verdel: 854-7		0.7		1.4			1.0	2	2.0
Marty: 866-6A					1.9	0.0	1.0	2	1.9
Marty: 866.6-C					1.3	0.1	0.7	2	1.4
Verdel: 851-8A	1.0						1.0	1	1.0
Ft-Randall Dam: 874-8				0.3	0.6		0.5	2	0.9
Marty: 867				0.8			0.8	1	0.8
Marty: 870-1			0.4		0.3		0.4	2	0.7
Marty: 866.6-D		0.5					0.5	1	0.5
Marty: 866.6-B					0.2	0.1	0.1	2	0.3
Total Acres	28.0	12.7	6.5	11.9	8.6	1.3	11.4		

Table 5-11 shows nesting-habitat acreage by year for each NestArea, mean acreage for the 6 years of analysis, number of years the NestArea was active, and importance value (IV). This table contains results for both species. Because the larger piping plover nesting polygons overlap many of the least tern nesting polygons, acreage numbers for most years are similar to the acreage figures for piping plover alone. Nesting summary data is listed at the bottom of the table for comparison by year. The lowest estimated acreage (14.1) for the 2003 breeding season supported the highest total nest count per acre (3.7) and the highest successful nest count per acre (2.8). The density of successful nests and the percentage of successful nests was significantly higher (more than double) than for other years. This suggests that these species can, at times, successfully nest at higher than average densities.

Table 5-11
Measured Nesting Habitat Acreage by Year and NestArea

NestArea	2001	2002	2003	2004	2005	2006	Mean Acres	Active Years	IV
Marty: 869-5	9.5	11.6	5.8	12.4	5.5	10.2	9.1	6	54.8
Verdel: 851-8B	15.7	6.1			5.5		9.1	3	27.3
Marty: 867-1	13.4	2.0			2.9	7.2	6.4	4	25.6
Verdel: 851-8C	6.1				3.6	7.6	5.8	3	17.3
Marty: 870-2	5.4	2.0	3.1	1.5	2.1	2.6	2.8	6	16.7
Niobrara: 848-3	11.1	2.6	1.0	1.9			4.1	4	16.6
Verdel: 854-7		4.1	1.0	2.9	2.9		2.7	4	10.9
Marty: 867	5.2	2.0		2.2			3.2	3	9.5
Lynch: 863.8		2.0	1.8	1.9	0.7	1.5	1.6	5	7.9
Ft-Randall Dam: 874-8			1.0	1.9	0.6	3.8	1.8	4	7.4
Verdel: 854-3		1.4			3.4	2.4	2.4	3	7.2
Marty: 869-4	5.2						5.2	1	5.2
Verdel: 855-5				1.9	2.9		2.4	2	4.8
Verdel: 851-8A	2.3			1.9			2.1	2	4.3
Marty: 866-6A					4.0	0.0	2.0	2	4.1
Marty: 866.6-C					1.3	2.3	1.8	2	3.6
Marty: 870-1			0.4		3.0		1.7	2	3.4
Verdel: 851-8D		2.0					2.0	1	2.0
Ft-Randall Dam: 874-5				1.9			1.9	1	1.9
Marty: 866.6-D		0.5					0.5	1	0.5
Marty: 866.6-B					0.2	0.1	0.1	2	0.3
Total Acres	73.8	36.3	14.1	30.6	38.6	37.8	38.5		
Active Sites	9	11	7	10	14	10			
Total Nests	73	85	52	66	81	62			
Successful Nests	39	33	39	37	49	31			
T-Nest/Acre	1.0	2.3	3.7	2.2	2.1	1.6			
S-Nest/Acre	0.5	0.9	2.8	1.2	1.3	0.8			

Table 5-12 shows the results derived from combining the nesting acreage polygons for both species and for all years by NestArea to estimate the entire area used for nesting during the period of analysis (2001-2006). As shown in the table, the entire measured area used for nesting in the Fort Randall River Segment for the 1999 through 2006 period of analysis was 131.7 acres.

Table 5-12
Measured Nesting Habitat Acres by NestArea

NestArea	Acres
Marty: 869-5	19.4
Verdel: 851-8B	16.5
Marty: 867-1	16.4
Niobrara: 848-3	11.9
Verdel: 851-8C	9.8
Marty: 870-2	6.6
Marty: 867	6.0
Marty: 869-4	5.2
Verdel: 854-7	4.9
Verdel: 851-8A	4.1
Ft-Randall Dam: 874-8	4.1
Verdel: 855-5	4.1
Marty: 866-6A	4.0
Lynch: 863.8	4.0
Verdel: 854-3	3.8
Marty: 866.6-C	3.2
Marty: 870-1	3.0
Verdel: 851-8D	2.0
Ft-Randall Dam: 874-5	1.9
Marty: 866.6-D	0.5
Marty: 866.6-B	0.2
Total Acres	**131.7**

5.6 Estimation of ESH using LiDAR Elevation Data

Flow and stage data for the Fort Randall River Segment were not available with sufficient lead time to conduct analyses similar to those conducted for the Gavins Point River Segment. Nevertheless, inferences were drawn from examinations of limited gage data, and analysis of the differences between mapped habitat types.

LiDAR data were collected in the Fort Randall River Segment from October 10-25, 2005, a period of very low flow throughout the system but with normal daily fluctuation due to power-peaking activity. The closest USGS continuous monitoring gage for this segment is approximately 5 miles below the most downstream nest cluster (RM 846.2 near Verdel Nebraska). The gage reading was at approximately 1,229 feet elevation during LiDAR capture, and averaged 1,231.5 feet during the previous breeding season. This difference of approximately 2.5 feet appears to expose much of the normally inundated areas near ESH that were mapped as Daily Inundated Sand Plain and Shallow Water in 2005. This allowed spot measurements of the differences between habitat types.

Spot elevations were generated using the LiDAR data in two ways. First, the nest points collected by intersection with the 2005-mapped ESH polygons (discussed above) were used to extract elevation point data. Selected point-spot elevations were then obtained from all habitats within and surrounding NestAreas. At this point, both the 2005 ESH habitat polygons (rendered translucent) and the 2005 CIR imagery could be observed. The data collected enabled the comparison of habitat elevations, including ESH, and the calculation of inter-habitat elevation differences. These comparisons are summarized in Table 5-13. Blank cells in the table indicate that the habitat type did not occur adjacent to ESH for the NestArea. The values for all Herb/Shrub/Sapling habitat types are negative because this habitat type is generally found at a higher elevation than ESH.

From the data presented in Table 5-13, it can be deduced that mean monthly water elevations during the breeding season (which would constitute an approximate 2.5 foot increase in water levels) may have inundated or saturated ESH at some sites. For example, if the water level were raised 2.5 feet at the Fort Randall Dam: 874-8 NestArea, it is assumed the mean elevation of shallow water would be raised accordingly to 1,233.5 feet, one foot higher than the mean ESH elevation in the LiDAR data set. Under this scenario, some areas classified as ESH in the LiDAR would likely become either Shallow Water or Open Water. This finding is consistent with the general observations and topographic data collected during 2006 field surveys.

Table 5-13
Differences between ESH Elevations and Other Habitat Elevations

		Mean Differences in Feet Between Habitat Types				
NestArea	**Mean ESH Elevation (msl)**	**Open Water**	**Shallow Water**	**Daily-inundated Sand**	**Wetland Matrix**	**Shrub / Herb / Sapling**
Ft-Randall-Dam 874-8	1232.5	4.8	1.5	1.5		-1.4
Marty 870-2	1230.7	5.7	4.9	2.3		
Marty 869-5	1229.6	5.8	6.4	2.6		-0.4
Marty 867-1	1230.6	6.4	6.4	4.0		-0.8
Marty 867-0	1230.4	7.5	7.7	4.0	3.2	0.0
Marty 866.6-C	1230.2	5.3	5.1	1.0		
Marty 866-6A	1229.0	5.9		1.5		
Lynch 863.8	1228.5	7.3	6.9	3.6		
Verdel 855-5	1224.6	6.8	3.6			
Verdel 854-7	1223.8	6.7	4.1	2.9	1.4	
Verdel 854-3	1223.9	5.9		2.5	2.5	
Verdel 851-8A	1222.4	5.1		2.4	0.6	
Verdel 851-8B	1222.7	5.6		2.3	0.8	-1.1
Verdel 851-8C	1222.9	5.5			1.4	-0.5
Niobrara 848-3	1222.6	3.5	2.7		0.2	-0.3
Mean Feet		**5.9**	**4.9**	**2.6**	**1.5**	**-0.7**

5.6.1 First Encompassing Contour

A second nesting area elevation assessment procedure, the First Encompassing Contour (FEC) method was developed specifically for the Fort Randall River Segment. The FEC method compares nesting-habitat area elevations derived by other methods, and was conducted in Arc GIS using the 2005 LiDAR-generated elevation data. With the nest point dataset active on screen, the "create contour" tool was applied near several of the outward nest points of a nest cluster. A continuous line of equal elevation was created and the elevation of that line was stored. Several repetitions were conducted at each nesting cluster to obtain the line that encompassed all, or as many nest points as possible.[42] Nests segregated in this manner were at elevations higher than the created contour line.

The procedure was applied throughout the Fort Randall River Segment and collected 76 percent of all nests established during the period of record (319 of 419) within areas mapped as ESH

[42] It was not always possible to collect all nest points because of erosion losses of land upon which nests had been established years prior to 2005.

using 2005 imagery. A majority of the nests not captured were single nests or nest sites utilized for only one year. The success ratio for nests segregated in this manner was 64 percent, greater than the overall segment success ratio of approximately 54 percent for the Fort Randall River Segment. This finding reinforces the importance of establishing higher elevations for managed sandbar habitat.

Contour lines created to define lower nesting thresholds at NestAreas were converted to polygons for calculation of nesting area acreages. Table 5-14 compares the FEC method estimated acreage with the acreage of ESH mapped polygons from the 2005 imagery that had contained nests during the period of analysis. As shown in the table, the total acreages measured by these two methods are similar. However, the acreages of individual sites sometimes differ considerably. While compared here, the estimates represent slightly different slices of the nest population data. The 2005 polygons include some areas of Daily Inundated Sand, Wetland Matrix, and Herb/Shrub/Sapling habitats that were not visible during the May capture of the imagery.

The acreages measured with the FEC method vary from the other two acreage measurements because of nest points lost to erosion that were not captured using the FEC method, or were lost to vegetation encroachment. The FEC method was found to encompass areas mapped as Herb/Shrub/Sapling habitat occurring within elevation zones along with ESH habitat.

Table 5-14
Mapped ESH Comparison of FEC Acres

NestArea	2005 Polygon Acres	FEC Acres 2005	Mean Measured Acres
Ft Randall Dam 874.8	7.4	1.4	1.8
Lynch 863.8	3.5	2.7	1.6
Marty 866.6A	0.8	0.4	2
Marty 866.6C	8.4	1.0	1.8
Marty 867.0	1.6	3.1	3.2
Marty 867.1	5.2	7.0	6.4
Marty 869.5	18.6	32.6	9.1
Marty 870.2	8.9	5.7	2.8
Niobrara 848.3	0.9	0.001	4.1
Verdel 854.3	1.4	1.5	2.4
Verdel 854.7	3.8	3.0	2.7
Verdel 851.8A	1.9	1.9	2.1
Verdel 851.8B	1.9	1.7	9.1
Verdel 851.8C	0.4	0.5	5.8
Verdel 855.5	4.0	2.3	2.4
Total	**68.6**	**64.9**	**57.3**

The strong similarity between the findings from these different methods of identifying nesting-habitat, compared to the 56 acres that precisely intersect between the 1998 and the 2005 ESH mapping, reinforce several general findings for this and other segments analyzed, which are provided below.

- In the Fort Randall River Segment, piping plover and least tern have consistently nested on the most elevated sandbar available.
- Sandbars were repeatedly utilized and a few highly productive locations supported more than 75 percent of nests established between 2001 and 2006.
- The number of nests established and the numbers of nesting sites utilized show no clear trends of decline or increase over time during the period of record.
- Acreage used for nesting was approximately 38.5 acres when averaged over the period of 2001-2006.
- The majority of sand deposited from the 1997 event rapidly converted to successional wetlands.

5.7 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defines those areas most suitable for ESH construction and maintenance, as well as those areas that if used would result in potentially significant impacts to either the natural or manmade environment. This process of eliminating areas that should be avoided leaves the remaining areas as the most suitable for ESH construction and maintenance for the Fort Randall River Segment. These areas include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment. The steps involved in conducting this analysis are explained in detail in Section 2 of this document, and are outlined below.

1. Solicit input on sensitive resources and buffer distances from affected states and agencies;
2. Create an anthropogenic features dataset from aerial imagery;
3. Establish the separation distance between nesting habitat and anthropogenic features; and
4. Establish the minimum flow channel, channel width restrictions, and define the predator moat area;

The result of the analysis is a set of spatial restrictions that categorize the riverine corridor acreage into three categories. These categories are listed below.

1. **Exclusion Areas** are locations at which ESH could not be constructed because intrusion into these locations could cause significant geomorphic alterations to the river corridor. Such an intrusion would risk physical and economic damages to public and private infrastructure or land uses. Exclusion areas include the estimated minimum flow way for normal flowage (i.e., the thalweg), narrow channel reaches, and areas needed to provide a predator moat.

2. **Restrictive Areas** are locations at which ESH could be constructed and maintained at relatively low physical risk, but could put nesting habitat in areas at risk from predation, recreation encroachment, or locations otherwise limited for nesting use and productivity. Areas of limited usability are those areas defined by analysis of distances from features that have shown to be restrictive to nest establishment or nest success.

3. **Available Areas** are locations that are most suitable for the construction and maintenance of ESH. However, it is important to note that any construction activities would need to ensure that other high-interest features (e.g., archeological and cultural resources, or other protected species) would be avoided.

The acreage for Restrictive Areas, and Available Areas is summarized by habitat type for the Fort Randall River Segment in Table 5-15. It is important to note that Available Area acres is a subset of Restrictive Area acres.

Table 5-15
Residual Available Area: Fort Randall River Segment

Habitat Type	Acres 2005	Restrictive Area Acres	Available Area Acres
Open Water	4,926	1,381	724
Emergent Sandbar Habitat	128	90	77
Herb-Shrub-Sapling	2,162	1,859	553
Non-ESH Sand	120	66	26
Riverine Forest	859	745	42
Active Agricultural Row Crop	60	60	8
Wetland Matrix	1,684	1,577	0
Shallow Water	2,471	1,410	785
ESH M&C Test Areas	10	10	1
Daily-Inundated Sand Plains	1,370	868	568
Lacustrine Fine Sediments	0.0		0.0
Total	**13,789**	**8,065**	**2,784**
Percent		**58%**	**20%**

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6 Garrison River Segment

The Garrison River Segment begins at Lake Oahe at RM 1303.8 and continues to Garrison Dam at RM 1389.9; a distance of 86.1 river miles (see Figures 6-1 and 6-2 below). Riverine habitat area within the high banks is approximately 24,500 acres, which translates to 266 acres per river mile with an average width of 2194 feet. This average is only slightly above the lower channel width threshold for formation and retention of sandbars (Biedenharn 2001). Riverine habitat area increased by 72 acres between 1998 and 2005, which could be in part due to bank erosion, and is likely the cause of the loss of nearly 800 acres of Non-ESH Sand. The lower 15 miles (from approximately RM 1315.0 to RM 1389.9) of the reach appears to be in the backwater of the Lake Oahe pool.

Figure 6-1
Regional Overview of the Study Area

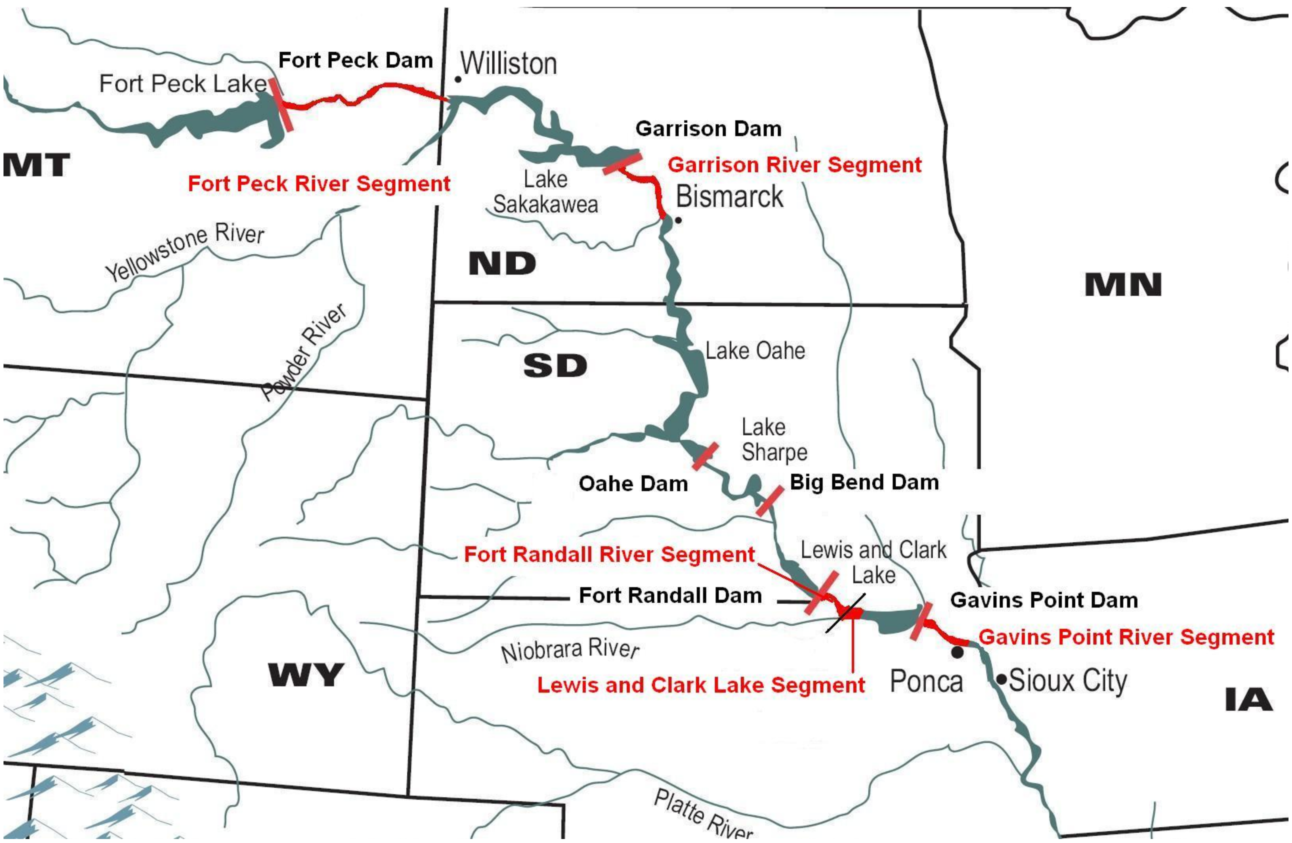
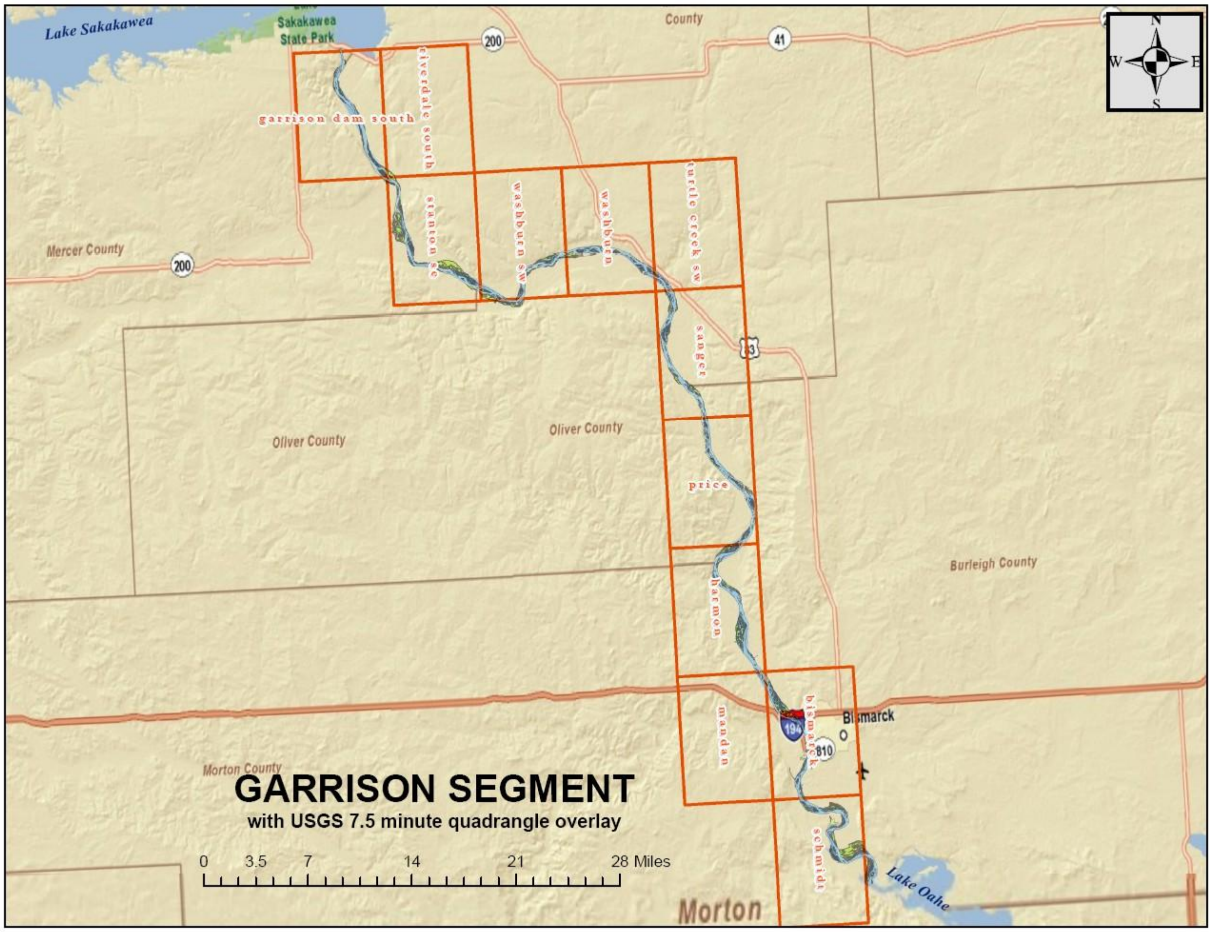


Figure 6-2
Overview of the Garrison River Segment with USGS Quadrangles



A practical problem that needed to be overcome in delineating habitat in the Garrison River Segment occurred due to missing 1998 imagery for the Schmidt Quadrangle. The resolution entailed clipping and copying the lower 10.2 miles of the 2005 delineation, modifying some habitat codes, and appending the data to the 1998 delineation dataset. This procedure likely over-estimated 1998 ESH because the lower portion of the Garrison River Reach is Lake Oahe backwater (and actually may be in the pool at times). It can also be assumed that the missing area on the 1998 imagery was a depositional environment. This appeared to be the situation for the immediately upstream areas with imagery coverage for both 1998 and 2005. In these areas, there has been an increasing trend toward Shallow Water and Daily-inundated Sand Plain habitat types. Sandbars either retained original approximate form and area, or became larger because of sediment deposition on the upstream end of bars.

This resolution of the missing Schmidt Quadrangle imagery likely provides a fair estimate of the extent of 1998 ESH and assures that comparisons for habitat types above the missing section truly reflect spatial changes, not incomplete photographic data coverage.

6.1 Habitat Delineation

Table 6-1 summarizes the changes in habitat observed for the Garrison River Segment between 1998 and 2005. Figure 6-3 depicts the changes by habitat type and year. Nine of the 12 habitat types defined in Section 2 are present in the Garrison River Segment.

All lower elevation sandbar and bank habitat types (ESH, Non-ESH Sand and Wetland Matrix) have greatly declined since 1998, while habitats representing deposition have increased (Shallow Water and Daily Inundated Sand Plain). ESH mapped from the 2005 imagery amounted to 588 acres, a 72 percent reduction from what was mapped from the 1998 imagery (2066 acres).

The 588 acres delineated from the 2005 imagery represent the quantity of ESH required for the Garrison River Segment under the PEIS for Alternative 4: Maintain and Create ESH Area As Present in 2005. The 2,066 acres delineated from the 1998 imagery represent the quantity of ESH required for the Garrison River Segment under PEIS Alternative 3: Create and Maintain ESH Area as Present in 1998/1999.

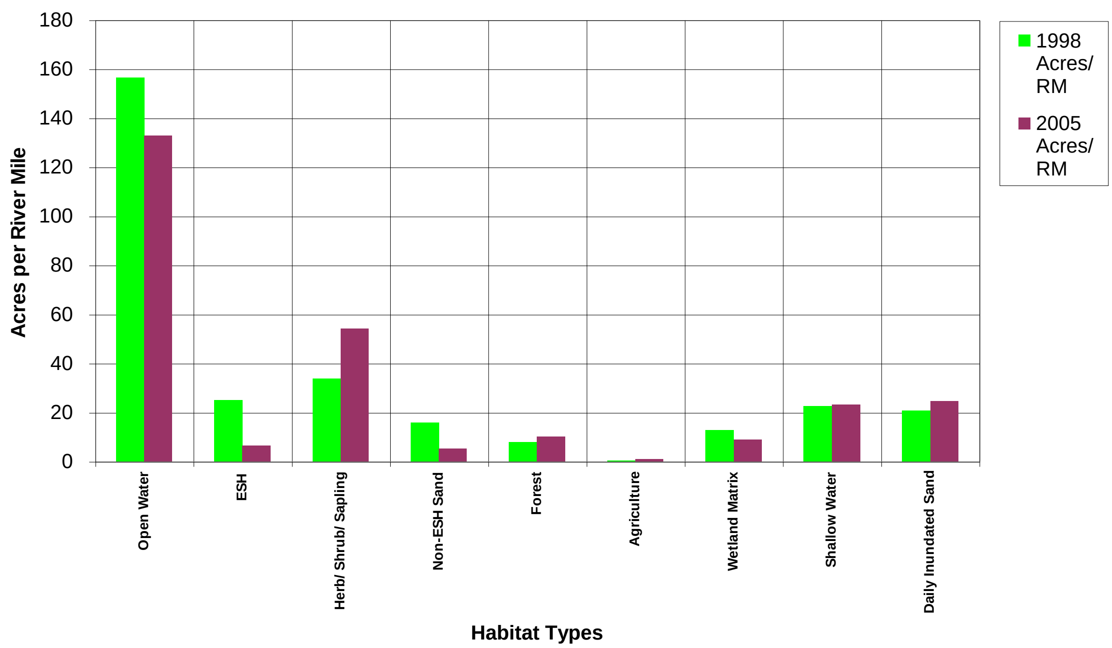
The dominant habitats in the Garrison River Segment are Open Water and Herb/Shrub/Sapling habitats, which together comprise 65 percent of total habitat acres for 1998 and over 70 percent of total habitat acres for 2005.

The last row of Table 6-1 includes acreage for Daily Inundated Sand Plain, a habitat type resulting from power generation peaking surges. Daily Inundated Sand Plain habitat does not always border suitable nesting-habitat. However, in situations where this habitat type is adjacent to an area suitable for nesting, it is likely to provide foraging opportunities for piping plovers whenever exposed. Daily Inundated Sand Plain and low-lying Non-ESH Sand account for another 10 percent of habitat acreages in both 1998 and 2005.

Table 6-1
Habitat Acreage Summary: Garrison River Segment 1998 and 2005

Habitat Type	1998 Acres	2005 Acres	Change in Acres	1998 Acres/ RM	2005 Acres/ RM	Change in Acres/ RM	1998 Pct of Total	2005 Pct of Total
Open Water	12,951	12,237	-715	157	133	-24	53.0%	49.9%
ESH	2,066	588	-1,478	25	6	-19	8.5%	2.4%
Herb/ Shrub/ Sapling	2,798	4,977	2,179	34	54	20	11.5%	20.3%
Non- ESH Sand	1,306	480	-826	16	5	-11	5.3%	2.0%
Forest	650	927	276	8	10	2	2.7%	3.8%
Agriculture	29	94	65	0	1	1	0.1%	0.4%
Wetland Matrix	1,058	822	-236	13	9	-4	4.3%	3.4%
Shallow Water	1,856	2,137	281	22	23	1	7.6%	8.7%
Daily Inundated Sand	1,711	2,257	546	21	25	4	7.0%	9.2%
Total	24,427	24,518						

Figure 6-3
Change in Riparian Habitat Composition – Garrison River Segment



6.1.1 Emergent Sandbar Habitat Lost Between 1998 and 2005

Table 6-2 summarizes habitat changes to ESH delineated in 1998 for the Garrison River Segment by 2005. As shown in the table, the majority (54 percent) of ESH loss was roughly equally divided into losses due to erosion and losses due to upland vegetation encroachment. There were 360.3 acres of ESH that remained in the same location between 1998 and 2005. The remaining 228 acres of ESH mapped in 2005 within this segment represent new ESH that changed from other 1998 habitat types over the intervening period.

Table 6-2
Disposition of ESH Lost from 1998 to 2005: Garrison River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	584.8	28%	ESH lost to erosion and carried down river
ESH	360.3	17%	ESH retained from original 1998 area
Herb/ Shrub/ Sapling	534.6	26%	Natural succession of well-drained sand bar to upland shrubs and herbs
Non-ESH Sand	96.2	5%	Became terrestrialized or surrounded by forest
Forest	10.5	1%	Natural growth of shrubs into forest-sized trees
Wetland Matrix	60.2	3%	Natural succession of low-lying sand bar to hydrophytic shrubs and herbs
Shallow Water	173.3	8%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand Plain	246.5	12%	ESH redistributed to low plateaus by daily high flows from power peaking at Garrison Dam
Total	2,066.4		

6.1.2 Geomorphic Analysis of Selected Reaches

The distance affected by channel scouring below Garrison Dam appears to be approximately 25 miles, which approximates the length of Biedenharn's upper two geomorphic reaches (see Table 6-3). As shown in the table, Biedenharn (2001) divides the Garrison River Segment into six geomorphic reaches, which differ in local geology, plan form and balance between erosion and deposition. Three reaches, totaling approximately 31 river miles, are highly erosional and unsuited to construction and maintenance of ESH. Islands and bars forming in these reaches rarely persist.

Table 6-3
Geomorphic Erosive and Depositional Reaches - Garrison River Segment

	Erosion		Deposition		Balance	
	Bank	Bed	Bank	Bed	Bank	Bed
Geomorphic Reach - River Mile (RM)	(1980-1998) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)		
GR 1 - RM 1390-1376	-140,353	-142,828	7,486	34,762	-132,867	-108,066
GR 2 - RM 1375-1363	-85,192	-411,339	28,852	142,302	-56,340	-269,037
GR 3 - RM 1362-1363	-53,114	-72,115	104,450	114,648	51,336	42,533
GR 4 - RM 1352-1349	-59,943	-434,067	204,528	28,510	144,585	-405,557
GR 5 - RM 1339-1324	-62,131	-92,694	3,226	97,328	-58,905	4,634
GR 6 - RM 1323-1315	-64,399	-92,694	3,226	97,328	-61,173	4,634

Source: Data excerpted from Biedenharn 2001

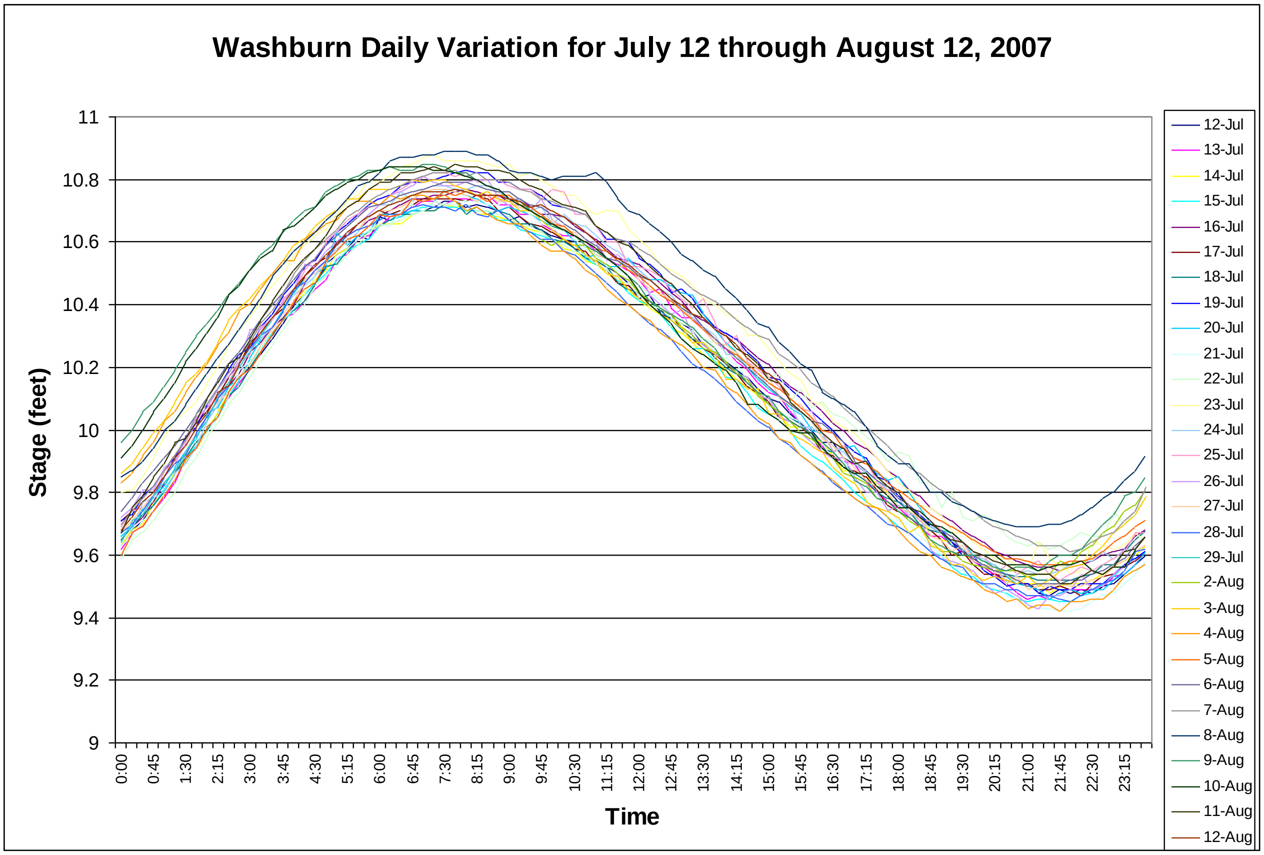
All lower elevation sandbar and bank habitat types (ESH, Non-ESH Sand and Wetland Matrix) have greatly declined since 1998. This change is particularly prevalent in Biedenharn's GR 1, 2 and 4. Habitats representing deposition (Shallow Water and Daily-inundated Sand Plain) have increased in Biedenharn's GRs 3, 5 and 6. A 50 percent increase in forest type (see previous Table 6-1) suggests that bed erosion may have been more important than bank erosion during the period in some areas; bank-edge forest was retained while herb/shrub/sapling stands advanced to forest. As stated previously, ESH declined by 72 percent for the Garrison River Segment between 1998 and 2005. While erosion played a part, especially in GRs 1, 2, and 4, upland vegetation encroachment accounts for most losses in depositional reaches (GRs 3, 5, and 6). GIS overlay of the interchannel bars existing in 1998 and 2005 shows high positional coincidence between the two years, although the portions of the interchannel bars sufficiently elevated to support nesting drastically declined by 2005.

6.1.3 Impact of Fluvial Processes – Garrison River Segment

The Garrison River Segment is affected by daily power-peaking at the Garrison Dam. Power-peaking releases a regularly increasing then decreasing volume of water through turbines at Garrison Dam on a daily basis, to provide power generation during periods of high electricity demand. Stage impacts are most pronounced in the upper third of the segment. Daily variations are much higher at the Stanton USGS gage (nearly two feet) than at the Bismarck USGS gage (about 0.6 feet). Peak timing appears to occur from 11:00 AM to 5:00 PM, but the stage surge may require several hours to subside. The energy gradient of the daily surge is more erosive than observed in the Fort Randall River Segment, possibly because of the relatively narrow channel of the Garrison River Segment. Sandbars in the upper portion of the segment observed at low water are chiefly composed of clean cobbles two to 12 inches in diameter, showing strong evidence of frequent scouring of the streambed.

Figure 6-4 depicts the highly consistent daily variations in stage experienced throughout the Garrison River Segment. The daily stage fluctuation range was approximately 1.5 feet recorded for a 31-day period at the Washburn USGS Gage 06314000 during July-August 2007. This routine rise and fall of water surface elevation intermittently exposes and inundates thousands of acres of barren sand, resulting in plateaus of winnowed, coarse sand that is planed flat each day by retreating waters.

Figure 6-4
Daily Stage Variation for a 31-Day Period for the Garrison River Segment



Source: Washburn USGS Gage 06314000

Five long-term river monitoring gages are located on the Garrison River Segment. Each of the gages provides data useful for the documentation of daily stage changes throughout the segment and for understanding ESH location and distribution. Table 6-4 compares daily stage change for gages spanning approximately 68 river miles of the segment. Interpolation of stage change near Garrison Dam approximately 17 miles upstream from Stanton (the most upstream gage station) reveals a daily stage change estimated at more than 5 feet. These stage conditions not only add a high degree of uncertainty to measurement of barren sand as potential ESH, but they also demonstrate a regularly fluctuating geomorphic regime that was probably less affected by the 1996-1997 high-flow events than the segments of the river not subject to power peaking.

Table 6-4
Daily Stage Variation Recorded at UGSG Gages -
Garrison River Segment

USGS ID No.	Gage Name	Approximate RM	Mean Daily Stage Variation (feet)
06340700	Stanton, ND	1372.5	2.84
06314000	Washburn, ND	1355.4	1.27
06342020	Price, ND	1338.3	0.74
06342500	Bismarck, ND	1315.1	0.37
06349700	Schmidt, ND	1309.8	0.29

These data demonstrate the effects of increasing cross-section through natural channel widening, from upstream to downstream, on daily stage fluctuations for an equivalent volume of discharge. Additionally, areas surrounding nesting sites that are inundated during portions of the day could be erroneously classified as ESH depending on the time of photo capture. While these frequently inundated sites would not support nest establishment, they may serve as forage areas when they are exposed.

Hydrologic data evaluated for the Garrison River Segment included the continuous daily mean stages measured at the Price USGS Gage for the January 1, 1996 through August 8, 2007 period. The 1997 high-flow event was recorded at the Price Gage as averaging 26 feet above the datum. Flow was maintained above 24 feet for 176 days, from May 1 through November 27, 1997. A commensurate event had not occurred in the previous period of record,[43] or since. Gage data for the Garrison River Segment show that the 1997 high water event affected the segment, but did not create sufficiently elevated sand to support the high nest establishment levels and population increases observed for birds in the Garrison River Segment.

Controlled flows have occurred in the Garrison River Segment every year during winter, and these high flows resulted in the redistribution of sand in the Garrison River Segment. Some of this newly deposited sand accumulated at elevations near the annual peak stage elevations, which as stage fell, became elevated, dry ESH. Some of the most elevated of these deposits placed by the 1997 event remained as ESH in 2005.

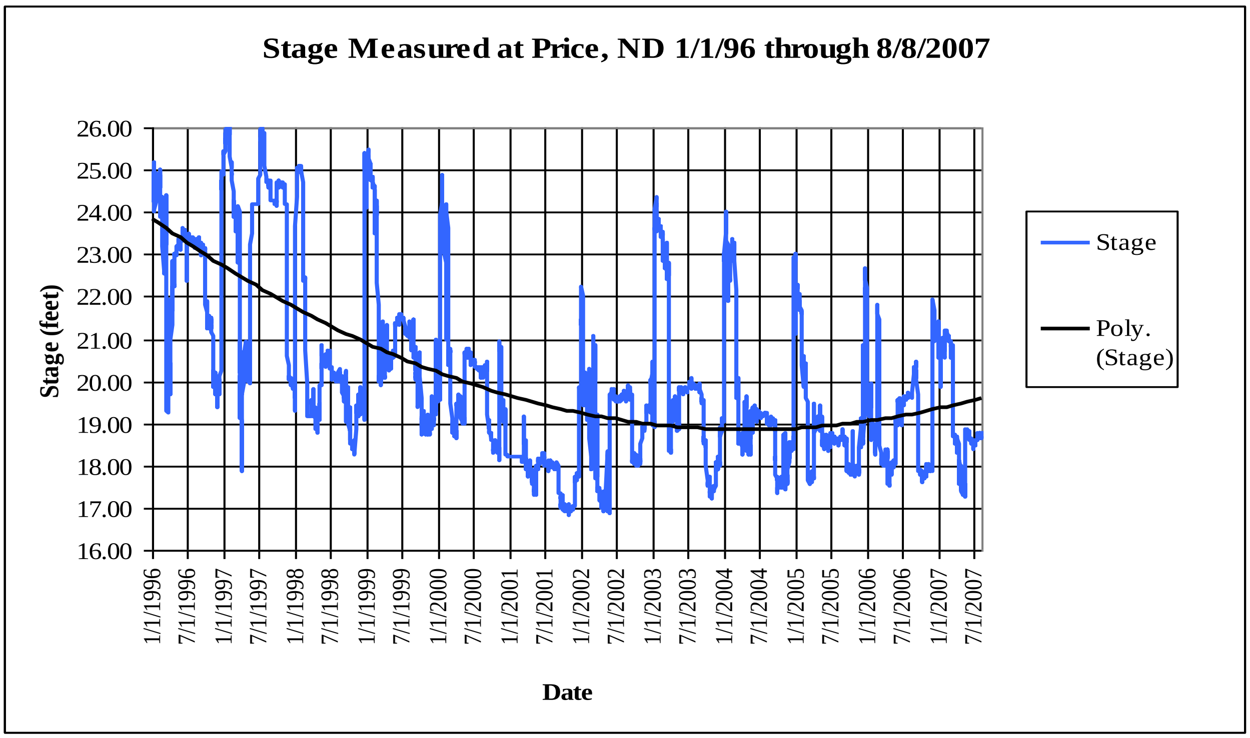
Figure 6-5 graphs the daily stage data from the Price Gage, and shows a generally falling hydrograph during the analysis period (January 1996 - August 2007). The figure shows that maximum stages in several years after 1997 approach the maximum stages associated with the 1997 high-flow event. More importantly, this figure shows the existence of three distinct, repetitive annual flow regimes, that are markedly different than the flow regime experienced in the Gavins Point River Segment. These seasonal regimes include a fairly consistent period of median flow maintained during the breeding season (generally May 1 through July 31), a high-

[43] Gage established 11-4-1959.

flow period maintained variably between late December and mid-March, and a low-flow period occurring during October and November.

In 1998 and 1999, stages during winter peak discharges averaged to within 1 foot of the 1997 peak stage. Similar post-1997 peaks recorded for gages in the Gavins Point River Segment eroded away much of the sand deposited in 1997. While the 1997 flow on the Garrison River Segment was higher than normal annual peak flow, subsequent flows have resulted in stages sustained at less than 2 feet below the 1997 peak four times in eight out of the 11 years in the period of analysis, and to within three feet during an additional three years. Comparatively, the 1997 flow in the Gavins Point River Segment was measured at five feet above subsequent peaks and more than 7 feet above mean stages during the breeding season.

Figure 6-5
Historic Daily Stage Data at Price, North Dakota



Unlike the Gavins Point River Segment flow-regime, high winter peak flows were sustained nearly every winter in the Garrison River Segment. Each year, the flow from Garrison Dam and resulting stage dropped during the breeding season, and continued to decline through December, a simulation of the pattern of the natural annual hydrological regime, minus the storm peaks observed in uncontrolled rivers. Table 6-5 summarizes the seasonal mean values for annual flow-induced stages at the Price Gage. Breeding season means were calculated using a fixed period of May 1 through July 30.

Mean values for annual high flows and annual low flows were calculated for variable periods, based on changes in the shape of the hydrograph, varying from 185 days for the 1997 event to 58 days for 2000. As shown in the table, the difference between the winter high stage and the breeding season stage presented has averaged 2.34 feet. The difference between winter and breeding season stage has exceeded three feet during five years since 1997. In 1999, the annual winter high stage average slightly exceeds the high stage average for the 1997 record high-flow event.

Table 6-5 also lists the difference between the mean 1997 winter peak and the mean seasonal winter high stages for subsequent years. Since sandbar elevation is controlled by river stage, the difference was thought to have some relevance to the understanding of persistent nesting areas and the rate and extent of vegetation encroachment.

Table 6-5
Mean Stage Statistics for the Price Gage 1997 2007

YEAR	Annual Peak (Jan thru Mar)	Annual Breeding (May thru July)	Annual Low (Oct thru Nov)	Annual Peak Stage Minus Breeding Stage	1997 Peak Minus Annual Peak
1996 Record High-Flow Event	24.29	23.49	22.48	0.80	
1997 Record High-Flow Event	24.61	24.98	24.55	-0.38	
1998	24.12	20.64	19.80	3.48	0.49
1999	24.62	21.50	20.25	3.12	-0.01
2000	23.83	20.68	20.04	3.15	0.78
2001	19.73	18.20	17.62	1.53	4.88
2002	19.97	19.72	19.14	0.24	4.64
2003	23.24	19.94	18.88	3.30	1.37
2004	22.73	19.35	18.53	3.39	1.87
2005	21.39	18.97	18.84	2.42	3.21
2006	20.01	19.47	19.50	0.53	4.60
2007	21.06	18.82		2.24	3.55
Post 1997 Mean	22.07	19.73	19.18	2.34	2.54
Difference 1997 Stage and Post 1997 Mean Stage	2.54	5.26	5.37	-2.72	

6.2 Summary of Nest Data

The Garrison River Segment nest dataset used for this assessment is limited to six years (2001-2006) and includes 973 nests, of which 692 (71 percent) were successful. Least tern comprised 46 percent of total nests (449 nests), with piping plover comprising 54 percent (524) of total nests. Notably, the total number of successful least tern and piping plover nests were approximately equal, showing a somewhat higher failure rate for piping plovers.

The nest data showed a relatively stable population of nesting least terns and piping plovers, with only minor year-to-year changes in nest counts. Self-sustaining conditions were demonstrated by annual formation of new nesting-habitat at a much higher frequency and for a shorter duration (1 or 2 seasons) than for the Gavins Point River Segment.

The dataset begins three breeding seasons after the 1997 high-flow event with vegetation encroachment well underway. Total nest numbers and the rate of nest increase are modest compared to the Gavins Point River Segment. The Garrison River Segment nest numbers increased from 128 to 196 (53 percent). The Gavins Point River Segment nest numbers increased from 198 to 543 (275 percent) during the same period (2001-2006). This suggests either that the degree of improvement to nesting-habitat resulting from the 1996-1997 high-flow event was much less than for Gavins Point River Segment, or that the best nesting-habitat in the Garrison River Segment was lost to erosion before the 2001 breeding season.

Trends in nest numbers were uninformative. The number of active nest sites decreased between 2001 and 2004, increased in 2005, and declined again in 2006. The majority of increases in nests noted for 2005 were due to single plover nests on small habitat patches. Many of these subsequently failed, as evidenced by the general declining trend in nest success that was particularly pronounced in 2006.

Table 6-6 shows the distribution of nests by year and a number of descriptive statistics derived from the dataset. *Total Nest Count* is the sum of all recorded nests for both species, for all sandbar NestAreas. *Number of Active NestAreas* is the count of all separate sites used for nesting during a breeding season. *Nests per NestArea* is an indicator of density of use computed by dividing the total number of recorded nests by the number of active NestAreas. *Number of First Time Use NestAreas each Year* is the annual count of first time nest establishment for a NestArea.

Statistics for successful nests (S-Nests) were derived in the same way as for total nests (T-Nests), using only those that were recorded to have had at least one hatched egg. The percentage of successful nests was calculated by dividing the number of successful nests by the number of total nests. A similar computation was made for percent *First Time Use Sites Successful*.

Table 6-6
Distribution of Nests by Year

Statistic: T-Nest	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**
Total Nests	128	148	154	153	196	194	162
Number of Active NestAreas	43	37	37	41	60	49	45
Nest per active site	2.98	4.00	4.16	3.73	3.27	3.96	3.68
Number of First Time Use NestAreas each Year	43	21	13	20	33	18	21[1]
Statistic: S-Nest	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**
Successful Nests	98	115	117	127	135	100	115
Number of Active NestAreas	28	29	29	35	42	28	32
Nest per Active NestArea	3.50	3.97	4.03	3.63	3.21	3.57	3.65
Number of First Time Use NestAreas each Year	23	19	9	14	23	10	15[2]
Percent Success	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**
Percent Successful Nests	77%	78%	76%	83%	69%	52%	73%
Pct First Time Use Sites Successful	65%	90%	82%	88%	74%	71%	78%

[1] New nests average is based on 2002 through 2006 only.
[2] Successful new site average based on 2002 through 2006 only.

Table 6-7 presents the statistical analysis of the various stage-related statistics from Table 6-4 and the nesting statistics presented in Table 6-6. Negative correlation is depicted in red text. The strongest positive correlation (0.97) was between the total number of nests established (T-Nests) per site and annual stage during the breeding season. The number of successful nests (S-Nests) per site also showed a strong positive correlation with annual breeding season stage (0.71). These relationships seem intuitive as the numbers of nesting birds must, to some extent, reduce their internest distances to accommodate the reduction of barren sand available at higher water stages during the breeding season.

The number of T-Nest active sites was somewhat negatively correlated (-0.39) with stage during the breeding season. A possible explanation is that higher stage reduced the number of sites exposed. The count of successful nesting sites was less negatively correlated with breeding season stage, suggesting that successful nests occur above, thus outside the effects of a breeding season stage nesting threshold.

Table 6-7
Correlations between Stage and Nesting Statistics for the Price USGS Gage

	Nest Statistics									
Mean Values for Hydrologic Statistic	**T-Nest Count**	**Active Site Count**	**T-Nest per Site**	**S-Nest Count**	**Successful Site Count**	**S-Nest per Site**	**% Success**	**Number of first-time T-Nest sites**	**Number of first-time S-Nest sites**	**% First-time Use Sites Successful**
Annual Peak Stage (Jan thru Mar)	0.03	-0.17	0.36	0.62	0.34	0.25	0.40	-0.31	-0.31	0.20
Annual Breeding Stage (May thru July)	0.24	-0.39	0.97	0.25	-0.15	0.71	-0.07	-0.76	-0.65	0.44
Annual Low Flow Stage (Oct thru Nov)	0.70	0.12	0.77	0.16	0.01	0.25	-0.58	-0.16	-0.23	-0.46
Annual Peak Stage Minus Breeding Stage	-0.08	-0.01	-0.04	0.59	0.46	-0.04	0.48	-0.12	-0.15	0.09
1997 Peak Stage Minus Annual Peak Stage	-0.03	0.17	-0.36	-0.62	-0.34	-0.25	-0.40	0.31	0.31	-0.20

The number of successful nests (0.59), the numbers of sites supporting successful nests (0.46) and the percentage of successful to total nests (0.48) were all positively correlated with the difference in feet between annual peak stage and the stage of the breeding season following it. The number of successful nests was also positively correlated (0.62) with the height of the preceding winter peak. This follows the notion that successful nesters benefited from more highly elevated sandbar creation from higher winter flows and from a falling stage during the normal annual sequence of peak declining to trough from spring to fall.

The correlations for annual breeding peak stage and annual peak stage subtracted from the 1997 peak stage were mirror images. Moderate to strong correlations were derived for T-Nests per site, S-Nest count, successful nest site count and the percent of successful nests. The area described by both stage statistics is reflective of the area of elevated sand created by the highest stages during 1997. When the distance between the residual elevated sites created by the 1997 flows and the annual stage during the breeding season is greatest, the maximum area of suitable nesting habitat is available for nesting.

The strong positive correlation between the annual low flow stages and total nests and numbers of T-Nests per site coupled with the moderately high negative correlation with nest success demonstrated the value of a falling hydrograph during the breeding season to both nest site selection and to successful nesting. The annual low flow event for which correlations were calculated occurs either after or near the end of the annual breeding season. Lower stage values more strongly demonstrate the falling hydrograph. Nest success increased as the rate of late season stage decline increased.

The numbers of annually new T-Nest sites and the number S-Nest sites was strongly negatively correlated with the stage during the breeding season. Both active nest site numbers and nest site success increased as the stage during the breeding season declined. The number of first time sites that supported successful nests was positively correlated with stage during the breeding season and negatively correlated with late season stage declines. This suggests that not only the rate of decline was important to nest success, but the magnitude of decline also played an important part.

The Price USGS gage located near the mid-point of the profile for the segment may be considered representative of trends in stage change throughout the segment. It does not however fully account for the localized variability from wetted perimeter width and thalweg depth for various widely separated nest clusters. Correlations found between stage and nesting statistics may be strengthened if nesting data was analyzed as local clusters, interpolated to the closest (or most appropriate) gage, to account for differences caused by localized cross-section area effects.

6.3 Distribution of Nesting Habitat by NestArea

NestAreas in the Garrison River Segment are, unlike the Gavins Point River Segment, all individual sandbar islands. Table 6-8 presents total nest counts by NestArea, separated for least terns (ILT) and piping plovers (PPL). Table 6-9 presents nest counts for only successful nests. There were 136 sites that supported establishment of at least one nest during the 2001-2006 period of analysis. There were 104 sites that supported successful nests, 60 of which supported successful nests for more than one year.

Table 6-8
Total Nest Distribution by NestArea, Year, and Species

	Year by Species												
	2001		2002		2003		2004		2005		2006		
NestArea	ILT	PPL	ILT	PPL	ILT	PPL	ILT	PPL	ILT	PPL	ILT	PPL	Total Nests
Washburn: 1367.4	8	8	11	7	14	6	3	11	5	3		3	79
Mandan: 1319.9	3	6	4	4	2	2	9	5	10	4	10	6	65
Washburn: 1361.4	11	10	8	16		2	4	3		2	1	3	60
Sanger: 1347.5			4	2	11	7	3	4	1	3	8	6	49
Sanger: 1348.3		1	6	5	11	6	2	6		1		1	39
Price: 1334.2	1	1	4	3	1	2	5	5	1	1	5	9	38
Stanton: 1367.8		1		3	2	4	11	3		1	4	5	34
Schmidt: 1304.0					11	2	9	3		2	3	3	33
Schmidt: 1309.0							4	2	10	6	5	6	33
Schmidt: 1301.8			1	2	2	3		2	8	3	7	2	30
Washburn: 1358.4					3	3	2	3	8	4		4	27
Washburn: 1364.5			3	4	1	2		1		1	5	10	27
Stanton: 1374.3		1						1	8	4	6	5	25
Sanger: 1344.9B						1	3	1	7	6	1		19
Sanger: 1343.8	9	5											14
Turtle CK: 1352.6						1	2	3	5	3			14
Mandan: 1319.8										1	9	3	13
Turtle CK: 1351.4									9	4			13
Sanger: 1348.4		1	3	1	1	2		3		1			12
Schmidt: 1303.A	1	3	2	4		1		1					12
Stanton: 1369.0B		2	2	2	2	2		1			1		12
Mandan: 1319.4			2	2	6	1							11
Washburn: 1362.5B	1	1	1		2	2		1	1	1		1	11
Mandan: 1319.3			2		5	3							10
Price: 1335.8											8	2	10
Washburn: 1367.8		1		2		2	1	2		1		1	10
Harmon: 1329.1			6	1	1	1							9
Schmidt: 1308.6A			5	3				1					9
Schmidt: 1308.6B	2	1					2	2		2			9
Harmon: 1327.2									4	4			8
Harmon: 1328.2	1	1	2	1	2	1							8
Price: 1334.5	3	2				1						2	8
Schmidt: 1302.6B	4	2				2							8
Bismarck: 1310.5B	2	4										1	7
Garrison Dam 1379.9A		1				1					3	2	7
Price: 1332.2									4	3			7
Sanger: 1347.9							2	1	2	2			7
Stanton: 1373.8				1			1	1		1		3	7
Turtle CK: 1352.1							1	1		2	2	1	7
Turtle CK: 1352.3											3	3	6

	Year by Species												
	2001		2002		2003		2004		2005		2006		
NestArea	**ILT**	**PPL**	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**Total Nests**
Sanger: 1345.0							1	1	1	2			5
Sanger: 1348.5A						1	3	1					5
Turtle CK: 1351.6									3	2			5
Washburn: 1364.3					2	2						1	5
Washburn: 1364.7				1		1		1			1	1	5
Garrison Dam 1380.0						1				1	1	1	4
Harmon: 1325.8									1	3			4
Schmidt: 1302.8			2	1		1							4
Schmidt: 1302.9B		1		1		1		1					4
Schmidt: 1303.B									1	1		2	4
Schmidt: 1304.1		1								1		2	4
Schmidt: 1304.2										1		3	4
Schmidt: 1309.8										3		1	4
Bismarck: 1310.7B				1						1		1	3
Bismarck: 1311.2				1	1	1							3
Price: 1341.2	2	1											3
Stanton: 1368.4							1	1		1			3
Stanton: 1374.1										1		2	3
Bismarck: 1302.4	1	1											2
Bismarck: 1310.5A										2			2
Harmon: 1325.9							2						2
Harmon: 1327.8	2												2
Harmon: 1328.9				1		1							2
Price: 1332.3										1		1	2
Price: 1338.4									1			1	2
Price: 1339.6		1		1									2
Sanger: 1344.8B								1		1			2
Schmidt: 1306.6					1	1							2
Stanton: 1374.7		1		1									2
Washburn: 1353.9B										1		1	2
Washburn: 1358.7	1	1											2
Washburn: 1362.5A	1	1											2
Washburn: 1364.9		1	1										2
Washburn: 1367.6B		1								1			2
Bismarck: 1302.3		1											1
Bismarck: 1310.2												1	1
Bismarck: 1310.3										1			1
Bismarck: 1310.4										1			1
Bismarck: 1310.7A				1									1
Garrison Dam 1379.9B										1			1
Garrison Dam 1381.0												1	1
Harmon: 1322.2												1	1
Harmon: 1327.7		1											1

	Year by Species												
	2001		2002		2003		2004		2005		2006		
NestArea	**ILT**	**PPL**	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**Total Nests**
Harmon: 1328.1											1		1
Harmon: 1328.A												1	1
Harmon: 1328.B	1												1
Mandan: 1319.6				1									1
Price: 1338.5										1			1
Price: 1338.7		1											1
Price: 1339.1										1			1
Price: 1339.4		1											1
Price: 1339.7		1											1
Price: 1339.9												1	1
Sanger: 1344.8A										1			1
Sanger: 1344.9A										1			1
Sanger: 1347.6								1					1
Sanger: 1348.5B		1											1
Sanger: 1350.0										1			1
Schmidt: 1298.9						1							1
Schmidt: 1299.7												1	1
Schmidt: 1302.6A						1							1
Schmidt: 1302.7								1					1
Schmidt: 1302.9A				1									1
Schmidt: 1303.0								1					1
Schmidt: 1303.8A												1	1
Schmidt: 1303.8B										1			1
Schmidt: 1306.3A				1									1
Schmidt: 1306.3B												1	1
Schmidt: 1306.4								1					1
Schmidt: 1307.7										1			1
Schmidt: 1308.3A										1			1
Schmidt: 1308.3B										1			1
Schmidt: 1308.4A										1			1
Schmidt: 1308.4B				1									1
Schmidt: 1308.7				1									1
Stanton: 1369.0A		1											1
Stanton: 1369.1		1											1
Stanton: 1374.0										1			1
Stanton: 1374.2								1					1
Stanton: 1374.6												1	1
Stanton: 1374.8								1					1
Stanton: 1377.0		1											1
Stanton: 1377.1				1									1
Turtle CK: 1351.5										1			1
Turtle CK: 1351.8										1			1
Turtle CK: 1352.4												1	1

	Year by Species												
	2001		2002		2003		2004		2005		2006		
NestArea	**ILT**	**PPL**	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**Total Nests**
Turtle CK: 1352.5A						1							1
Turtle CK: 1352.5B										1			1
Washburn: 1353.9A								1					1
Washburn: 1353.9C								1					1
Washburn: 1356.4A		1											1
Washburn: 1356.4B				1									1
Washburn: 1356.4C		1											1
Washburn: 1362.6												1	1
Washburn: 1367.5		1											1
Washburn: 1367.6A								1					1
Total	**54**	**74**	**69**	**79**	**81**	**73**	**71**	**82**	**90**	**106**	**84**	**110**	**973**

Table 6-9
Total Successful Nest Distribution by NestArea, Year and Species

	2001		2002		2003		2004		2005		2006		
NestArea	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	Total
Washburn: 1361.4	9	9	8	9		1	4	3		2	1	1	47
Washburn: 1367.4	8	8	1	7	1	6	2	8	4	1			46
Mandan: 1319.9	1	3	4	3	1	2	7	5	6	2	6	4	44
Sanger: 1347.5			3	1	11	5	3	4	1	2	5	4	39
Sanger: 1348.3			2	4	9	6	2	5				1	29
Schmidt: 1304.0					11	2	8	3		1	1	1	27
Price: 1334.2	1	1	4	2		2	3	5			3	5	26
Schmidt: 1309.0							4	2	7	4	4	2	23
Schmidt: 1301.8				1	1	3		1	6	3	6	1	22
Washburn: 1358.4					3	3	2	3	7	4			22
Stanton: 1367.8		1		1	2	2	1	3			3	3	16
Stanton: 1374.3		1						1	5	4	3	1	15
Sanger: 1343.8	9	5											14
Washburn: 1364.5			2	3							2	6	13
Sanger: 1344.9B						1	1	1	4	5			12
Turtle CK: 1352.6						1	2	3	3	3			12
Schmidt: 1303.A	1	3	2	3		1		1					11
Washburn: 1362.5B	1	1	1		2	2			1	1		1	10
Harmon: 1329.1			6	1	1	1							9
Price: 1335.8											7	2	9
Sanger: 1348.4			3	1	1	2		2					9
Schmidt: 1308.6A			5	3				1					9
Turtle CK: 1351.4									7	2			9
Mandan: 1319.4			2	2	3	1							8
Harmon: 1328.2		1	2	1	2	1							7
Mandan: 1319.8											5	2	7
Price: 1332.2									4	3			7
Schmidt: 1302.6B	3	2				2							7
Stanton: 1369.0B			2	1	2	2							7
Schmidt: 1308.6B	1	1					2	1		1			6
Washburn: 1367.8		1		2		1	1	1					6
Bismarck: 1310.5B	2	3											5
Mandan: 1319.3			2			3							5
Sanger: 1347.9							1		2	2			5
Sanger: 1348.5A						1	3	1					5
Harmon: 1325.8									1	3			4
Harmon: 1327.2									2	2			4
Price: 1334.5	3	1											4
Schmidt: 1302.8			2	1		1							4
Turtle CK: 1351.6									2	2			4
Turtle CK: 1352.1							1	1		2			4
Turtle CK: 1352.3											2	2	4

	2001		2002		2003		2004		2005		2006		
NestArea	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	Total
Price: 1341.2	2	1											3
Sanger: 1345.0							1	1	1				3
Schmidt: 1303.B									1			2	3
Schmidt: 1304.1										1		2	3
Washburn: 1364.7				1							1	1	3
Bismarck: 1302.4	1	1											2
Bismarck: 1310.5A										2			2
Bismarck: 1310.7B				1						1			2
Harmon: 1325.9							2						2
Harmon: 1327.8	2												2
Harmon: 1328.9				1		1							2
Price: 1338.4									1			1	2
Price: 1339.6		1		1									2
Sanger: 1344.8B								1		1			2
Schmidt: 1302.9B				1				1					2
Schmidt: 1304.2										1		1	2
Schmidt: 1306.6					1	1							2
Schmidt: 1309.8										2			2
Stanton: 1368.4							1	1					2
Stanton: 1373.8				1				1					2
Washburn: 1353.9B										1		1	2
Washburn: 1362.5A	1	1											2
Bismarck: 1310.2												1	1
Bismarck: 1310.4										1			1
Bismarck: 1310.7A				1									1
Garrison Dam 1379.9B										1			1
Garrison Dam 1380.0										1			1
Harmon: 1322.2												1	1
Harmon: 1328.1											1		1
Harmon: 1328.A												1	1
Harmon: 1328.B	1												1
Mandan: 1319.6				1									1
Price: 1332.3												1	1
Price: 1338.7		1											1
Price: 1339.1										1			1
Price: 1339.4		1											1
Price: 1339.7		1											1
Price: 1339.9												1	1
Sanger: 1344.8A										1			1
Sanger: 1344.9A										1			1
Sanger: 1350.0										1			1
Schmidt: 1298.9						1							1
Schmidt: 1302.6A						1							1
Schmidt: 1302.7								1					1
Schmidt: 1303.0								1					1

	2001		2002		2003		2004		2005		2006		
NestArea	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	**ILT**	PPL	Total
Schmidt: 1303.8B										1			1
Schmidt: 1306.4								1					1
Schmidt: 1307.7										1			1
Stanton: 1374.0										1			1
Stanton: 1374.1												1	1
Stanton: 1374.2								1					1
Stanton: 1374.7		1											1
Stanton: 1374.8								1					1
Stanton: 1377.0		1											1
Turtle CK: 1351.8										1			1
Turtle CK: 1352.5A						1							1
Turtle CK: 1352.5B										1			1
Washburn: 1353.9A								1					1
Washburn: 1353.9C								1					1
Washburn: 1358.7	1												1
Washburn: 1364.9			1										1
Washburn: 1367.6B		1											1
Total	**47**	**51**	**52**	**54**	**51**	**57**	**51**	**67**	**65**	**70**	**50**	**50**	**665**

The number of nests established increased for both least tern and piping plover between 2001 and 2005 (60 percent and 70 percent, respectively), but the number of successful nests increased at higher rates during that period (each by 73 percent). The number of nests established remained about the same in 2006. However, success rates declined significantly (60 percent and 45 percent, respectively). Possible explanations for this include vegetation encroachment and flow differences. The difference for the 2005-2006 winter high-flow and the flows during the breeding season and low-flow period was the least during the period. These conditions would have resulted in little new sandbar establishment and less effective suppression of vegetation as a result.

Table 6-10 shows nest and nest site distribution and the frequency of occurrence of NestArea nest count numbers. There were 136 total sites (NestAreas) at which at least one nest was established. Sites supporting only a single nest during the 6-year period of analysis accounted for nearly 46 percent of all NestAreas. Sites supporting five or fewer nests made up nearly 71 percent of all NestAreas. This pattern of NestArea distribution and period of usage is consistent with a hydrologic regime favoring frequent annual creation and loss of small areas of sandbar habitat suitable for nesting.

Table 6-10
Distribution of NestAreas by Nest Count 2001-2006

Numbers of Sites Supporting a Number of Nests Sorted by Count Bin			Numbers of Sites Supporting a Number of Nests Sorted by Frequency of Occurrence of a Bin Number		
Nest Count Bin	**Frequency**	**Cumulative Percent**	**Nest Count Bin**	**Frequency**	**Cumulative Percent**
1	62	45.59%	1	62	45.59%
2	16	57.35%	10	17	58.09%
3	5	61.03%	2	16	69.85%
4	8	66.91%	15	9	76.47%
5	5	70.59%	4	8	82.35%
10	17	83.09%	3	5	86.03%
15	9	89.71%	5	5	89.71%
20	1	90.44%	40	5	93.38%
25	1	91.18%	30	3	95.59%
30	3	93.38%	20	1	96.32%
40	5	97.06%	25	1	97.06%
50	1	97.79%	50	1	97.79%
60	1	98.53%	60	1	98.53%
70	1	99.26%	70	1	99.26%
80	1	100.00%	80	1	100.00%

The construct of importance value (IV)[44] was used to identify top performing NestAreas. Table 6-11 lists the 18 NestAreas with an IV greater than 20. These areas supported nearly 64 percent of all successful nests during the 6-year period of analysis. Six persistent highly successful sites with an IV greater than 100 supported nearly 35 percent of the successful nests. These locations were the most highly elevated areas, which were created by the 1996-1997 high-flow event and mapped for both 1998 and 2005.

[44] Importance Value is the number of successful nests multiplied by the number of years in which nesting occurred at a site.

Table 6-11
Most Important NestAreas Sorted by S-Nest IV

NestArea	IV	S-Nests	Percent of Total	Cumulative Percent
Mandan: 1319.9	264	44	6.6%	6.6%
Washburn: 1361.4	235	47	7.1%	13.7%
Washburn: 1367.4	230	46	6.9%	20.6%
Sanger: 1347.5	195	39	5.9%	26.5%
Price: 1334.2	117	26	3.9%	30.4%
Sanger: 1348.3	102	29	4.4%	34.7%
Schmidt: 1304.0	95	27	4.1%	38.8%
Schmidt: 1301.8	88	22	3.3%	42.1%
Schmidt: 1309.0	69	23	3.5%	45.6%
Washburn: 1358.4	66	22	3.3%	48.9%
Stanton: 1367.8	64	16	2.4%	51.3%
Stanton: 1374.3	45	15	2.3%	53.5%
Washburn: 1362.5B	40	10	1.5%	55.0%
Schmidt: 1303.A	33	11	1.7%	56.7%
Sanger: 1344.9B	30	12	1.8%	58.5%
Turtle CK: 1352.6	30	12	1.8%	60.3%
Washburn: 1364.5	26	13	2.0%	62.3%
Sanger: 1348.4	23	9	1.4%	63.6%

The percentage of the total and successful nests that occurred in repeatedly used NestAreas accounted for 64 percent of all nests. In contrast, this type of NestArea supported more than 85 percent of all nests in Gavins Point River Segment.

The total number of NestAreas varied between years, but did not show a clear trend between 2001 and 2005. The largest number of NestAreas occurred in 2005, the lowest water year for this segment since before 1996-1997 period. The lowest number of NestAreas (59) occurred in 2003, a year with the highest mean stage during the breeding season. These observations suggest the importance of flow and stage on the distribution of NestAreas. NestArea distribution was further evaluated by comparing some NestArea linear distribution statistics with the river stage statistics from Table 6-5 shown earlier in this section. NestAreas were binned by nearest river mile to determine the yearly extent of NestArea distribution, the most upstream river mile utilized for nesting, the most downstream river mile used, and the mean river mile, or weighted center of the distribution of NestAreas in the segment. Table 6-12 shows these statistics.

The extent of NestArea distribution in miles for the segment was found to be negatively related to mean stage during the breeding season. The finding that the distance of NestArea extent increases as mean stage values decreases seems intuitively correct.

The mean river mile of the annual NestArea distribution was negatively related to the average breeding season stage, suggesting that as the river stage declines, the centroid of the nesting area distribution moves upstream. It is interesting to note that this centroid migrated a full nine miles between 2003 and 2004. The Garrison River Segment, like most river corridors that have not been subject to glacial reversal, narrows from downstream to upstream. Similarly the cross-sectional width and flow capacity also decline. It seems that the narrower the riparian corridor, the greater the sensitivity to stage changes. This finding compares favorably with the finding of a higher rate of nest failure in the upstream one-third of the Gavins Point River Segment (see Section 3 of this document). A finding in Biedenharn (2001) is consistent with these observations. Biedenharn identified river width thresholds for each Missouri River segment, below which sandbars do not accumulate and islands fail to be sustained. This information was used in the analyses provided in the Sensitive Features Assessment (see Section 2) to identify narrow reaches where ESH construction should be avoided.

The minimum river mile (the farthest downstream location of a NestArea) seemed to occur when preceding winter peak was highest, the difference between the winter peak and breeding mean stages was greatest, and post-breeding season mean low stage was least. It would seem that more nesting-habitat is available for a greater extent of the segment during years with a high winter stage, followed by a consistent decline through the breeding season.

Upstream distribution of nesting-habitat was negatively related to the pre-breeding season annual peak and the breeding season mean. It was also positively related to the difference between the 1997 mean winter peak and the annual winter peak. This finding indicates that nesting-habitat created by both the 1997 flow event and subsequent high-flow events is better utilized during years with lowered breeding season stages. It also suggests that new habitat is to some extent, being created each year, a finding that again supports the observation of the frequent single-year usage pattern of nesting.

Table 6-12
Linear Distribution of NestAreas and Hydrologic Statistics

STATISTIC	YEAR				
Linear Distribution of NestAreas	**2002**	**2003**	**2004**	**2005**	**2006**
Extent (distance in river miles between most upstream and most downstream nest)	72	59	72	77	64
Max RM (most upstream river mile)	1374	1358	1375	1380	1374
Min RM (most downstream river mile)	1302	1299	1303	1303	1310
Mean RM	1333	1330	1339	1336	1333
Hydrologic Statistics					
Mean Annual Peak (Jan thru Mar)	19.97	23.24	22.73	21.39	20.01
Annual Mean Stage during Breeding (May thru July)	19.72	19.94	19.35	18.97	19.47
Mean Annual Low (Oct thru Nov)	19.14	18.88	18.53	18.84	19.50
Annual Peak Stage Minus Breeding Stage	0.24	3.30	3.39	2.42	0.53
1997 Peak Minus Annual Peak	4.64	1.37	1.87	3.21	4.60

6.4 Productive Emergent Sandbar Habitat Characteristics

The 2005 ESH polygons were used to select nest points to assess the persistence of nesting-habitat and the significance of nesting-habitat loss. The 2005 imagery allowed delineation of 150 polygons definable as ESH that comprised approximately 588 acres. Only 54 of these polygons contained nests. The ESH polygons containing nests totaled 370 acres (62 percent of 2005 acres) and resulted in selection of 609 nest points; 63 percent of the total nest points located between 2001 and 2006. The 96 ESH polygons not containing nests totaled 213 acres and averaged 2.3 acres in size. Sites with nests averaged 6.3 acres and ranged from 0.2 acres to 32 acres. Sites without nests ranged from 0.001 to 38 acres.

Table 6-13 lists the 2005 NestArea polygons in descending order of importance value (IV). Multiplying nest count by acreage derives IV for this array. The ten, top-rated NestAreas with IVs greater than 100 contained more than 60 percent of the nests, but only 25 percent of the total ESH acreage that contained nests. The five, top-rated NestAreas with IVs greater than 200 contained 38 percent of the nests but only 13 percent of the acreage. The single most prolific site (Mandan: 1319.9) has supported more than 12 percent of all nests on less than 2 percent of the acreage.

The most productive sites are some or all of the same ESH acreage mapped in the 1998 imagery and probably represent the most elevated habitat created by the 1997 high-flow event. The four to five top-rated sites may be sites that existed before the high-flow event and were only scoured by the peak flows. The lower-ranked 45 to 50 sites probably represent nesting-habitat created by annual winter high flows that occurred after the 1997 event.

Table 6-13
Garrison River Segment 2005 Islands with Nests

NestArea	T-Nests	Percent of Total Nests	Cumulative Percent Nests	Acres	Percent Total Acres	Cumulative Percent Acres	Active Years	IV
Mandan: 1319.9-121	75	12.3%	12.3%	6.6	1.8%	1.8%	6	450
Stanton: 1367.8-31	43	7.1%	19.4%	3.9	1.1%	2.9%	6	258
Price: 1334.2-97	37	6.1%	25.5%	13.7	3.7%	6.6%	6	222
Sanger: 1348.3-59	37	6.1%	31.5%	13.8	3.7%	10.3%	6	222
Sanger: 1347.6-62	42	6.9%	38.4%	9.8	2.7%	12.9%	5	210
Stanton: 1374.3-42	29	4.8%	43.2%	26.4	7.1%	20.1%	6	174
Schmidt: 1304.2-133	28	4.6%	47.8%	13.2	3.5%	23.6%	6	168
Washburn: 1367.4-32	28	4.6%	52.4%	0.8	0.2%	23.9%	4	112
Washburn: 1358.4-10	27	4.4%	56.8%	3.2	0.9%	24.7%	4	108
Washburn: 1367.4-33	21	3.4%	60.3%	1.2	0.3%	25.1%	5	105
Schmidt: 1309.0-125	31	5.1%	65.4%	12.4	3.3%	28.4%	3	93
Sanger: 1344.9B-65	18	3.0%	68.3%	2.7	0.7%	29.1%	4	72
Garrison Dam 1380.0-0	12	2.0%	70.3%	33.8	9.1%	38.2%	6	72
Turtle CK: 1352.6-2	17	2.8%	73.1%	21.9	5.9%	44.2%	4	68
Sanger: 1348.4-58	11	1.8%	74.9%	3.5	0.9%	45.1%	5	55
Schmidt: 1301.8-149	10	1.6%	76.5%	2.6	0.7%	45.8%	4	40

NestArea	T-Nests	Percent of Total Nests	Cumulative Percent Nests	Acres	Percent Total Acres	Cumulative Percent Acres	Active Years	IV
Price: 1334.5-95	6	1.0%	77.5%	5.9	1.6%	47.4%	6	36
Stanton; 1373.8-43	7	1.1%	78.7%	15.8	4.3%	51.6%	5	35
Schmidt: 1303.0-142	8	1.3%	80.0%	14.7	4.0%	55.6%	3	24
Schmidt: 1301.8-148	6	1.0%	81.0%	4.8	1.3%	56.9%	4	24
Turtle CK: 1352.1-5	7	1.1%	82.1%	4.1	1.1%	58.0%	3	21
Bismarck: 1310.7B-113	4	0.7%	82.8%	12.2	3.3%	61.3%	5	20
Turtle CK: 1351.6-7	19	3.1%	85.9%	10.1	2.7%	64.0%	1	19
Schmidt: 1304.0-137	8	1.3%	87.2%	0.2	0.1%	64.1%	2	16
Washburn: 1361.4-29	4	0.7%	87.8%	2.8	0.7%	64.8%	4	16
Bismarck: 1310.5A-114	5	0.8%	88.7%	14.6	4.0%	68.8%	2	10
Sanger: 1345.0-64	5	0.8%	89.5%	0.8	0.2%	69.0%	2	10
Sanger: 1348.5A-57	5	0.8%	90.3%	1.7	0.5%	69.5%	2	10
Schmidt: 1308.6B-129	5	0.8%	91.1%	5.8	1.6%	71.0%	2	10
Schmidt: 1308.6A-128	3	0.5%	91.6%	5.8	1.6%	72.6%	3	9
Washburn: 1353.9B-21	3	0.5%	92.1%	3.7	1.0%	73.6%	3	9
Schmidt: 1303.B-140	4	0.7%	92.8%	0.9	0.2%	73.8%	2	8
Price: 1335.8-90	7	1.1%	93.9%	2.3	0.6%	74.5%	1	7
Stanton: 1368.4-47	3	0.5%	94.4%	1.1	0.3%	74.8%	2	6
Harmon: 1327.2-104	5	0.8%	95.2%	6.2	1.7%	76.4%	1	5
Price: 1332.2-102	5	0.8%	96.1%	1.3	0.4%	76.8%	1	5
Harmon: 1325.8-106	4	0.7%	96.7%	23.5	6.4%	83.1%	1	4
Schmidt: 1309.0-127	2	0.3%	97.0%	6.8	1.8%	85.0%	2	4
Bismarck: 1311.2-110	2	0.3%	97.4%	7.6	2.1%	87.1%	1	2
Schmidt: 1309.8-124	2	0.3%	97.7%	0.6	0.2%	87.2%	1	2
Price: 1332.3-98	1	0.2%	97.9%	0.6	0.2%	87.4%	1	1
Price: 1338.5-87	1	0.2%	98.0%	1.6	0.4%	87.8%	1	1
Price: 1339.1-86	1	0.2%	98.2%	0.5	0.1%	88.0%	1	1
Price: 1339.9-81	1	0.2%	98.4%	0.6	0.2%	88.1%	1	1
Sanger: 1344.8A-68	1	0.2%	98.5%	0.8	0.2%	88.3%	1	1
Sanger: 1344.8B-70	1	0.2%	98.7%	0.7	0.2%	88.5%	1	1
Sanger: 1344.9A-67	1	0.2%	98.9%	0.5	0.1%	88.6%	1	1
Schmidt: 1303.A-136	1	0.2%	99.0%	0.6	0.2%	88.8%	1	1
Schmidt: 1308.3B-131	1	0.2%	99.2%	2.5	0.7%	89.5%	1	1
Stanton: 1374.6-41	1	0.2%	99.3%	7.6	2.1%	91.5%	1	1
Stanton: 1374.7-39	1	0.2%	99.5%	0.3	0.1%	91.6%	1	1
Stanton: 1374.8-36	1	0.2%	99.7%	7.8	2.1%	93.7%	1	1
Washburn: 1353.9C-28	1	0.2%	99.8%	3.0	0.8%	94.5%	1	1
Washburn: 1364.9-75	1	0.2%	100.0%	20.2	5.5%	100.0%	1	1
	609			370.4				

The number of nests was strongly related to the number of years that a site was active. Persistence, rather than acreage, was the factor most influencing site productivity. Persistence of ESH in the Garrison River Segment, like with the Gavins Point River Segment, is strongly controlled by elevation. The highest elevated nesting sites either created or scoured by the 1997 high-flow event supported very important portions of the population of nests over the 2001- 2006 period of analysis. However, the prevalence of this elevated habitat is on the decline due to continued erosion and, most importantly, natural vegetation encroachment onto residual high-flow event sandbars. Higher winter flows that apparently create suitable ESH each year have supplemented nesting-habitat. The degree of utilization appeared to be controlled by the stage maintained during the subsequent breeding season.

6.5 Establish ESH Acreage Goal for PEIS Alternative 5

This analysis measures the area of nesting-habitat for least tern and piping plover in the Garrison River Segment. The results of the analysis were used to establish the ESH acreage goal for this segment under Alternative 5 of the PEIS. The methodology described in Section 2 of this document was used to measure nesting-habitat on an annual and total basis for the Garrison River Segment. Steps in the analysis are briefly reviewed below.

1. Separate the data by year, species, and NestArea.
2. Measure distances between nests, and identify the nearest-neighbor distance for each nest.
3. Establish the radius of nesting-habitat circles for each NestArea, species, and year.
4. Establish nesting-habitat polygons for each NestArea, species, and year as the area within habitat circles, counting overlapping areas only once.
5. Combine species and year habitat circles for each Nest Area, counting overlapping areas only once.
6. Establish acreage goals for the Garrison River Segment under PEIS Alternative 5 by adding the acreage for each NestArea in the segment.

Data generated during implementation of the steps listed above are shown in Tables 6-14 and 6-15. Table 6-14 provides the measured nesting-habitat for least tern, and Table 6-15 provides the measured nesting-habitat by NestArea for piping plover.

As shown in Table 6-14, the measured nesting-habitat acreage used by least tern ranged from a high of 16.8 acres in 2001 to a low of 7.6 acres in 2003. The average annual measured nesting-habitat used by least tern was 13.3 acres. Nesting acreage was distributed among 18 to 21 sites, with an average of 20 sites utilized annually. The average number of active sites (20) were less than 0.7 acres in area but supported an average of 2.7 nests at an average density of 4.2 nests per acre.

Table 6-15 shows that the measured nesting-habitat acreage used by piping plovers ranged from a high of 223.1 acres in 2001 to 64 acres in 2006. The average annual acreage estimated to be used for nesting by piping plover was 120.6 acres. Nesting acreage was distributed over 34 to 59 sites, with an average of 43 sites used annually. The average number of active sites (43) was approximately 2.7 acres in area, and supported an average of 1.4 nests at an average density of 0.6 nests per acre. Large distances between nests in the Garrison River Segment NestAreas and a majority of single use sites may have over-estimated piping plover nesting-habitat[45].

[45] See Section 2 for a discussion of ways in which large distances between nests and single use sites could over-estimate nesting habitat.

Table 6-15 also shows that variability in annual measured nesting-habitat was high. The pattern of nesting-habitat usage was statistically linked to other phenomena, particularly flow and stage data. It is unclear if actual nesting-habitat area is declining, but the percentage of successful nests declined from 79 percent to 52 percent during the period of analysis.

When the measured nesting-habitat acreages are consolidated across species, years, and Garrison River Segment NestArea, the total area measured was calculated at 502 acres.

While the mapped acreage of ESH in Garrison River Segment for 2005 was 588 acres, only 297 acres distributed on 28 sandbars supported nesting activity during the period analyzed. The figure of 183 acres estimated for nesting in 2005 (see Tables 6-14 and 6-15) is coincident with and "fits inside" the 297 acres available during that year. The remaining 319 acres (502-183 acres) may be considered as an estimate of the total area created by annual winter high-flow events.

While topographic data were lacking for this segment, it was assumed that the extent of barren sand elevated above both seasonal flow maxima and above maximum daily stage fluctuation height from power-peaking characterized the area used for nesting.

Table 6-14
Least Tern Measured Nesting Habitat Acres by NestArea and Year

NestArea	2001	2002	2003	2004	2005	2006	Average	Year Count	IV
Washburn: 1361.4	3.7	1.7		1.0		0.2	1.6	4	6.58
Washburn: 1367.4	1.6	1.9	1.2	0.8	0.9		1.3	5	6.27
Mandan: 1319.9	1.0	0.8	0.2	1.1	1.6	1.4	1.0	6	6.18
Price: 1334.2	0.4	0.9	0.1	1.2	0.2	0.8	0.6	6	3.59
Sanger: 1347.5		0.6	1.0	0.6	0.2	1.1	0.7	5	3.58
Schmidt: 1309.0				0.9	1.5	0.8	1.1	3	3.22
Schmidt: 1301.8		0.2	0.2		1.4	1.3	0.8	4	3.15
Sanger: 1348.3		1.1	1.2	0.5			0.9	3	2.78
Schmidt: 1304.0			0.7	1.4		0.4	0.9	3	2.63
Stanton: 1367.8			0.2	1.6		0.7	0.8	3	2.48
Stanton: 1374.3					1.4	1.1	1.2	2	2.45
Sanger: 1343.8	2.2						2.2	1	2.18
Washburn: 1358.4			0.3	0.5	1.3		0.7	3	2.13
Sanger: 1344.9B				0.6	0.8	0.2	0.6	3	1.67
Washburn: 1364.5		0.7	0.1			0.8	0.5	3	1.59
Schmidt: 1302.6B	1.4						1.4	1	1.43
Price: 1335.8						1.4	1.4	1	1.41
Turtle CK: 1352.6				0.5	0.9		0.7	2	1.37
Turtle CK: 1351.4					1.2		1.2	1	1.21
Schmidt: 1308.6B	0.8			0.4			0.6	2	1.17
Harmon: 1329.1		1.1	0.1				0.6	2	1.16
Price: 1334.5	1.1						1.1	1	1.13
Washburn: 1362.5B	0.4	0.2	0.2		0.2		0.2	4	0.95
Mandan: 1319.4		0.4	0.5				0.5	2	0.94

NestArea	2001	2002	2003	2004	2005	2006	Average	Year Count	IV
Mandan: 1319.3		0.4	0.5				0.5	2	0.91
Harmon: 1328.2	0.4	0.3	0.2				0.3	3	0.91
Mandan: 1319.8						0.9	0.9	1	0.89
Stanton: 1369.0B		0.4	0.2			0.2	0.3	3	0.87
Schmidt: 1303.A	0.4	0.4					0.4	2	0.81
Sanger: 1347.9				0.4	0.4		0.4	2	0.81
Price: 1332.2					0.8		0.8	1	0.79
Schmidt: 1308.6A		0.8					0.8	1	0.79
Bismarck: 1310.5B	0.8						0.8	1	0.75
Sanger: 1348.4		0.6	0.1				0.3	2	0.68
Harmon: 1327.8	0.7						0.7	1	0.67
Harmon: 1327.2					0.6		0.6	1	0.62
Price: 1341.2	0.6						0.6	1	0.61
Turtle CK: 1352.1				0.3		0.4	0.3	2	0.60
Turtle CK: 1351.6					0.6		0.6	1	0.59
Sanger: 1348.5A				0.6			0.6	1	0.57
Harmon: 1325.9				0.5			0.5	1	0.50
Turtle CK: 1352.3						0.5	0.5	1	0.47
Sanger: 1345.0				0.3	0.2		0.2	2	0.45
GarrisonDam1379.9A						0.4	0.4	1	0.42
Schmidt: 1302.8		0.4					0.4	1	0.39
Bismarck: 1302.4	0.4						0.4	1	0.38
Harmon: 1328.B	0.4						0.4	1	0.38
Washburn: 1358.7	0.4						0.4	1	0.38
Washburn: 1362.5A	0.4						0.4	1	0.38
Stanton: 1368.4				0.3			0.3	1	0.25
Stanton: 1373.8				0.3			0.3	1	0.25
Washburn: 1367.8				0.3			0.3	1	0.25
Washburn: 1364.9		0.2					0.2	1	0.22
Washburn: 1364.3			0.2				0.2	1	0.22
Garrison Dam 1380.0						0.2	0.2	1	0.20
Harmon: 1325.8					0.2		0.2	1	0.20
Harmon: 1328.1						0.2	0.2	1	0.20
Price: 1338.4					0.2		0.2	1	0.20
Schmidt: 1303.B					0.2		0.2	1	0.20
Washburn: 1364.7						0.2	0.2	1	0.20
Bismarck: 1311.2			0.1				0.1	1	0.11
Schmidt: 1306.6			0.1				0.1	1	0.11
Total Active Acres	16.8	13.2	7.6	13.9	14.8	13.2	13.3		
Number of Active Sites	18	19	20	21	20	20	20		
Average Acres per Site	0.95	0.69	0.37	0.67	0.74	0.66	0.68		
Number of Least Tern Nests	47	52	51	51	65	50	53		
Nests per Site	2.6	2.7	2.6	2.4	3.3	2.5	2.7		
Nests Per Acre	2.7	4.0	6.9	3.6	4.4	3.8	4.2		

Table 6-15
Piping Plover Measured Nesting Habitat Acres by NestArea and Year

NestArea	2001	2002	2003	2004	2005	2006	Average	Count	IV
Washburn: 1361.4	25.0	14.8	3.3	3.4	3.9	2.1	8.7	6	52.42
Washburn: 1367.4	11.5	4.3	6.0	7.1	4.5	2.1	5.9	6	35.46
Mandan: 1319.9	8.0	3.8	2.6	4.2	4.2	2.7	4.2	6	25.47
Sanger: 1348.3	4.0	4.6	6.9	5.1	1.9	0.7	3.9	6	23.22
Price: 1334.2	4.0	3.6	3.3	3.8	1.9	5.2	3.6	6	21.86
Sanger: 1347.5		2.5	6.5	4.0	4.7	3.2	4.2	5	20.95
Stanton: 1367.8	4.0	2.6	3.6	2.4	1.9	1.8	2.7	6	16.28
Washburn: 1364.5		4.8	1.8	1.1	1.9	5.5	3.0	5	15.2
Schmidt: 1301.8		1.9	4.9	2.2	4.6	1.4	3.0	5	15.06
Schmidt: 1309.0				1.7	8.9	3.2	4.6	3	13.73
Washburn: 1358.4			3.3	2.9	5.0	2.1	3.3	4	13.25
Stanton: 1374.3	4.0			1.1	5.3	2.8	3.3	4	13.22
Stanton: 1369.0B	7.4	1.9	2.5	1.1			3.2	4	12.87
Washburn: 1367.8	4.0	1.7	2.7	1.4	1.9	0.7	2.1	6	12.47
Sanger: 1348.4	4.0	1.2	2.9	2.3	1.9		2.5	5	12.46
Schmidt: 1303.A	6.9	2.8	1.6	1.1			3.1	4	12.43
Schmidt: 1302.6B	8.0		3.2				5.6	2	11.17
Price: 1334.5	7.8		1.6			1.2	3.6	3	10.65
Sanger: 1343.8	10.6						10.6	1	10.63
Washburn: 1362.5B	4.0		2.7	1.1	1.9	0.7	2.1	5	10.45
Bismarck: 1310.5B	9.1					0.7	4.9	2	9.756
Schmidt: 1308.6B	4.0			1.5	3.9		3.1	3	9.405
Schmidt: 1304.0			2.3	1.9	3.3	1.5	2.2	4	8.935
Turtle CK: 1352.6			1.6	2.6	4.6		2.9	3	8.802
Sanger: 1344.9B			1.6	1.1	5.7		2.8	3	8.429
Schmidt: 1302.9B	4.0	1.2	1.6	1.1			2.0	4	8.029
Schmidt: 1304.1	4.0				1.9	1.2	2.4	3	7.162
Harmon: 1328.2	4.0	1.2	1.6				2.3	3	6.908
Garrison Dam 1379.9A	4.0		1.6			1.2	2.3	3	6.83
Stanton: 1373.8		1.2		1.1	1.9	2.0	1.6	4	6.351
Schmidt: 1309.8					5.4	0.7	3.1	2	6.139
Washburn: 1367.6B	4.0				1.9		3.0	2	5.964
Harmon: 1327.2					5.7		5.7	1	5.726
Turtle CK: 1352.1				1.1	3.9	0.7	1.9	3	5.681
Price: 1339.6	4.0	1.2					2.6	2	5.266
Stanton: 1374.7	4.0	1.2					2.6	2	5.266
Washburn: 1364.7		1.2	1.6	1.1		0.7	1.2	4	4.703
Schmidt: 1308.6A		3.3		1.1			2.2	2	4.385
Garrison Dam 1380.0			1.6		1.9	0.7	1.4	3	4.281
Harmon: 1325.8					4.2		4.2	1	4.181

NestArea	2001	2002	2003	2004	2005	2006	Average	Count	IV
Sanger: 1347.9				1.1	3.0		2.1	2	4.165
Bismarck: 1302.3	4.0						4.0	1	4.024
Bismarck: 1302.4	4.0						4.0	1	4.024
Harmon: 1327.7	4.0						4.0	1	4.024
Price: 1338.7	4.0						4.0	1	4.024
Price: 1339.4	4.0						4.0	1	4.024
Price: 1339.7	4.0						4.0	1	4.024
Price: 1341.2	4.0						4.0	1	4.024
Sanger: 1348.5B	4.0						4.0	1	4.024
Stanton: 1369.0A	4.0						4.0	1	4.024
Stanton: 1369.1	4.0						4.0	1	4.024
Stanton: 1377.0	4.0						4.0	1	4.024
Washburn: 1356.4A	4.0						4.0	1	4.024
Washburn: 1356.4C	4.0						4.0	1	4.024
Washburn: 1358.7	4.0						4.0	1	4.024
Washburn: 1362.5A	4.0						4.0	1	4.024
Washburn: 1364.9	4.0						4.0	1	4.024
Washburn: 1367.5	4.0						4.0	1	4.024
Sanger: 1345.0				1.1	2.8		2.0	2	3.951
Bismarck: 1310.7B		1.2			1.9	0.7	1.3	3	3.881
Washburn: 1364.3			3.2			0.7	1.9	2	3.878
Mandan: 1319.3			3.7				3.7	1	3.679
Price: 1332.2					3.6		3.6	1	3.633
Schmidt: 1304.2					1.9	1.6	1.8	2	3.542
Turtle CK: 1351.4					3.5		3.5	1	3.498
Mandan: 1319.4		1.8	1.6				1.7	2	3.447
Mandan: 1319.8					1.9	1.3	1.6	2	3.253
Stanton: 1374.1					1.9	1.3	1.6	2	3.204
Sanger: 1344.8B				1.1	1.9		1.5	2	3.061
Stanton: 1368.4				1.1	1.9		1.5	2	3.061
Schmidt: 1303.B					1.9	1.0	1.5	2	2.944
Bismarck: 1310.5A					2.9		2.9	1	2.928
Bismarck: 1311.2		1.2	1.6				1.4	2	2.884
Harmon: 1328.9		1.2	1.6				1.4	2	2.884
Harmon: 1329.1		1.2	1.6				1.4	2	2.884
Schmidt: 1302.8		1.2	1.6				1.4	2	2.884
Sanger: 1348.5A			1.6	1.1			1.4	2	2.763
Turtle CK: 1351.6					2.7		2.7	1	2.692
Price: 1332.3					1.9	0.7	1.3	2	2.639
Washburn: 1353.9B					1.9	0.7	1.3	2	2.639
Bismarck: 1310.3					1.9		1.9	1	1.94
Bismarck: 1310.4					1.9		1.9	1	1.94
Garrison Dam 1379.9B					1.9		1.9	1	1.94

NestArea	2001	2002	2003	2004	2005	2006	Average	Count	IV
Price: 1338.5					1.9		1.9	1	1.94
Price: 1339.1					1.9		1.9	1	1.94
Sanger: 1344.8A					1.9		1.9	1	1.94
Sanger: 1344.9A					1.9		1.9	1	1.94
Sanger: 1350.0					1.9		1.9	1	1.94
Schmidt: 1303.8B					1.9		1.9	1	1.94
Schmidt: 1307.7					1.9		1.9	1	1.94
Schmidt: 1308.3A					1.9		1.9	1	1.94
Schmidt: 1308.3B					1.9		1.9	1	1.94
Schmidt: 1308.4A					1.9		1.9	1	1.94
Stanton: 1374.0					1.9		1.9	1	1.94
Turtle CK: 1351.5					1.9		1.9	1	1.94
Turtle CK: 1351.8					1.9		1.9	1	1.94
Turtle CK: 1352.5B					1.9		1.9	1	1.94
Turtle CK: 1352.3						1.7	1.7	1	1.741
Schmidt: 1298.9			1.6				1.6	1	1.642
Schmidt: 1302.6A			1.6				1.6	1	1.642
Schmidt: 1306.6			1.6				1.6	1	1.642
Turtle CK: 1352.5A			1.6				1.6	1	1.642
Price: 1335.8						1.4	1.4	1	1.359
Bismarck: 1310.7A		1.2					1.2	1	1.242
Mandan: 1319.6		1.2					1.2	1	1.242
Schmidt: 1302.9A		1.2					1.2	1	1.242
Schmidt: 1306.3A		1.2					1.2	1	1.242
Schmidt: 1308.4B		1.2					1.2	1	1.242
Schmidt: 1308.7		1.2					1.2	1	1.242
Stanton: 1377.1		1.2					1.2	1	1.242
Washburn: 1356.4B		1.2					1.2	1	1.242
Sanger: 1347.6				1.1			1.1	1	1.121
Schmidt: 1302.7				1.1			1.1	1	1.121
Schmidt: 1303.0				1.1			1.1	1	1.121
Schmidt: 1306.4				1.1			1.1	1	1.121
Stanton: 1374.2				1.1			1.1	1	1.121
Stanton: 1374.8				1.1			1.1	1	1.121
Washburn: 1353.9A				1.1			1.1	1	1.121
Washburn: 1353.9C				1.1			1.1	1	1.121
Washburn: 1367.6A				1.1			1.1	1	1.121
Bismarck: 1310.2						0.7	0.7	1	0.698
Garrison Dam 1381.0						0.7	0.7	1	0.698
Harmon: 1322.2						0.7	0.7	1	0.698
Harmon: 1328.A						0.7	0.7	1	0.698
Price: 1338.4						0.7	0.7	1	0.698
Price: 1339.9						0.7	0.7	1	0.698

NestArea	2001	2002	2003	2004	2005	2006	Average	Count	IV
Schmidt: 1299.7						0.7	0.7	1	0.698
Schmidt: 1303.8A						0.7	0.7	1	0.698
Schmidt: 1306.3B						0.7	0.7	1	0.698
Stanton: 1374.6						0.7	0.7	1	0.698
Turtle CK: 1352.4						0.7	0.7	1	0.698
Washburn: 1362.6						0.7	0.7	1	0.698
Total Acres	223.1	79.2	96.4	74.5	168.1	64.0	120.6		
Number of Active Sites	41	34	37	40	59	46	43		
Average Acres per Site	5.42	2.31	2.59	1.85	2.82	1.40	2.73		
Number of Least Tern Nests	51	54	57	67	70	50	58		
Nest per Site	1.2	1.6	1.5	1.7	1.2	1.1	1.4		
Nest Per Acre	0.2	0.7	0.6	0.9	0.4	0.8	0.6		

6.6 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defines those areas most suitable for ESH construction and maintenance, as well as those areas that if used would result in potentially significant impacts to either the natural or manmade environment. This process of eliminating areas that should be avoided leaves the remaining areas as the most suitable for ESH construction and maintenance for the Garrison River Segment. These areas include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment. The steps involved in conducting this analysis are explained in detail in Section 2 of this document, and are outlined below.

1. Solicit input on sensitive resources and buffer distances from affected states and agencies;
2. Create an anthropogenic features dataset from aerial imagery;
3. Establish the separation distance between nesting habitat and anthropogenic features; and
4. Establish the minimum flow channel, channel width restrictions, and define the predator moat area;

The result of the analysis is a set of spatial restrictions that categorize the riverine corridor acreage into three categories. These categories are listed below.

1. **Exclusion Areas** are locations at which ESH could not be constructed because intrusion into these locations could cause significant geomorphic alterations to the river corridor. Such an intrusion would risk physical and economic damages to public and private infrastructure or land uses. Exclusion areas include the estimated minimum flow way for normal flowage (i.e., the thalweg), narrow channel reaches, and areas needed to provide a predator moat.

2. **Restrictive Areas** are locations at which ESH could be constructed and maintained at relatively low physical risk, but could put nesting habitat in areas at risk from predation, recreation encroachment, or locations otherwise limited for nesting use and productivity. Areas of limited usability are those areas defined by analysis of distances from features that have shown to be restrictive to nest establishment or nest success.

3. **Available Areas** are locations that are most suitable for the construction and maintenance of ESH. However, it is important to note that any construction activities would need to ensure that other high-interest features (e.g., archeological and cultural resources, or other protected species) would be avoided.

The acreage for Restrictive Areas, and Available Areas is summarized by habitat type for the Garrison River Segment in Table 6-16. It is important to note that Available Area acres is a subset of Restrictive Area acres.

Table 6-16
Residual Available Area for ESH Construction: Garrison River Segment

Habitat Type	Acres 2005	Restrictive Area Acres	Available Area Acres
Open Water	12,237	2,589	1,483
Emergent Sandbar Habitat	588	445	339
Herb-Shrub-Sapling	4,977	3,098	942
Non-ESH Sand	480	287	112
Riverine Forest	927	651	1
Active Agricultural Row Crop	94	65	10
Wetland Matrix	822	459	0
Shallow Water	2,137	871	596
ESH M&C Test Areas	0	0	
Daily-Inundated Sand Plains	2,257	1,213	879
Lacustrine Fine Sediments	0		0
Total	**24,519**	**9,678**	**4,361**
Percent		**39%**	**18%**

6.6.1 Summary of Findings for the Garrison River Segment

The Garrison River Segment differed significantly from the Gavins Point River Segment in several major aspects:

- The 1996-1997 high-flow event was not as effective in creating sustainable, elevated sandbar. Stage during the high flow period was 3 to 5 feet lower, with respect to post-high flow stage regimes. Subsequent annual winter high flows were both near the 1996-

97 event stage and relatively long. These flows would have quickly eroded accumulated sandbar and participated in its redistribution.

- The flow regime in the Garrison River Segment since the high-flow event included a winter high flow peak, a significant breeding season decline (>3 feet) and a continual stage decline throughout and following the breeding season. In contrast, the Gavins Point River Segment operated with a low winter flow, a stable breeding season flow and a high post-breeding season flow.
- The 1997 high flow event was only slightly higher than subsequent annual high flows in the Garrison River Segment, and was not as effective at ESH creation in the Garrison Segment.
- Approximately 60 percent of the nests occurred on sites persistent between 1998 and 2006.
- The Garrison River Segment nesting data did not show significant increases in productivity or populations during the period of analysis (2001-2006). Nesting habitat in the Garrison River Segment appeared to be self-sustaining at a relatively low level, due to the existing hydrologic regime.
- The Garrison River Segment is comparatively narrow, averaging less than one-half the width of the Gavins River Point Segment. In terms of usability to least terns and piping plovers, approximately 9,000 acres of riverine corridor habitat is within the 600-foot gallery forest buffer distance, which seems to be a barrier to most nesting.
- Power-peaking flows release a regularly increasing volume of water through turbines at Garrison Dam to enhance power generation during periods of high electricity demand. Interpolation of stage change for the river near Garrison Dam approximately 17 miles upstream from Stanton (the most upstream station), reveals a daily stage change estimated at more than 5 feet. Stage change for a given flow is significantly higher in this and other narrow reaches, increasing the risk of nest inundation.
- The Garrison River Segment has been proportionally more important to piping plover than other study area segments.
- Statistical correlations of nesting data and the hydrologic record indicated that increased nesting and nest success were tied in part to higher winter flows, low flows during the nesting season, and a declining hydrograph during the nesting season.
- The strong, positive correlation between the annual low flow stages and total nests and numbers of T-Nests per site coupled with the moderately high negative correlation with nest success demonstrates the value of a falling hydrograph during the breeding season to both nest site selection and to successful nesting. The annual low flow event for which correlations were calculated occurs after (or near he end of) the annual breeding season. Lower stage values more strongly demonstrate the falling hydrograph. Nest success increases as the rate of late season stage decline increases
- The numbers of annually new nest sites and the number of successful nest sites is strongly negatively correlated with the stage during the breeding season. Both active nest

site numbers and nest site success increases as the stage during the breeding season declines.

- The number of first-time nest sites that support successful nests is positively correlated with stage during the breeding season, and negatively correlated with late season stage declines. This suggests that not only the rate of decline is important to nest success, but magnitude of decline also plays an important part.
- Higher winter flows that apparently create suitable ESH each year have supplemented nesting habitat. Apparently, a sustainable area of nesting habitat is created each year by winter flows. The degree to which the habitat is used for nesting is controlled by the stage maintained during the breeding season.

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7 Fort Peck River Segment

The Fort Peck River Segment begins in the upper end of Lake Sakakawea at RM 1568.0 near Trenton, North Dakota and ends 203 miles upstream at the Fort Peck Dam (see Figures 7-1 and 7-2 below). This segment is 500 miles and three climate zones farther north than the southern-most portion of the study area, and has the largest riverine corridor of all the segments included in this analysis.

Figure 7-1
Regional Overview of the Study Area

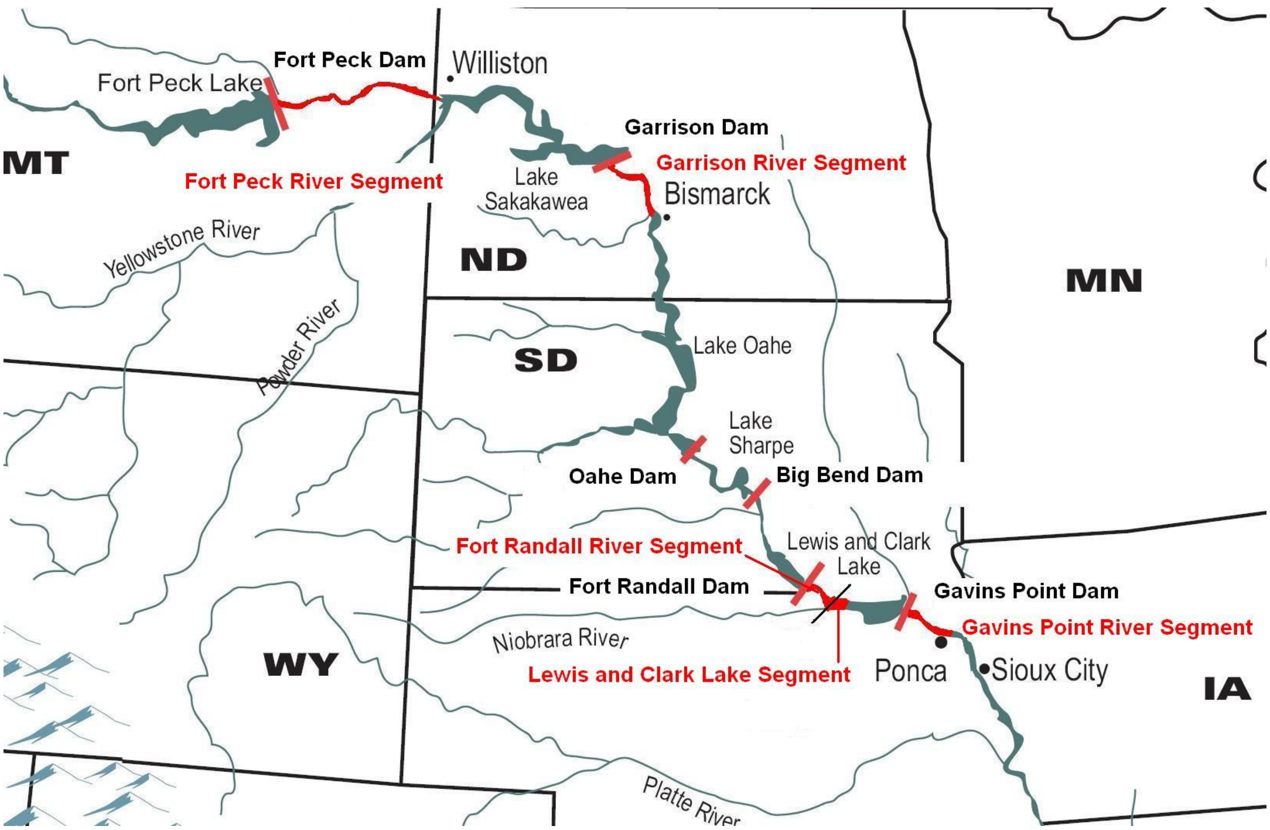
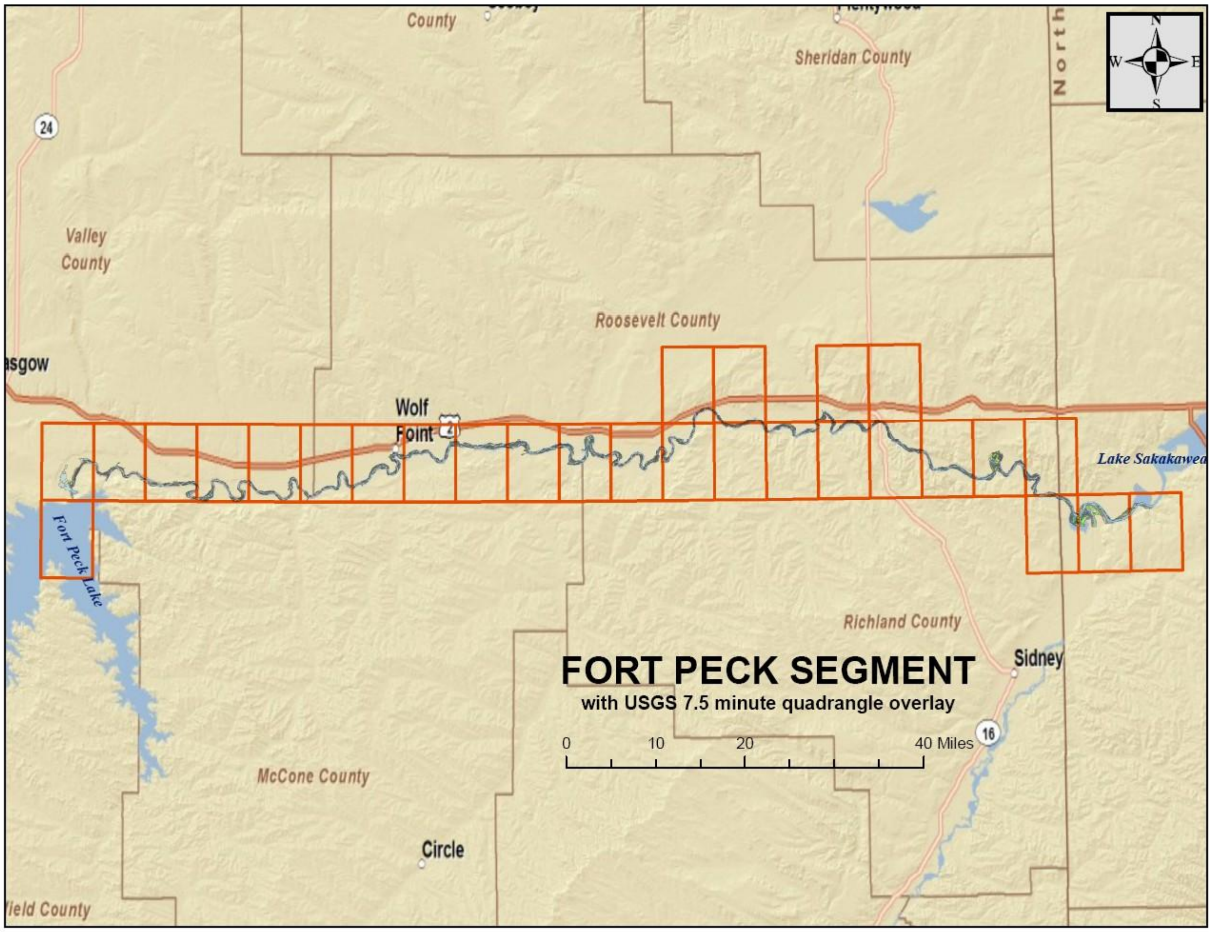


Figure 7-2
Overview of the Fort Peck River Segment with USGS Quadrangles



There are approximately 37,000 acres in the riverine corridor, for an average of 192.2 acres per river mile and an average width of 800 feet. The downstream 12 miles of the reach near the confluence with the Yellowstone is in backwater from Lake Sakakawea, and the lowest downstream four miles may be in the lake's pool.

Aerial imagery captured in 1999 was used for the Fort Peck River Segment delineation because 1998 imagery was available only for the Bainville SW quadrangle. A comparison delineation was conducted for the seven-mile reach from RM 1599.3 to RM 1606.3 of the available 1998 imagery and matching 1999 imagery. The comparison showed that the water level was higher in 1998 than in 1999. The 1998 Open Water polygon was only 104 percent of the 1999 Open Water polygon in this comparison reach. However, the area of ESH mapped in this test for 1998 was 45 percent of the ESH area mapped using the 1999 imagery. This test suggested that use of the 1999 imagery over estimated the acreage of ESH in the Fort Peck River Segment.

It is important to note that the 1999 imagery was obtained at a flow of 10,100 cfs; and the 2005 imagery split in time between June and July flights at flows of 5,600 cfs and 5,200 cfs, respectively. Using the Wolfe Point USGS gage as a difference surrogate, the stage for 1999 was 3.7 feet, the June 2005 flight at 2.55 feet and the July flight at 1.97. A 1.15- to 1.73-foot difference is significant in this reach.

7.1 Habitat Delineation

Table 7-1 summarizes the change in acres for all habitat types between 1998 and 2005. Table 7-2 depicts the changes in ESH acreage between 1998 and 2005. Figure 7-3 shows the changes in acres per river mile of each habitat type between 1998 and 2005. Ten of the 12 habitat types defined in Section 2 are present in the Fort Peck River Segment, which revealed a habitat type not seen in any of the other segments: Lacustrine Sediments (see discussion of habitat types in Section 2). It is expected that the Lacustrine Sediments habitat will vanish from the Fort Peck River Segment when normal precipitation returns to the upper Missouri River Basin.

Table 7-1 shows that ESH habitat declined by 72 percent (883 to 247 acres) in the Fort Peck River Segment over the period of analysis. There is little sandbar formation and few suitable nesting sites in the upper 69 miles of this segment. Downstream of RM 1712, island formation begins, however the next suitable nest site does not occur until RM 1692, 20 miles further downstream. Proceeding downstream, sandbar formation is discontinuous, with nesting-habitat occurring at wide intervals. There are only six suitable sandbar sites (RMs 1689.7, 1682.9, 1679.6, 1664.0, 1659.0, 1636.0) until RM 1615, a distance of 77 additional miles. Each of these is a single island or sandbar, representing short deposition zones, and are located in major river bends. The longest reach supporting suitable ESH occurs between RM 1615.5 and RM 1616.5 (one mile). Two additional suitable ESH nesting areas occur at RMs 1598.5 and 1606.3. The extent of depositional area within the Fort Peck River Segment is less than 10 miles.

Significant differences in seasons and river stages between the 1999 and 2005 aerial imagery were found to weaken meaningful comparison of ESH acreage between these years. However, a comparison between the two mapped instances still expresses the declining trends in barren sandbar observed in the other downstream segments. Comparisons of habitat type that typically occur above river stage fluctuation levels are meaningful. Habitat types that occur near or within river stage fluctuation levels probably declined much more than indicated, due to the below-normal stage at the time of 2005 photograph acquisition.

Table 7-1
Habitat Acreage Summary: Fort Peck River Segment 1999 and 2005

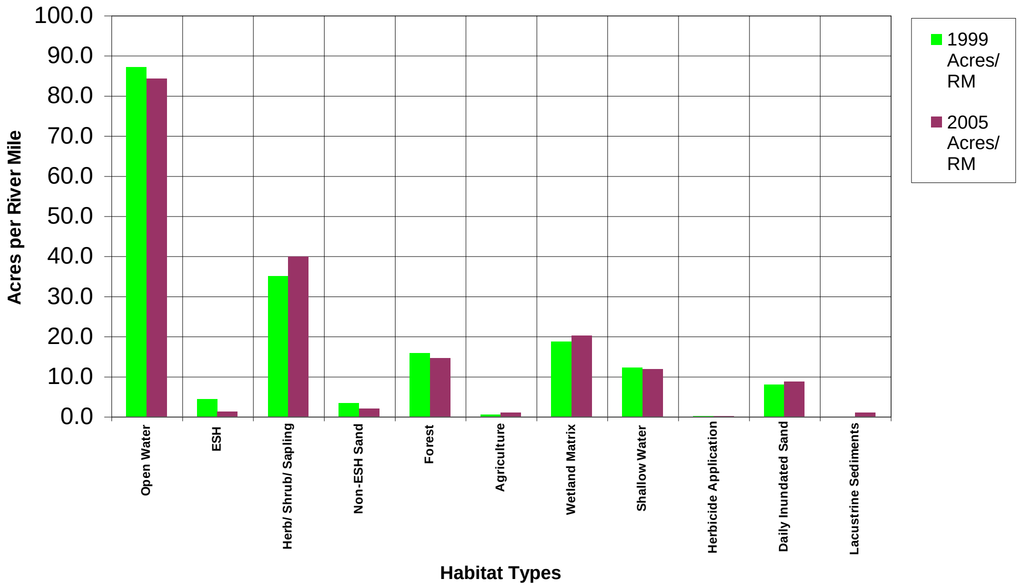
Habitat Type	1999 Acres	2005 Acres	Change in Acres	1999 Acres/ RM	2005 Acres/ RM	Change in Acres/ RM	2005 Pct of Total	1999 Pct of Total
Open Water	17,714	17,135	-578	87	84	-3	45.7%	47.1%
ESH	883	247	-635	4.3	1.2	-3.1	0.7%	2.3%
Herb/ Shrub/ Sapling	7,122	8,093	970	35.0	39.8	4.8	21.6%	19.0%
Non- ESH Sand	676	399	-277	3.3	2.0	-1.4	1.1%	1.8%
Forest	3,204	2,954	-250	15.7	14.5	-1.2	7.9%	8.5%
Agriculture	93	190	98	0.5	0.9	0.5	0.5%	0.2%
Wetland Matrix	3,791	4,102	311	18.6	20.2	1.5	10.9%	10.1%
Shallow Water	2,474	2,405	-69	12.2	11.8	-0.3	6.4%	6.6%
Daily Inundated Sand	16	7	-9	0.1	0.0	-0.0	0.0%	0.0%
Lacustrine Sediments	0	3.0	3	0.0	0.0	0.0	0.0%	0.0%
Total	35,973	35,535						

Table 7-2 shows that only 96.5 acres of the 883 acres of ESH identified in 1998 was still mapped as ESH in 2005. The remaining 150.5 acres of ESH mapped in 2005 within this segment represent new ESH that changed from other 1998 habitat types over the intervening period. As shown in Table 7-2, 33 percent of ESH delineated for the Fort Peck River Segment from the 1998 imagery has been lost to erosion (Open Water and Shallow Water). Natural succession of lower areas into Wetlands Matrix and to Herb/Shrub/Sapling accounts for 43 percent of lost ESH.

Table 7-2
Disposition of ESH Lost from 1999 to 2005: Fort Peck River Segment

Habitat Name	Acres	Percent of Total	Explanation
Open Water	262.9	30%	ESH lost to erosion and carried down river
ESH	96.5	11%	ESH retained from original 1999 area
Herb/Shrub/Sapling	250.2	28%	Natural succession of well-drained sandbar to upland shrubs and herbs
Non-ESH Sand	44.3	5%	Became terrestrialized or surrounded by forest
Forest	0.0	0%	Natural growth of shrubs into forest-sized trees
Wetland Matrix	131.6	15%	Natural succession of low-lying sandbar to hydrophytic shrubs and herbs
Shallow Water	29.9	3%	ESH lost to erosion and redistributed in local backwater shallows
Daily Inundated Sand Plain	64.5	7%	ESH redistributed to low plateaus by daily high flows from power peaking at Fort Peck Dam
Lacustrine Sediments	3.0	0%	ESH eroded; resulting high point coved by silt and clay
Total	882.9		

Figure 7-3
Change in Habitat Composition – Fort Peck River Segment



7.1.1 Impact of Fluvial Processes – Fort Peck River Segment

Fort Peck Dam is a hydropower generating facility, and uses daily power peaking to offset daily peak power demands. Mean daily variation at the Fort Peck Dam gage is approximately 0.6 feet, which declines to 0.2 feet at the Wolfe Point gage, and becomes negligible at the Culbertson gage. Much of the channel is narrow (under 1,000 feet) and designated by Biedenharn (2001) as erosional, as indicated in Table 7-3.

Table 7-3
Geomorphic Erosive and Depositional Reaches for the Fort Peck River Segment

Geomorphic Reaches - RM	Erosion		Deposition		Balance	
	Bank	Bed	Bank	Bed	Bank	Bed
GR - RM	(1980-1998) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)	(1976-1985) (m^3/yr)		
GR 1 - RM 1768-1750	-13,831	-142,964	21,761	42,929	7,930	-100,035
GR 2 - RM 1749-1753	-108,329	-238,976	93,122	30,438	-15,207	-208,538
GR 3 - RM 1712-1700	-64,803	-34,104	1,209	24,255	-63,594	-9,849
GR 4 - RM 1699-1686	-46,945	-251,561	42,889	0	-4,056	-251,561
GR 5 - RM 1685-1654	-182,203	-170,633	100,791	54,650	-81,412	-115,983
GR 6 - RM 1653-1621	-101,863	-97,388	184,369	0	82,506	-97,388
GR7&8 - RM 1620-1599	-131,167	-50,447	65,815	240,488	-65,352	190,041

Data excerpted from Biedenharn 2001

Fieldwork in 2005 and sediment sampling by Biedenharn (2001) indicated that available bedload sediments are generally finer than in other segments. Segment length is twice that of the Garrison River Segment and nearly four times the length of Gavins Point River Segment. It is a narrow segment, with riverine corridor widths averaging less than 800 feet, compared to the Gavins Point River Segment, which averages 3,000 feet in width.

7.2 Summary of Nest Data

Despite its large riparian habitat acreage, the TP DMS contains only 102 nest records for the Fort Peck River Segment. These 102 nest records span the 2001 through 2006 breeding seasons. Given this limitation in data, many of the assessments conducted for the downstream segments were found to be less useful for the Fort Peck River Segment because so few nests are distributed over a much larger riparian area.

7.3 Distribution of Nesting Habitat by NestArea

The NestArea segmentation of the nest database was prepared to group nests by location to show trends over breeding seasons. Table 7-4 shows the distribution of total nests established for both species. As shown in the table, least terns established 96 nests and piping plovers only 6 nests throughout the six-year period of analysis. The number of nests established increased each year, from one in 2001 to 23 in 2006.

Nests were clustered on available nesting-habitat distributed within only 12 river miles of the nearly 200-mile segment (indicated by the number of rows in Table 7-4). Three river mile locations (RMs 1598, 1607, and 1615) supported 75 percent of all nests established during the period of record. Two river mile locations (RMs 1598 and 1615) supported nesting-habitat for the last four years out of the six years in the analysis period. Only five sites continued to support nesting in 2006.

Table 7-4
Distribution of Least Tern and Piping Plover Nests by RM and Year

	2001		2002		2003		2004		2005		2006		Total Nests		Total
RM	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**ILT**	**PPL**	**All**
1580					3		5						8		**8**
1598			7	1	8	1	3				1		19	2	**21**
1607									5		7		12		**12**
1615					3	2	6		10	1	10	1	29	4	**33**
1637			3										3		**3**
1659			6				2						8		**8**
1665									1		1		2		**2**
1674									1				1		**1**
1690					2		4		2				8		**8**
1692											3		3		**3**
1712	1												1		**1**
1683									2				2		**2**
Total	**1**	**0**	**16**	**1**	**16**	**3**	**20**	**0**	**21**	**1**	**22**	**1**	**96**	**6**	**102**

7.4 Productive Emergent Sandbar Habitat Characteristics

As stated previously, mapped ESH in the Fort Peck River Segment declined by 72 percent from 1999 to 2005 (883 to 247 acres). The 247 acres of ESH mapped for 2005 were comprised of 142 separate polygons representing islands or habitat patches. These 2005 ESH polygons were used to select nests from the TP DMS located within the Fort Peck River Segment.

An intersection of the 1999 and 2005 ESH acres revealed that the polygons overlapped at 78 locations, which had a total area of 93 acres. It is important to note that none of these areas contained a recorded nest between 2001 and 2006. The sustained high stage from the 1997 releases was only 1.5 feet above mean stage for an extended period[46]. These two observations indicate that the 1996-1997 high-water event did not create persistent and frequently used nesting-habitat. It is more likely that the high discharge event re-set natural successional processes and mobilized sand for subsequent redistribution by more normal flows.

The 1999 and 2005 ESH polygons were intersected with the nest-point data. Three nests from the period analyzed (2001-2006) were spatially coincident with 1999 ESH polygons. All three were least tern nests established in 2002 and none were successful. The analyzed nests that were coincident with 2005 ESH polygons included one from 2004, 10 from 2005 and 12 from 2006, all of which were recorded as successful. Seventy-nine nests, 77 percent of the total, were not contained within ESH polygons in 1999 or 2005.

An intersection was performed between nests established in 2004, 2005 and 2006 and the 2005 habitat delineation. Approximately 75 percent of these nests occurred on habitat polygons mapped as ESH or as Daily Inundated Sand Plain.[47] The 2005 aerial imagery was obtained during higher flows in the early part of the breeding season. Nesting-habitat identified as Daily Inundated Sand Plain may identify either sites within the daily power-peaking pulse stage change prior to nesting activity, or areas used during prior years that have subsequently eroded. Upland natural succession had overcome 8 percent of nest sites, and erosion accounted for the loss of 17 percent of mapped nesting sites that appeared as either Shallow Water or Lacustrine Sediments in the 2005 imagery. The 2005 habitat polygons that captured nest points sum to 92 acres. Approximately seven acres were mapped as ESH and 65 acres as daily-inundated sand for 2005. A much smaller portion of each of these was used for nesting in the period of analysis.

Nesting in this segment appears to have occurred principally on sandbar habitat created through redistribution of mobilized sands by operational flows during annual high discharge periods. Temporary nesting sites were, for the most part, either inundated during a subsequent higher flow regime or redistributed by annual high flows. Similar to the Garrison River Segment, the annual peak flow of the Fort Peck River Segment occurs outside the breeding season.

The seven acres mapped as ESH for 2005 that supported a nest in the period of record is only 3 percent of the ESH mapped for that year. The remaining 240 acres may be suitable for nesting when considered from aspects of elevation and period of exposure during the breeding season.

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[46] USGS continuous stream flow gage on the Missouri at Culbertson, Montana.

[47] Section 2 describes the difficulty in delineation of boundaries between these habitat types due to the influence of daily stage changes.

7.4.1 Mapped ESH Not Used for Nesting Habitat

The phenomenon of non-use of barren sandbar for nesting by least tern and piping plover was assessed for the Gavins Point River Segment (see Section 3). Sandbar non-use was principally explained for more than 90 percent of sites by proximity to cottonwood gallery forest (or other elevated shoreline features), high flooding frequency (relative low elevation), and small habitat patch size. Thresholds derived for these factors were used in the Sensitive Features Assessment. The assessment defines potential locations in each study area segment that are most likely to support ESH management activities and attract nesting pairs. The most effectively prohibitive feature to nesting was the proximity to gallery forest canopies.

Within the Fort Peck River Segment, a distance of 550 feet from gallery forest edge was found to exclude 95 percent of all nests, using the entire 2001-2006 nest point dataset (see discussions in Section 2 and Section 3). Forest buffer polygons created using this distance for the Fort Peck River Segment sensitive features assessment were used to select 2005 ESH polygons. Of the 142 ESH polygons comprising 247 acres, only 33 were found to be fully outside the gallery forest buffer. Eight of these, accruing to 7.2 acres, supported a nest during one or more years between 2001 and 2006. Review of the GIS mapping reveled that the majority of these occurred at locations where agricultural practices had removed stream bank edge forest.

There were 57 ESH polygons completely within forest buffers within the Fort Peck River Segment. Another 20 polygons were at least 50 percent within the forest buffer. The total acreage of ESH within the buffer was found to be 212 acres (86 percent of the total ESH acreage). Twenty-five ESH polygons comprising 27 acres (11 percent of the ESH acreage), and not occurring within the forest buffer, did not support nesting. Several of these are close to other elevated features such as bridges that also restrict nesting. Other ESH polygons were in restrictive buffers for one or more anthropogenic features that also appear to restrict nesting proximity such as irrigation pumps and domiciles. The remaining 8 acres could not be explained within the existing dataset. These may be topographically too low and thus frequently flooded. They may be too small (three were less than 0.07 acres). It may be that these remaining ESH sites will be colonized in future years. Combined with the polygons that supported nests, a total of approximately 35 acres (acres that did support nesting plus areas that might support nesting) of ESH may be suitable for nesting in the 39,000-acre, 196-mile long Fort Peck River Segment.

7.5 Establish ESH Acreage Goals for PEIS Alternative 5

This analysis defines the area of measured nesting-habitat for least tern and piping plover in the Fort Peck River Segment. The results of the analysis were used to provide ESH acreage goals for the segment under Alternative 5 of the PEIS. The methodology described in Section 2 of this document was used to measure nesting-habitat on an annual and total basis for the Fort Peck River Segment. Steps in the analysis are briefly reviewed below.

1. Separate the data by year, species, and NestArea.
2. Measure distances between nests, and identify the nearest-neighbor distance for each nest.
3. Establish the radius of nesting-habitat circles for each NestArea, species, and year.
4. Establish nesting-habitat polygons for each NestArea, species, and year as the area within habitat circles, counting overlapping areas only once.

5. Combine species and year habitat circles for each Nest Area, counting overlapping areas only once. Establish acreage goals for the Fort Peck River Segment under PEIS Alternative 5 by adding the acreage for each NestArea in the segment.

Since there were only six piping plover nests established in the period of record, measured nesting-habitat area is not relevant. The average annual measured distance derived for the entire Garrison River Segment was used to estimate the area used by piping plover (151 foot habitat circle radius) under the assumption that the Garrison River Segment nest spacing average would serve as a reasonable proxy for this segment. Since birds either nested at widely separated locations or in different years, each nest is estimated to account for 1.64 acres of nesting-habitat, shown in Table 7-5.

Table 7-5
Piping Plover Measured Nesting Habitat Acres by NestArea and Year

NestArea	2002	2003	2005	2006
3Buttes: 1614.6				1.64
3Buttes: 1615.1B		1.64		
3Buttes: 1615.2		1.64		
3Buttes: 1615.6B			1.64	
Bainsville: 1598.3B	1.64	1.64		
Total	1.64	4.93	1.64	1.64

Table 7-6 shows the measured nesting-habitat acreage used by least terns. The average annual acreage used by least tern for the period record is 3.52 acres for the entire Fort Peck River Segment.

Table 7-6
Least Tern Measured Nesting Habitat Acres by NestArea and Year

	YEAR								
NestArea	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**	**Year Count**	**IV**
Bainsville: 1598.3B		0.16	0.20	2.18		1.01	0.89	4	3.55
Chelsea: 1692.2						2.84	2.84	1	2.84
Sprole: 1664.6					1.01	1.01	1.01	2	2.01
Buford: 1580.4				1.79			1.79	1	1.79
Buford: 1580.3B				1.71			1.71	1	1.71
Poplar: 1673.6					1.01		1.01	1	1.01
Poplar: 1682.9					1.01		1.01	1	1.01
Poplar: 1683.0					1.01		1.01	1	1.01
Nickwall: 1689.7			0.15	0.31	0.45		0.30	3	0.91
3Buttes: 1615.0A				0.79			0.79	1	0.79
Buford: 1580.3A			0.48	0.27			0.38	2	0.75
3Buttes: 1615.0C				0.75			0.75	1	0.75
Nickwall: 1689.6					0.45		0.45	1	0.45
3Buttes: 1615.2			0.36				0.36	1	0.36
3Buttes: 1615.6B					0.33		0.33	1	0.33
Bainsville:1 598.3A				0.30			0.30	1	0.30
Cedar Coulee: 1606.7					0.10	0.19	0.14	2	0.28
3Buttes: 1614.6						0.27	0.27	1	0.27
3Buttes: 1615.6A					0.23		0.23	1	0.23
Mortarstone Bluff: 1659.1				0.22			0.22	1	0.22
Cedar Coulee: 1606.8						0.22	0.22	1	0.22
3Buttes: 1615.0B				0.13			0.13	1	0.13
Wolf Point: 1712.2	0.09						0.09	1	0.09
Mortarstone Bluff: 1659.2		0.06					0.06	1	0.06
2Mile Ck: 1636.7		0.03					0.03	1	0.03
3Buttes: 1615.1A				0.02			0.02	1	0.02
Mortarstone Bluff: 1659.3		0.00					0.00	1	0.00
Total	0.09	0.26	1.21	8.48	5.58	5.53	3.52		
Active NestAreas	1	4	4	11	9	6	6		
Active Nest Count	1	16	16	20	21	23	16		

Measured nesting-habitat acreages were calculated to determine the total acreage used for nesting by each species for the period of record at all nesting sites. The entire acreage used for nesting by piping plover was 8.98 acres. Least tern utilized a total of 19.2 acres. A second and final procedure combined nesting sites for least tern and piping plover to estimate the entire area used by both species during the period of record. The measured nesting-habitat usage area for least tern and piping plover is 26.58 acres.

The measured nesting-habitat acreages compare well with the habitat mapping assessment using 2005 polygons, and the acreage estimated to be usable for nesting. The area of sandbar islands mapped for 2005 that supported nests was 7.2 acres, which compares favorably with the 7.22 acres for combined least tern and piping plover measured nesting-habitat acreage for that year. The estimate based on the summary of unencumbered acres (those completely outside of restrictive areas and exclusionary zones) and separated from the shoreline during the breeding season, was 35 acres. This area is large enough to include the 26.28 acres of least tern and piping plover nesting-habitat estimated as the total area used for nesting for all years of record by the measured nesting-habitat method. The area of sandbar supporting nesting and the 2005 polygons (all habitats except open water) overlap with the residual area outside all restrictions and exclusionary zones described in 7.4.1. The measured nesting-habitat acreages are fully within all three of these areas.

The similarities of nesting-habitat estimations and the spatial coincidences between mapped ESH area and estimated ESH build zones suggests that the Fort Peck River Segment has limited ability to support ESH. The distribution of nesting-habitat over time demonstrates that nesting-habitat is being created and lost each year.

7.6 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defines those areas most suitable for ESH construction and maintenance, as well as those areas that if used would result in potentially significant impacts to either the natural or manmade environment. This process of eliminating areas that should be avoided leaves the remaining areas as the most suitable for ESH construction and maintenance for the Fort Peck River Segment. These areas include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment. The steps involved in conducting this analysis are explained in detail in Section 2 of this document, and are outlined below.

5. Solicit input on sensitive resources and buffer distances from affected states and agencies;
6. Create an anthropogenic features dataset from aerial imagery;
7. Establish the separation distance between nesting habitat and anthropogenic features; and
8. Establish the minimum flow channel, channel width restrictions, and define the predator moat area;

The result of the analysis is a set of spatial restrictions that categorize the riverine corridor acreage into three categories. These categories are listed below.

4. **Exclusion Areas** are locations at which ESH could not be constructed because intrusion into these locations could cause significant geomorphic alterations to the river corridor. Such an intrusion would risk physical and economic damages to public and private infrastructure or land uses. Exclusion areas include the estimated minimum flow way for

normal flowage (i.e., the thalweg), narrow channel reaches, and areas needed to provide a predator moat.

5. **Restrictive Areas** are locations at which ESH could be constructed and maintained at relatively low physical risk, but could put nesting habitat in areas at risk from predation, recreation encroachment, or locations otherwise limited for nesting use and productivity. Areas of limited usability are those areas defined by analysis of distances from features that have shown to be restrictive to nest establishment or nest success.

6. **Available Areas** are locations that are most suitable for the construction and maintenance of ESH. However, it is important to note that any construction activities would need to ensure that other high-interest features (e.g., archeological and cultural resources, or other protected species) would be avoided.

The acreage for Restrictive Areas, and Available Areas is summarized by habitat type for the Fort Peck River Segment in Table 7-7. It is important to note that Available Area acres is a subset of Restrictive Area acres.

Table 7-7
Residual Available Area for ESH Construction: Fort Peck River Segment

Habitat Type	Acres 2005	Restrictive Area Acres	Available Area Acres
Open Water	17,120	4,497	1,646
Emergent Sandbar Habitat	247	193	101
Herb-Shrub-Sapling	8,341	5,902	1,171
Non-ESH Sand	399	266	64
Riverine Forest	3,796	3,125	39
Active Agricultural Row Crop	337	268	35
Wetland Matrix	4,326	2,877	0
Shallow Water	2,481	1,453	384
ESH Maintenance/Creation Test Areas	7	6	3
Daily-Inundated Sand Plains	1,770	1,015	341
Lacustrine Fine Sediments	185	153	40
Total	**39,009**	**19,753**	**3,825**
Percent		**51%**	**10%**

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8 Summary of Findings and Comparisons

This section presents summary observations from analysis, data collection, and investigations of the characteristics of riverine habitat conducted between 2004 and 2006 for the five study area segments of the upper Missouri River. In addition, the analyses provide initial guidance for implementation of the Emergent Sandbar Habitat Creation and Maintenance Program. Summary findings and observations are provided within this section under five major headings, which are provided below.

1. Habitat Delineation Summary;
2. Comparisons to Previous Study Area Habitat Delineations;
3. The Effect of River Stage on Habitat Delineation;
4. Measures of Population Productivity; and
5. ESH Construction and Maintenance Program Considerations.

8.1 Habitat Delineation Summary

Ten separate habitat delineations[48] were performed to define and measure the habitat in nearly 400 miles of riverine environment totaling approximately 116,000 acres (181 square miles) within five designated segments of the Missouri River.

Table 8-1 shows the results from the habitat delineations conducted for both years for each of the five study area segments. The ESH acreage measured was used to establish the acreage goals for Alternatives 3 and 4 in the PEIS. The 6,754 acres of ESH delineated in all five study area segments from the 1998/1999 imagery established acreage goals for Alternative 3 of the PEIS. The 1,985 acres of ESH delineated in all five study area segments from the 2005 imagery established acreage goals for Alternative 4 of the PEIS. As shown in the table, each of the study area segments incurred a substantial decrease in ESH acreage. Over 6,700 acres of ESH were delineated from the 1998/1999 imagery, which was reduced to about 2,000 acres of ESH delineated from the 2005 imagery. The table also shows that gains in acreage for the entire study area occurred in the following habitat types: Agriculture Row Crop (280 acres), Daily Inundated Sand Plain (1,560 acres), Riverine Forests (765 acres), Herb/Shrub/Saplings (5,122 acres), Lacustrine Fine Sediments (185 acres), and Wetland Matrix (1,625 acres).

Table 8-2 provides a summary of the acreage in each of the habitat classification types for both delineation years over the entire study area. The table also provides a brief description of the processes that influenced the habitat acreage changes.

[48] Two separate years for each of the five study area segments.

Table 8-1
Acreage Summaries by Habitat Type and Segment for 2005 and 1998/1999

Habitat Name	Imagery Year	Gavins Point River Segment	Lewis and Clark Lake Segment	Fort Randall River Segment	Garrison River Segment	Fort Peck River Segment	Total
Active Agricultural Row Crop	1998/1999	54	91	20	29	93	287
	2005	77	147	60	94	190	568
Anthropogenic Features	1998/1999	0	0	0	0	0	0
	2005	0	0	10	0	0	10
Daily Inundated Sand Plain	1998/1999	0	431	478	1,711	1,600	4,220
	2005	0	380	1,370	2,257	1,770	5,777
Emergent Sandbar Habitat	1998/1999	2,944	566	295	2,066	883	6,754
	2005	880	142	128	588	247	1,985
Riverine Forest	1998/1999	3,425	254	1,014	650	3,204	8,547
	2005	4,325	247	859	927	2,954	9,312
Herb/Shrub/Sapling	1998/1999	1,498	599	1,405	2,798	7,122	13,422
	2005	2,391	919	2,164	4,977	8,093	18,544
ESH Creation Test Area	1998/1999	0	0	0	0	16	16
	2005	0	0	0	0	7	7
Lacustrine Fine Sediments	1998/1999	0	0	0	0	0	0
	2005	0	0	0	0	185	185
Non-ESH Sand	1998/1999	2,208	259	327	1,306	676	4,776
	2005	256	20	120	480	399	1,275
Open Water	1998/1999	11,893	3,270	5,639	12,951	17,714	51,467
	2005	12,678	3,684	4,926	12,237	17,135	50,660
Shallow Water	1998/1999	1,290	3,666	2,931	1,856	2,474	12,217
	2005	1,932	3,222	2,470	2,137	2,405	12,166
Wetland Matrix	1998/1999	144	7,570	1,505	1,059	3,791	14,069
	2005	688	8,397	1,684	822	4,102	15,693
1998/1999 Total		23,456	16,706	13,615	24,427	37,573	115,777
2005 Total		23,228	17,157	13,790	24,518	37,487	116,180

Table 8-2
Summary of Acres Changed by Habitat Type for All Segments Combined

Habitat Name	Total Acres 1998/1999	Total Acres 2005	Interpretation/Comment
Active Agricultural Row Crop	287	568	Slight increases in use of the riverine corridor for agriculture have occurred over the past nine years.
Anthropogenic Features	0	10	Slight increases in use of the riverine corridor for other anthropogenic uses have occurred over the study period.
Daily Inundated Sand Plain	4,220	5,777	Power-peaking in the upper study area segments redistributed ESH locally around persistent sandbars and islands.
Emergent Sandbar Habitat	6,754	1,985	Sediments mobilized and deposited by the extended duration high-flow releases have been reduced by the processes of erosion and vegetation encroachment. Some sediments have redeposited at lower elevations by subsequent high-water events. Some volume of sediment has been swept from the reaches downstream to lakes or to the navigation channel below the Gavins Point River Segment.
Riverine Forest	8,547	9,312	Areas previously classified as Herb-Shrub-Sapling habitat have grown sufficiently to be reclassified as forest habitat.
Herb-Shrub-Sapling	13,422	18,544	Vegetation encroachment of formerly barren areas has occurred through natural succession for both upland and wetland habitats.
ESH Creation Test Area	16	7	The effects of the vegetation control trials observable in 1998 have been reduced through natural succession.
Lacustrine Fine Sediments	0	185	Nearly nine years of drought since 1997 lowered Lake Sakakawea levels, exposing silt-clay lacustrine plains in the lower part of the Fort Peck River Segment.
Non-ESH Sand	4,776	1,275	Terrestrialized areas of barren sand have eroded into the river and/or succumbed to vegetation encroachment for both upland and wetland habitats.
Open Water	51,467	50,660	Open Water declines are due to redistribution of sediments from banks, islands, and sandbars to Shallow Water and Daily Inundated Sand Plain habitats.
Shallow Water	12,217	12,166	Slight change in shallow water area suggests that the energetics of the various segments have changed little, retaining a similar sediment retention capacity following the 1997 releases.
Wetland Matrix	14,069	15,693	Hydrophytic community succession has naturally proceeded, particularly in the Lewis and Clark Lake Segment. The most dramatic change however occurred in the Gavins Point River Segment.
Total	115,777	116,180	Minor, incremental bank erosion along the lengths of all segments has increased the total area of riverine habitats within the high banks.

Table 8-3 shows a comparison of percent habitat composition by segment, and provides a normalized comparison among the study area segments. As shown on the table, ESH measured in the 2005 imagery was approximately 30 percent of the ESH measured in the 1998/1999 imagery.[49] The direction and magnitude of changes in habitat composition among the segments indicates differences in the fate of ESH measured from 1998/1999 imagery – changes in ESH are controlled by both natural and induced influences that dominate each study area segment. Conclusions that can be drawn from Table 8-3 include:

- ESH acreage lost from the Gavins Point River Segment was converted to wetlands, herbaceous upland vegetation and shallow water;
- ESH acreage lost in the Lewis and Clark Lake Segment was colonized by vegetation and converted to upland and wetland vegetation, with little material redistribution occurring;
- ESH acreage lost in the Fort Randall River Segment eroded into lower-elevation shallow plateaus, due to the segment's low energy and influence from daily power-peaking; and
- ESH acreage lost in the Garrison River Segment and Fort Peck River Segment eroded primarily from the upstream reaches of the segments.

Table 8-3
Comparison of Percent Habitat Composition by Segment

Habitat Name	Imagery Year	Gavins Point	Lewis and Clark	Fort Randall	Garrison	Fort Peck	Total
Active Agricultural Row Crop	1998/1999	0.23%	0.54%	0.15%	0.12%	0.25%	0.25%
	2005	0.33%	0.86%	0.44%	0.38%	0.51%	0.49%
Anthropogenic Features	1998/1999	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	2005	0.00%	0.00%	0.07%	0.00%	0.00%	0.01%
Daily Inundated Sand Plain	1998/1999	0.00%	2.58%	3.51%	7.00%	4.26%	3.65%
	2005	0.00%	2.21%	9.93%	9.21%	4.72%	4.97%
Emergent Sandbar Habitat	1998/1999	12.55%	3.39%	2.17%	8.46%	2.35%	5.83%
	2005	3.79%	0.83%	0.93%	2.40%	0.66%	1.71%
Riverine Forest	1998/1999	14.60%	1.52%	7.45%	2.66%	8.53%	7.38%
	2005	18.62%	1.44%	6.23%	3.78%	7.88%	8.02%
Herb/Shrub/Sapling	1998/1999	6.39%	3.59%	10.32%	11.46%	18.96%	11.59%
	2005	10.29%	5.36%	15.69%	20.30%	21.59%	15.96%
ESH Creation Test Area	1998/1999	0.00%	0.00%	0.00%	0.00%	0.04%	0.01%
	2005	0.00%	0.00%	0.00%	0.00%	0.02%	0.01%
Lacustrine Fine Sediments	1998/1999	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	2005	0.00%	0.00%	0.00%	0.00%	0.49%	0.16%
Non-ESH Sand	1998/1999	9.41%	1.55%	2.40%	5.35%	1.80%	4.13%
	2005	1.10%	0.12%	0.87%	1.96%	1.06%	1.10%
Open Water	1998/1999	50.70%	19.57%	41.42%	53.02%	47.15%	44.45%
	2005	54.58%	21.47%	35.72%	49.91%	45.71%	43.60%
Shallow Water	1998/1999	5.50%	21.94%	21.53%	7.60%	6.58%	10.55%
	2005	8.32%	18.78%	17.91%	8.72%	6.42%	10.47%
Wetland Matrix	1998/1999	0.61%	45.31%	11.05%	4.34%	10.09%	12.15%
	2005	2.96%	48.94%	12.21%	3.35%	10.94%	13.51%

[49] Total ESH as a percent of total habitat change from 1998/1999 to 2005: 5.83 % reduced to 1.71%.

8.1.1 System Responses to the 1996-1997 High Flows

The 1996-1997 high-flow releases maintained higher than normal stage throughout the five study area segments for more than 180 days. Extensive sand depositions created during this event prompted increases in least tern and piping plover populations and productivity, which were most notable in the Gavins Point River Segment (see Attachment 3 for details).

The 1996-1997 high flow releases were experienced very differently in the various study area segments. While the Gavins Point River Segment had experienced a flow driven stage 5 to 8 feet above breeding season normal, the other segments appear to have been subject to high flows from 0.5 to 3 feet above normal.[50] The Lewis and Clark Lake Segment and the Fort Randall River Segment each experienced stages of 0.5 to 1.7 feet above mean stage. This range is less than the daily power peaking stage range for Fort Randall River Segment (0.7 to 4.0 feet). The Garrison River Segment experienced a 2 to 3 feet increase in stage during the high-flow period. A great amount of sand was likely mobilized in these upper segments due to the duration of high water surface elevations. However, the majority of the sand appears to have created extensive shoals of daily-inundated sand plain, succumbed to wetland vegetation or been eroded and washed downstream.

In the Gavins Point River Segment, much of the habitat formed was lost to erosion and natural vegetation succession. Erosion was the most dominant cause of ESH loss in all five study area segments except the Lewis and Clark Lake Segment, where the relatively low-lying sand accumulations were colonized by cattails, cottonwoods and willows. The Gavins Point releases that exceeded 45,000 cfs for approximately 30 days in the winter of 1999, and again in the winter of 2000 appear to have eroded and redistributed sand. A number of small, relatively low elevation sandbars were created in the lower portion of the segment – these bars briefly supported nesting. As a result of rapid erosion, the area of sand presumably visible in early 1998 was noted to have declined 75 percent by 2002 (BiOp 2003, Vander Lee 2004) in the Gavins Point River Segment. Approximately 550 acres of ESH that was suitable for nesting remained in the segment (Vander Lee; 2003, 2004). The area of elevated, barren sand located in flow-protected portions of the river remained approximately the same from 2001 to 2005, although vegetation succession had began to reduce the area suitable for nesting by 2003.

ESH acreage declined significantly between 1998 and 2005, with losses ranging between 60 percent and 75 percent among the study area segments. A comparison of the habitat acreage findings in Tables 8-1 through 8-3 above illustrates the systematic stabilization responses, by segment, to the perturbations of the 1996-1997 high releases.

8.2 The Effect of River Stage on Habitat Delineation

The Fort Peck River Segment, the Garrison River Segment, the Fort Randall River Segment, and the Lewis and Clark Lake Segment experience a daily change in stage from about 0.5 feet to more than 5 feet because of changes to releases associated with daily peak power generation. This stage change repeatedly inundates and exposes low elevation sandbars. As such, the time of day when the aerial imagery is captured is essential information for the development of an accurate ESH acreage estimate. Slopes of many low elevation sandbars were measured to be less than 1 percent, which means that a 0.5-foot increase in river stage would move the waterline 50 feet up the sandbar

[50] Duration and stage data are assessable using readily available from USGS continuous stream flow gages located throughout each segment.

slope. The reaches affected by this daily ebb and flow show acreages of the Daily Inundated Sand Plain habitat type.

Comparisons between habitats delineated from aerial imagery obtained at different times cannot be reliably compared unless differences in stage are known. Differences in stage during aerial image capture can profoundly affect the acreage estimates of habitats that exist at the lower elevations of a sandbar. For example, Table 8-4 provides both daily flow volume and stage measured from stream gages located within each segment for the day the photographs were acquired. These data illustrate the potential effect of river stage on habitat delineation.

The areal extent of Lacustrine Fine Sediments, Non-ESH Sand, Open Water, Shallow Water, and Wetland Matrix would be most affected by these differences Other spatial measurements, including elevation data, could be used to correct for stage differences between photo sets in order to accurately measure habitat and evaluate trends.

Table 8-4
Flow and Stage for Day of Aerial Photograph Acquisition

Segment & Gage	Year	Date	Flow (cfs)	Stage (feet)
Gavins Point River Segment Gage: Maskell, NE	1998	05/04/1998	26,000	22.5
	1999	06/16/2000	34,000	23.6
	1999	07/07/1999	38,400	24.6
	2000	08/09/2000	31,500	23.3
	2005	06/15/2005	21,000	21.6
	2005	06/17/2005	21,000	21.6
Fort Randall River Segment Lewis and Clark Lake Segment Gage: Springfield, SD	1998	05/04/1998	22,000	6.94
	2005	06/15/2005	14,800	8.17
	2005	06/18/2005	14,700	8.13
	2005	07/07/2005	20,000	7.44
Garrison River Segment Gage: Washburn, ND	1998	05/03/1998	20,100	11.12
	2005	07/05/2005	15,100	10.04
	2005	07/06/2005	15,200	10.05
Fort Peck River Segment Gage: Culbertson, MT	1998	09/02/1998	10,912	6.05
	1999	07/07/1999	10,100	5.09
	2005	06/25/2005	5600	4.53
	2005	07/01/2005	5200	4.16

8.2.1 Gavins Point River Segment

The 1998 and 2005 acreage findings for the Gavins Point River Segment are reasonably comparable for ESH, Non-ESH Sand, and Wetlands, while the actual extent of Shallow Water is probably over-represented for 2005 due to a slightly lower stage than 1998. The 1998 flow is 5,000 cfs higher than the 2005 flow; but the stage differences across the segment may be less than 1 foot (0.9 feet measured at the Maskell gage).

Most sandbars in the Gavins Point River Segment have a 1:1 or greater slope near the waterline[51]. Most of the distance around the perimeters creates a small step (0.5 to 2.0 feet). Therefore, a stage

[51] Derived from the 2005 LiDAR, topographic surveys, and field observations in 2005 and 2006.

difference of less than one foot would have little effect on acreage estimates. Most persistent wetlands visible in early summer support vegetation that is taller than one foot, which is visible at either stage. Shallow water would be relatively more visible in 2005, since it is observed and delineated through standing water – any difference between years for this type can be explained by the difference in stage.

8.2.2 Fort Randall River Segment / Lewis and Clark Lake Segment

The stage difference for the Fort Randall River Segment and the Lewis and Clark Lake Segment taken together averages 0.96 feet. It is likely the Wetlands Matrix and Open Water acreage comparisons are reliable for both segments, while Non-ESH Sand, Daily Inundated Sand Plain, and Shallow Water are over-represented in 2005. Since remaining ESH in the Lewis and Clark Lake Segment would be found on the raised Niobrara Delta islands, stage-area relationships are probably not greatly affected by the year-to-year differences. Many of the Fort Randall River Segment sandbars are very gradual in cross-section, lacking the “step” often seen in the Gavins Point River Segment.

8.2.3 Garrison River Segment

Stage differences between imagery years for the Garrison River Segment roughly one foot. The time of day (morning) suggests that power-peaking was not occurring. A higher water level in 1998 would have under-represented ESH, Non-ESH Sand, and Daily Inundated Sand Plain as compared to the 2005 imagery. The losses to lower elevation habitat types resulting primarily from erosion are probably greater in 2005 than could be measured because the higher stage in 1998 would have concealed these habitat types.

8.2.4 Fort Peck River Segment

The problems with the Fort Peck River Segment delineations, discussed in Section 7, indicate a significant stage difference between 1998, 1999, and 2005 imagery. Due to a higher stage in 1998, the 1999 imagery likely represents a greater amount of ESH and other low-lying habitat types than was available in the previous year. Due to stage difference, comparison of the 1999 and 2005 delineations likely underestimates the actual amount of ESH lost to erosion.

8.3 Comparisons to Previous Study Area Habitat Delineations

Results from three previous habitat delineation efforts were compared to the delineation results presented in this PEIS support document.[52] Results from the delineations presented in this document were first compared to the 2015 RPA[53] goals from the 2003 BiOp Amendment. Delineations of study area segments conducted as part of geomorphological assessments related to bank stabilization were then compared to the PEIS delineations. The third comparison was to delineations conducted for the Gavins Point River Segment on behalf of the Omaha District’s Threatened and Endangered Species Section.

8.3.1 Comparison of PEIS Delineations to 2015 RPA Goals

In order to comply with the 2015 RPA goals from the 2003 BiOp Amendment, the Corps must create and maintain approximately 12,000 acres of ESH within the five study area segments. The

[52] Delineations presented in this document are referred to as PEIS Delineations.
[53] RPA: Reasonable and Prudent Alternative.

BiOp states that the Corps is to provide "tern and plover habitat as seen on Segments 4, 8, 9 and 10 in 1998".[54] Table 8-5 provides a comparison of the 2015 RPA goals[55] and 1998/1999 ESH acreages delineated for the PEIS. Table 8-6 shows the differences between the 2015 RPA goals and the PEIS delineation of the 1998/1999 imagery on an acre per river mile basis.

Table 8-5
2015 RPA Goals Compared to PEIS Delineation of 1998/1999 Imagery
Total Acres

Segment	2015 RPA Objective (acres)	PEIS ESH 1998/1999 (acres)	Difference (acres)
Gavins Point River Segment	4,648	2,944	1,704
Lewis and Clark Lake Segment	1,360	566	795
Fort Randall River Segment	700	295	405
Garrison River Segment	4,295	2,066	2,229
Fort Peck River Segment	883	883	N/A
Total Acres	11,886	6,754	5,132

Table 8-6
2015 RPA Goals Compared to PEIS Delineation of 1998/1999 Imagery
Acres per River Mile

Segment	Segment Length (RM)	2015 RPA Objective (acres / RM)	PEIS ESH 1998/1999 (acres / RM)	Difference (acres / RM)
Gavins Point River Segment	58.1	80	50.7	29.3
Lewis and Clark Lake Segment	16.9	80	46.7	33.3
Fort Randall River Segment	35.0	20	8.4	11.6
Garrison River Segment	86.1	50	25.0	25
Fort Peck River Segment	203.5	4.3[56]	4.3	N/A

In an effort to reconcile the differences between the 2015 RPA goals and the ESH measured from the 1998/1999 imagery for the PEIS, segment-specific habitat delineation summary data from the

[54] Segment 4: Garrison River Segment , Segment 8: Fort Randall River Segment, Segment 9: Lewis and Clark Lake Segment, Segment 10: Gavins Point River Segment.
[55] The Fort Peck River Segment goals were not prescribed in the 2015 RPA goals.
[56] 2015 RPA objective based on PEIS delineation of 1999 imagery.

2000 BiOp were examined. Table 8-7 below shows acreage totals for three different types of delineated habitats from the 2000 BiOp[57]. Footnotes to the table in the 2000 BiOp state that the figures represent "all interchannel emergent habitat on the described segments", and that the data are based on information received from the Corps in 2000.

Table 8-8 shows a comparison of the 2015 RPA Goals, PEIS delineation of ESH from 1998/1999 imagery, and dry sand from Table 19 of the 2000 BiOp. As shown in the table, the acreage totals for the 2000 BiOp delineation of dry sand compare favorably to the PEIS delineation of ESH from the 1998/1999 imagery.

Table 8-7
1998 Habitat Delineation Data Excerpted from 2000 BiOp Table 19

Segment	River Miles	Dry Sand (acres)	Wet Sand (acres)	Vegetation (acres)	Total (acres)
Gavins Point River Segment	58.0	2,749	1,076	2,104	5,930
Lewis and Clark Lake Segment	19.1	671	762	9,132	10,565
Fort Randall River Segment	35.0	305	289	1,110	1,704
Garrison River Segment	85.9	2,338	1,219	1,045	4,602

Table 8-8
Comparison of 2015 RPA Goals, PEIS Delineation ESH for 1998/1999, and 2000 BiOp Table 19 Dry Sand

Segment	2015 RPA Goals (acres)	PEIS ESH 1998/1999 (acres)	Dry Sand 2000 BiOp (acres)	Difference (acres)
Gavins Point River Segment	4,648	2,944	2,749	195
Lewis and Clark Lake Segment	1,360	566	671	-105
Fort Randall River Segment	700	295	305	-10
Garrison River Segment	4,295	2,066	2,338	-272

8.3.2 Biedenharn Delineations

Within Biedenharn's 2001 report on geomorphology, the results of measuring interchannel sandbar habitat for portions of four of the five study area segments was presented.[58] This study included a

[57] 2000 BiOp Table 19: Least Tern and Piping Plover Habitat Acreage on Selected Missouri River Segments during 1996 and 1998.

[58] Biedenharn, D.S. et al. 2001. Missouri River – Fort Peck Dam to Ponca State Park Geomorphological Assessment Related to Bank Stabilization. Prepared for the Corps of Engineers Omaha District. ERDEC, Coastal and Hydraulic Laboratory. 3909 Halls Ferry Road, Vicksburg, MS 39180.

multi-year, GIS-based analysis of the locations, distribution, and area of inter-channel sandbar. Table 8-9 shows the measured area of ESH reported by Biedenharn for these river segments, and the area of ESH delineated for the PEIS from 1998/1999 imagery. However, while comparisons of year-to-year differences between delineations may identify trends in habitat changes, interpretation of the differences can lead to erroneous conclusions.

Table 8-9
ESH Delineated for Four Separate Years Within Four Study Area Segments

Segment	* Length Delineated (Miles)	1974/76 Delineated ESH (Acres)	1990/94 Delineated ESH (Acres)	1997/98 Delineated ESH (Acres)	1998/1999 PEIS ESH (Acres)
Fort Peck River Segment	174	92	155	183	883
Fort Randall River Segment	37	977	91	224	295
Garrison River Segment	75	790	771	760	2066
Gavins Point River Segment	60	405	270	772	2944

* The length of delineated segments in Biedenharn differs slightly from the study area segment lengths.

Differences in water surface elevation at the time of aerial image capture have a profound effect on the areal extent of habitat types delineated. For example, the differences in discharge at the time of aerial imagery capture shown in Table 8-10 translate to differences in stage of about 3 feet in Fort Peck River Segment, 4 to 5 feet in the Garrison River Segment, 2 feet in the Fort Randall River Segment and more than 5 feet in the Gavins Point River Segment. These stage differences limit the confidence with which year-to-year comparisons can be made because only the ESH at the highest elevations would be visible in all years for all study area segments.

Table 8-10
Discharge on Date of Aerial Imagery Capture: Biedenharn Analysis

Segment	Date of Aerial Imagery Capture	Discharge (cfs)
Fort Peck River Segment	08/16/74	12,219
	10/26/90	7,910
	09/02/98	10,912
Garrison River Segment	10/10/76	13,384
	10/25/90	10,312
	08/05/97	50,006
Fort Randall River Segment	10/17/76	37,999
	05/04/94	29,488
	08/28/98	28,287
	08/29/98	28,887
Gavins Point River Segment	06/06/81	31,995
	05/05/94	30,618
	08/08/97	64,520
	08/21/97	65,120

8.3.3 Vander Lee Delineations

Bruce Vander Lee, a contractor with the Omaha District, performed least tern and piping plover database management and habitat delineations of the Gavins Point River Segment. He employed a raster-based supervised classification program to delineate riverine islands and sandbars. Polygon features were created of islands and sandbars, with numerical attributes used for differentiating between forested and non-vegetated, and between terrestrialized and interchannel features. Delineations were performed using imagery collected in 1996, 1998, 1999, and 2000. File creation dates for GIS data were from late 2002 to early 2003, and some of the findings were included in the 2003 BiOp Amendment. The text provided below from page 110 of the 2003 BiOp Amendment cites this work.

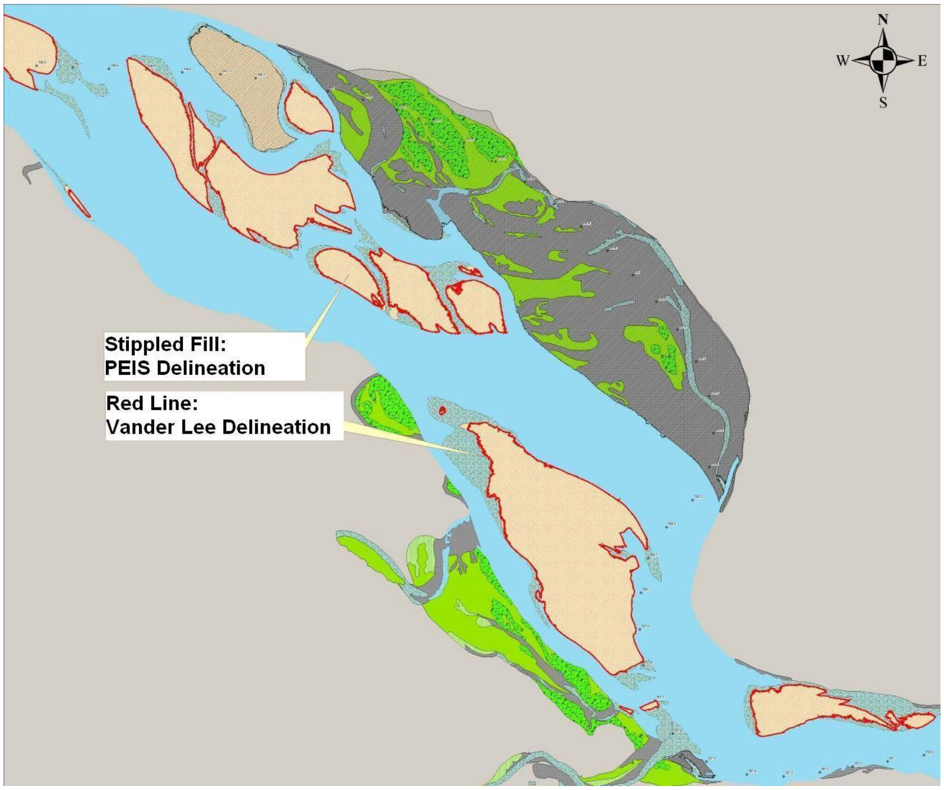
> The maximum acreage of habitat with the lowest extent of vegetated sandbars (approximately 3,000 acres) occurred in 1998 and has gradually declined since. Of the current 1,760 acres of total emergent sandbar habitat, 1,168 acres (67 percent) is more than 10 percent vegetated, leaving 582 acres of potential nesting habitat (less than 10 percent vegetated) below Gavins Point Dam. However, 322 of these acres are small, low elevation sandbars that do not provide suitable nesting habitat (B. Vander Lee pers. com. 2003). The remaining 260 acres is higher, unvegetated sandbars. These 260 acres provide the primary suitable nesting habitat below Gavins Point Dam (B. Vander Lee pers. com. 2003).

Mr. Vander Lee divided the Gavins Point River Segment into 12 sub-segments for classification. Raster-based aerial images were classified as habitats using some spectral signature grouping or pattern recognition software. Converted grids were simplified and merged by type into shapefiles. Sub-segment polygon sets were combined into shapefiles for the entire Gavins Point River Segment, and coded as either forested or non-forested habitat, and interchannel or terrestrialized habitat.

The Vander Lee 1998 habitat delineations were conducted using the same imagery that was used for the PEIS 1998 delineation of the Gavins Point River Segment, and a comparison was made between the two delineations.

The Vander Lee delineation consisted of 186 polygons, which overlaid 220 of 240 PEIS delineation polygons; overall acreage differed by only 39 acres, a difference of less than 0.2 percent. The PEIS delineation classified pools and minor chutes as Shallow Water, whereas, Vander Lee usually delineated these habitats as sandbar. Also, Vander Lee sometimes included small patches of dense vegetation with delineated ESH, while the PEIS delineation classified small patches of dense vegetation as separate habitats. Figure 8-1 overlays a portion of the PEIS and Vander Lee delineations of the Gavins Point River Segment, which shows that differences are minor; the separate delineations depict the same basic area.

Figure 8-1
Overlay of PEIS and Vander Lee 1998 Delineations
Gavins Point River Segment



8.4 Measures of Population Productivity

The RPA 2015 acreage goals require the creation and maintenance of a fixed number of acres of ESH for each study area. Findings suggest that substantially less ESH than is required by RPA 2015 goals may be sufficient.

In the Gavins Point River Segment, measurements and inter-year comparisons showed that 2,100 acres of ESH delineated from 1998 imagery were lost to natural processes or inundation when compared to ESH delineated from 2005 imagery. At the same time, only 172 additional acres of ESH were accrued (12:1 lost to gained ESH ratio). The overall ESH losses (2,996 acres down to 880 acres) represent a 70 percent reduction. During this same period, 2,910 nests were recorded in the Gavins Point River Segment, which represents a 280 percent increase in nest numbers between 1999 and 2006. Additionally, nearly 75 percent of all nests and 72 percent of successful nests (2,168 nests) identified between 1999 and 2006 were located within the same 490 acres of ESH exposed in 1998, and delineated from the 2005 imagery.

The loss of ESH was not at a uniform rate over the period of analysis. ESH acreage had significantly declined by the time aerial imagery was captured in 2000 (Vander Lee, unpublished data cited in the 2000 BiOp), yet the 2000-2003 reproductive data showed increases in adult population, nest establishment, and the running average fledge ratios met required goals. ESH acreage was substantially less than that required by the 2015 RPA goals.

Fledgling productivity from constructed ESH sites was high. The observation by Corps monitoring crews in 2004 that three constructed ESH sites (Ponca complex – area of less than 30 acres) had "carried the reach" for least tern in terms of all reproductive measurements, particularly fledge ratios (Pavelka 2004).

Statistical analyses showed that overall ESH acreage did not correlate with nesting use, nest numbers, or nest density.

Analyses were conducted using TP-DMS data, segment fledge ratios, topographic data, and delineations of habitat from multiple aerial image sets. This assessment is found in Attachment 2 – Indices of Reproduction. Reproductive measurements (nests, chick counts, fledged birds, and fledge ratios) and measured acres of ESH were not statistically correlated. ESH was measured for the Gavins Point River Segment from aerial imagery collected at various river stages in 1996, 1998, 1999, 2000, and 2005.

Between 2001 and 2006, the Gavins Point River Segment and the Garrison River Segment accounted for 77 percent and 88 percent of all least tern and piping plover nests established in the five study area segments. Segment-specific data summaries for the Gavins Point River Segment include additional data from 1999 and 2000, since high-quality GPS productivity data are were available for Gavins Point back to 1999 but only to 2001 for the Garrison River Segment. This time scale illustrates the relative importance of individual sandbars to least tern and piping plover reproduction during the period following the 1996-1997 releases, the ensuing period of erosion and sandbar habitat loss through natural succession, and several years of mechanical habitat creation efforts by the Corps (2004 - 2005).

Within each segment, adult census counts, nest counts, successful nest counts, and fledgling counts were summarized for selected NestAreas. Within the nesting season, three count metrics (nests, successful nests, and fledglings) are sequentially related; since nests precede successful nests, and successful nests precede fledglings. Because the fourth metric, adult counts, was obtained from the adult census, adult counts were anticipated to be most closely related to total nests, then successful nests, and then to a lesser degree, fledglings. To examine relationships among metrics within this temporal framework, a series of regression models were constructed (see Attachment 2: Indices of Reproduction) to examine the extent to which each metric was predictive of the next population metric in the sequence.

Counts of successful nests should strongly predict counts of fledglings, unless there is considerable chick mortality. A regression with nests as the independent variable and fledglings as the dependent variable would then illustrate the combined effects of nest mortality and chick mortality on total number of fledglings. NestAreas with higher or lower than average nest mortality during the incubation period should have large residual values in the regression with nests as the independent variable and successful nests as the dependent variable. Similarly, NestAreas with higher or lower than average chick mortality during the chick rearing period should have large residual values in the regression with successful nests as the independent variable and fledglings as the dependent variable.

Regressions of both log-transformed and un-transformed data (which excluded low-count sandbar NestAreas) were all highly significant (all P values <0.0046, most P values <0.0001) and strongly predictive (all R^2 values >0.53, with many >0.80). Regressions with successful nests, total nests, and even adult counts as the independent variable, were all strongly predictive of the number of fledglings on a nesting sandbar, even though many adults could not be directly tied to individual nests. High R^2 values for all regression models with fledglings as the dependent variable indicated that all three metrics can be viewed as relatively good indices of reproductive output.

8.5 ESH Construction and Maintenance Program Considerations

Findings from the analyses described in this document and its attachments provide information that could prove useful to the Corps for the ESH Construction and Maintenance program. Findings from the sensitive features and protective buffers analysis can be used as a means to identify areas at which ESH can be constructed without impacting other resources, and increase the likelihood that the constructed ESH will yield successful nests. Findings derived from fieldwork and general analyses provide additional information on substrate quality (see Attachment 4), vegetation (see Attachment 5), and hydrology (see Attachment 3).

8.5.1 Sensitive Features and Protective Buffers Assessment

The sensitive features and protective buffers assessment defined areas most suitable for ESH construction and maintenance, as well as those areas that should be avoided. The process of identifying and eliminating areas that should be avoided results in a residual acreage that would be the most suitable for ESH construction and maintenance on a segment-by-segment basis.

The basis for this evaluation assumes the existence of an array of man-made and natural features that should be conserved or protected from the land use changes that would occur from ESH program implementation. These include known locations for the habitats of other protected plant and animal species, natural heritage and cultural resources, public and private infrastructure features, existing public and private recreational features, and other elements of the constructed environment.

In addition to sensitive resources that should be avoided, a number of physical constraints limit the locations where ESH sites can be constructed. There are many high-energy or sediment-starved reaches where the placement of substrate to construct sandbars would be nearly impossible.

The sensitive features and protective buffers assessment described in Section 2 was performed for each of the study area segments using the results of the 2005 habitat delineations. The acreage for Restrictive and Available Areas is summarized by habitat type for the five study area segments in Table 8-11. It is important to note that Available Area acres is a subset of Restrictive Area acres. Table 8-12 provides a comparison of the ESH goals from the five PEIS alternatives and the total Available Area for all of the study area segments combined.

Table 8-11
Study Area Summary of Residual Acres by Habitat Type

Habitat Type	Acres 2005	Restrictive Area Acres	Available Area Acres
Active Agricultural Row Crop	715	548	84
Daily-Inundated Sand Plains	5,777	3,401	2,051
Emergent Sandbar Habitat	1,985	1,592	1,084
ESH Maintenance and Creation Test Areas	17	16	1
Herb-Shrub-Sapling	18,790	13,366	3,548
Lacustrine Fine Sediments	185	153	40
Non-ESH Sand	1,275	769	262
Open Water	50,645	14,313	7,393
Riverine Forest	10,154	6,271	104
Shallow Water	12,243	7,891	4,992
Wetland Matrix	15,917	13,028	0
TOTALS	**117,702**	**61,348**	**19,559**
Percent		**52%**	**17%**

Table 8-12
Comparison of PEIS ESH Acreages Goals and Residual Available Acres

Segment	Alternative 1 (ESH acres)	Alternative 2 (ESH acres)	Alternative 3 (ESH acres)	Alternative 4 (ESH acres)	Alternative 5 (ESH acres)	Available Area (Acres)
Gavins Point River Segment	4,648	2,324	2,944	880	570	3,880
Lewis and Clark Lake Segment	1,360	680	566	142	80	4,710
Fort Randall River Segment	700	350	295	128	135	2,784
Garrison River Segment	4,295	2,148	2,066	588	500	4,360
Fort Peck River Segment	883	n/a	883	247	30	3,825
TOTAL	11,886	5,502	6,754	1,985	1,315	

8.5.2 Findings from Spatial Analyses and Field Work

Many physical constraints within the study area segments may prevent the creation or management of ESH. Substrate quality, highly erosive channels, and vegetation succession are all important factors to address in selecting a site for ESH construction, and when maintaining a constructed ESH site.

A number of analyses were performed to understand the distribution of nesting in an effort to identify characteristics of successful and productive ESH. Nest data from each of the study area segments was analyzed against the background of segment-specific delineated habitats yielded information that may be useful for the ESH maintenance and construction program. Major findings from the spatial analyses of nests are presented below, and are followed by discussions on substrate quality, erosive channels, hydrology, and jurisdictional wetlands.

8.5.2.1 Nesting Habitat Distributions

The distribution of nests may be used to identify the areas most suitable for the restoration, creation, and maintenance of nesting-habitat. Between 50 percent and 75 percent of ESH delineated from the 2005 imagery never supported nesting. Nesting was highly concentrated on a few sites in each study area segment. These sites were found to have contained 60 percent to 85 percent of all nests during the period of record. The locations represented positions where islands and elevated bars had sustained a dynamic stability with ambient fluvial processes since the 1997 high-flow event. They were found to be in depositional positions (inside bends, wide runs) or in protected locations in the lea of upstream islands or shoals not used for nesting.

The characteristics of highly successful sites may be useful to inform design and construction of ESH. The most successful nesting sites were those that persisted for the longest duration. These sites produced between 40 percent and 80 percent of all nests, and yielded a higher percentage of successful nests than for the entire population of nests. Common characteristics of these sites included large distances from shorelines, high elevation, and very low vegetation density. These sites were selected for nesting as early as 1998 and used annually until the sites were lost to erosion or vegetation succession.

The characteristics of lost sites, rarely used sites, abandoned sites and sites associated with high nest failure are also be useful to inform design and construction of ESH. The majority of mapped ESH was not used for nesting. More than 90 percent of mapped ESH not used for nesting was found to be too low in elevation, too small, or too close to gallery forest or other features that appear to inhibit nest selection.

The most widespread characteristic that appears to inhibit nesting is the proximity to gallery cottonwood forest. More than 95 percent of nesting occurred at distances more than 600 feet from a forest edge. The relative effect of this inhibition on nest establishment increases as the river corridor narrows. Due to channel widths that often exceed 3,000 feet in depositional areas, the Gavins Point River Segment prime nesting sites were seldom affected by forest proximity. Conversely, the majority of sandbar habitat used for nesting in Fort Peck River Segment was limited to locations where gallery forest had been removed and suppressed by agricultural practices.

Nest failure appeared to cluster in select locations. An evaluation of the Gavins Point River Segment found that the average failure rate was approximately 35 percent. The majority of sites with failure rates higher than the average for the Gavins Point River Segment, were located upstream of RM 785. Sites located between RMs 797 and 804 showed contiguous high failure rates with the highest overall failure rates occurring at RMs 799 and 800. Gage data for upstream gages (Yankton Gage) showed a more rapid and greater gage response for dam discharges than gages farther downstream (e.g., Maskell). This suggests that higher nest failure may be related to more frequent inundation than occurs in the upper portion of study area segments.

8.5.2.2 Substrate Quality

The primary ESH nesting substrate in the Gavins Point River Segment is medium to coarse sand with a 10 percent to 80 percent pea-gravel fraction. This condition seems to be most favorable and most preferred for nesting (Kruse and others), a condition strongly supported by the findings of a directed sediment sampling effort in 2006. See Attachment 4: Sandbar Composition and Geometry.

Significant portions of other study area segments appear to lack suitable substrates, and may not be suitable for construction of ESH. Exposed substrates considered to be unsuitable are composed of either very coarse gravel (1-inch to more than 4-inch diameters), or of silts and clays. Coarse substrates are present in the high-energy upper portions of the Fort Peck River Segment and the Garrison River Segment. Fine sediments are abundant in the downstream, backwater portions of the study area segments (e.g., the Lewis and Clark Lake Segment and the Fort Peck River Segment). At these locations, true lacustrine conditions prevail for several miles.

These lacustrine habitat types were revealed to be saturated clay deposits or dried and cracked clay pans, both with no history of nesting in the recorded data. Both the coarse and fine unsuitable substrates were indistinguishable from sand in aerial photographs. Field investigation in 2005 and 2006 led to a redefinition of these as separate habitat types. The presence of these substrates indicates the potential for either a lack of proper building material or energy conditions poorly suited for the creation and maintenance of sandbar.

8.5.2.3 Highly-Erosive Narrow Channels

The portions of study area segments downstream of dams support little ESH as depicted in either the 1998/1999 or 2005 habitat delineations. Significant other areas are also subject to erosion, and are not ideal construction locations for ESH. High daily flows and high daily stage fluctuations participate in removing finer gravels and coarse sands most suitable for nesting, leaving behind cobbles beaches in the upper portions of the power pulsed study area segments. The Fort Peck River Segment and the Garrison River Segment are most affected by erosive conditions.

The extent of effects observed during field investigations is generally supported by Biedenharn et al (2001). Because of these conditions, constructed sandbars placed in these areas will likely erode rapidly. The limitations imposed by these conditions would tend to compress impacts from ESH maintenance and creation into remaining, more suitable portions of each study area segment

8.5.2.4 Hydrology

The differences among fluvial processes that exist in each segment require that segment-specific approaches to implementation of the ESH program be developed. Flows in each study area segment are controlled within a relatively narrow realm of variability to accommodate the authorized purposes of the Missouri River Main Stem System. These authorized purposes include navigation, irrigation, recreation, power generation, and flood control. As such, there is little opportunity within the flow regulation regime to create ESH through fluvial processes. The exception is the

Garrison River Segment, which gained new ESH each year as a result of large flow (and stage) differences between extended duration winter peak flows, and low breeding season flows.

Portions of the each segment are more suitable for ESH construction and maintenance because of their depositional characteristics (i.e., aggradation reaches). Other reaches within the segments (i.e., degradation reaches) cannot sustain constructed sandbar against rapid erosion, lacking concurrent hardened/permanent erosion prevention measures.

The daily affects of power peaking hydrology must be considered when designing ESH for the four upstream study area segments. ESH would need to be constructed at elevations well above daily peak stages.

8.5.2.5 Jurisdictional Wetlands

Habitat mapping and field investigations revealed a high coincident prevalence of Section 404 Jurisdictional Wetlands within and adjacent to ESH. Wetlands are also prevalent in suitable ESH construction and maintenance sites, since wetlands occur most frequently in low energy, depositional areas. Wetland conditions increase in prevalence from upstream to downstream in all study area segments except the Gavins Point River Segment. Virtually the entire non-water portion of the Lewis and Clark Lake Segment is currently emergent, graminoid-dominated, persistent wetlands. Given the geomorphic occurrence of ESH at elevations of about 0.5 feet to 1.5 feet above mean water surface elevation, natural vegetative succession will almost always produce a wetland plant community. If wetlands are avoided, it would further compress ESH construction and maintenance activities into smaller portions of study area segments.

8.5.3 Vegetation Management

Attachment 5 (Vegetation) includes detailed discussions of the plant communities and dominant species found in the Missouri River riparian area. Processes of natural vegetation succession (perpetual seed dispersal, propagule distribution, germination, etc.), also discussed in the attachment, continue ceaselessly to colonize and occupy any newly created substrate, such as riverine sandbars. A major aspect of the ESH management program will include efforts to stall, reverse or re-set natural succession processes so as to extend or restore the usability of sandbar for use by least terns and piping plovers. Several observations and findings from Attachment 5 are thus presented in the summary.

Late summer water releases from dams to support navigation would enhance vegetative succession on sandbars. Daily power-peaking in other segments would also enhance growth and expansion of the willow dominated zone by maintaining root saturation late in the growing season. River flow management appears to provide the following beneficial effect to cottonwood and willow recruitment and growth.

1. increasing the saturated soil area available for seed germination,
2. concentrating wind and water-born seeds higher on stream banks and islands,
3. reducing the natural mortality of seedlings, and
4. enhancing the growth rate of stems and roots

These inadvertent benefits for vegetation establishment must be overcome to extend the usability of sandbars for multiple breeding seasons. Management and control of cottonwood and willow succession would require that the considerations outlined below be applied to the long-term management of constructed ESH.

- Primary cottonwood and willow succession must be controlled during the first growing season of sandbar creation and must be continued until loss of the sandbar from due to erosion.
- Higher than normal flows during the cottonwood and willow seedling germination season (June through July) and during the growth season (May through October) improves recruitment and enhances the growth rate and establishment of existing cottonwood seedlings and saplings.[59]
- Raising water levels in late summer transports viable cottonwood seeds high onto ESH sandbars. These seeds will likely germinate and have sufficient time to establish adequate heights and root systems during the more than two-month subsequent growth period before first killing frost. The elevated water level will transport other water-borne seeds to the interiors of sandbars and enhance the growth of sandbar willow and other hydrophytic species. The stage increase would also prevent any post-nesting mechanical or chemical control of vegetation below the elevated stage.
- Cottonwood and willow recruitment is an annual management problem that needs to be addressed during the first germination season every year.
- Because first year cottonwood and willow seedlings are extremely sensitive to damage and invest relatively little growth energy in root tissue during the first season, it is unlikely that many seedlings would re-sprout following simple and relatively inexpensive mowing in August and September. If left to the second year, mowing could actually enhance willow growth by providing copious viable stems for sprouting elsewhere.
- Islands presently occupied by cottonwood 3 to 6 feet in height must be completely denuded or habitat quality will rapidly decline due to the accumulation of fine sand and the development of established weed populations in wind protected areas.
- Complete physical removal of, including tops and roots must occur to re-set natural succession to “zero”. Removed material should be burned, buried, hauled off site, or disposed of in the river. No vegetation tops or chips should be left behind to act as mulch and wind protection for subsequent seeds delivered by wind and water.
- Islands supporting cottonwood stands greater than eight feet or willow fringes greater than 2 feet in height may be beyond cost-effective mechanical or chemical control.
- The form and final grade of created or reshaped sandbars created or manicured for development of ESH should be configured in a smooth, convex form, lacking niches and wind barriers that would facilitate seed collection and germination. These forms should rise from the water as steeply as possible, while continuing to facilitate chick foraging in the rack line; at least for some portion of an island.
- Chemically induced mortality of cottonwood saplings does not reduce natural succession by other species, particularly from propagules delivered to a site once necessarily short-lived

[59] This effect is demonstrated in the Gavins Point River Segment on both natural low-lying sandbar and at the created ESH site at RM 770. Rising water levels in late July (to support navigation) provide moisture to recently established seedlings. The majority of these seedlings would perish under an unregulated, normal hydrologic regime.

herbicides have decayed. Only complete mechanical removal of stems halts the successional processes.

Attachment 1
Summary of Additional Findings: 2006 - 2009

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Constructed Sandbars 2006 – 2009

Gavins Point

- 2004 – 755.5 (Ponca complex)
- 2005 – 770.0 & 761.3
- 2006 – no construction
- 2007 – no construction
- 2008 – 791.5, 777.7, 775.0
- 2009 – 795.5, 774.0

Lewis & Clark Lake

- 2007 – 826.5 north sandbar partially completed
- 2008 – 826.5, north sandbar enlarged, south sandbar partially completed
- 2009 – 826.5, north sandbar reshaped, south sandbar completed

Trends

Gavins Point Least Terns

1. Through all years, 2005-2009, nest success has been very high on the constructed sandbars, averaging nearly 76%. Nest success on non-constructed bars has been good, with 55% successful (2005-2009), but not nearly as good as on the constructed bars. Total nest success has risen steadily, from 63% in 2005 to 79% in 2009.
2. The percent of nests found on the constructed sandbars as steadily increased from 45% of all nests in 2005 to 96% of all nests in 2009.
3. The number of total nests has decreased every year since 2005 when 351 nests were found, down to 123 in 2009, a decline of 65% in four years
4. The percent of adults and fledglings on the constructed sandbars compared to the non-constructed bars has steadily risen, going from 43% of the adults and 57% of the fledglings in 2005 to 90% of the adults and 100% of the fledglings in 2009.
5. The number of adults using the constructed sandbars has stayed consistent from 2005 through 2009, averaging around 217 with a high of 254 in 2006 and a low of 191 in 2009. However the number of terns using the non-constructed bars has plummeted, going from 270 in 2005 to 20 in 2009. Fledglings have also plummeted, going from 137 in 2005 to 0 in 2009.
6. Productivity on the constructed sandbars was exceptional in 2005 with a fledge ratio (fledglings/(adults/2)) was 1.76. Far above the fledge ratio goal of 0.94 set forth in the 2003 BiOp amendment. However, productivity dropped substantially on the constructed bars in 2006 (0.65) and in 2007 (0.33), before recovering to 1.27 in 2008 and 1.10 in 2009. One possible cause for the low productivity in 2006 and 2007 was predation of chicks on the constructed bars. The rebound in 2008 and 2009 may be due to the construction of new sandbar complexes on the river.

7. On the non-constructed sandbars productivity has been lower than on the constructed sandbars for every year from 2005 – 2009 except for 2007 when productivity on the non-constructed bars was 0.84 and was 0.33 on the constructed sandbars. In 2007 releases were low out of Gavins Point Dam and terns nested successfully on several low sandbars that normally are submerged.
8. The population trend on Gavins Point from 2005 – 2009 has been downward for both adults and fledglings, going from 476 adults and 318 fledglings in 2005 to 211 adults and 105 fledglings in 2009. This represents a 56% decline in adult numbers and 67% decline in fledgling numbers for the segment.

Lewis & Clark Lake Least Terns

Prior to the construction of the sandbar complex at RM 826.5 on Lewis & Clark Lake, the terns had abandoned the lake with no adults or nests being found in 2006. With construction of complex, tern numbers have jumped. These were augmented by a small tern colony that used a small natural sandbar complex in the upper lake that was exposed by low releases out of Fort Randall Dam in 2007 and 2008.

1. Least tern nest success has been very high on the constructed sandbars, averaging 76% for the three years the terns have been using the complex.
2. Tern use of the constructed complex has been high, ranging from 70 nests on the partially completed complex in 2007 to 154 in 2009. This is more than 123 nests for all of the Gavins Point River Segment in 2009.
3. Least tern adult numbers have averaged over 200 for 2008 and 2009. With the decrease by more than 50% of tern adults below Gavins Point, the argument can be made that the terns are leaving Gavins Point for the constructed complex on Lewis & Clark. There has also been a drop in least tern adults on the Fort Randall River Segment. It is possible that the terns are also leaving this segment for Lewis & Clark.
4. In 2007, productivity on the constructed complex was exceptional with a fledge ratio of 2.15. Since then the fledge ratios have been much lower with the 2008 being 0.57 and 2009 being 0.79. Predation of chicks is believed to be a cause for the low fledge ratios, especially on the north sandbar of the complex.

Gavins Point Piping Plovers

1. Through all years, 2005-2009, nest success has been very high on the constructed sandbars, averaging nearly 70%. However nest success has been trending down with nest success only at 62% in 2009. Nest success on non-constructed bars has been good, with 53% successful (2005-2009). However nest success has been quite variable ranging from 74% in 2008 to 19% in 2009. Overall, total nest success has been good at 63% for 2005-2009.
2. The percent of nests found on the constructed sandbars as steadily increased from 37% of all nests in 2005 to 81% of all nests in 2009. Unlike the terns, total number nests for the plovers has remained fairly consistent, averaging 189 over the past five year, with a high of 206 in 2006 and a low of 170 in 2009.

3. The percent of adults and fledglings on the constructed sandbars compared to the non-constructed bars has steadily risen, going from 40% of the adults and 41% of the fledglings in 2005 to 91% of the adults and 98% of the fledglings in 2009.
4. The number of adults using the constructed sandbars has consistently risen, going from 136 in 2005 to 215 in 2009. The number of adults on the non-constructed sandbars has plummeted, going from 204 in 2005 down to 21 in 2009. Overall, the number of adults remained consistent around 320 for 2005-2008, but then dropped to 236 in 2009.
5. Fledgling numbers and fledge ratios have paralleled each other on both the constructed and non-constructed sandbars. In 2005, fledgling numbers and fledge ratios were high for both with 138 fledglings and a fledge ratio of 2.03 on the constructed bars and 197 fledglings and a fledge ratio of 1.93 on the non-constructed bars. In 2006 the fledge ratio on the constructed bars dropped to 1.15 (fledglings – 90) while on the non-constructed bars the fledge ratio dropped to 0.41 (fledglings – 31). In 2007 the fledge ratio on the constructed sandbars dropped to 0.41 (fledglings – 30) while on the non-constructed sandbars the fledge ratio dropped to 0.38 (fledglings – 29). In 2008, with the construction of new sandbar complexes, the fledge ratio on the constructed bars rebounded to 1.68 (fledglings – 151) while on the non-constructed bars the fledge ratio rebounded to 1.01 (fledglings 71). In 2009, though new sandbar complexes were constructed, the fledge ratio on the constructed bars dropped to 1.18 (fledglings – 127) and the fledge ratio on the non-constructed bars dropped to 0.29 (fledglings - 3). By 2009 the plovers were making little use of the non-constructed sandbars.
6. Overall, piping plovers had high productivity below Gavins Point in 2005 (fledge ratio – 1.97). Productivity plunged in 2006 and 2007, falling to 0.78 and 0.39 respectively. With the construction of new sandbars in 2008 productivity rose to 1.39, but in 2009 the productivity declined to 1.10.

Lewis & Clark Lake Piping Plovers

Prior to the construction of the sandbar complex at RM 826.5 on Lewis & Clark Lake, the plovers made little use of Lewis & Clark Lake, with just three nests found. Following the construction of the sandbar complex at RM 826.5, piping plover use of this complex has steadily risen, while the plovers had made very little use of natural habitat on the lake.

1. Piping plover nest success has been good two out of past three years with 2008 being low at 48% while 2007 was 92% and 2009 at 79%,
2. Piping plover use of the constructed complex has greatly increased in the three years going from 13 nests in 2007 to 37 nests in 2008 to 77 nests in 2009.
3. Likewise piping plover adult numbers have similarly increased going from 16 in 2007 to 48 in 2008 to 120 in 2009. The same is true for fledglings with 18 in 2007, 39 in 2008 and 110 in 2009.
4. Unlike the terns, productivity on the constructed sandbar has remained high through the three years of its existence with a fledge ratio of 2.25 in 2007, 1.63 in 2008 and 1.83 in 2009.

5. It is possible that piping plovers are leaving Gavins Point for the constructed complex at Lewis & Clark Lake. Plover adult numbers were down 84 for Gavins Point and up 72 for Lewis & Clark Lake from 2008 to 2009.

Attachment 2
Relationships among Indices of Reproduction

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ATTACHMENT 2
RELATIONSHIPS AMONG INDICES OF REPRODUCTION

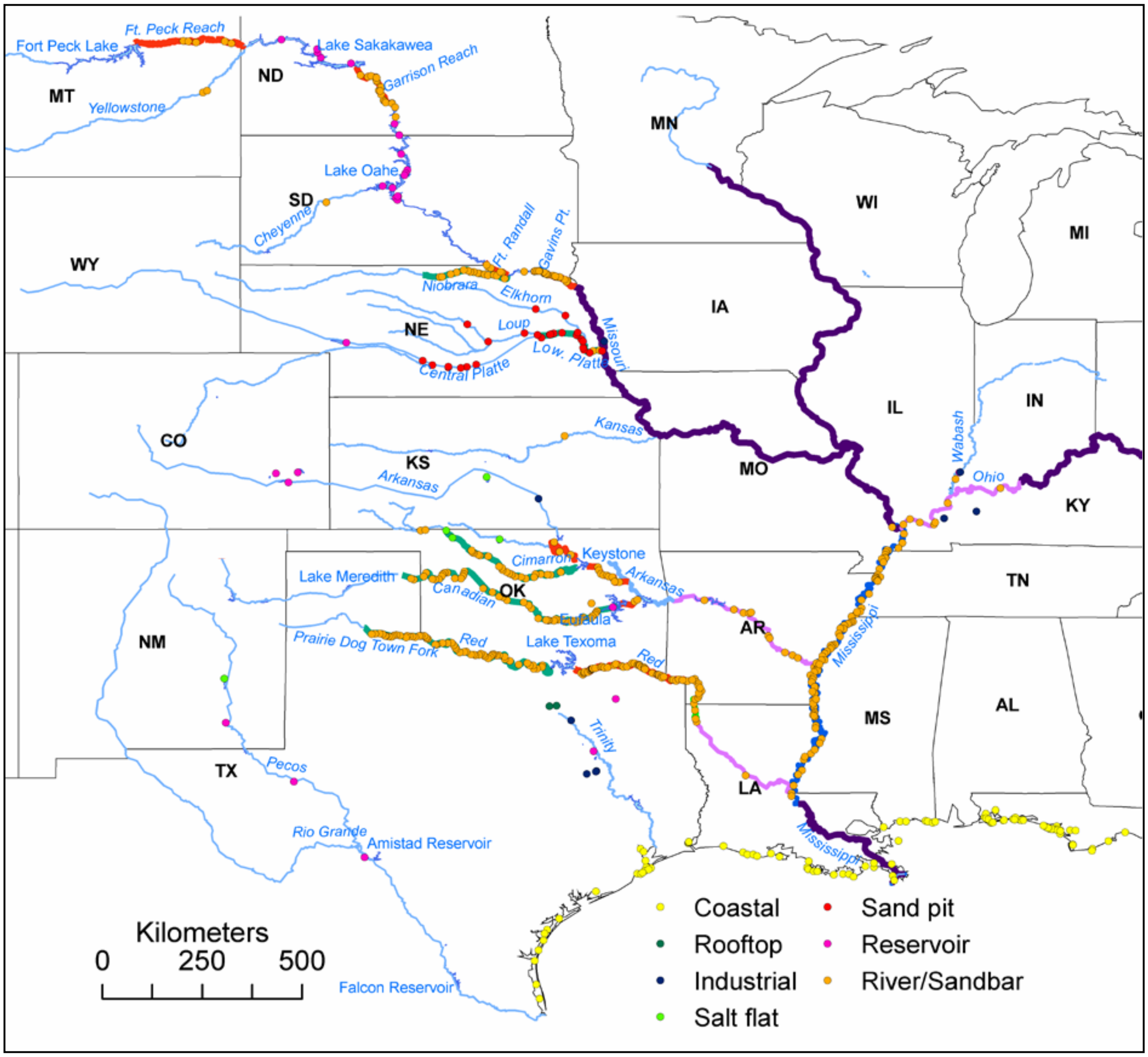
1 Range-Wide Distribution of Least Terns

Least terns are a widespread species with a breeding range that extends well beyond the boundaries of the upper Missouri River. From a regulatory standpoint, least terns are segregated into three distinct populations by the U.S. Fish and Wildlife Service (Service). Two of these populations are listed as endangered (the California and interior populations) and a third (the coastal population) is not federally listed. Missouri River least terns are considered part of the interior least tern (ILT) population, which is defined as any least tern >50 miles inland from the Gulf of Mexico coast (see Figure 1).

Interior least terns are not listed by the Service as a subspecies; but rather by geography, reflecting the strong ecological association of interior least terns with large rivers (USFWS, 1990). Interior least terns are distributed in patches along the Mississippi River and its large tributaries (the Missouri, Ohio, Platte, Arkansas, Canadian, Cimarron, and Red) and to a much lesser degree along the Trinity and Pecos/Rio Grande Rio systems. A recent genetics study documented similarities between interior least terns and some coastal least tern populations (Draheim, 2006). However, this same study suggested that only a few immigrants per generation are necessary to result in high degrees of genetic similarity among populations. Therefore, it is possible for distant populations to be genetically similar, yet remain relatively isolated demographically. This has been neither confirmed nor refuted with banding studies, because such studies have not been conducted at large enough scales or with enough intensity to describe rates of exchange among populations.

Limited banding data for ILT have shown large natal and breeding dispersal distances, with both young and adults breeding on different river systems in years subsequent to their initial banding. Additionally, band recoveries have shown that dispersal distances within the interior population are frequently greater than the distance between the southernmost ILT breeding locations and Coastal least tern populations in Alabama, Mississippi, Louisiana, and Texas. Therefore, there may be regular demographic exchange among Gulf Coast least terns and ILT, particularly in the southern part of their range on the Red, Arkansas, and Mississippi Rivers. The degree to which population dynamics of northern Great Plains ILT populations are related to population dynamics of more southern ILT populations is unknown; however, it is possible that northern ILT populations have some degree of demographic isolation from the southern ILT-coastal least tern meta-population.

Figure 1
Range-Wide Distribution of Interior Least Terns[1]

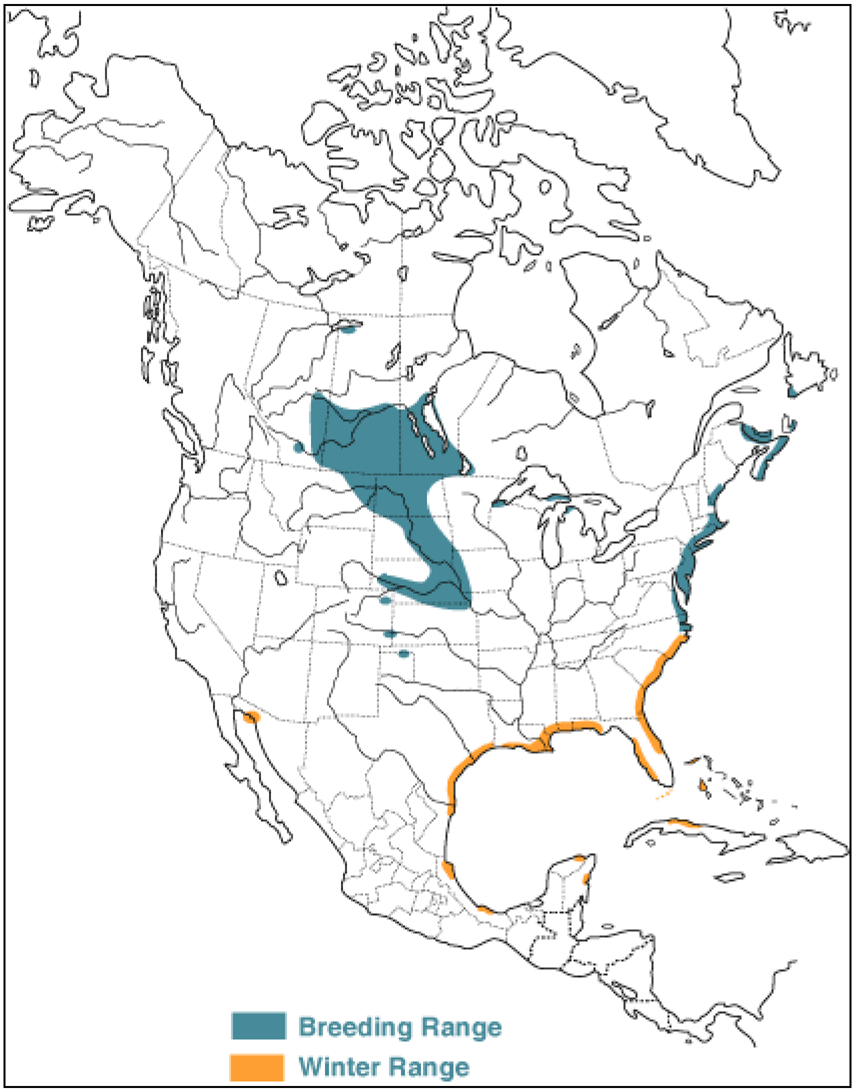


[1] Adapted from Lott, 2006

2 Range-Wide Distribution of Piping Plovers

The Service segregates piping plovers throughout North America into three separate populations. Two are listed as threatened (the Great Plains population and the Atlantic Coast population) and one is listed as endangered (the Great Lakes population)[2]. Figure 2 depicts the approximate areas for breeding and wintering piping plovers. Missouri River piping plovers are considered part of the Great Plains population. The Great Plains population is patchily distributed, with large population segments on reservoirs, alkali lakes, and to a lesser degree, rivers. Most individuals breed from Nebraska north through Prairie Canada (Haig et al. 2005).

Figure 2
Piping Plover Breeding and Wintering Range[3]



[2] Determination of Endangered and Threatened Status for Piping Plover; 50 FR 50726-50734

[3] Birds of North America Online; http://bna.birds.cornell.edu/bna Cornell Lab of Ornithology and the American Ornithologists' Union

3 Importance of the Upper Missouri River to Interior Least Terns

The first and only survey of the entire breeding range of interior least terns in the same year was completed in 2005. Lott (2006) described counts from the 2005 survey and summarized recent counts of least terns from across the entire U.S. portion of their breeding range for all three populations. Since counts are an estimate of population size (to some unknown degree) the resulting count totals should be viewed as the minimum number of individuals alive at the time of the survey, not as an unbiased estimate of population size (Krebs 1998). Since least terns also nest in Mexico (California least terns nest in Baja and coastal least terns nest along the Gulf of Mexico) and throughout the Caribbean, this summarized total is also missing counts for all least tern breeding in areas south of U.S. border. Neither the absolute nor the relative accuracy of least tern counts has been assessed for any of these data sources. However, it is assumed that least tern counts are biased particularly low in some areas due to issues of poor survey coverage (e.g., the Texas coast) or relatively low detection probabilities related to habitat features and/or the intensity of survey effort. Still, the summed 2005 counts (Lott, 2006) can be used as a coarse assessment of the importance of the Missouri River to larger least tern population designations at several different scales (Table 1).

Table 1
Least Tern Counts at Three Spatial Scales:
Range, Interior Region, and Missouri River

LEAST TERN	Count	Percent of Species	Percent of Interior
Entire Range (All 3 Populations)	85,715		
Interior Population	17,591	20.5%	
Missouri River	904	1.1%	5.1%

Coastal least terns are much more abundant than ILT, and ILT made up 20.5 percent of all least terns counted in the U.S. Missouri River Least Terns accounted for only 1.1 percent of the U.S. count for this species. For the listed population of ILT, the Missouri River accounted for 5.1 percent of the range-wide count.

4 The Importance of the Upper Missouri River to Piping Plovers

Range-wide surveys for piping plovers have been conducted in the U.S. and Canada, as part of the International Piping Plover Census (IPPC) in four out of the last 20 years: 1991, 1996, 2001, and 2006 (Haig et al. 2005). This survey effort results in counts with the same accuracy and bias issues identified previously for least terns, although efforts were initiated in 2006 to begin to assess detectability (Sue Haig, USGS, personal communication). To date, tabulation of all counts for 2006 have been completed but the results of the detectability study have not been presented. IPPC data are presented below to evaluate the importance of the Missouri River populations to larger piping plover population designations at several different scales (Table 2).

Counts for Great Plains piping plovers are the highest of the three listed piping plover populations (Haig et al. 2005). However, counts are not unbiased estimates of population size, and if detection probabilities vary among regions, comparing numbers of birds among regions may be problematic. With this caveat in mind, the Great Plains region comprised between 50 percent and 63 percent of range-wide counts for piping plovers in the four years where range-wide counts were available (Table 2). Missouri River piping plovers comprised between 3 percent and 16 percent of all piping plover counts. When counts are restricted to the Great Plains population, Missouri River piping plovers comprised between 6 percent and 27 percent of the regional count. The large range in the proportion of Great Plains piping plovers that were counted on the Missouri River may be related to sub-regional differences in habitat conditions in any given survey year. For example, water levels on the Missouri River were too high in 1996 for many piping plovers to nest on either riverine sandbars or reservoir shorelines and this may have resulted in more birds nesting on alkali lakes within this region (Haig et al. 2005). It is unclear whether variation in numbers among regions in the different years of the IPPC are related to biological phenomenon or issues of sampling error and detection probability specific to a certain region or habitat.

Table 2
Piping Plover Counts at Three Scales:
Range, Great Plains Region, and Missouri River[4]

	Adult Count	Percent of Species Population	Percent of Plains Population
2006 IPPC			
Entire Range (All Three Populations)	8,092	100%	
Northern Great Plains/Prairie Population	4,662	58%	
Missouri River	1,266	16%	27%
2001 IPPC			
Entire Range (All Three Populations)	5,945	100%	
Northern Great Plains/Prairie Population	2,953	50%	
Missouri River	796	13%	27%
1996 IPPC			
Entire Range (All Three Populations)	5,931	100%	
Northern Great Plains/Prairie Population	3,286	55%	
Missouri River	191	3%	6%
1991 IPPC			
Entire Range (All Three Populations)	5,484	100%	
Northern Great Plains/Prairie Population	3,469	63%	
Missouri River	625	11%	18%

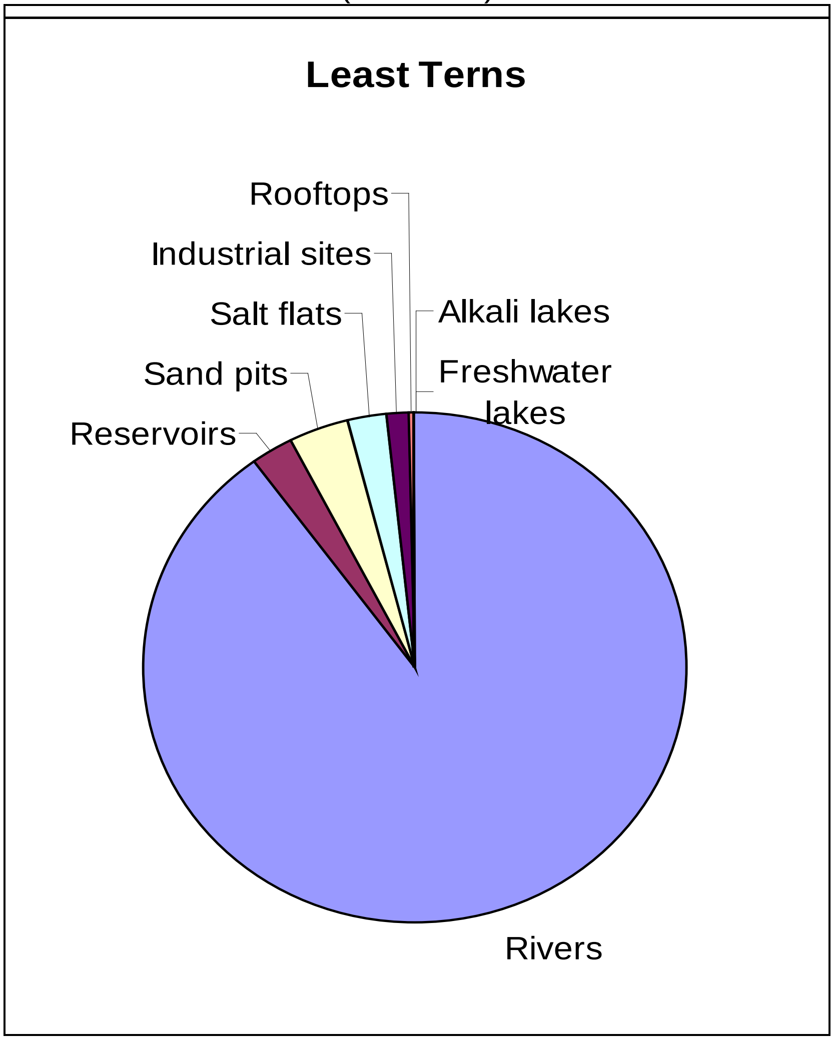
[4] Data for Table 2 were obtained from Ferland and Haig (2002) for 1991-2001; and Elliot-Smith, E., Haig, S.M., and Powers, B.M., 2009, Data from the 2006 International Piping Plover Census: U.S. Geological Survey Data Series 426, 332 p. for 2006

5 Importance of Riverine Sandbars to Interior Least Terns and Great Plains Piping Plovers

Interior least terns and Great Plains piping plovers differ in their proportional reliance on riverine sandbars. During the 2005 range-wide survey for ILT, a vast majority of individuals (89.9%) were counted on rivers (Figure 3). Much smaller numbers of ILT were detected on Platte River sand pits (3.6%), reservoirs (2.5%), salt flats (2.3%), industrial sites (1.4%) and rooftops (0.3%).

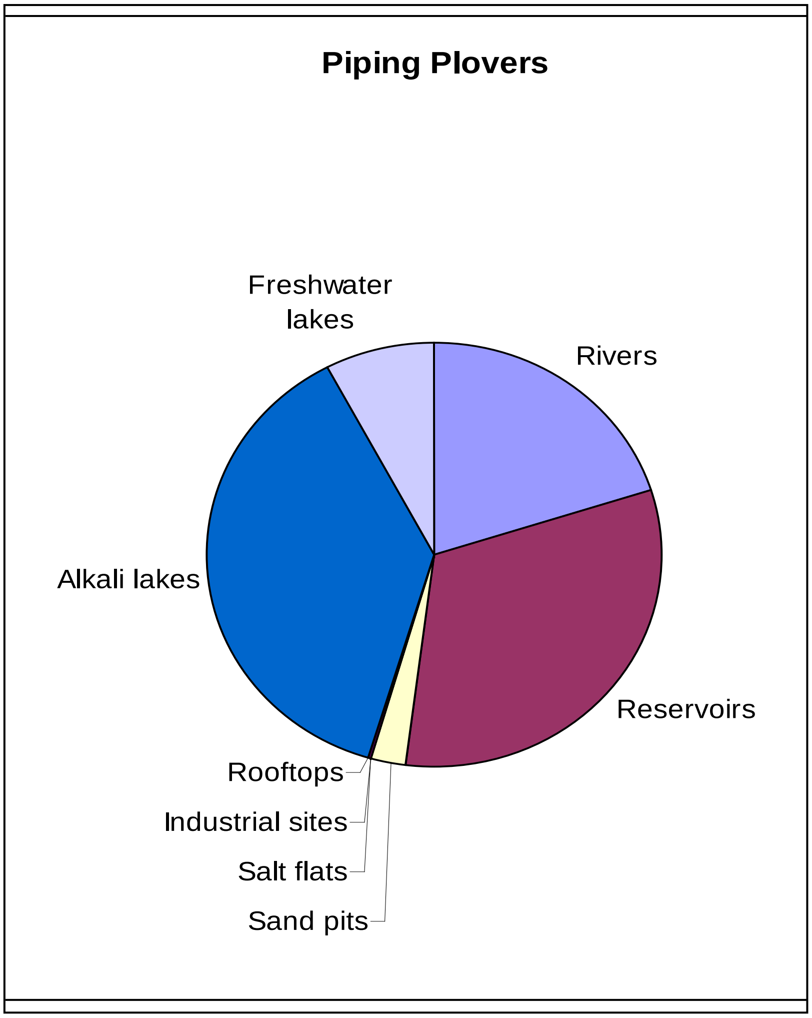
During the most recent IPPC where habitat-specific data summaries are available (2001), piping plovers were detected across a much greater range of habitats, without such a strong association with rivers (data from Ferland and Haig 2002). As seen in Figure 4, 34.3 percent were detected on alkali lakes, 31.7 percent on reservoirs, 19.7 percent on rivers, 7.6 percent on freshwater lakes, 2.4 percent on dry alkali lakes, 2.3 percent on Platte River sandpits, and 0.5 percent at industrial sites.

Figure 3
Proportion of Interior Least Terns Counted by Habitat Type
(Lott 2006)



The U.S. Army Corps of Engineers, Omaha District, has conducted an annual survey (referred to as the "adult census") across all breeding areas for least terns and piping plovers on the Missouri River from 1988-2006. In addition to providing counts for the range-wide surveys discussed above, this effort provides a longer time series of counts for the Missouri River than the range-wide surveys, which have only been conducted during a few years. Between 1988 and 2006, an average of 78 percent of all Missouri River least terns were counted on riverine sandbars (minimum year = 71.6%, maximum year = 87.4%). During the same time period, an average of 54.3 percent of all Missouri River piping plovers were counted on riverine sandbars (minimum year = 32.1%, maximum year = 92.4%). Although the percentage of piping plovers nesting on sandbars is higher on the Missouri River than elsewhere in the Great Plains, the relatively low percentage of piping plover counts on riverine sandbars (compared with terns) and the higher variability in the proportion of piping plovers nesting on sandbars in any given year, may reflect a tendency for Great Plains piping plovers to select between riverine or other (e.g., reservoir, alkali lake) NestAreas depending on habitat conditions that year, whereas least terns may be more strongly tied to sandbar habitat, regardless of conditions.

Figure 4
Proportion of Great Plains Piping Plovers Counted by Habitat Type



6 Omaha District Tern and Plover Monitoring Program

The Omaha District's tern and plover monitoring program covers over 850 river miles over the entire Upper Missouri River main stem (both reservoirs and rivers) from Ponca, Nebraska upstream to include the Fort Peck Reservoir in Montana. The District hires seasonal employees each year to count terns and plovers and monitor reproductive success during the breeding season between the months of April and August. Additional full-time staff members perform a variety of planning, logistical, personnel management, and data management tasks associated with this program A detailed description of monitoring program protocols is available as a manual that is distributed to seasonal employees (Yankton Office, Bird Monitoring Manual).

The annual bird monitoring program has two primary components: 1) the "adult census" is an attempt to count all individual adults present within the study area during the last two weeks of June; and 2) the "productivity survey" is a more intensive, nest-based monitoring program. For the productivity survey, NestAreas are identified and then re-visited once every 7-10 days throughout the breeding season to find and follow the fates of individual nests. These two components satisfy different monitoring objectives, and both provide data that are useful to assess different aspects of Missouri River tern and plover population ecology. Program data are used to gauge progress towards recovery plan goals for population size, BiOp goals for reproductive success and to report take.

Productivity surveys have three chronological phases across the breeding season, which can overlap to differing degrees in different years, depending on the extent of re-nesting: 1) nesting site surveys, 2) nest surveys, and 3) chick surveys; which are described here in chronological order, followed by a description of adult census methods. A brief description of field protocols for data collection is required here to differentiate the different types of bird monitoring data collected. Data summaries from the bird-monitoring program are available from the Omaha District as annual reports (USACE, 1994-2005).

6.1 Productivity Surveys, Phase 1 - Nesting Site Surveys

Nesting site surveys occur from early May (when plovers begin breeding) through the first few weeks of June (when terns are settling on NestAreas). During nesting site surveys, monitoring crews cover the entire survey area every 7-10 days, scanning all sandbars with a history of bird use and any sandbar habitat that may not have been used before but looks suitable for bird nesting behavior.

Crews survey individual sandbars either by scanning with binoculars from offshore, landing on a sandbar and scanning from a high point, or by walking across the sandbar looking and listening for birds. A crew could, and many times does, employ all three survey methods at the same sandbar. A crew will first use binoculars to scan the shoreline. If birds are spotted, the crew will land. Once on land they might scan from an isolated location, where they will not disturb the birds while trying to find nest locations. After scanning from a distance, the crew will then conduct a ground search. There will be times when the crew will skip scanning from a distance and proceed immediately to a ground search if they feel reasonably certain that there are nests at the site. Even if the crew does not see birds during the offshore survey, if the site has historically been a nesting site, the crew will land and continue surveying for birds. Once nesting activity has been detected, crews move on to phase 2 - nest surveys to search for active nests on sandbars where nesting activity was detected during nesting site surveys. After the second week of June, all of the current year's NestAreas are assumed to have been identified and nesting site surveys are terminated so that monitoring crews can focus on nest surveys.

6.2 Productivity Surveys, Phase 2 - Nest Surveys

During nest surveys, monitoring crews intensively search for active nests on sandbars where nesting activity was detected during nesting site surveys. Two different methods are used to find nests. The first method is to stand at a distance from the nesting area and observe the birds until individual adults are seen incubating nests. Then, the observer attempts to mark the spot where a bird is sitting (often using a nearby feature such as a piece of driftwood) and walks towards that spot until the nest is actually found. Another method is to conduct a grid search, where multiple observers split a sandbar into sections and walk on transects through a nesting area, looking for nests as they go. The search method that was used during each individual nest survey is not recorded in the database. Lacking data to assess detectability issues, counts of nests over time should be interpreted as an index to the actual number of nests present, with uncertain amounts of bias. In many cases, more than one of the described search methods is used when conducting a search at a site. Detectability is considered to be good on sandbars in the riverine segments, but detectability is considered to be not as good on the reservoir segments due to the large areas of habitat that are possible during periods of drought. Detectability is being addressed in a monitoring study being conducted by the USGS.

Once a nest is detected, it is given a nest number, marked with a wooden tongue depressor, and a GPS location is taken. Generally, only one to two inches of the tongue depressor is visible. It is not believed to be a visible cue for predators. Each nest that is found is re-visited once every 7-10 days to determine its fate until the nest has either hatched or been destroyed. If evidence is present to indicate that eggs in a nest have hatched ($\geq$1 chicks present in or very near to the nest bowl or eggshell evidence indicating $\geq$1 hatched eggs) the nest is given the fate of hatched, and the nest in considered successful. Then, monitoring crews attempt to determine how many eggs might have hatched (either from direct counts of chicks, indirect evidence provided by eggshells, or from the number of eggs counted in the nest during the previous nest visit). This determination is done after the nest fate has terminated (i.e., been determined to be successful, unsuccessful, or indeterminate).

If a nest has been destroyed, an attempt is made to assess the cause of nest failure. Monitoring crew personnel record data on nest fates and causes for failure using pre-defined codes in two different, but related, database fields: "fate" and "cause". These fields underwent some revision in 2005 and are currently undergoing additional revision towards a new protocol and new database codes for recording nest fates and causes (USGS, 2007). Causes for nest failure are difficult to determine because the actual event of nest failure is generally not observed directly, and indirect evidence may be missing or difficult to interpret if a large number of days have passed between nest failure and the monitoring crew's last visit. Consequently, many nests are assigned uncertain fate/cause combinations, such as "unknown" or "abandoned" in the database.

6.3 Productivity Surveys, Phase 3 - Chick Surveys

Once one or more eggs have hatched, monitoring crews begin to conduct chick surveys at individual sandbars. Nest surveys and chick surveys overlap considerably until the later part of the season, when either all nests have failed or had $\geq$1 egg hatch, at which point chick surveys are conducted exclusively until late August, when birds have departed the Missouri River for wintering areas. Similar to nest surveys, chicks are detected using two different methods: observing the sandbar from a distance (from a boat anchored either offshore or from a high point on the sandbar) and walk-through searches. In most cases both methods will be used; a boat anchored offshore or viewing from an isolated location on shore allows the crew to look for chicks without disturbing the birds. A ground survey is then conducted to look for new nests, evaluate previously found nests and to look for chicks. There are detectability issues with both methods. Detectability has not been analyzed by the Corps, but the issue in regard to chicks, as with nests, is a part of a USGS monitoring study that will be released in 2010.

Chicks are recorded as fledglings if either: 1) juvenal-plumaged birds are observed in flight, or 2) flightless chicks are observed at ages ≥ 20 days for piping plovers or ≥ 16 days for least terns (methods for determining chick age by plumage are included in the Monitoring Manual). Method one assumes that all flighted juvenal-plumaged birds observed on a sandbar were hatched on that sandbar (see Section 5.3). Using method two, chicks are recorded as fledglings regardless of whether or not these individuals are detected during a subsequent visit, unless a dead older chick is found on site, providing evidence to the contrary. This assumes that all older chicks survive through fledging and dispersal from the natal colony. Complex protocols are described in the Monitoring Manual to avoid double counting fledglings that may be present during multiple visits to the same sandbar. In the protocol it is assumed that the older piping plover chicks (ages 21-24 days) and least tern chicks (16-20 days) survive only in regard to fledging. It is not assume that they survive through dispersal. The basis for the assumption of survival to fledging is that if a chick has segmented the last age group before fledging (16-20 days for terns and 21-24 days for plovers) that it will probably survive the additional two to four days it takes to fledge. This assumption is scientifically supported by data. However, if this becomes a critical concern, data could be obtained from Virginia Tech researchers who have five years of chick data from two studies of piping plovers on the Missouri River and from USGS researchers who have three years of chick data from a least tern study on the Missouri River.

6.4 The Adult Census

The annual adult census occurs concurrently with normal productivity surveys during the last two weeks of June. However, during the census, an effort is made to count adults across the entire study segment, rather than just at areas that have already been identified as nesting sites that year. This results in counts of some individuals that can be associated with individual nesting sandbars (via the “site number” field in the database) and counts of other individuals that cannot be assigned to individual nesting sandbars (adults observed away from nesting sites previously identified by monitoring crews). High-accuracy GPS data were available for all 5 riverine segments starting in 2001. Between 2001 and 2006, 90 percent of all adult piping plovers counted during the adult census could be associated with known nesting sandbars; although this percentage varied from 72 percent on the Fort Peck segment to 92 percent on the Garrison segment. Similarly, 85 percent of all adult least terns counted during the adult census between 2001 and 2006, could be associated with known nesting sandbars; although this percentage also varied from a low of 72 percent on the Fort Peck Segment to a high of 97 percent on the Garrison Segment (Table 3).

The only real outlier among the segments is the Fort Peck River for both species. In the case of the piping plover, this may because of the very low number of piping plover adults that were counted on this segment. For the six years (2001-2006), the total number of plovers was just eighteen adults or an average of three per year. This represents a very small number of adults compared to the other segments listed. The terns on Fort Peck River averaged 38 adults per year for the six years. This is substantially more than the plovers, but nonetheless represents only 6.2% of all terns from the five segments (229 of 3699). Another important factor for the terns is that the Fort Peck River is the northernmost and westernmost part of the range of the interior population of the least tern. This means that these terns have the farthest distance to travel of any least terns in central North America and consequently they arrive later on the Missouri River than other least terns. An analysis of the initiation date for the 127 least tern nests from 2001-2006 on the Fort Peck River shows an average initiation date of June 20. What this means is that the terns on the Fort Peck River were more likely to be unsettled and still searching for nesting sites on this segment during the adult census compared to the four other more southern and eastern segments in the chart. Therefore a higher percentage of terns would have been found on sites that turned out not to have been used for nesting.

Table 3
Percentage of Adults Assigned to Individual Nesting Sandbars (2001-2006)

River Segment	Piping Plovers	Least Terns
Fort Peck	72%	72%
Fort Randall	89%	87%
Garrison	92%	97%
Gavins Point	90%	83%
Lewis & Clark	86%	84%
All Segments Combined	90%	85%

Counts of adult birds during the adult census are made using one of three different methods (described in more detail in the Monitoring Manual). These methods involve: 1) counting all adults from a distance; 2) walking into the nesting area and counting all adults as they fly into the air due to the disturbance; and 3) using counts of active nests + broods x 2 from the productivity survey dataset to come up with a total adult count. This approach assumes that each nest and each brood represents two adult birds. Field crews often use more than one of these three methods to count birds on the same sandbar. The method that yields the highest count is accepted as the adult census count for that site and the method that was used to arrive at this count is recorded (see earlier discussion in Section 6.1).

7 Population and Fledge Ratio Targets

Monitoring program results are annually evaluated relative to management targets for both population size (adults for least terns and pairs for piping plovers) and “fledge ratios” (an index to annual reproductive success). Population targets in the 2000 Biological Opinion, as amended (2003) are cited as originating from individual recovery plans for both species.

Recovery population targets for the entire Missouri River system (including reservoirs and riverine segments) are 900 adults for least terns and 425 breeding pairs for piping plovers. The 525 breeding pair target for piping plovers has been expressed as 850 adults; using the assumption that one pair equals two adults. Expressing population targets for piping plover as numbers of adults, as is the case for least terns, would allow for direct comparison of monitoring results to population targets. For example, the average adult census total for Missouri River piping plovers between 2001 and 2006 was 1,363 adults. This would exceed the population target of 425 pairs (or a minimum of 850 breeding adults) only if an average of at least 77 percent of the adult-plumaged birds in the population were breeding individuals.

7.1 Interpretation of Adult Census Counts and Fledge Ratios

Adult census count totals are best interpreted as a measure of adult population size. Since detection probabilities for counts are not known, but are likely to be lower than 1, this index is most likely biased low relative to true population size. If detection probabilities vary by habitat type (e.g., if a greater proportion of the birds that are truly present are likely to be counted on rivers than on reservoirs) or within habitat types (e.g. detection probabilities are higher on one river segment, or one portion of a river segment, or one sandbar, than another) then the relative accuracy of counts is likely to vary among survey locations within the study area. Detection probabilities for the adult census count methods are currently being assessed using a double sampling approach on the Garrison Segment (USGS, 2007). Results are expected to be available in 2010.

Additionally, adult census counts reflect only the number of adult-plumaged birds counted during the adult census. The proportion of these birds that actually breed is unknown. Therefore, adult census counts are more clearly an index of adult population size than breeding population size. While USFWS population targets for recovery of least terns are expressed as adult population size rather than breeding population size, population targets for recovery of piping plovers are expressed as numbers of breeding pairs. The monitoring program is not designed to count numbers of pairs directly.

“Fledge ratios,” identified as the primary indicator of reproductive success in the 2000 Biological Opinion, as amended (2003), utilize data from both monitoring components. The monitoring program calculates fledge ratios as the total number of fledged birds counted during the productivity survey divided by the number of pairs (calculated by dividing the number of adults counted during the adult census by two). This is used as a conservative method of estimating the fledge ratio as using the total number of adults would inflate the number of breeding pairs, thus underestimating the number of chicks per pair. As with any large scale monitoring program, 100% accuracy for any of the measured factors cannot be assured so population numbers and fledge ratios must be considered to be indices of species tends.

7.2 Framing Bird Monitoring Data within The Breeding Biology of Terns and Plovers

Both terns and plovers exhibit behaviors and life history traits that make their reproductive success difficult to monitor. First, the nests of both species are cryptic in appearance, making their detection difficult within the large areas of unvegetated substrates where they are most commonly placed. Ongoing studies suggest that nests may go undetected using the current monitoring protocols (USGS, 2007). Similarly, young chicks of both species are cryptic in coloration, making their detection difficult against the background of sandbar substrates. Furthermore, chicks of both species have a range of behaviors that also make their detection difficult (e.g., hiding in vegetation or under driftwood, remaining unmoving against a sandy background).

Piping plover chicks leave the nest bowl within a few hours after hatching and least tern chicks leave the nest bowl within 1-2 days after hatching. It may be difficult to determine how many eggs hatched from each nest, since chicks are no longer present and indirect evidence that individual eggs have hatched (e.g., eggshells) can disappear within a few days.

Once chicks have left the nest bowl, they can travel considerable distances in a short period of time and unmarked chicks can no longer be connected to a specific nest, only the sandbar where they hatched. Therefore, counts of chicks or fledglings occur at the scale of sandbar, whereas nest locations and counts of successful nests can be tied to individually marked nests. During the young chick period, (e.g., <14 days) behaviors make chicks very difficult to accurately count. As they get older, chicks become slightly more detectable, because their juvenal plumage is easier to see against sandbar substrates than their downy nestling plumage. Similarly, their larger size and propensity to spend more time in open areas (e.g., near the waterline) makes them more detectable than they were in the first 14 days after hatching.

Fledglings of both species can disperse from natal sandbars within 2-4 weeks after they are able to fly (25-30 days old for piping plovers, 21-24 days old for least terns). Therefore, there may only be a few weeks where older chicks and fledglings are present and detectable at their natal sandbars before dispersing. For these reasons, it is likely that counts of fledglings are biased low. If unmarked fledglings disperse from one sandbar to another, it is impossible to tell if a flighted bird in juvenal plumage was hatched on the sandbar where it is encountered or if it has dispersed from a nearby natal sandbar. This behavior makes the interpretation of sandbar-specific counts of fledglings problematic when birds are not individually marked.

Finally, both least terns and piping plovers are known to re-nest (sometimes more than once in a single breeding season) after nest failure or after losing young chicks. However, neither species regularly re-nests after successfully raising a brood to fledging. Therefore, re-nesting attempts indicate previous nest failure or early chick loss, not an attempt to raise a second clutch within the same breeding season. Consequently, cumulative counts of nests on one sandbar should not be interpreted as representative of the total number of pairs that attempted nesting on that sandbar. This count (total nests) depends on the degree of re-nesting, which is likely to vary year to year and between sandbars. There may be some years, where few nests are lost, that the total nest count is relatively low, because the first nests were mostly successful. However, there may be other years, where conditions cause repeated nest failure, where the total number of nests is high relative to the number of breeding adults present. In years where repeated nest failure results in many re-nesting attempts, higher nest counts for a sandbar will not necessarily correlate with high nest success or high numbers of fledged young. However, in the analyses of the 1999-2006 monitoring data there were strong correlations between total nests, numbers of successful nests, and numbers of fledglings, suggesting that all three of these indices of reproduction were providing related information about sandbar-specific reproductive output. This may not be the case for other datasets (from other regions or from other time periods on the Missouri) with higher rates of re-nesting.

7.3 Presentation and Interpretation of Monitoring Program Data

This section presents data from four different monitoring program count metrics that provide information about sandbar use, reproductive effort, and reproductive output: 1) adult counts; 2) total nest counts; 3) successful nest counts (a successful nest is defined as a nest where $\geq$1 egg hatched); and 4) total fledgling counts. Data are presented at two different spatial scales: 1) for the entire main-stem Missouri River (including reservoirs and river segments); and 2) by individual sandbars within riverine survey segments only, Although counts should be interpreted with the previously-discussed caveats, useful information is to be gained by summarizing and analyzing these data within the context of appropriate limits to inference and interpretation as summarized in Table 4. The fact that each of these indices correlate well with each other at the scale of the whole system (summarized by segment) or at the scale of individual segments (summarized by sandbar) suggests that collectively, and perhaps even individually, they describe the relative importance of different segments or sandbars to site use, reproductive effort, and reproductive output.

Table 4
Limits of Inference for Selected Count Metrics

Count Metric	Viewed as an Index To	Sandbar-Specificity
Adult Count (From Census)	Site Use	Not Always Site Specific
Total Nests	Reproductive Effort	Always Site-Specific
Successful Nests	Reproductive Output	Always Site-Specific
Fledglings	Reproductive Output	Uncertain Site-Specificity

Count totals for individual segments of sandbars are presented for each metric individually, rather than as ratios (e.g., fledglings/pair or fledglings/nest) or percentages (e.g., apparent percent nest success) for two reasons: 1) when two quantities are measured with unknown magnitudes of bias, combining the two into a ratio makes them very difficult to interpret, and 2) ratios remove very important information about the magnitude of counts. Comparison of population-independent ratios like fledge ratios or percent nest success across sites often obscures important information about the relative importance of an individual site to the population. When the entire population is monitored and there is no sampling error (as is theoretically the case with the comprehensive spatial coverage of the monitoring program) interpretation of actual counts rather than ratios preserve this important information about the importance of any one site to the population as a whole.

7.4 Spatial Scale of Bird Monitoring Data Summaries - System, Segment, and Sandbar

Both adult census and productivity survey results are regularly summarized and discussed at the scale of the entire Missouri River (including both reservoirs and riverine areas) or by survey segment (USACE, 1994-2005). Fledge ratios are typically summarized at larger scales (e.g., the total number of fledglings counted across an entire survey segment during a given year's productivity survey are divided by the number of adults counted for that segment during that year's adult census).

Effects of management on reproduction occur at the scale of individual sandbars. Presenting monitoring data at the scale of individual sandbars could help inform where management efforts should be spent. Understanding the physical and biological factors affecting the use and/or successful use of individual sandbars is essential to design and site selection criteria for created sandbars in ways that will maximize reproductive success.

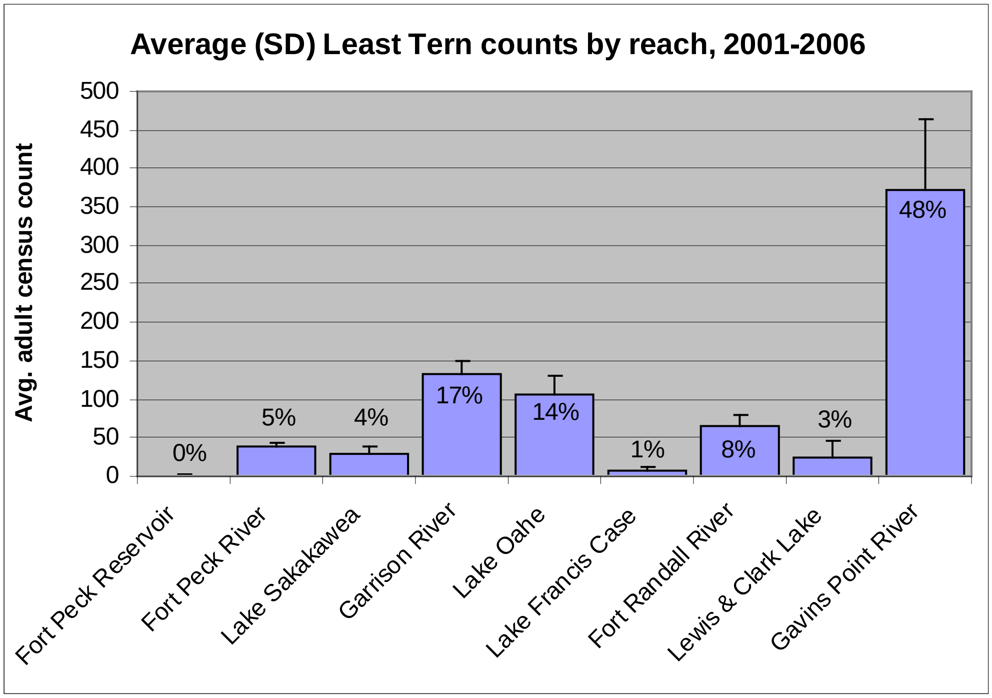
Linking the bird monitoring data to individual sandbars permits sandbar-specific analyses of the existing data. By comparing habitat delineations based on aerial photography with high-accuracy GPS nest locations, nests could be assigned to individual sandbar NestAreas. For this purpose, nest-based data from the annual productivity survey were useful for relating nests to individual sandbars. Because GPS locations associated with productivity survey data were essential to analyses, data presentations were restricted to the years where high accuracy GPS nest locations were available.

8 Monitoring Program Results at the scale of the Entire Upper Missouri River System

8.1 Adult Census Counts by River Segment

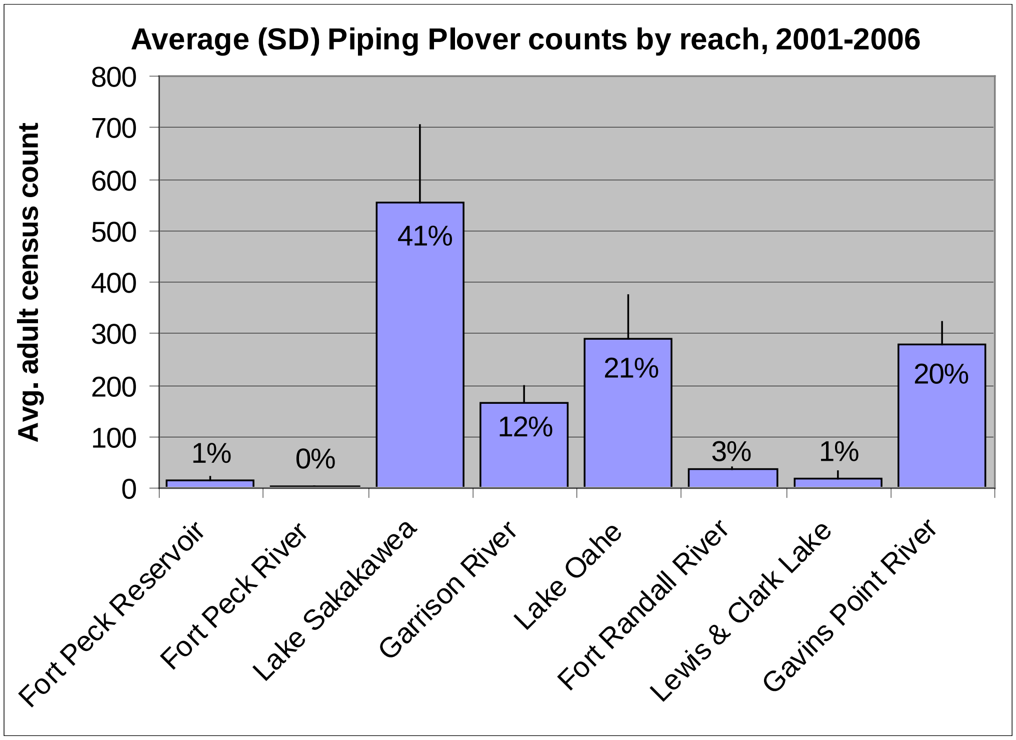
Between 2001 and 2006 (the time period for which high accuracy GPS location data were available for all segments) adult census counts for least terns were highest below Gavins Point Dam (48% of all counts) and below Garrison Dam (17%) (Figure 5). These two river segments - Gavins Point and Garrison - accounted for >65 percent of all least tern counts. Lake Oahe was also relatively important to least terns, contributing >14 percent of all least tern counts, more than the next closest river segment, Fort Randall (8%). All other segments contributed <5 percent to system-wide counts for least terns.

Figure 5
Average (±SD) Least Tern Adult Census Counts by Segment, 2001-2006



The two most important riverine segments for piping plovers were the Gavins Point (20%) and Garrison (14%) segments. Within the Upper Missouri, the riverine segments were relatively less important to piping plovers as counts were by far the highest on Lake Sakakawea (41%) and Lake Oahe (21%) (Figure 6). All other segments contributed less than 3 percent to system-wide counts for piping plovers. It should be noted that four survey segments (Fort Peck Reservoir, Fort Peck River, Lake Francis Case, and Lewis & Clark Lake) contributed relatively little to total counts for either species on the Missouri River. d

Figure 6
Average (±SD) Piping Plover Adult Census Counts by Segment, 2001-2006



8.2 All Four Count Metrics by River Segment

The segments that contributed most to adult census totals for each species also contributed the most to reproductive effort (total nests) and reproductive output (successful nests and fledglings) (Figures 7 and 8). When annual counts were compared by segment, all four count metrics were strongly positively correlated with each other (spearman rank correlations were all >0.91 for least terns and piping plovers, all P values <0.0001). Among the riverine segments, the Gavins Point and Garrison Segments contributed much higher proportions of counts (of all four metrics) than the others did, with the Fort Randall, Fort Peck, and Lewis & Clark segments contributing far less to the Missouri River populations of both species.

Figure 7
Least Tern Count Metrics by Segment, 2001-2006

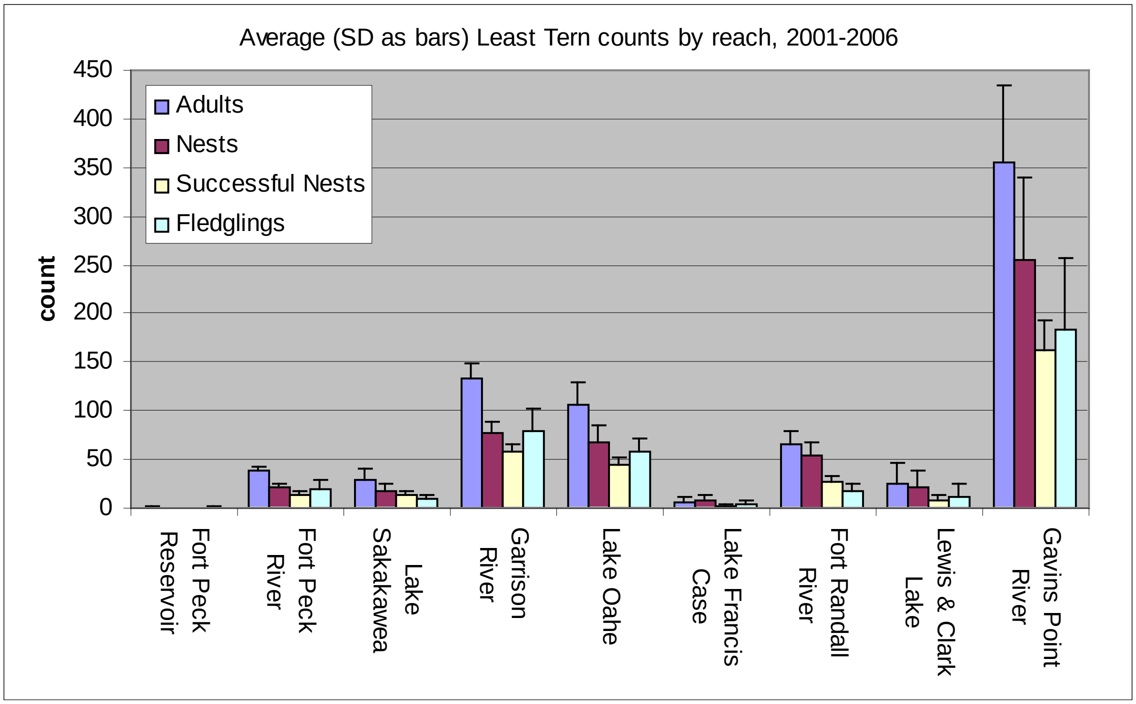
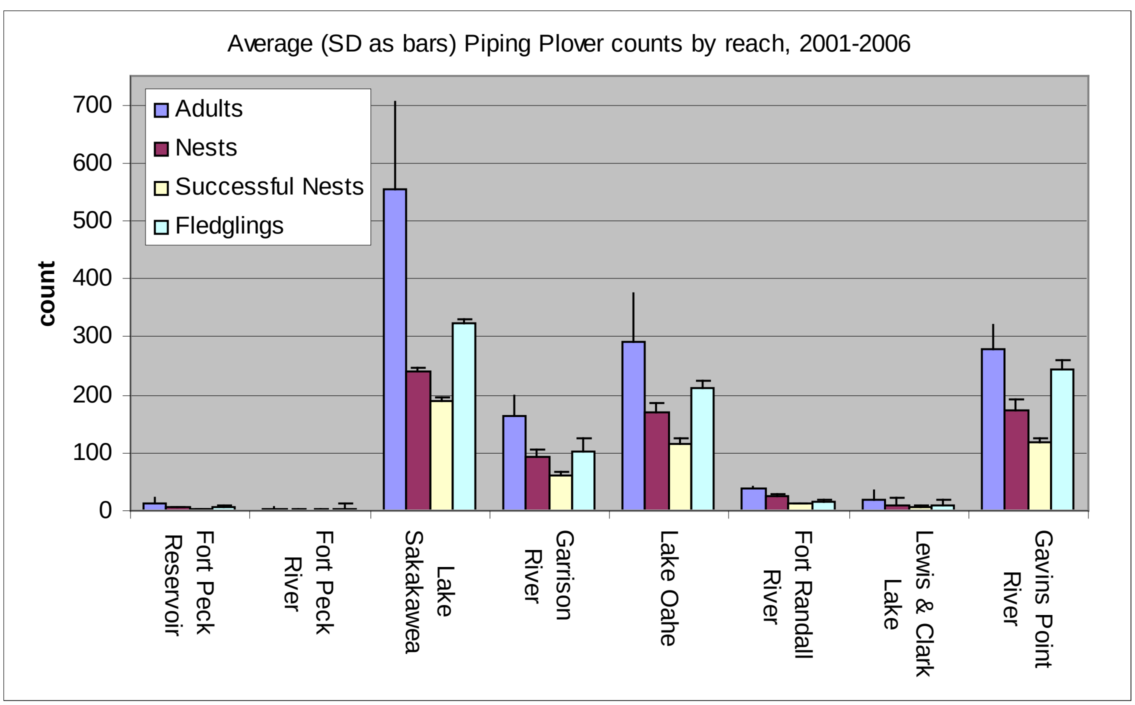


Figure 8
Piping Plover Count Metrics by Segment, 2001-2006



9 Monitoring Program Results: Individual Sandbars Within the Gavins Point and Garrison River Segments

9.1 Spatial And Temporal Scales Of Analysis

Between 2001 and 2006, the years where high-accuracy GPS data were available for all segments , the Gavins Point and Garrison segments accounted for 77 percent and 88 percent of all Missouri River tern and plover nests respectively (among the five riverine segments only). The more detailed descriptions of sandbar use and indices of reproductive success focus on these two segments. Segment-specific summaries for Gavins Point include additional data since high-quality GPS data was available for Gavins Point back to 1999. In subsequent summaries, we present eight years of data for Gavins Point (1999-2006) and six years for Garrison (2001-2006). This temporal scale illustrates the relative importance of individual sandbars to tern and plover reproduction during the time period following the major event associated with the 1997 releases, the ensuing period of erosion and sandbar habitat loss through natural succession, and several years of mechanical habitat creation efforts by the Corps (2004 - 2005).

Within each segment, the four previously identified count metrics (adult census counts, nest counts, successful nest counts, and fledgling counts) were summarized at the scale of “sandbar nesting area.” NestAreas were defined as either: 1) individual sandbars that always occurred as islands, or 2) complexes of adjacent sandbars (separated by water at higher flows) that were contiguous at lower flows. The following example illustrates why we chose to present results by “sandbar nesting area” rather than by the “site” field in the District’s database. Between 1999 and 2006, there were ≥1 least tern nests detected at 34 unique sandbar NestAreas in the Gavins Point segment. During this same time period, field crews recorded ≥1 nest at 133 different sites in the database. After inspecting GPS nest locations it was clear that many of these sites belonged to the same sandbar nesting area (as defined above). Individual sandbar NestAreas had an average of 3.9 (SD ±2.8) associated site IDs, with as few as 1 site ID per nesting area and as many as 11. New site IDs were assigned to unique sandbar NestAreas using GPS nest locations and aerial photography habitat delineations for the purpose of this analysis.

Two of the mechanically created sandbar NestAreas: Burbank-769.4-770.4 and Burbank-Elk PT-761.5 were created on top of the footprint of natural sandbar NestAreas that had been previously used for nesting. In order to separate out the use of natural sandbars and created sandbars, each of these sandbars were given two different names, with the suffix A indicating use of the sandbar prior to the habitat creation event and the suffix B indicating use of the sandbar after the habitat creation event. For example, Burbank-769.4-770.4A includes use of this sandbar between 1999 and 2004, prior to the Corps’ habitat creation, and Burbank-769-770.4B signifies use of this sandbar in 2005 and 2006, after the habitat creation project.

9.2 Interpretation of Regressions Describing Relationships Among Count Metrics

Within the breeding season, three count metrics (nests, successful nests, and fledglings) could be viewed as sequentially related since nests precede successful nests, and successful nests precede fledglings. Because the fourth metric, adult counts, was from the adult census (which was scheduled to occur near peak incubation) adult counts were anticipated to be most closely related to total nests, then successful nests, and then to a lesser degree, fledglings. To examine relationships among metrics within this temporal framework, a series of regression models were constructed to examine just how predictive each metric was of the next metric in this sequence. Theoretically, counts of nests should strongly predict counts of successful nests, unless there is considerable nest mortality. Similarly, counts of successful nests should strongly predict counts of fledglings, unless there is considerable chick mortality. A regression with nests as the independent variable and fledglings as the dependent variable would then illustrate the combined effects of nest mortality and chick mortality on total number of fledglings. NestAreas with higher or lower than average nest mortality during the incubation period should have large residual values in the regression with nests as the independent variable and successful nests as the dependent variable. Similarly, sandbar NestAreas with higher or lower than average chick mortality during the chick-rearing period should have large residual values in the regression with successful nests as the independent variable and fledglings as the dependent variable.

These regressions provide more information than simple ratios of fledglings/nest, fledglings/successful nest, or successful nests/nest (apparent nest success), because: 1) information about population size is preserved, and 2) the relative importance of either the numerator or the denominator to the final ratio can be evaluated. Additionally, like ratio estimators, regression residuals can be used to evaluate the relative success of one site versus another when sandbar NestAreas within the same segment is compared. Similar to ratios like apparent nest success or fledge ratios, the biological interpretation of regression residuals outlined above is confounded by potential differences in nest or fledgling detectability among sites. For example, a large negative residual in the regression between successful nests and fledglings could represent either high chick mortality or consistently low fledgling detectability (at a particular site relative to other sites). Table 5 illustrates potential interpretations of regression residuals when both count metrics are enumerated with unknown amounts of bias, as is the case with the Omaha District's bird monitoring data.

Table 5
Biological Interpretations of Residual Values in Regression Models

Residual Value	Biological Interpretation With No Bias	Potential Bias
point near line	average relationship for segment	x biased low, y biased low
positive residual value	dependent variable above average for segment	x biased low, y biased high
negative residual value	dependent variable below average for segment	x biased high, y biased low

9.3 Data Distributions, Transformations, and Data Reduction for Regressions

For each river segment, counts of each metric were not normally distributed and were positively skewed due to the large number of sandbar NestAreas with low counts. Natural log-transformations for all four count metrics were attempted to normalize regression residuals, since variance increased with mean counts; although this trend was due mostly to consistently small variances associated with very low counts and not a trend of increasing variances for moderate to high counts. Natural log transformations improved the distribution of regression residuals; however, in most cases, regression residuals still deviated from normality in regressions with transformed variables. Since the failure to achieve normal distributions of regression residuals was mostly driven by the large number of sandbar NestAreas with low counts (sandbars used only once or infrequently with few nest establishments), separate regressions were performed on reduced datasets, using untransformed counts, with low-count sites removed.

The first step in this process was to identify the cut-off for low-count sites from natural breaks in the data when data were sorted by nest counts. For example, for least terns on the Gavins Point Segment, regression models were constructed using only the 14 sandbar NestAreas with ≥46 nests over the eight-year period, which included 85 percent of all nests and 88 percent of all fledglings (Figure 9). These sandbars had been identified in Section 3 of this document as “highly productive” NestAreas on the basis of high importance values derived by multiplying the total number of established nests by the number of active years.

This resulted in the removal of 20 low-count sandbar NestAreas from the analysis. This approach resulted in the exclusion of a large number of low-count sandbar NestAreas for each river segment, all of which comprised less than 2 percent (many much less than 2 percent) of the total nest count for a segment during the period of analysis. While based on a subset of the entire nest database, this subset represents all of the sites the analysis of which would best inform ESH design, construction and habitat maintenance actions. Regressions using only the highly productive sites had normally distributed residuals and retained the original scaling of the data, facilitating interpretation of regression models relative to population size, which was not possible with residuals from log-transformed counts.

Regressions of both log-transformed (including all sandbar NestAreas) and untransformed data (which included only the highly productive NestAreas) were all highly significant (all P values <0.0046, most P values <0.0001) and strongly predictive (all R^2 values >0.53, with many >0.80) (See Tables 4.7-4.10). As expected, regressions for the stages of reproduction that were closer to each other in time had the highest R^2 values. However, regressions with successful nests, total nests, and even adult counts as the independent variable, were all strongly predictive of the number of fledglings on a nesting sandbar, even though many adults could not be directly tied to individual nests. High r^2 values for all regression models with fledglings as the dependent variable indicated that all three metrics could be viewed as relatively good indices of reproductive output for nesting sandbars over this long of a time period. Data summaries and analyses by sandbar nesting area are presented individually for both terns and plovers on both the Gavins Point and Garrison segments below.

9.4 Highly Productive Sandbars for Least Terns on the Gavins Point Segment

A vast majority of all tern nests (85%) and fledglings (88%) on the Gavins Point segment were counted on only 14 of the 34 sandbar NestAreas between 1999 and 2006. Figure 9 presents, from upstream to downstream, all sandbar NestAreas on which ≥1 tern nests were recorded during the period of analysis. Figure 10 presents the same data, sorted by total number of nests. The top 14 NestAreas included three productive sandbar NestAreas that were created by the Corps prior to the 2004 (Ponca3) or 2005 (2 Burbank sites) nesting seasons. Aside from these recently created NestAreas, which were only available for two or three of the eight years of this dataset, tern nests occurred on the remaining 11 important natural sandbars an average of 6.4

(SD ±1.0) out of eight years and on all important natural sandbar NestAreas in ≥4 out of eight years, indicating regular use of important NestAreas. Of the 14 main sandbar NestAreas, the 11 natural sites had average cumulative counts of 94 nests, 65 successful nests, and 88 fledglings in the eight years between 1999 and 2006. The three important created sites had average cumulative counts of 125 nests, 82 successful nests, and 103 fledglings between 2005 and 2006 (for the two Burbank sites) and 2004 and 2006 (for the Ponca3 site). These sites produced more nests, successful nests, and fledglings in two or three years than natural sites produced over an 8-year time span**.** By contrast, the remaining 20 low-count NestAreas had average cumulative counts of 13 nests, 8 successful nests, and 9 fledglings and all 20 areas had cumulative counts of ≤28 nests, ≤21 successful nests, and ≤29 fledglings during this 8-year period. NestAreas with low counts (which also included 2 created sandbars) were also less frequently used than the 14 main sandbar NestAreas. The 18 natural sandbars with low counts had nests an average of 1.9 years (SD ±1.0), 14 out of 18 of these areas had nests in only 1 or 2 out of 8 years, and all 18 had nests in ≤4 out of 8 years.

Highly Productive sandbar NestAreas for least terns did not occur uniformly or randomly within the Gavins Point segment. In fact, the majority of important natural sandbars occurred in seven different clusters of sandbars (ranging from 0.1 – 2.2 river miles each) spanning between river miles 803.5-802.0, 795.4-793.4, 790.4-788.2, 781.5, 778.9-777.0, 770.4-769.4, and 757.3-756.3 (Figure 9). These heavily used areas, which total only 9.7 of the 58 river miles of the Gavins Point segment, all reflect aspects of riverine planform or channel geometry conducive to sandbar formation or retention.

Figure 9
Gavins Point Least Tern NestAreas 1999-2006

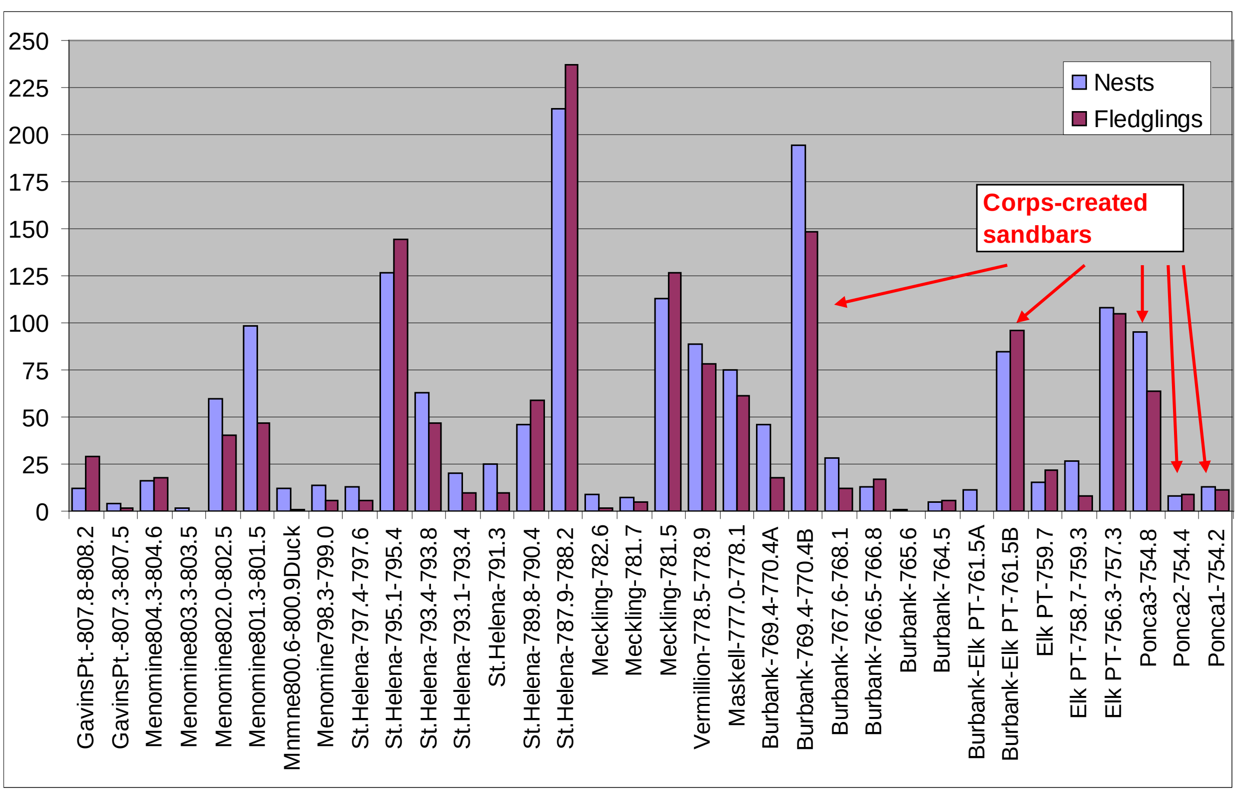
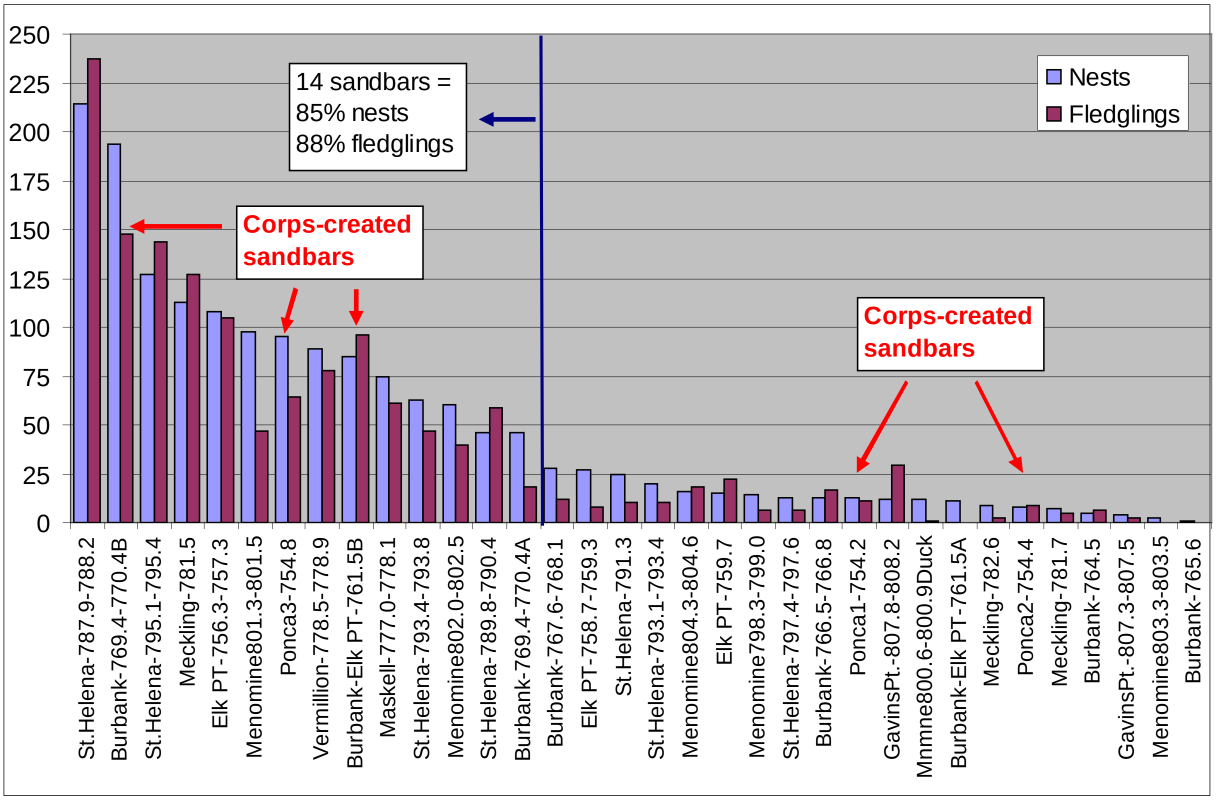


Figure 10
Gavins Point Least Tern NestAreas 1999- 2006
Numbers of Nests



9.4.1 Relationships Among Count Metrics for Gavins Point Least Terns

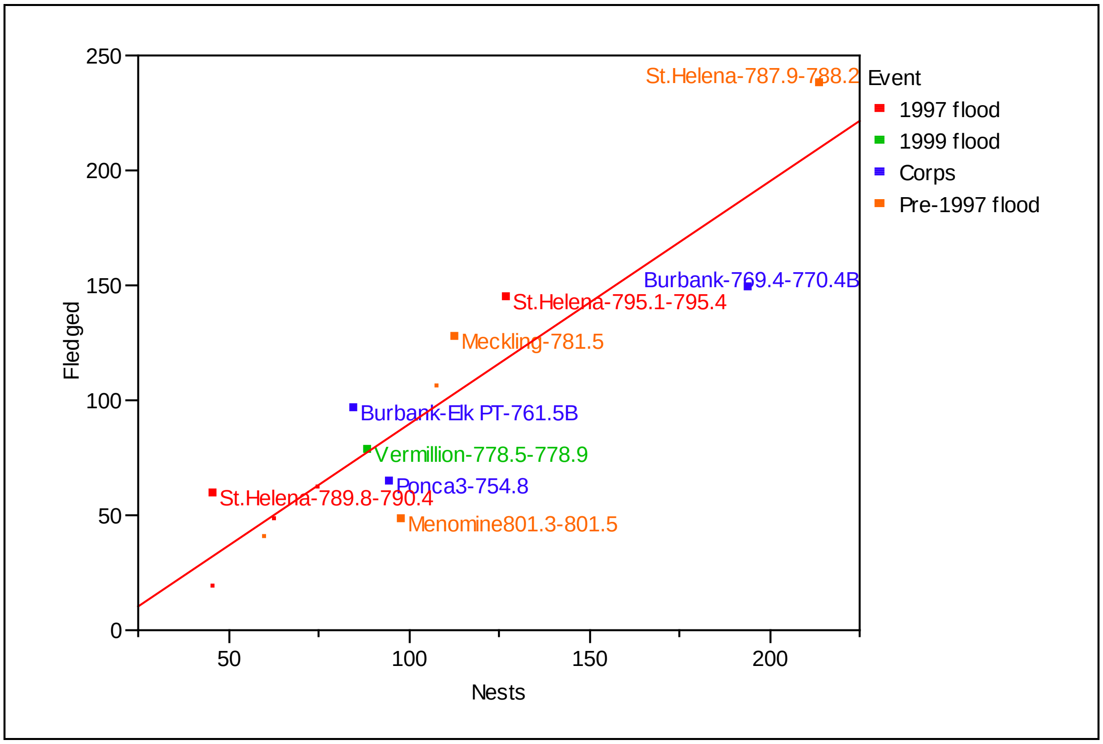
Table 6 includes r^2 values, minimum and maximum x values, and prediction equations for six different regression models linking sequential count metrics within the breeding season for the 14 main least tern sandbar NestAreas on the Gavins Point segment, 1999-2006. Sequential regressions of all four metrics were strongly predictive. Total numbers of nests were strongly predictive of numbers of fledglings ($r^2 = 0.83$) for the 14 main sandbar NestAreas, which ranged from 46 to 214 nests (Figure 11). This regression model covers the entire breeding season from nest initiation to fledging. When the breeding season was broken down into stages by sequential regressions, regressions were even more strongly predictive. For example, total nests were very strongly predictive of successful nests ($r^2 = 0.96$) and successful nests were very strongly predictive of fledglings ($r^2 = 0.91$) (Figures 4.12-4.13). The regression of successful nests predicted by total nests is most useful to explore site-specific differences in nest success or failure during the incubation period and the regression of fledglings predicted by successful nests is useful to explore site-specific differences in chick mortality or fledging success during the chick-rearing period. Individual sandbar NestAreas with particularly large residuals in any of the three regressions are labeled with text identifiers in all regression figures below.

Table 6
Regression Results: Highly Productive NestAreas - LT / Gavins Point

Independent Variable	Dependent Variable	R^2	min x	max x	Regression Equation
Nests	Successful nests	0.96	46	214	Success = -10.00 + 0.77 Nests
Successful nests	Fledglings	0.91	19	164	Fledged = -4.46 + 1.40 Success
Nests	Fledglings	0.83	46	214	Fledged = -15.76 + 1.06 Nests
Adults	Nests	0.87	48	258	Nests = 12.74 + 0.67 Adults
Adults	Successful nests	0.83	48	258	Success = 0.14 + 0.52 Adults
Adults	Fledglings	0.66	48	258	Fledged = 2.05 + 0.68 Adults

The regression of fledglings by nests (Figure 11) showed that the sandbar nesting area at Menominee 801.3-801.5 had the largest negative residual value, indicating relatively poor reproductive output (or low detectability of fledglings) at this sandbar compared to others on the Gavins Point segment. This was one of the high elevation sandbars that did not have its top elevations scoured during the high flows of 1997 and retains an associated older vegetation community. Similarly, large negative residual values for two of the three heavily used Corps-created sites, Burbank-769.4-770.4B and Ponca3-754.8 suggest relatively poor reproductive output compared to what is possible for this segment.

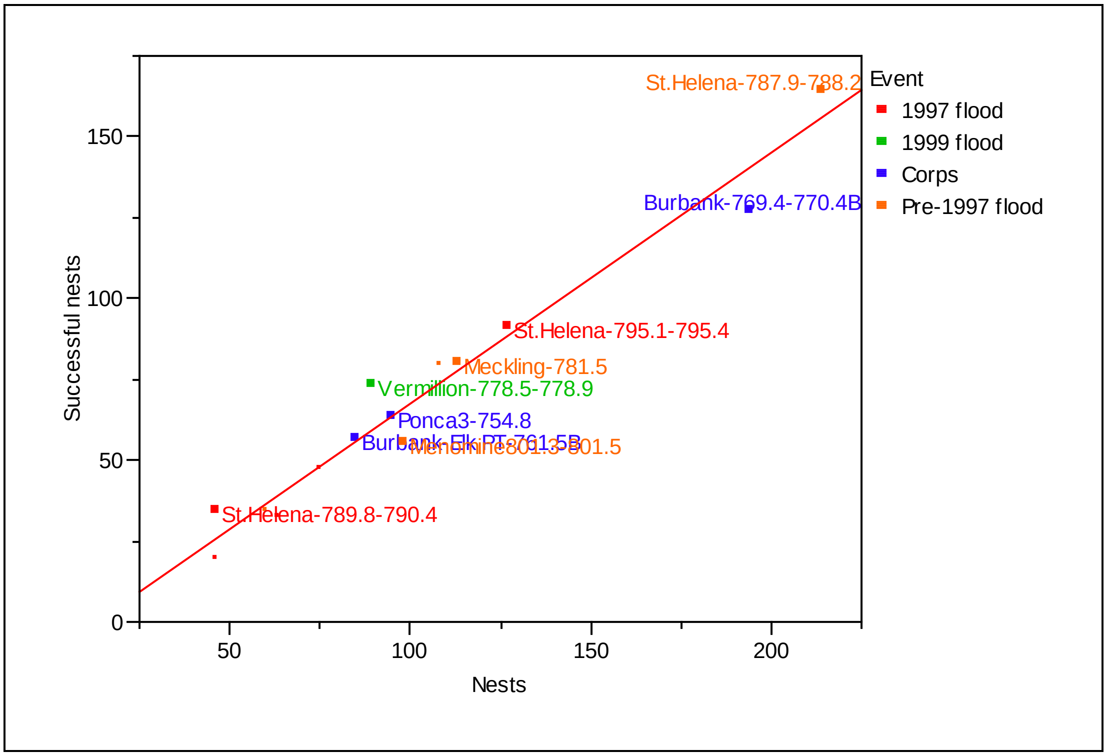
Figure 11
Regression of Least Tern Fledglings Predicted by Number of Nests for the 14 Highly Productive Least Tern NestAreas in the Gavins Point River Segment.



In other words, reproductive output on these two created sandbars, although extraordinary high compared with many natural sites, may have not been maximized. The large negative residual for the Burbank-769.4-770.4B site is troubling because this site had the second highest number of nests on the Gavins Segment between 1999 and 2006 and chick detectability should be relatively high at this site, as it is relatively new with less vegetation for chicks to hide in compared with older sites. Alternatively, a negative residual value could indicate high nest detectability at this site, a possibility given the openness of this site compared with older sandbars in this segment.

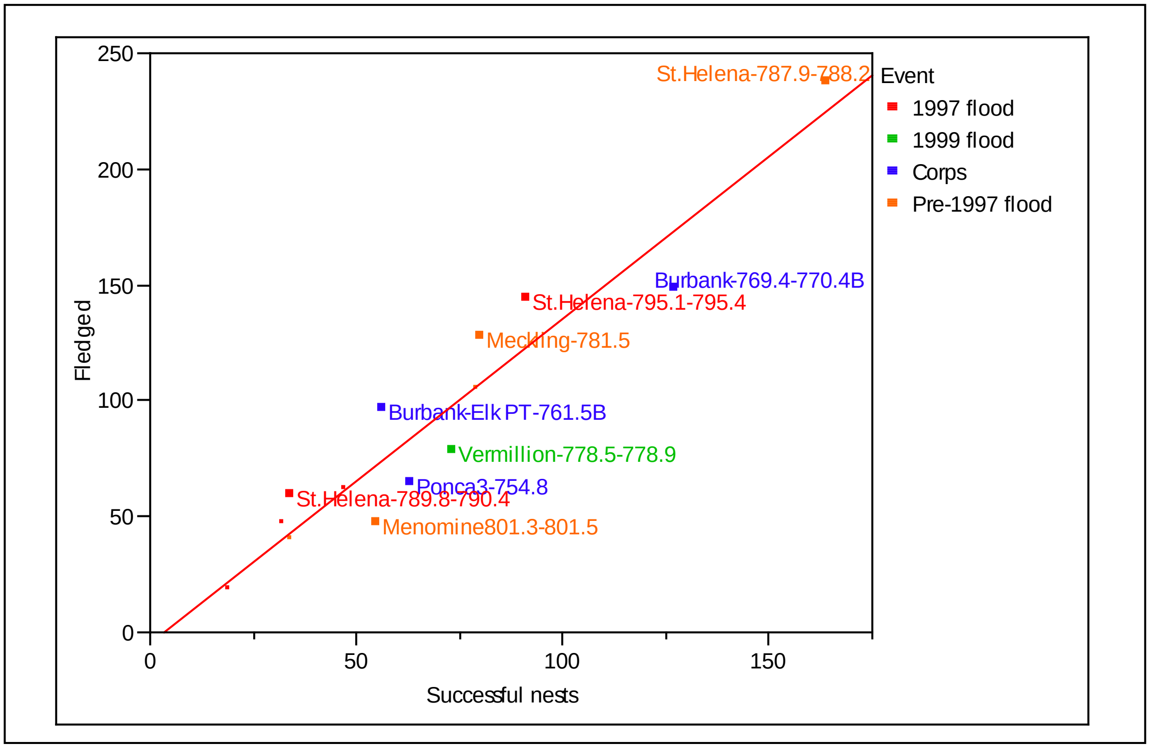
Two sandbar NestAreas had particularly large negative residual values during both the incubation period (Figure 12) and the chick rearing period (Figure 13), indicating higher than average nest mortality and chick mortality at the Corps-created sandbar at Burbank-769.4-770.4B and the natural sandbar at Menomine 801.3-801.5. The sandbar nesting area at Vermillion-778.5-778.9 had a negative residual value during the chick rearing period that seems to have been compensated for by higher than average nest success during the incubation period (as evidenced by the large positive residual value for this nesting area in the successful nests by total nests regression (Figure 12) and the position of this site near the regression line in the regression of fledglings by nests that covers the whole breeding season (Figure 11). Four sandbar NestAreas that were created in 1997 had higher than average reproductive output, as evidenced by large positive residual values on all three regression graphs, but particularly the fledglings by successful nests graph, indicating relatively high chick survival (or detectability) at these four sandbars. Listed in order from highest to lowest nest counts, these were: St. Helena-787.9-788.2, St. Helena 795.1-795.4, Meckling 781.5, and St. Helena-789.8-790.4.

Figure 12
Regression of Successful Nests Predicted by Numbers of Nests for the 14 Highly Productive Least Tern NestAreas in the Gavins Point River Segment



Conditions at the four sites below Gavins Point that were more productive than predicted for the population might be worth investigating to see if common habitat features can be identified that made these sandbars relatively more productive. Similarly, conditions at sites with lower than average reproductive output could be investigated to see if there are common problems with these sites that result in their lower than average reproductive output. However, while this approach focuses on sandbars that perform better or worse than predicted for their relative amount of use, it is important to remember that sandbars further to the right on the x-axis have higher absolute numbers of nests, or successful nests, and thus contribute more to population recovery than sites to the left with lower counts. Therefore, it is of greater importance to identify and address problems at sites with large negative residual values further to the right on these graphs or to emulate the conditions of sites with positive residual values, or even small negative residual values, on the right side of these graphs, because these sites contribute more fledglings to the population given their greater proportionate use.

Figure 13
Regression of Fledglings Predicted by Successful Nests for the 14 Highly Productive Least Tern NestAreas in the Gavins Point River Segment



9.5 Highly Productive Sandbars for Piping Plovers on the Gavins Point Segment

A vast majority of all Gavins Point piping plover nests (90%) and fledglings (90%) were counted on only 20 of the 40 sandbar NestAreas that were used between 1999 and 2006. Figure 11 presents, from upstream to downstream, all sandbar NestAreas on which ≥1 plover nests were recorded during the period of analysis. Figure 12 presents the same data, sorted by total number of nests. This group included three highly productive sandbar NestAreas that were created in 2004 or 2005. Aside from these recently created NestAreas, plover nests occurred on the 17 remaining important natural sandbars on an average of 5.9 years (SD ±2.0). Sixteen out of 17 important natural sandbar NestAreas had nests in ≥5 out of eight years, and eight sandbars had nests in at least seven of the eight years. Of the 20 main sandbar NestAreas, the 17 natural sites had average cumulative counts of 50 nests, 34 successful nests, and 80 fledglings in the eight years between 1999 and 2006. The three important created sites had average cumulative counts of 61 nests, 44 successful nests, and 69 fledglings in 2-3 years (between 2005 and 2006 for the two Burbank sites, and 2004-2006 for the Ponca3 site). Note that the created sites produced similar cumulative counts of nests, successful nests, and fledglings in 2-3 years as natural sites did in the preceding eight years. By contrast, the remaining 20 NestAreas had average counts of six nests, four successful nests, and nine fledglings and all 20 areas had counts of ≤13 nests, ≤11 successful nests, and ≤29 fledglings during this entire eight -year period. NestAreas with low counts (which also included two created sandbars) were also less frequently used than the 20 main sandbar NestAreas. The 18 natural sandbars with low counts had nests an average of 2.6 years (SD ±1.5) and 16 out of 20 of these areas had nests in ≤3 years.

As with the least terns, important sandbar NestAreas for piping plovers did not occur uniformly or randomly within the Gavins Point Segment. In fact, the majority of important natural sandbars occurred in 6 different clusters of sandbars (ranging from 0.1 - 3 river miles each) spanning between river miles 804.6-804.3, 795.4-793.1, 790.4-787.9, 781.5, 778.9-777.0, and 759.3-756.3 (Figure 11). With the exception of the sandbar NestAreas at 804.6-804.3, each of these areas was also highly productive for terns (Figure 9). These heavily used areas, which total only 10.1 of the 58 river miles of the Gavins Point Segment, all reflect aspects of riverine planform or channel geometry conducive to sandbar formation or retention.

Figure 11
Gavins Point Piping Plover NestAreas 1999- 2006

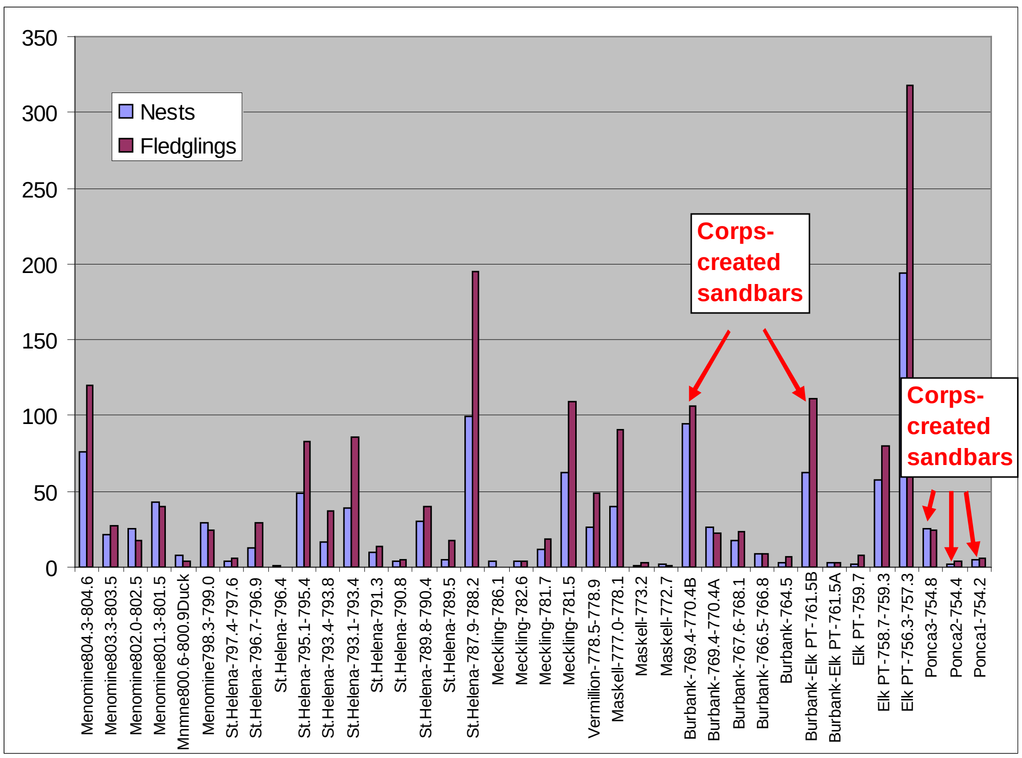
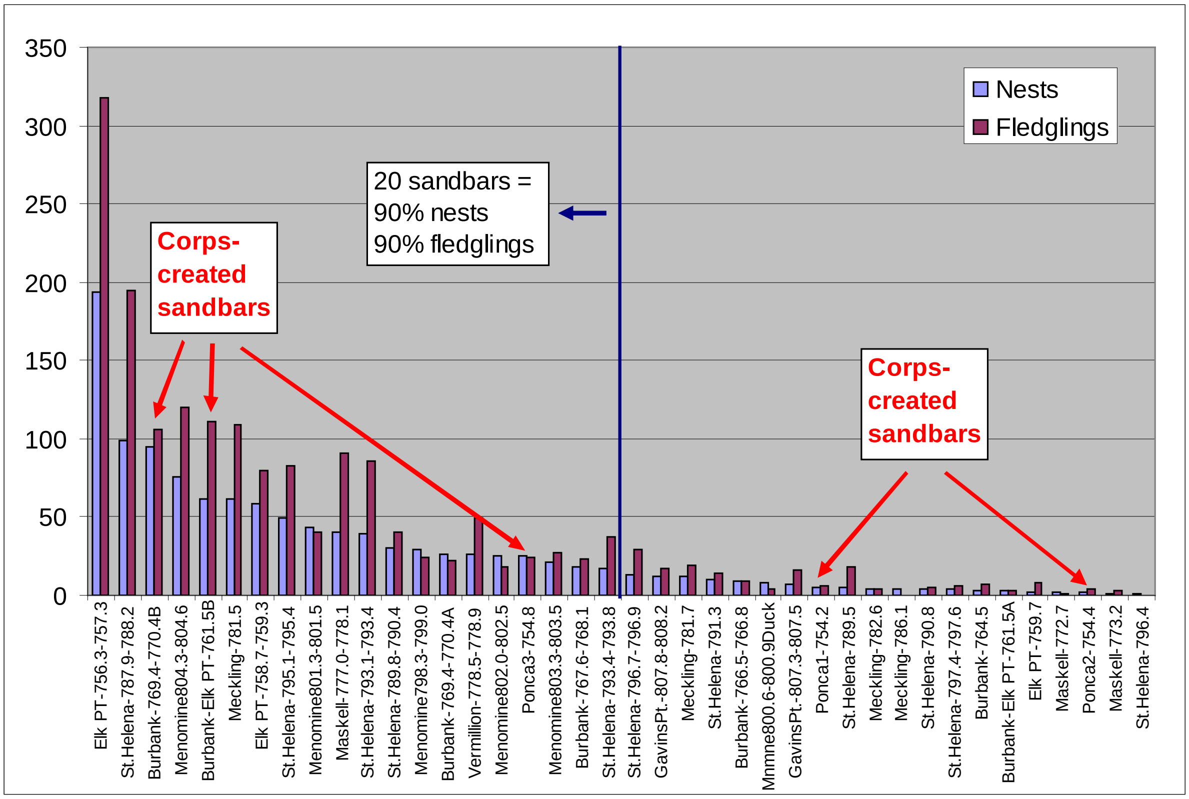


Figure 12
Gavins Point Piping Plover NestAreas 1999-2006
by Numbers of Nests



9.5.1 Relationships among Count Metrics for Gavins Point River Segment Piping Plovers

Table 7 includes r^2 values, minimum and maximum x values, and prediction equations for six different regression models linking sequential count metrics within the breeding season for 19 of the 20 main piping plover sandbar NestAreas on the Gavins Point Segment, 1999-2006. The extremely productive sandbar nesting area at Elk PT-756.3-757.3 was excluded from analyses as an outlier since it exerted too much leverage in all regressions. Sequential regressions of all four metrics were strongly predictive. Total numbers of nests were strongly predictive of numbers of fledglings (r^2 = 0.81) for sandbar NestAreas ranging from 17 to 99 nests (Figure 18). This regression model covers the entire breeding season from nest initiation to fledging. When the breeding season was broken down into stages by sequential regressions, regressions were even more strongly predictive. For example, total nests were very strongly predictive of successful nests (r^2 = 0.95) and successful nests were strongly predictive of fledglings (r^2 = 0.84) (Figures 4.19 and 4.20). The regression of successful nests predicted by total nests is useful to explore site-specific differences in nest success or failure during the incubation period and the regression of fledglings predicted by successful nests is useful to explore site-specific differences in chick mortality or fledging success during the chick-rearing period. Individual sandbar NestAreas with particularly large residuals in any of the three regressions are labeled with text identifiers in all regression figures below.

Table 7
Regression Results for 19 of the 20 Highly Productive NestAreas for Piping Plovers on the Gavins Point River Segment.

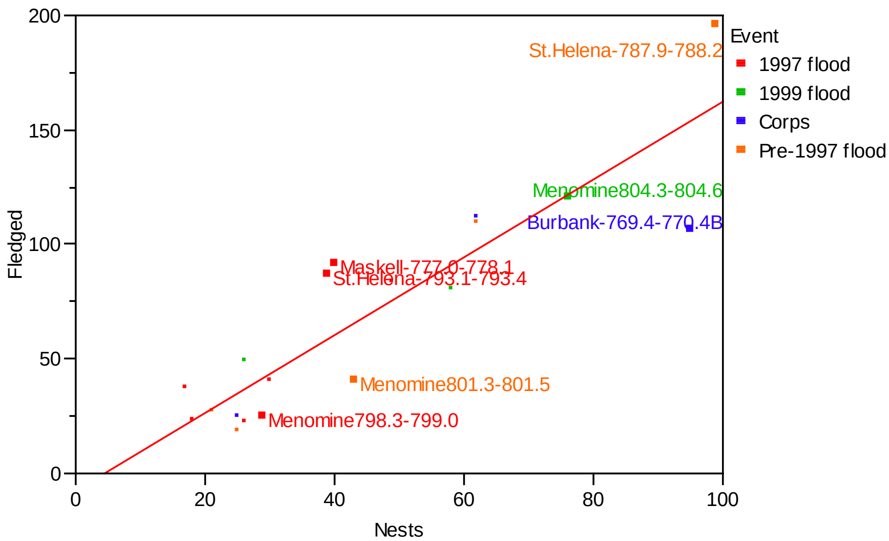
Independent Variable	Dependent Variable	R2	P value	min x	max x	Equation
Nests	Successful nests	0.95	<0.0001	17	99	Success = -2.92 + 0.75 Nests
Successful nests	Fledglings	0.84	<0.0001	11	74	Fledged = -022 + 2.24 Success
Nests	Fledglings	0.81	<0.0001	17	99	Fledged = -7.38 + 1.70 Nests
Adults	Nests	0.89	<0.0001	14	143	Nests = -0.52 + 0.66 Adults
Adults	Successful nests	0.82	<0.0001	14	143	Success = -2.84 + 0.49 Adults
Adults	Fledglings	0.75	<0.0001	14	143	Fledged = -0.71 + 1.14 Adults

Note: Elk PT-756.3-757.3 was excluded from analyses as an outlier.

The regression of fledglings by nests (Figure 18), which covers the entire breeding season, identified two sites with relatively low reproductive output compared with other sandbar NestAreas on the Gavins Point River Segment: Menomine801.3-801.5 and the Corps-created site at Burbank-769.4-770.4B. The large negative residual value at Menominee 801.3-801.5 was similar to the regression for Gavins Point Least Terns (Figure 11). This was one of the high sandbars that did not have its top elevations scoured during the high flows of 1997. The heavily used Corps-created site at Burbank-769.4-770.4B also had a large negative residual for both plovers and terns (Figure 11). However, for terns, reproductive failure seemed to be concentrated during the incubation period (Figure 12), whereas for plovers, reproductive failure seemed to be concentrated during the chick-rearing period (Figure 20). This site had the third highest number of piping plover nests on the Gavins Segment during the time period between 1999 and 2006, despite only being available in 2005 and 2006. Even though this site had a negative regression residual, suggesting relatively poor reproductive output compared to what may be possible for this segment, this sandbar nesting area still produced the fourth highest total of piping plover fledglings on the Gavins segment.

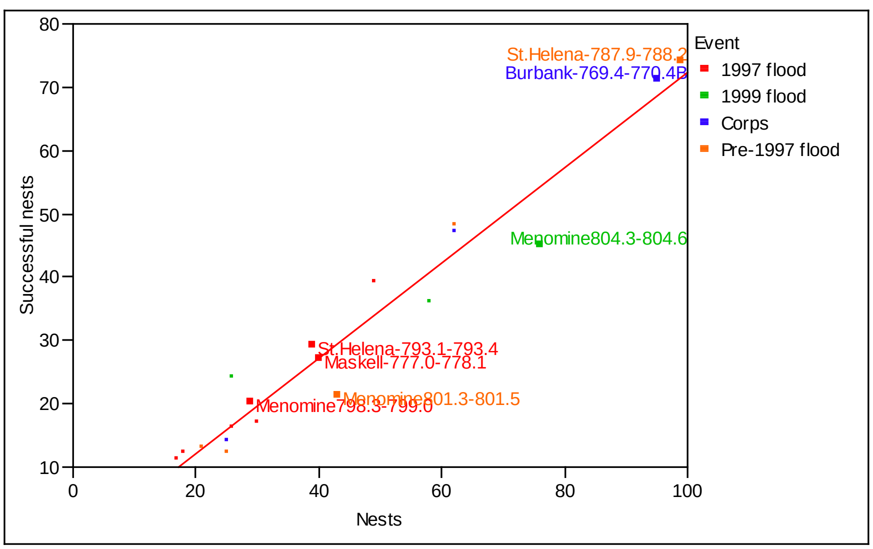
No sandbar NestAreas had particularly large negative residual values during both the incubation period (Figure 19) and the chick-rearing period (Figure 20). Relatively high reproductive failure or success at any one site across the entire breeding period (Figure 18) was due to large residual values in either the regression covering the incubation period (one site only, Menomine801.3-801.5) (Figure 19) or the regression covering the chick rearing period (5 of the 6 other sandbar NestAreas with point labels in the regression figures) (Figure 20). Negative residual values during the incubation period at Menomine804.3-804.6 (Figure 19) were counter-balanced by positive residuals during the chick rearing period (Figure 20), resulting in the point for this site lying close to the prediction line for the regression of fledglings by nest, which covers the entire breeding season (Figure 18).

Figure 18
Regression of Fledglings Predicted by Number of Nests for 19 of the 20 Highly Productive Piping Plover NestAreas in the Gavins Point River Segment.



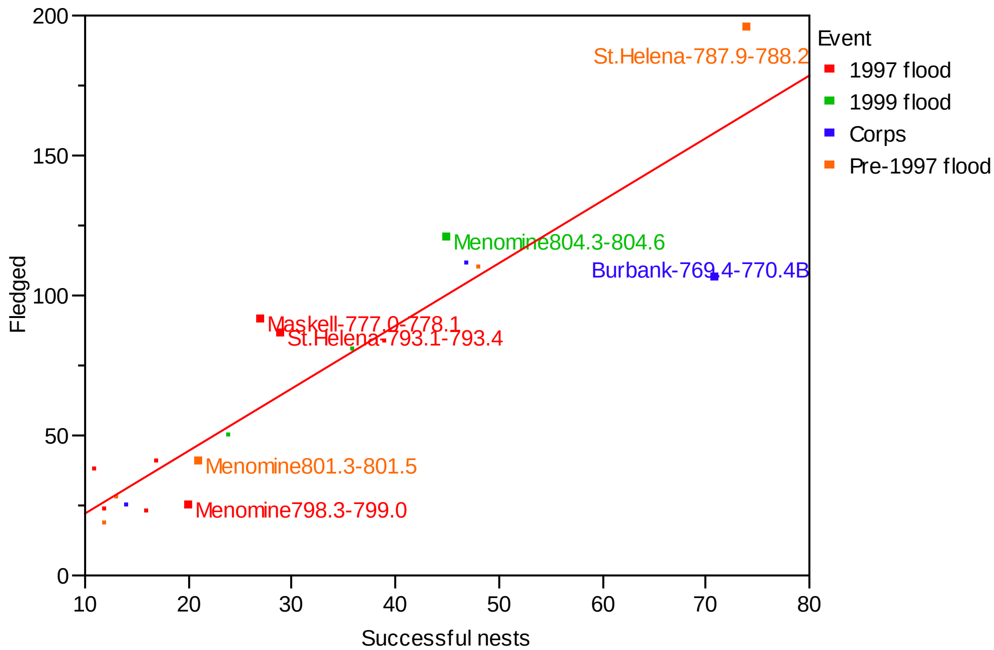
Note: Elk PT-756.3-757.3 was excluded from analyses as an outlier.

Figure 19
Regression of Successful Nests Predicted by Number of Nests for 19 of the 20 Highly Productive Piping Plover NestAreas in the Gavins Point River Segment.



Note: Elk PT-756.3-757.3 was excluded from analyses as an outlier.

Figure 20
Regression of Fledglings Predicted by Successful Nests for 19 of the 20 Most Highly Productive Piping Plover NestAreas in the Gavins Point River Segment.



Note: The extremely successful Elk PT-756.3-757.3 nesting area was excluded from analyses as an outlier.

9.6 Highly Productive Sandbars for Least Terns on the Garrison River Segment

Data presentations for the Garrison Segment differ in two ways from presentations for the Gavins Point Segment: 1) GPS nest location data are only available for six years (2001-2006) as opposed to eight for Gavins; and 2) Analyses have not been done to classify the flow event origins of individual sandbar NestAreas in the Garrison Segment (e.g., 1997 releases, pre-1997 releases, 1999 releases). Therefore, individual sandbars in regression figures are not coded by origin. Note that no sandbars have been mechanically created by the Corps in the Garrison Segment as has been done for the Gavins Point Segment.

A majority of all tern nests (69%) and fledglings (68%) were counted on only 14 of the 53 sandbar NestAreas that had ≥1 nest on the Garrison River segment between 2001 and 2006. Figure 13 presents, from upstream to downstream, all sandbar NestAreas on which ≥1 plover nests were recorded during the period of analysis. Figure 14 presents the same data, sorted by total number of nests. The 14 main sandbar NestAreas had average counts of 22 nests, 16 successful nests and 24 fledglings over the entire period from 2001 through 2006. Tern nests occurred on the 14 main sandbars an average of 3.4 (SD ±1.6) out of 6 years and 5 of these 14 NestAreas in ≥4 years. By contrast, the remaining 39 NestAreas had average counts of 4 nests, 3 successful nests, and 4 fledglings and all 39 areas had counts of ≤9 nests, ≤9 successful nests, and ≤12 fledglings during this 6 -year period. NestAreas with low counts were also less frequently used than the 14 main sandbar NestAreas. The 39 sandbars with low counts had nests an average of 1.4 years (SD ±0.6) out of 6 years. Nearly all of these areas (36 out of 39) had nests in only 1 or 2 out of 6 years and the remaining 3 low-count areas had nests in only 3 of 6 years.

Highly Productive sandbar NestAreas for least terns did not occur uniformly or randomly within the Garrison River segment. In fact, the majority of important natural sandbars occurred in 9 different clusters of sandbars (ranging from 0.1 – 1.9 river miles each). These heavily used areas, which total only 4 of the 84 river miles of the Garrison River segment, all reflect aspects of riverine planform or channel geometry conducive to sandbar formation or retention.

Figure 13
Garrison Least Tern NestAreas 2001- 2006

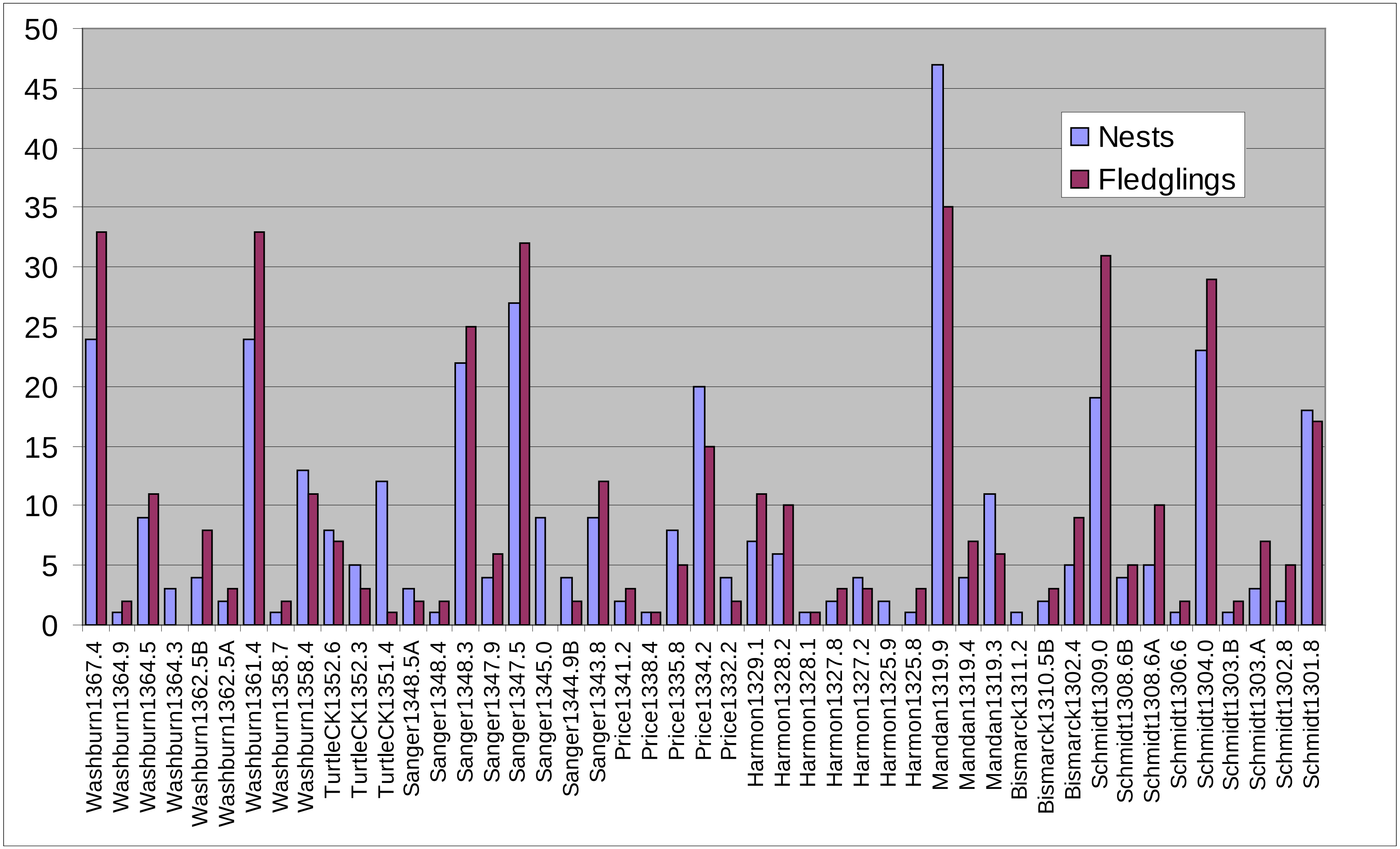
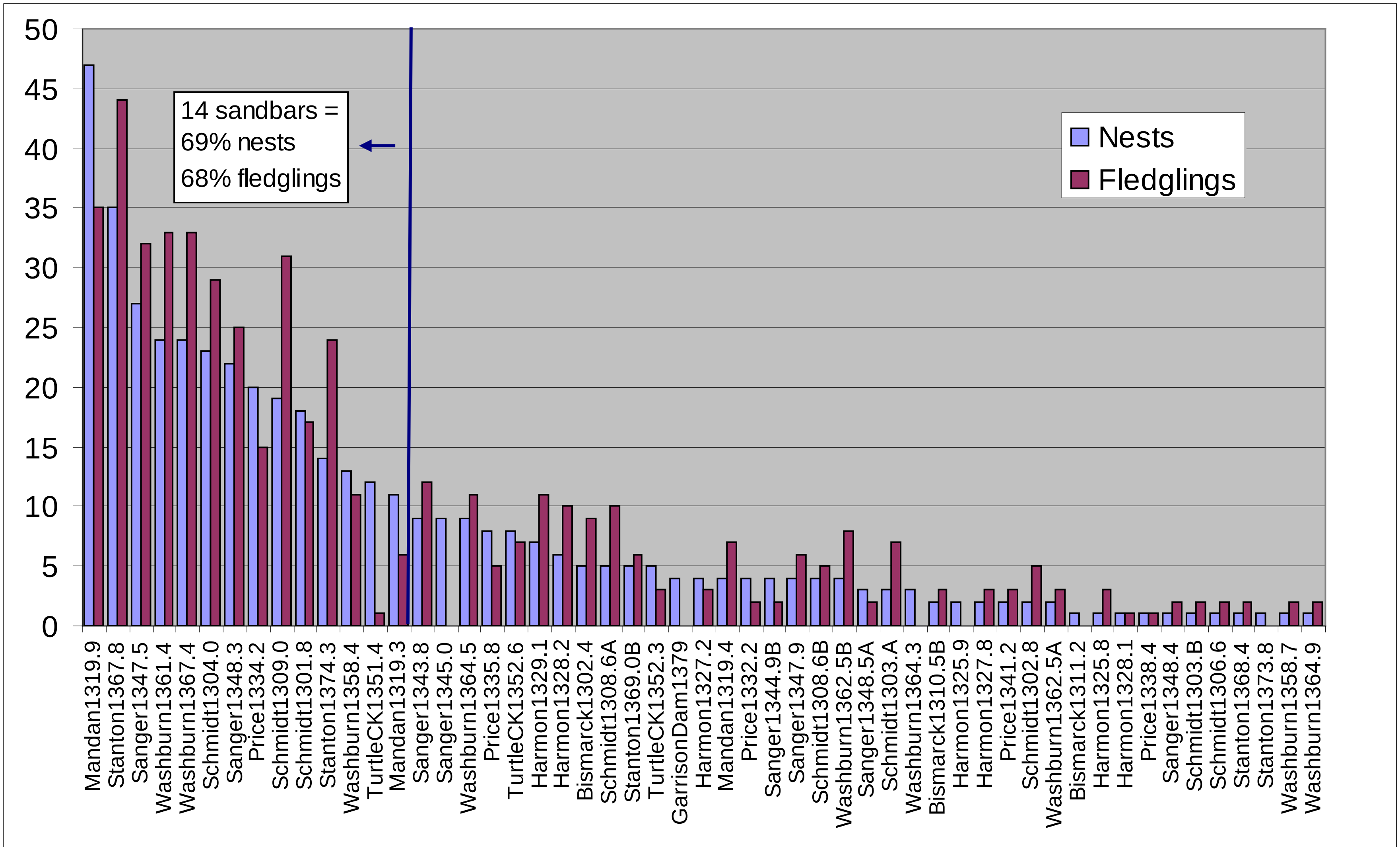


Figure 14
Garrison Least Tern NestAreas 2001-2006
by Numbers of Nests



counts had nests an average of 1.4 years (SD ±0.6) out of 6 years. Nearly all of these areas (36 out of 39) had nests in only 1 or 2 out of 6 years and the remaining 3 low-count areas had nests in only 3 of 6 years.

Highly Productive sandbar NestAreas for least terns did not occur uniformly or randomly within the Garrison River segment. In fact, the majority of important natural sandbars occurred in 9 different clusters of sandbars (ranging from 0.1 – 1.9 river miles each) (Figure 22). These heavily used areas, which total only 4 of the 84 river miles of the Garrison River segment, all reflect aspects of riverine planform or channel geometry conducive to sandbar formation or retention.

9.6.1 Relationships among Count Metrics for Garrison River Segment Least Terns

Table 8 includes r^2 values, minimum and maximum x values, and prediction equations for six different regression models linking sequential count metrics within the breeding season for the 14 main least tern sandbar NestAreas on the Garrison segment, 2001-2006. Sequential regressions of all four metrics were strongly predictive. Total numbers of nests were moderately predictive of numbers of fledglings ($r^2 = 0.58$) for the 14 main sandbar NestAreas, which ranged from 11 to 47 nests (Figure 24). This regression model covers the entire breeding season from nest initiation to fledging. When the breeding season was broken down into stages by sequential regressions, regressions were more strongly predictive. For example, total nests were very strongly predictive of successful nests ($r^2 = 0.85$) and successful nests were very strongly predictive of fledglings ($r^2 = 0.73$) (Figures 4.25-4.26). The regression of successful nests predicted by total nests is useful to explore site-specific differences in nest success or failure during the incubation period and the regression of fledglings predicted by successful nests is useful to explore site-specific differences in chick mortality or fledging success during the chick-rearing period. Individual sandbar NestAreas with particularly large residuals in any of the three regressions are labeled with text identifiers in all regression figures below.

The regression of fledglings by nests (Figure 24) showed that the heavily used sandbar nesting area at Mandan1319.9 had the largest negative residual value, indicating relatively poor reproductive output at this sandbar compared to others on the Garrison segment. This sandbar had large negative residuals during both incubation (Figure 24) and the chick-rearing period (Figure 25). In fact most sandbars on the Garrison segment had similar residual values in all three regressions, indicating that sandbars that had high reproductive success during incubation also fared well during chick rearing period. The other site with particularly large negative residual values was Turtle Creek1351.4; however, this site represented a relatively small number of total nests. The sandbar at Stanton1367.8 had both the second highest total number of nests and a strongly positive regression residual. Characteristics of this sandbar might be studied and emulated for sandbar creation projects in the Garrison segment. Similarly, two sites, Stanton1374.3 and Schmidt1309.0, also had relatively positive residual values, even though they contributed fewer nests to the population than Stanton1367.8. Conditions at these sites, and any other sites with relatively high nest numbers and positive regression residuals, might also inform future sandbar habitat creation on the Garrison segment.

Table 8
Regression Model Results for the 14 Highly Productive NestAreas for Least Terns on the Garrison Segment.

Independent variable	Dependent variable	R^2	P value	min x	max x	EQUATION
Nests	Successful nests	0.85	<0.0001	11	47	Success = 0.54 + 0.74 Nests
Successful nests	Fledglings	0.73	<0.0001	3	30	Fledged = 1.26 + 1.35 Success
Nests	Fledglings	0.58	0.0015	11	47	Fledged = 2.60 + 0.97 Nests
Adults	Nests	0.90	<0.0001	6	84	Nests = 4.25 + 0.49 Adults
Adults	Successful nests	0.80	<0.0001	6	84	Success = 3.36 + 0.37 Adults
Adults	Fledglings	0.58	0.0016	6	84	Fledged = 5.83 + 0.50 Adults

Figure 24
Regression of Fledglings Predicted by Number of Nests for the 14 Highly Productive Least Tern NestAreas in the Garrison Segment.

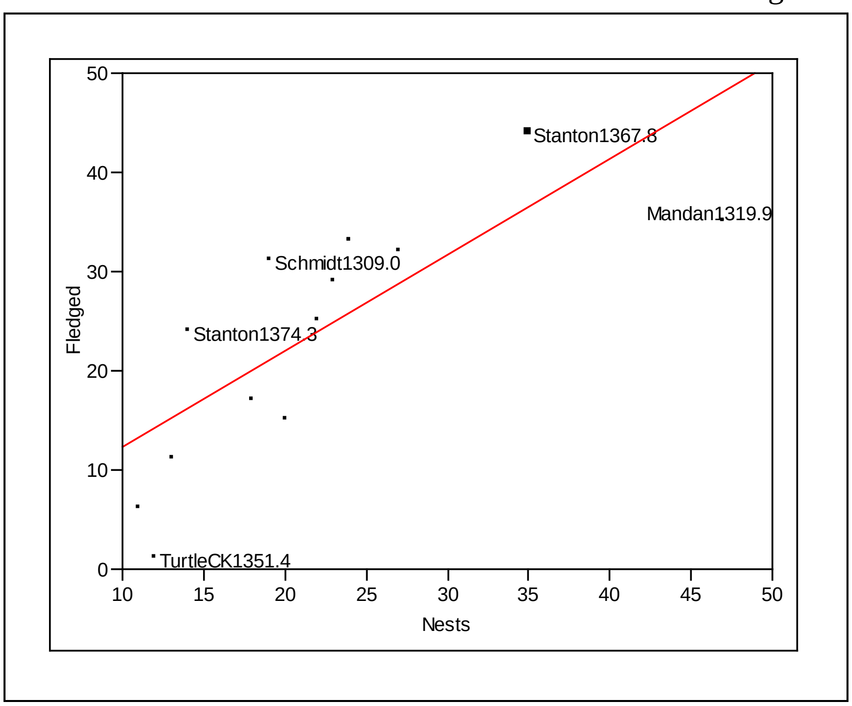


Figure 25
Regression of Successful Nests Predicted by Numbers of Nests for the 14 Highly

Productive Least Tern NestAreas in the Garrison Segment

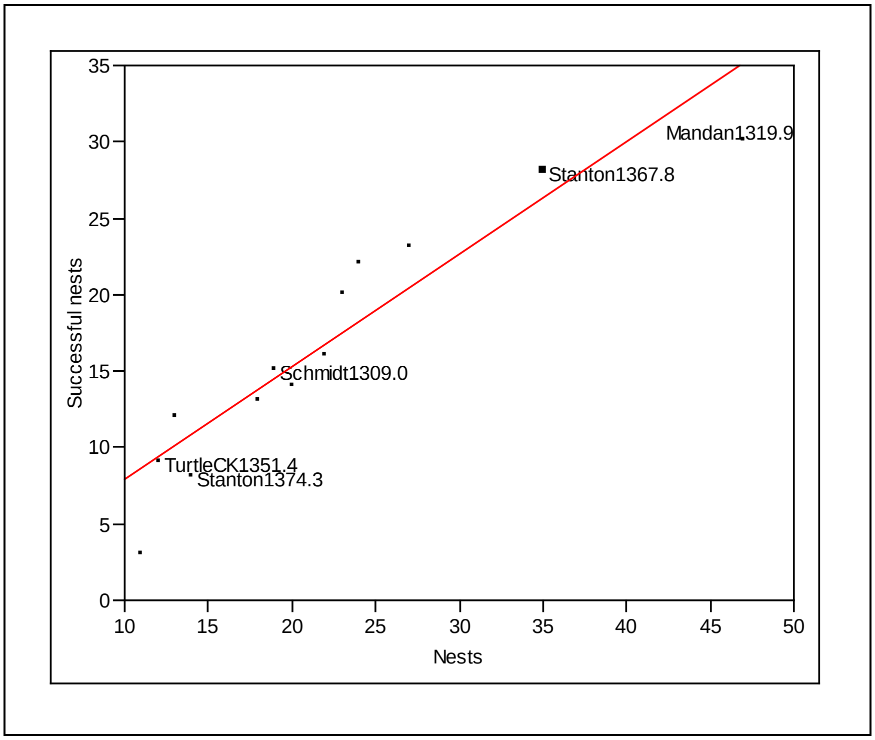
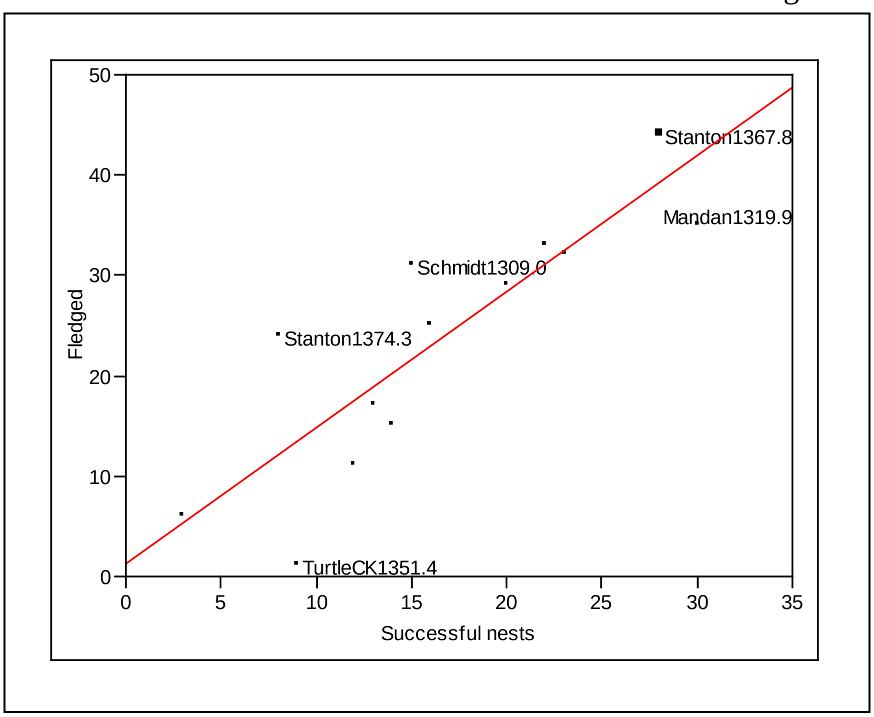


Figure 26
Regression of Fledglings Predicted by Successful Nests for the 14 Highly Productive Least Tern NestAreas in the Garrison Segment



9.7 Highly Productive Sandbars for Piping Plovers on the Garrison River Segment

A majority of all plover nests (59%) and fledglings (63%) were counted on only 14 of the 92 sandbar NestAreas that had ≥1 nest on the Garrison River segment between 2001 and 2006. Figure 15 presents, from upstream to downstream, all sandbar NestAreas on which ≥1 plover nests were recorded during the period of analysis. Figure 16 presents the same data, sorted by total number of nests. The 14 main sandbar NestAreas had average counts of 22 nests, 15 successful nests, and 28 fledglings between 2001 and 2006. Plover nests occurred on the 14 main sandbars an average of 4.1 (SD ±1.7) out of 6 years. Eleven out of 14 of these NestAreas in ≥3 out of 6 years and 6 out of 14 of these areas had nests in 5 or 6 out of 6 years. By contrast, the remaining 78 NestAreas had average counts of 3 nests, 2 successful nests, and 3 fledglings and all 78 areas had counts of ≤9 nests, ≤7 successful nests, and ≤17 fledglings during this 6-year period. NestAreas with low counts were also less frequently used than the 14 main sandbar NestAreas. The 78 sandbars with low counts had nests an average of 1.3 years (SD ±0.6) out of 6 years and 75 out of 78 of these areas had nests in only 1 or 2 out of 6 years.

Highly Productive sandbar NestAreas for piping plovers did not occur uniformly or randomly within the Garrison River segment. In fact, the majority of important natural sandbars occurred in 11 different clusters of sandbars (ranging from 0.1 - 2 river miles each) spanning between river miles (Figure 15). These heavily used areas, which total only 8.1 of the 84 river miles of the Garrison River segment, all reflect aspects of riverine planform or channel geometry conducive to sandbar formation or retention.

Figure 15
Garrison Piping Plover NestAreas 2001- 2006

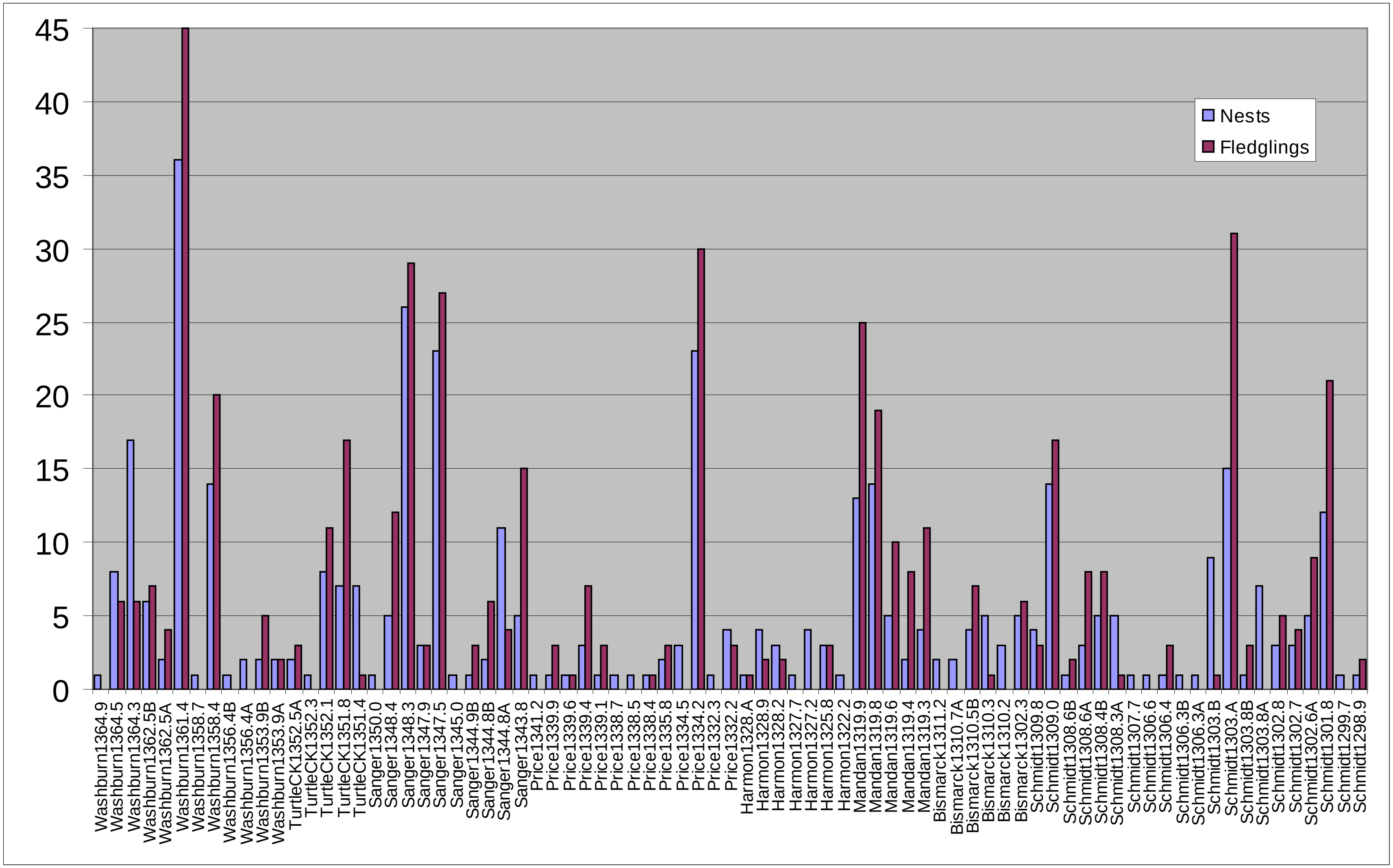
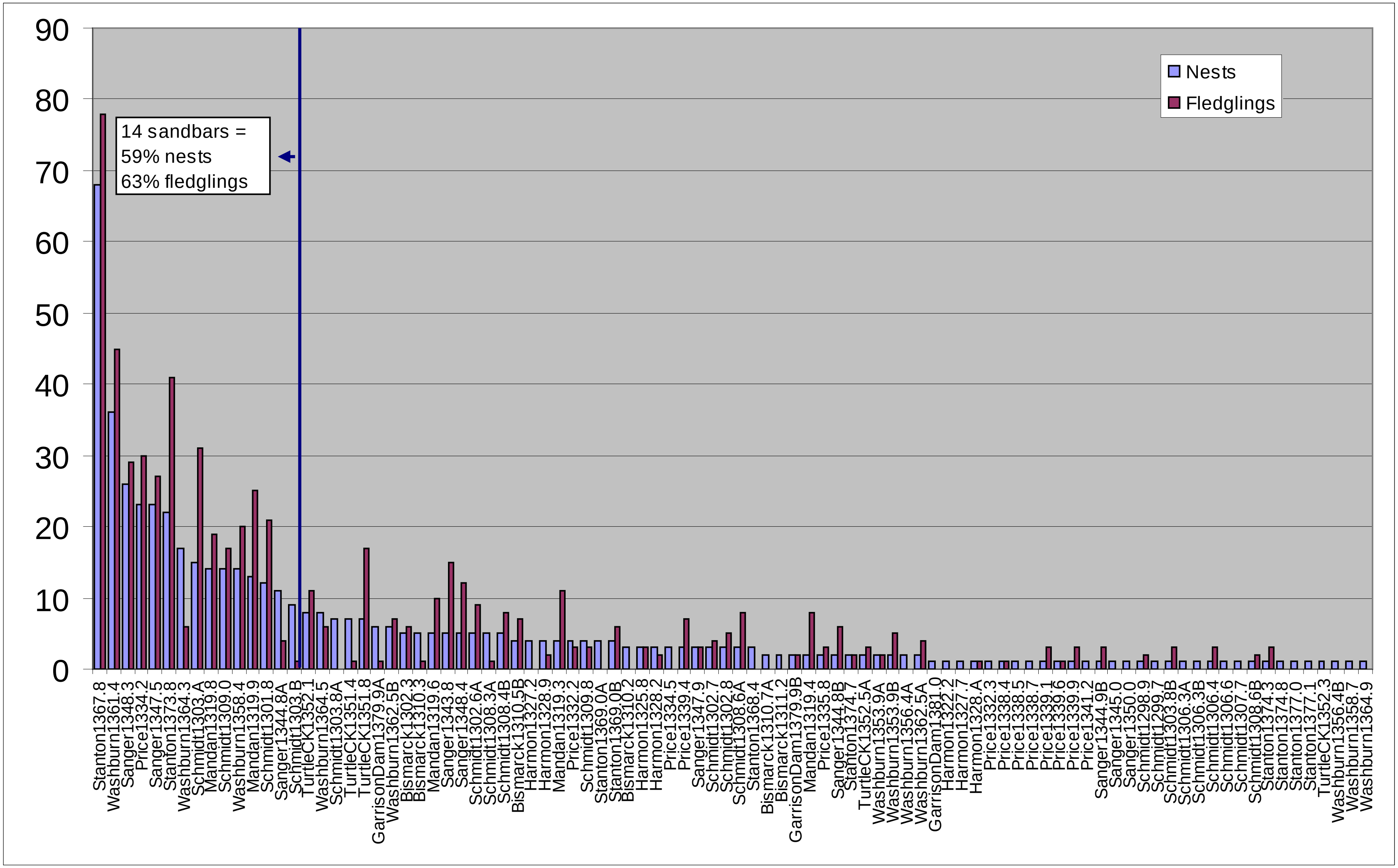


Figure 16
Garrison Piping Plover NestAreas 2001-2006 by Numbers of Nests



9.7.1 Relationships Among Count Metrics for Garrison Segment Piping Plovers

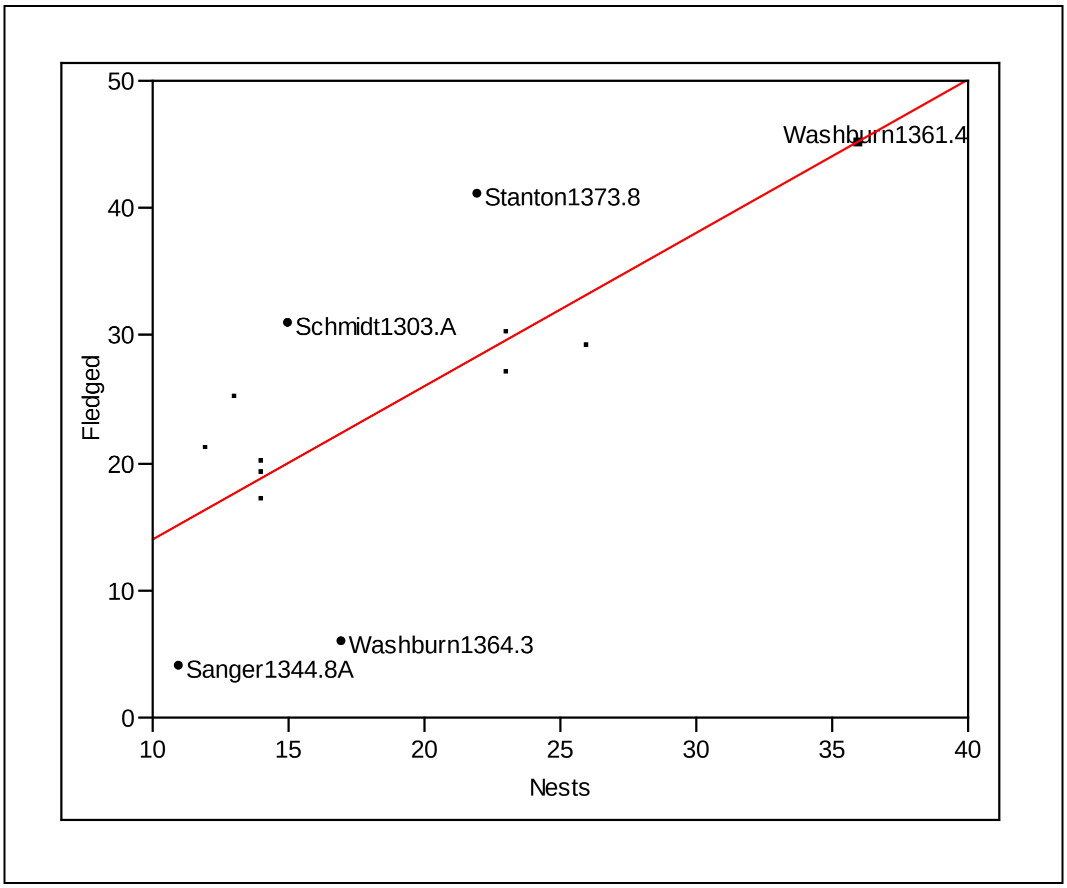
Table 9 includes r^2 values, minimum and maximum x values, and prediction equations for six different regression models linking sequential count metrics within the breeding season for 13 of the 14 main piping plover sandbar NestAreas on the Garrison segment, 2001-2006. The extremely productive sandbar nesting area at Stanton1367.8 was excluded from analyses as an outlier since it exerted too much leverage in all regressions. Sequential regressions of all four metrics were moderately predictive. Total numbers of nests were strongly predictive of numbers of fledglings (r^2 = 0.53) for sandbar NestAreas ranging from 11 to 34 nests (Figure 29). This regression model covers the entire breeding season from nest initiation to fledging. When the breeding season was broken down into stages by sequential regressions, total nests were strongly predictive of successful nests (r^2 = 0.85), however successful nests were only moderately predictive of fledglings (r^2 = 0.57) (Figures 4.30 and 4.31). The regression of successful nests predicted by total nests is useful to explore site-specific differences in nest success or failure during the incubation period and the regression of fledglings predicted by successful nests is useful to explore site-specific differences in chick mortality or fledging success during the chick-rearing period. Individual sandbar NestAreas with particularly large residuals in any of the three regressions are labeled with text identifiers in all regression figures below.

The regression of fledglings by nests (Figure 29), which covers the entire breeding season, identified two sites with relatively low reproductive output compared with other sandbar NestAreas on the Garrison Segment: Sanger1344.8A and Washburn 1364.3. Both of these sites had relatively low numbers of total nests and did not comprise a large percentage of the segment-wide or system-wide population. Therefore, efforts to improve conditions or solve problems causing mortality (if these could have been identified from the monitoring dataset) would have had little impact on the population as a whole. The sandbar at Stanton1367.8 had both the second highest total number of nests and a strongly positive regression residual. Successful reproduction at this site seemed to be driven by particularly high success during the chick-rearing period (Figure 31) which more than offset poor performance during the incubation period (Figure 30). Characteristics of this sandbar might be studied and emulated if sandbars are created in the Garrison segment. Similarly, two sites, Stanton1374.3 and Schmidt1309.0, also had relatively positive residual values, even though they contributed fewer nests to the population than Stanton1373.8 had a large positive residual value and relatively high numbers of nests. The sandbar at Schmidt1303A had a positive regression residual with few total nests. Conditions at these two sites, and at the four other sites with relatively high nest numbers and positive (or only slightly negative) regression residuals, might also inform future sandbar habitat creation on the Garrison segment. Additionally, the sandbar at 1367.8, which was excluded from regression analyses as an outlier, had nearly twice as many nests and fledglings as all other sandbars. This was also the second most productive site for least terns. Conditions at this site should also inform future habitat creation efforts on the Garrison segment.

Table 9
Regression Model Results for the 13 of the 14 Highly Productive NestAreas for Piping Plovers on the Garrison Segment.

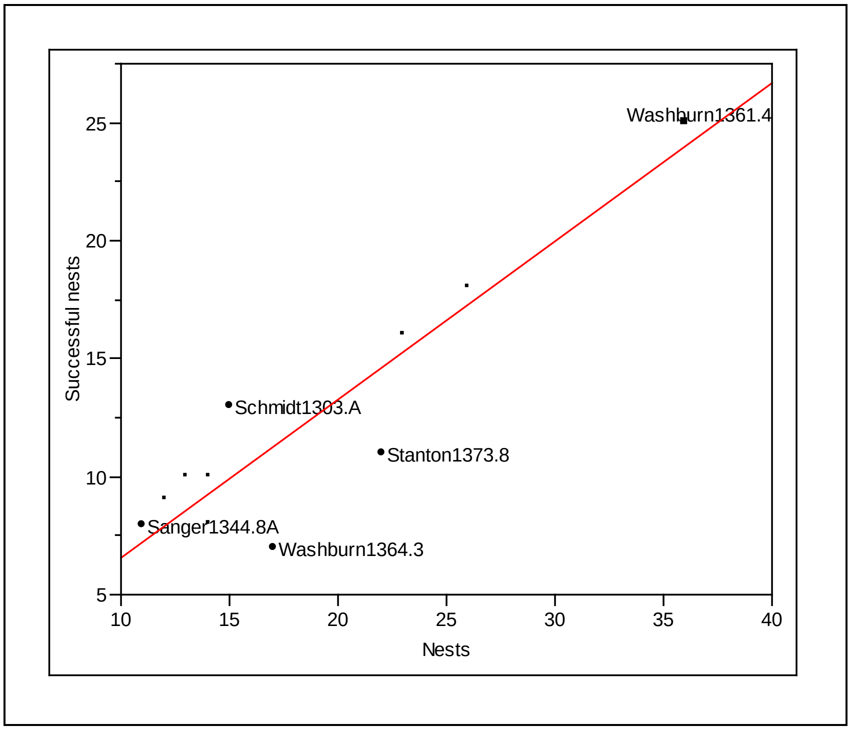
Independent variable	Dependent variable	R^2	P value	min x	max x	EQUATION
Nests	Successful nests	0.85	<0.0001	11	36	Success = -0.13 + 0.67 Nests
Successful nests	Fledglings	0.57	0.0027	7	25	Fledged = 3.32 + 1.71 Success
Nests	Fledglings	0.53	0.0046	11	36	Fledged = 2.06 + 1.20 Nests
Adults	Nests	0.67	0.0006	13	59	Nests = 3.44 + 0.49 Adults
Adults	Successful nests	0.65	0.0009	13	59	Success = 1.46 + 0.35 Adults
Adults	Fledglings	0.58	0.0024	13	59	Fledged = 1.20 + 0.75 Adults

Figure 29
Regression of Fledglings Predicted by Number of Nests for 13 of the 14 Highly Productive Piping Plover NestAreas in the Garrison Segment.



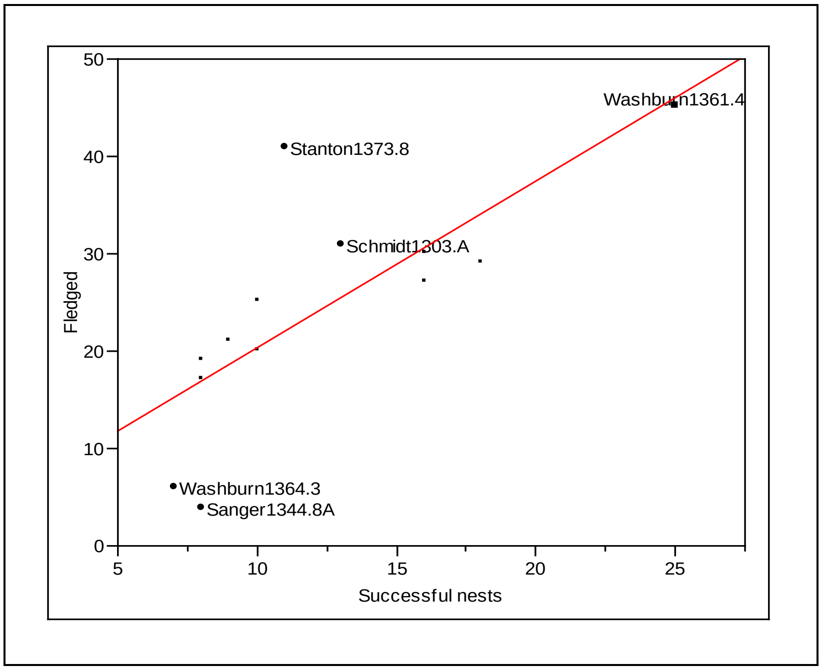
Note: The Extremely Productive NestArea at Stanton 1367.8 was excluded from analyses as an outlier.

Figure 30
Regression of Successful Nests Predicted by Number of Nests for 13 of the 14 Highly Productive Piping Plover NestAreas in the Garrison Segment.



Note: The Extremely Productive NestArea at Stanton 1367.8 was excluded from analyses as an outlier.

Figure 31
Regression of Fledglings Predicted by Successful Nests for 13 of the 14 Highly Productive Piping Plover NestAreas in the Garrison Segment.



Note: The Extremely Productive NestArea at Stanton 1367.8 was excluded from analyses as an outlier.

10 Conclusions

The Missouri River system represents less than 6 percent of the range-wide population of interior least terns and less than 2 percent of the U.S. population of all least terns. Missouri River piping plovers comprise a larger proportion of the range-wide population for Great Plains piping plovers (6% - 28%, depending on survey year) and 3% - 16% percent of the total U.S. and Canada breeding population for all piping plovers.

Interior least terns have an extremely strong association with sandbars across their range (~90% of all individuals were counted on riverine segments during the 2005 survey). This association is also strong on the Missouri River, but less so (an average of 79% of all Missouri River terns have been counted on sandbars during the District's adult census). Piping plovers have a less strong association with riverine sandbars than terns. Only 20 percent of all individual Great Plains piping plovers were counted on rivers during the 2001 IPPC, whereas 34 percent were counted on alkali lakes and 32 percent were counted on reservoir shorelines. On the Missouri River, the sandbar association was a little bit stronger than this, but still less than for terns, with an average of 54 percent of all piping plovers counted on riverine segments during the District's adult census.

Among the riverine segments, the Gavins Point and Garrison Segment were much more important to terns and plovers than the Fort Randall, Fort Peck River, or Lewis and Clark Lake segments. Counts for both species on the Gavins Point and Garrison River segments were comparable to counts in other important population segments across the breeding range of interior least terns or Great Plains piping plovers. This was not the case for the three other riverine segments. Initial indications of poor productivity on all of the constructed sandbars in 2007 may indicate that this relationship will not continue in the future.

At the temporal scale of this analysis (6-8 years) the extensive spatial coverage of the District's monitoring program was very effective at documenting the relative importance of different sandbars for least tern and piping plover reproductive effort and output during that period. Count metrics were highly correlated with each other, providing little ambiguity as to which sandbars were most heavily used by birds.

A relatively small number of sandbar NestAreas (each used in multiple years) contributed a high proportion of all nests and fledglings to both the Gavins Point and Garrison River segments. These sites were mostly: 1) high sandbars created during the 1997 releases; 2) mechanically created sandbars. A larger number of infrequently used small sandbars contributed little to segment-wide counts. These sites were often lower-elevation sandbars (highly vulnerable to flooding) that were successfully used only in years of extremely low releases, as described in Sections 3 and 6 of Appendix B.

Heavily used sandbars were concentrated in areas where riverine planform or channel geometry was conducive to sandbar formation and retention. These areas represent a small fraction of the total area downstream of dams.

The complete spatial coverage of the District's monitoring program clearly documented that important sandbar NestAreas were not distributed randomly or uniformly within either the Gavins Point or Garrison Segment. Random sampling for bird monitoring programs would probably result in small sample sizes (because important sandbars that are patchily distributed in clusters might not be encountered). Stratified sampling based on complete inventories of sandbar NestAreas to document major areas of bird use might be more appropriate for research or monitoring studies, which are beyond the scope of this investigation.

Unknown detectability of both nests and fledglings complicated interpretation of count metrics as site-specific reproductive indices. However, the large size (number of records) and temporal extent of the District's monitoring dataset still resulted in clear pictures of site importance.

Nest fate data from the monitoring program were not particularly valuable due to inconsistent methods of data recording, the large proportion of nests with unknown fates, and the small sample size for failed nests for any riverine segments other than Gavins Point. Additionally, several sites seemed to have problems with reproductive failure during the chick period. Nest fate data do not provide direct insight as to causes of chick mortality.

Although limited to the Gavins Point segment, created sites were remarkably successful, contributing more nests and fledglings in 2-3 years than natural sites did in 8 years.

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Attachment 3
Hydrologic Data Analyses

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Table of Contents

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Hydrologic Data Applications and Analyses

Hydrological data are discussed and used in the analyses presented throughout Appendix B. This attachment is provided to clarify assumptions and demonstrate processes used to organize and analyze hydrologic data. Issues addressed include a characterization of the "normal hydrological regime," which is used to contrast operations of the five Missouri River segments evaluated. A characterization of the 1999-97 high flow event in Gavins Point is provided to contrast natural flows with operational flows.

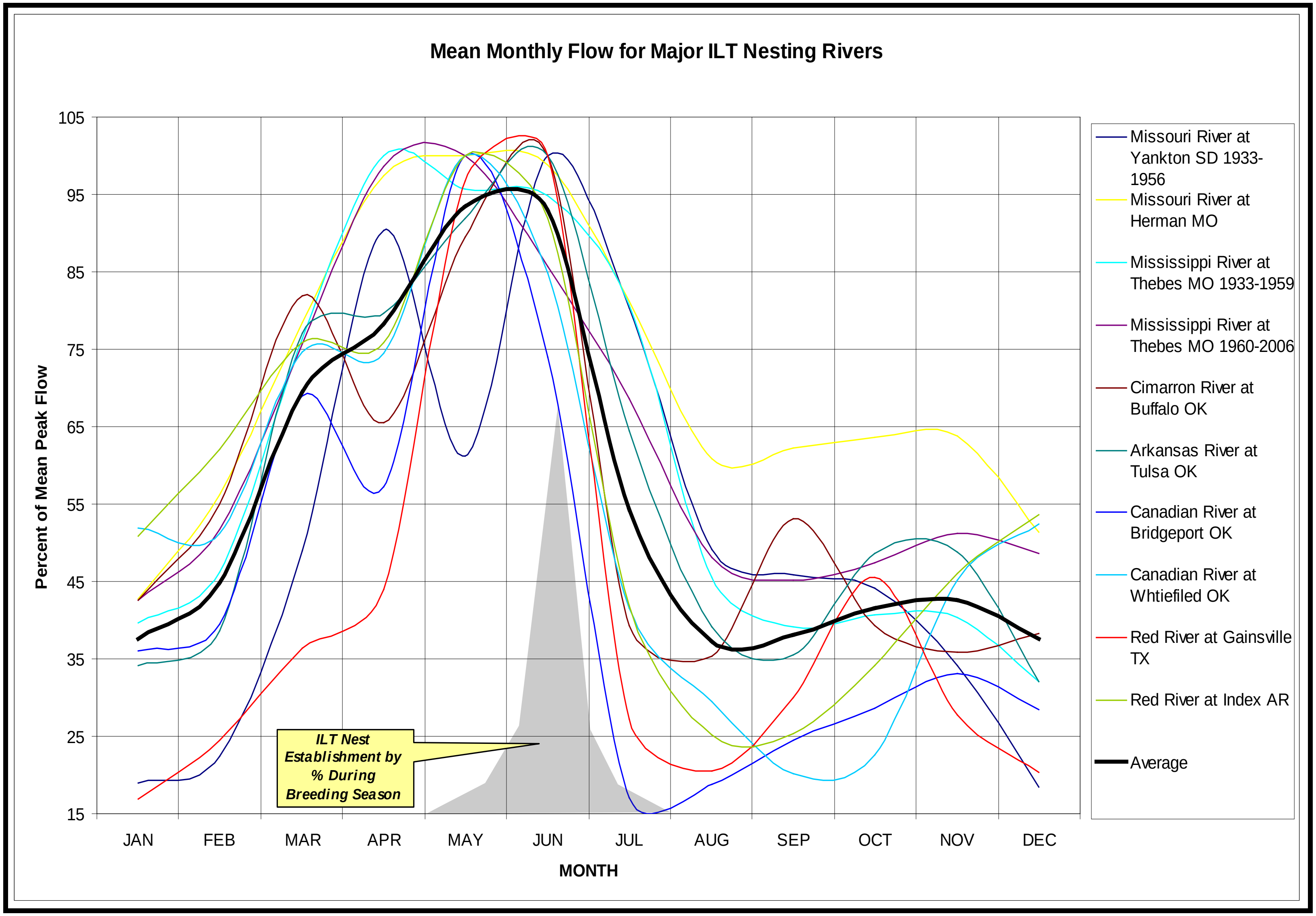
1 Normal Hydrological Regime

ILT and PPL breeding populations opportunistically respond to annual hydrologic cycles in large river systems of central North America (BiOp 2003, Lott 2004). The timing of flow maxima and minima and the rates of change vary specifically with the variability of the climatic patterns within the drainage area of each river segment. However, a distinct annual hydrologic pattern prevails throughout the breeding range. There is--on average--a period of high flow from March through June, followed by a low flow period from July through the following February, with the nadir late August to early October. The typical March rise follows snow-melting patterns in high latitudes and high elevations. Snowmelt runoff is enhanced and finally supplanted by runoff from spring rainfall, to maximize runoff and river flow between mid-May through mid-June in various rivers. Maximum annual flows decline very quickly and are followed by the summer flow reduction caused by seasonally reduced precipitation and seasonally maximized evapotranspiration throughout basin uplands. Figure 5.1 provides an example of the general annual trend in normal hydrograph from USGS long term flow gages on some of the river segments recently[1] used by ILT (Lott 2006) or PPL for nesting. Stream gages for this example were chosen from rivers with nesting ILT or PPL populations (from hundreds available). It is believed that any set of continental US gages selected for periods before the installation of river controls, or for uncontrolled rivers, would yield a similar pattern.

Figure 5.1 graphs the mean monthly flow from 10 major river gages for the periods of record. Widely distributed flow volume magnitudes are normalized for comparison by converting all flows to percentages of the mean monthly peak flow for each gage dataset. Gages were selected for this example from those with longer periods of gage record and for expectations of minimal dam-induced alterations to the hydrograph. The hydrographs represent the magnitudes of mean monthly flows in cubic feet per second for the period of record available, unless otherwise noted. The 1933 to 1956 period only was used for the Yankton Gage because this period precedes closure of the Fort Randall Dam and would more closely represent an unmodified hydrograph. The Herman Missouri Gage, assumed to respond to both dammed and non-dammed rivers, shows a pattern similar to the historic Yankton annual flow, but with a distinctly higher limb during the typical dry season due to maintenance of navigation flows. Data for the Thebes Missouri Gage on the Mississippi River is segregated at 1960 (period of record is 75 years) and plotted separately. As an example, the typical nest establishment distribution for ILT is plotted to show the occurrence of the peak nesting period during the falling limb portion of the spring runoff period. PPL demonstrate a similar nesting distribution period.

[1] The majority of population monitoring data is available for the 1980 through 2006 period. Much gage data precedes this period by 25 to 100 years; a period for which ILT usage is either unknown or inconsistently recorded (Lott 2006).

Figure 1
Mean Annual Hydrograph for 10 Selected River Segments



This division resulted in separate flow peaks, with the early period (1933-1959) occurring a full month earlier that the latter (1960-2006) period. This difference may reflect a delay or slowing of peak runoff from a combination of effects, such as; extensive erosion control practices implemented during the 1940s and 1950s and the closure of many flood control dams during the same period would have the effect of delaying the hydrograph peak.

Except for the historic Thebes Gage used in this example, these various river segments experience peak flow during either May or June. The distance north for the individual basins does not immediately explain the monthly peak differences. May and June peak tendencies appear to equally divided between basins both north and south of the approximate 36-degrees latitude northern boundary of the humid subtropical climate in eastern North America (Critchfield, 1974, Thornthwaite 1941). Peaks instead are likely the result of more complex topographic and meteorological patterns of their respective drainage basins. The April peak is probably associated with snowmelt in the lowlands, while the June peak combines the peak of high mountain snowmelt and spring rains in lowlands. The occurrence of a double peak hydrographs for river segments throughout breeding ranges may have influenced the evolution of a two month breeding season, within which each of these species carries out a one-month incubation period. Such variability would favor the re-nesting habit of these species and its demonstrated ability to use suitable sandbar habitat across their wide north-south breeding ranges (BiOp 2003, Lott 2004). This behavior would also accommodate both annual and basin-to-basin variability in the specific form of the hydrograph and late season high runoff storms.

The average peak of the hydrograph using the example data occurs in mid May and is strongly influenced by the Mississippi River, Thebes Gage data. The occurrence of this “normal” spring-peak pattern, or a very similar one prepared from a comprehensive gage dataset, would have been critical to sustaining the ILT and PPL river populations prior to extensive disturbances from land use alterations, damming, and navigation during the last 150 years. The understanding of a normal annual pattern such as this is also critical to the understanding of how nesting habitat is created, how it is maintained or lost, and how it may be measured. The concept of a normal annual pattern also provides the basis for comparison of differences in annual hydrographs from anthropogenic influences.

The gray polygon shown on Figure 1 is the averaged ILT nest establishment period during the breeding season, showing the typical temporal distribution of nest establishment (based chiefly on Missouri River data 1999 through 2006). Nest establishment begins near the normal hydrograph peak in early to mid May. Nests are established on the highest relative sandbar elevations that first become exposed by the rapidly falling river surfaces. The largest numbers of nests are established during the first two weeks after the peak subsides, but within a period when river flows are between 80 and 90 percent of the peak flow and falling. Primary and secondary establishment of nests continues, but rapidly declines in frequency, throughout July, ending as river flows are at 25 to 30 percent of the annual peak flow. Flows continue to decline to 20 to 23 percent after the end of normal nest establishment period in early August, after which, the latest hatched birds have completed fledging and migrate south.

The “normal annual hydrograph” is important as a concept for both measurement and management of nesting habitat. While these data represent flow, flow translates mile-by-mile, reach-by-reach, and segment-by-segment into stage: the local elevation of the water surface relative to bank height and to nesting platforms. Stage is the factor that controls the location and area of sandbar available for successful nesting during any given year. The degree of departure from the average hydrograph form on an annual basis may define a good from a bad nesting year on a particular river segment (Lott 2006). A greater difference in the height of the peak (as affects local stage) and the depth of the ensuing trough increases the area of sandbar present for nesting each breeding season.

This difference in water surface elevation also determines whether usable sandbars would be inundated on an annual basis. The depth and duration of inundation bears strongly on whether perennial or annual vegetation is established (which limits nesting habitat usability) and the rate of vegetation encroachment. The slope of the hydrograph, especially during the rising and falling periods, is indicative of the water velocities during the rise and fall. Water velocity is critical to sediment mobilization (erosion), transported sediment particle size, transported sediment volume, and sediment deposition.

The height of the peak controls the local relative elevation of a sandbar (Knighton 1998. Gomez 1983, Kalinske 1947). The duration of flow is important for the area of sandbar created by that event (Knighton 1998, Kalinske 1947, Ruhe 1975). The degree of departure of a post-dam hydrograph from the pre-dam “normal” hydrograph can identify the kinds of management and maintenance that must be artificially preformed if there is intent to sustain nesting habitat for use by ILT and PPL within a particular river segment. A reduced annual peak-trough difference or a reversal of the annual peak-trough relationship, as occurs for the maintenance of navigation pools, likely results in a lack of natural sandbar accumulation and a decrease in flow-induced inhibition of vegetation establishment.

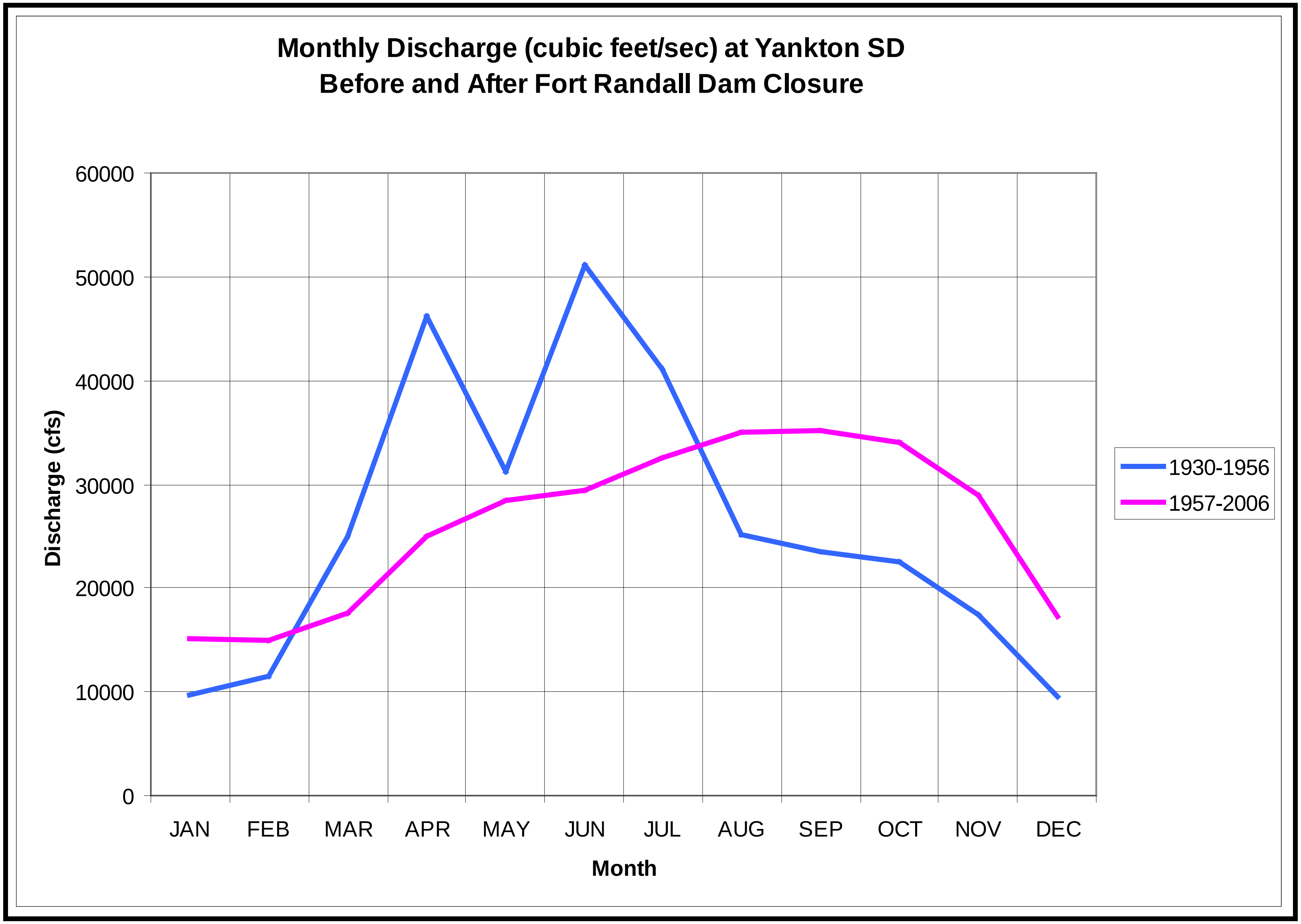
Figure 2 compares the annual hydrograph based on mean monthly flow (cfs) at the Yankton USGS gage for the periods before and after closure of the Fort Randall Dam. The average nesting peak periods for PPL is the second week of June and the fourth week of June for ILT. These periods are at the top of the hydrograph and on the declining limb. This would mean that any area selected for nesting would be the highest elevation available sandbars, and would remain above water throughout the breeding season due to continual water volume and stage decline. The post-nesting hydrograph would normally continue to decline, continually lowering the risk that an extreme storm would inundate nests.

The present operational condition, particularly in the Gavins Point River Segment, offers exposed sand for nesting on a rising hydrograph, which not only increases the risk of nest loss from the extreme storm or operational adjustment, but also inundates lower elevation nests.

Actual dam operation between 2000 and 2006 demonstrates intent to maintain flows between 20,000 and 28,000 cfs during the nesting season, and then increasing to navigation flows of approximately 33,000 cfs abruptly in late August. While the effect of this management on reproductive outputs for ILT and PPL is unknown, the most productive nest sites were found to be 2-4 feet above the influence of the navigation rise. Based on field observations in August 2006, this release pattern has been demonstrably beneficial for woody vegetation. Encroachment by cottonwood and willow had been enhanced through the provision of higher water levels during the typically dry, late summer season, drastically improving seedling survival and enhancing growth rates of established seedlings (see Vegetation Attachment).

Assuming that the operational pattern of the Gavins Point Segment continues according to the existing operations, and given the lesson from bird nesting patterns (see Section 3 through 7 in the main Appendix B), mechanically created sandbar habitat would be constructed and maintained at nesting habitat elevations above the stage created by the mean navigation stage increase (33kcfs) that resurges in late July. This approach has been used as a basis for the quantification of sand needed for creation and maintenance of ESH in the Construction Assumptions Appendix. Like the Gavins Point Segment, each of the other upstream segments of the Missouri River has been altered from the natural hydrograph (See Section 6 of this attachment for a more detailed discussion of the Garrison River Segment).

Figure 2
Mean Monthly Flow at the Yankton Gage Pre and Post Fort Randall Dam Closure.



2 The Controlled High Release in Gavins Point

The BiOp RPA acreage goals for the Missouri River are based on observations and measurements of the extensive areas of barren sand visible following the decline of the 1996-97 high flow events (Kruse and Vander Lee in Barbush 2004). This event was a release of excess water from the Missouri River management system to relieve flooding and dam failure risks for the series of reservoirs from Fort Peck to Gavins Point. The characteristics of this event explain much regarding the post-event conditions of sandbar habitat and the response of ILT and PPL to increased nesting habitat.

By early 1995, several wetter than normal years had filled much of the flood storage capacity of the Missouri River reservoir system. The first extended flow release from Gavins Point, the most downstream dam in the system, began on August 14, 1995 which maintained slightly above 50,000 cfs until December 1, 1995, a period of 108 days. This magnitude and duration of flow had been exceeded only once since closure of Fort Randall Dam in 1954. In 1975, a relief flow had maintained nearly 60,000 cfs for a then unprecedented period of 140 days. Subsequent year flows returned to normal levels after 1975. However, the 1995 controlled release event was followed by a release greater than 50,000 cfs for 168 consecutive days between June 16 and December 1, 1996. This release in 1996 was a new record for high flow duration in this segment. It is likely that these back-to-back events mobilized large volumes of sand.

In spite of these record discharge durations for two consecutive years, reservoir capacity continued to diminish due to runoff from heavy snowmelt and above normal spring rains in 1997. The record setting 1997 flow event began by exceeding 40,000 cfs on April 9, 1997, and 50,000 cfs by April 12. Flow was maintained at greater than 50,000 cfs for 233 continuous days, and peak flows were sustained at 70,000 cfs during the last month of the event, which ended on December 1, 1997. Discharge returned to below 28,000 cfs by December 14, 1997.

Table 1 summarizes flow magnitudes and durations and the resulting stages above 23,000 cfs, the modal flow prior to and the mean low flow since Fort Randall Dam closure for the Yankton and Maskell USGS gages.[2] No previously recorded flow event of this magnitude and duration had occurred in the Missouri River during the period of record. Short duration flow events (1 to 10 days in length) had occurred which exceeded 50,000 cfs several times prior to dam closure. Figure 5.3 graphs the daily flow at the Yankton for the pre-dam period where the highest instant flow of 472,000 cfs occurred on April 13, 1952.

Flows exceeding 100,000 cfs occurred at less than 2-year return intervals, but lasted only a few days. The approximate mean flow during the June peak that also corresponds to the peak nest establishment period for both ILT and PPL is 50,000 cfs, and is approximately the 90th percentile flow. This flow, occurring at less than annual intervals, may have sustained frequently available areas of barren sand at elevations suitable for nesting, as long as the normal annual hydrograph persisted (with its consistently falling limb after June). A frequently occurring event like the 50,000 cfs flow would have enabled sandbar-nesting birds to return year after year to the annually available barren sandbar such flows were likely to produce.

[2] The Yankton Gage is 5.3 miles downstream of Gavins Point Dam, Maskell Gage, 34.3 miles downstream.

Table 1
Characteristics of the 1996-97 High Flow Event

		YANKTON		MASKELL		
FLOW (CFS)	**Days Exceeded**	**Datum**	**Stage (ft)**	**Datum**	**Stage (ft)**	**Gage/Diff (ft)**
23,000	349	1153.21	0	1122.01	0	
40,000	236	1155.97	2.8	1124.34	2.3	0.43
50,000	233	1157.23	4.0	1125.35	3.3	0.68
60,000	204	1158.34	5.1	1126.2	4.2	0.94
65,000	109	1158.84	5.6	1126.59	4.6	1.05
70,000	31	1159.33	6.1	1126.95	4.9	1.18

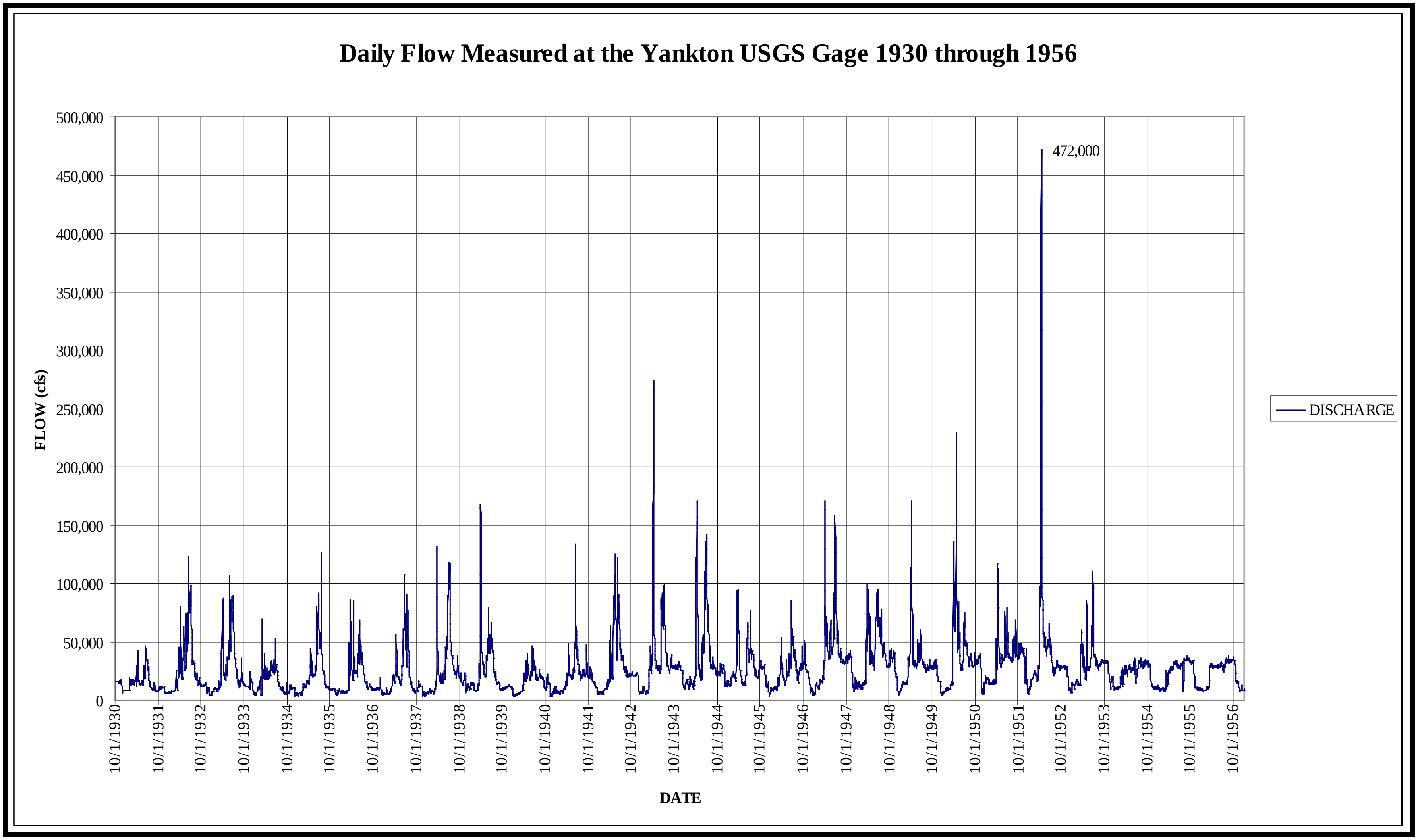
Depending on location below the Gavins Point Dam, 50,000 cfs translates to between 3 and 4 feet above the mean low breeding season flow of 23,000 cfs. This stage difference correlates with the findings for the measured freeboard of the most productive nest sites shown are separated by approximately 28 river miles (note how the differences in channel geometry are reflected by stage effect differences for given flows).

The Yankton USGS Gage has provided continuous stage and flow data since 1930. Table 2 compares the 1997 flow event to the three longest duration, pre-dam, high flow events during the period of record. The next closest continuous flow above 50,000 cfs occurred in 1948 and lasted only 56 days – less than 25% of the 1997 event duration. It is notable that the highest sustained flow during the 1997 event, 70,000 cfs, had been equaled or exceeded several times during the pre-dam record but only for very brief periods.

Table 2
Yankton Gage Flow Data: Comparison to Pre-Dam Peak Periods

Period	Flow over 50,000 cfs (Days)	Period	Flow over 70,000 cfs (Days)
1996 - 97	233	1996-97	31
1948	56	1944	35
1947	44	1943	29
1943	45	1932	29

Figure 3
Mean Daily Flow for the Yankton, SD USGS Gage 1930 to 1956



The 1996-97 high flow was a controlled event, not the result of a statistically recurrent storm or pattern of natural flows. A release of this duration and magnitude could never occurred in a natural (i.e., uncontrolled) river system (Swenson pers. com 2007). This event occurred in a controlled storage and release system that could allow the retention of a sufficient volume of water to support such an event. More than 1 trillion cubic feet (23 million acre-feet) of water passed through the Gavins Point Dam as a controlled discharge during the 233-day 1997 release period. This volume required that the majority of flood storage in the upper Missouri reservoir system was full and abnormally high inputs were continuing (Swenson 2007). The condition followed an unusually wet period of years in the Missouri River basin and an unpredictable set of incidental operational decisions, also occurring over a period of years prior to the event (Swenson 2007). The volumes of sand available for redistribution in 1997 relied on prior mobilizations of sand in 1995 and 1996. The manner in which the sand was distributed was strongly affected by the abrupt termination of the controlled release event in December of 1997. A rapid loss of flow from the dam resulted in a rapid loss of flow velocity and sediment carrying capability, blanketing recently submerged areas with new sand depositions.

While this alignment of circumstances resulting in this type of event could occur again through a combination of multiple wetter than normal water years and similar management decisions to retain storage, it is a highly unlikely event that is not statistically predictable. The results were an unprecedented period within which fluvial geomorphic processes mobilized and transported vast quantities of sediment. The fluvial processes that occur continually below the water surface at a much lower magnitude (Knighton 1998) were elevated by higher stages to operate at 4 to 6 feet higher than normal. The result, once water levels returned to normal, was the creation of extensive and potentially suitable sandbar habitat for ILT and PPL, but was not similar to any pre-dam naturally occurring event. The closest similar scene would be the riverbed exposed by drought to flows of ~ 6,000 cfs (25% of the approximate modal flow, 23-26,000 cfs during the breeding season).

The majority of deposited sediment was removed by erosion within 2-3 years following this event (see Sections 2 through 7) of the main Appendix B. A follow-up extended flow event in 1999 was probably participatory in most of the loss of the sand laid-down by the 1997 event. A sustained flow of greater than 40,000 cfs occurred for 228 days between September 22, 1999 and May 7, 2000. This flow redistributed sand and created short-duration nesting habitat used in 2000 and 2001 (see Section 3 of Appendix B). This nesting habitat was approximately 2 feet above maintained seasonal breeding stages and was quickly redistributed by flow processes or reoccupied by vegetation.

2.1 Affect on Upstream Segments

Flows in the other upstream segments (Fort Peck, Garrison, Fort Randall, and Lewis and Clark Lake) did not create extensive elevated sandbars like those created in the Gavins Point Segment during the 1996-97 controlled high flow release. Large areas of barren sand were visible in spring of 1998, however much of it was unsuitable for nesting and much of the emergent sandbar quickly succumbed to vegetation encroachment. Further, the majority of emergent sandbar laid-down in 1997 and observed in 1998 was lost to erosion before birds could colonize it in 1999. The primary factor controlling the extent and persistence of the elevated area of sand in upper segments was elevation of the water during the controlled release.

Each segment reacted differently to the high flows, and the post flow releases affected the sand deposits differently. All segments supported post-high flow nesting increases, but the nesting increases of the Gavins Point segment did not occur in any of the other four segments.

Lewis and Clark Lake Segment

Lewis and Clark Lake sediment accumulations were the result of a high-flow stage maintained a little more than a foot above normal pool and backwater fluctuation levels. Sand accumulations were initially used for nesting, but the habitat quickly declined as vegetation (particularly cattails and sandbar willow) rapidly colonized the new, fertile and perpetually moist sediments.

Fort Randall Segment

The Fort Randal Segment and the upper portion of the Lewis and Clark Segment experience daily power-peaking stage changes nearly equal (downstream portions) and above (in the upstream portions) the stages maintained during the 1996-97 high-flow event. Deposits visible in 1998 imagery were quickly redistributed by surge flows, some of which became new nesting area but the majority of which became daily-inundated sand plains or heavily vegetated flats.

Garrison Segment

The Garrison Segment is also subject to daily power-peaking surges that range from more than 5 feet in the upper portion to just under a foot at Bismarck, ND. Similar to the Gavins Point Segment, areas of high sand were created in some locations but these were mostly less than two acres in area. Erosion from power peaking removed between 70% and 85% of these emergent sandbars. Much of the sand was redistributed locally into daily-inundated sand plains, and because of the operating regime, into annually created, new sandbar habitat. This new sandbar habitat, created by the operation ional flow regime, has been used for approximately 45% of ILT and PPL nest establishment in the segment between 2000 and 2006.

Fort Peck Segment

The Fort Peck Segment, delineated using 1999 imagery, showed a major sand area loss between 1999 and 2005. Like the Garrison Segment, most of the sand was quickly redistributed into shallow shoals. Notably, there no records of any ILT or PPL nest established on any of the sandbars mapped from the 1999 imagery. All nesting occurred on sandbars created by the operational flow regime.

3 Stage-Area Measurement of Sandbar Habitat

Gage data, dam discharge records, and topographic data were used to develop areal models of sandbar visible at different river stages for the Gavins Point and Fort Randall Segments. These models were used to assess:

- flooding frequency of sandbars,
- local freeboard for nest platforms,
- acreage of nesting habitats (and all habitats within the realm of the point coverage) and
- correlation between nesting patterns and river stage

A LiDAR topographic dataset collected at 15,000 cfs in November 2005 and field-collected topographic data obtained in August 2006 were used to analyze the effects of stage on ESH and areas used for nesting.

The LiDAR data was obtained in leaf-free conditions and cleaned to provide a barren ground topographic dataset. Topographic data were adjusted to the local geodetic model, matching actual elevations to within an estimated accuracy of 0.5 feet. The 3-D Analyst extension for ESRI Arc Editor 9.X was used to create detailed triangulated integrated networks (TINs). A TIN is a model of a continuous topographic surface from which representations of elevation such as spot elevations and contour lines may be obtained. These data were used in several different ways to analyze habitat maps, nest point datasets, and develop flow-stage-area estimations. The techniques used to generate topographic data that supported a number of assessments through out Appendix B are herein described.

The time-stamped LiDAR fully characterized the topographic conditions at a stage and a discharge for the entire Gavins Point Segment. Simultaneous stage data were available from multiple continuously recording USGS stream flow gages along this segment. The Yankton gage and the Maskell gage were most usable, having the longest period of record. Instantaneous discharge data was available from the operators of Gavins Point Dam. Figures 4 and 5 show calculated stage-discharge curves for the Yankton and the Maskell-Gayville gages.

Discharge is based on dam flow records from the period following the 1997 high flow event through November 2006. Discharge data from the James River Gage (above the Yankton Gage) were added to provide a more complete discharge volume. However, other minor channels and lateral side inflows could not be accounted in the discharge totals at more downstream gages. The findings of these exercises in curve fitting were compared with LiDAR topography and found to correspond to within less than 0.5 feet.

Interpolation of the stage discharge relationship to other locations along the river required a simple distance-slope triangulation ratio. The USACE had historically used navigation rivermiles defined along the deep-flow channel (thalweg) to calculate stage effects between known points. This assessment method was refined and checked using the LiDAR data. First, a new thalweg centerline was created using the 2005 aerial imagery overlaid with LIDAR-generated contours. This line was incremented from both ends as either distance from the Gavins Point Dam or distance from the downstream end of the Gavins Point Segment. Distances used in the interpolation formula between the dam datum and the various gage datum elevations were derived from this new centerline.

The new centerline was incremented at 200-foot intervals, or vertices. The vertices, as points, were used to extract elevations from the TIN (which represents stage at 15,000 cfs). These data were used in two ways to check and modify the interpolation formula derived using just the gage datum elevations. For each feature (sandbar, nest site, polygon, etc.) the GIS buffer procedure was used to collect and determine the distance to each set of adjacent points and determine a local stage-discharge datum for the time of the LIDAR data collection. Small features used only one averaged datum. Longer features were segmented and assigned 2-5 local datums. Centerline points were then used as cross-section locations where local stage-discharge interpolations could be checked against the land surface topography. Stage-discharge interpolations along the new centerline were then calculated for each feature from each gage and the findings averaged to determine the water surface elevation differences at each sandbar.

Figure 6 provides an example of the LiDAR-generated topography to assess stage-area-discharge relationships between interpolated gages. Imagery is infrared spectrum, rendering vegetation to red. Nest points are shown by year to demonstrate relationships between them, elevation and vegetation. Figures 7 through 11 demonstrate the results of one example of how the stage discharge interpolations and the LIDAR were applied to analyze nesting site area and nest establishment-stage-flow relationships with nest points and nesting habitat.

The sandbar polygons represented in these images are used to derive area of sandbar available at various river stages and flows. They can be used to circumscribe the nesting platform and to demonstrate statistical relationships between it and nesting patterns, which are the relationships between nesting and river flow dynamics. It can be used to assign risks of nest loss to flooding or operational stage changes. This model can also be used to develop local design parameters, expected maintenance (i.e., vegetation removal) requirements, and to assess the rates and nature of vegetation encroachment.

The elevation data used here is high-density LiDAR, but topographic data annually collected by traditional means on created and maintained nesting habitat sites can be used. An elevation survey using traditional ground-based methods was conducted in 2006 and used to generate similar topographic models. Figure 12 is an example of the result.

Figure 4
Stage-Discharge Curve at Yankton, SD, 5.3 Miles below Gavins Point Dam

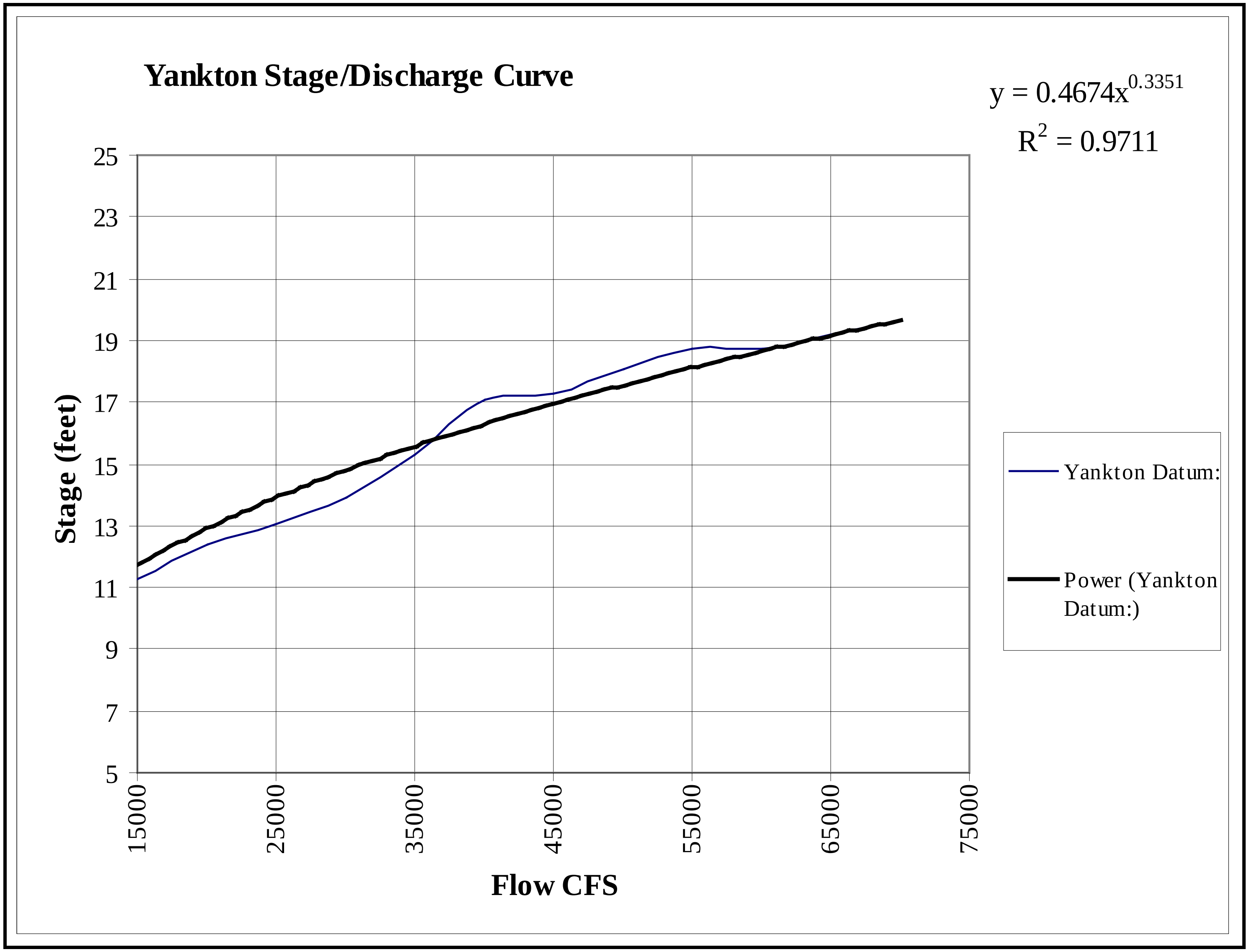


Figure 5
Stage-Discharge Curve at Gayville, SD, 34.3 Miles below Gavins Point Dam

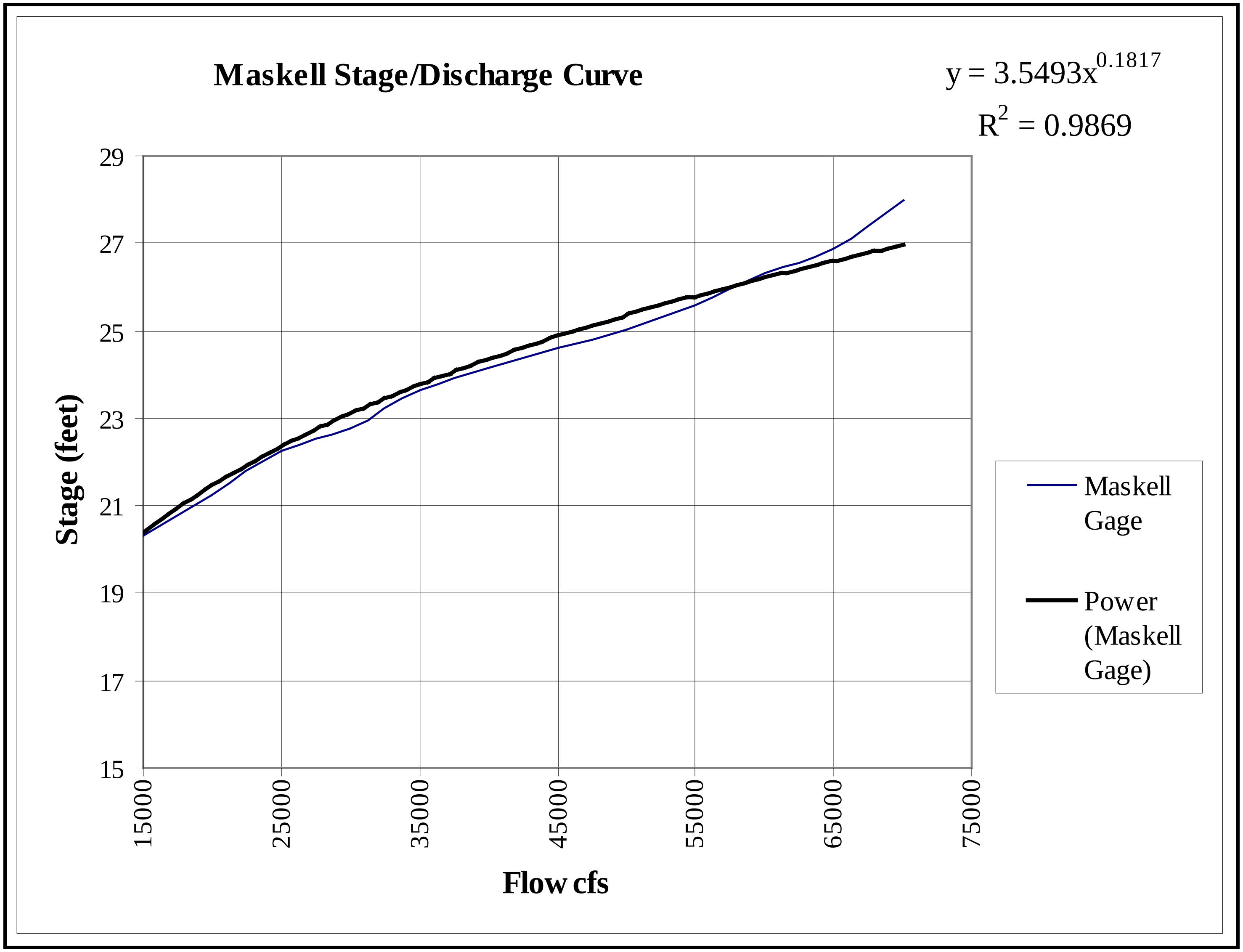


Figure 6
Sandbar Geometry Assessment using LiDAR and Aerial Imagery

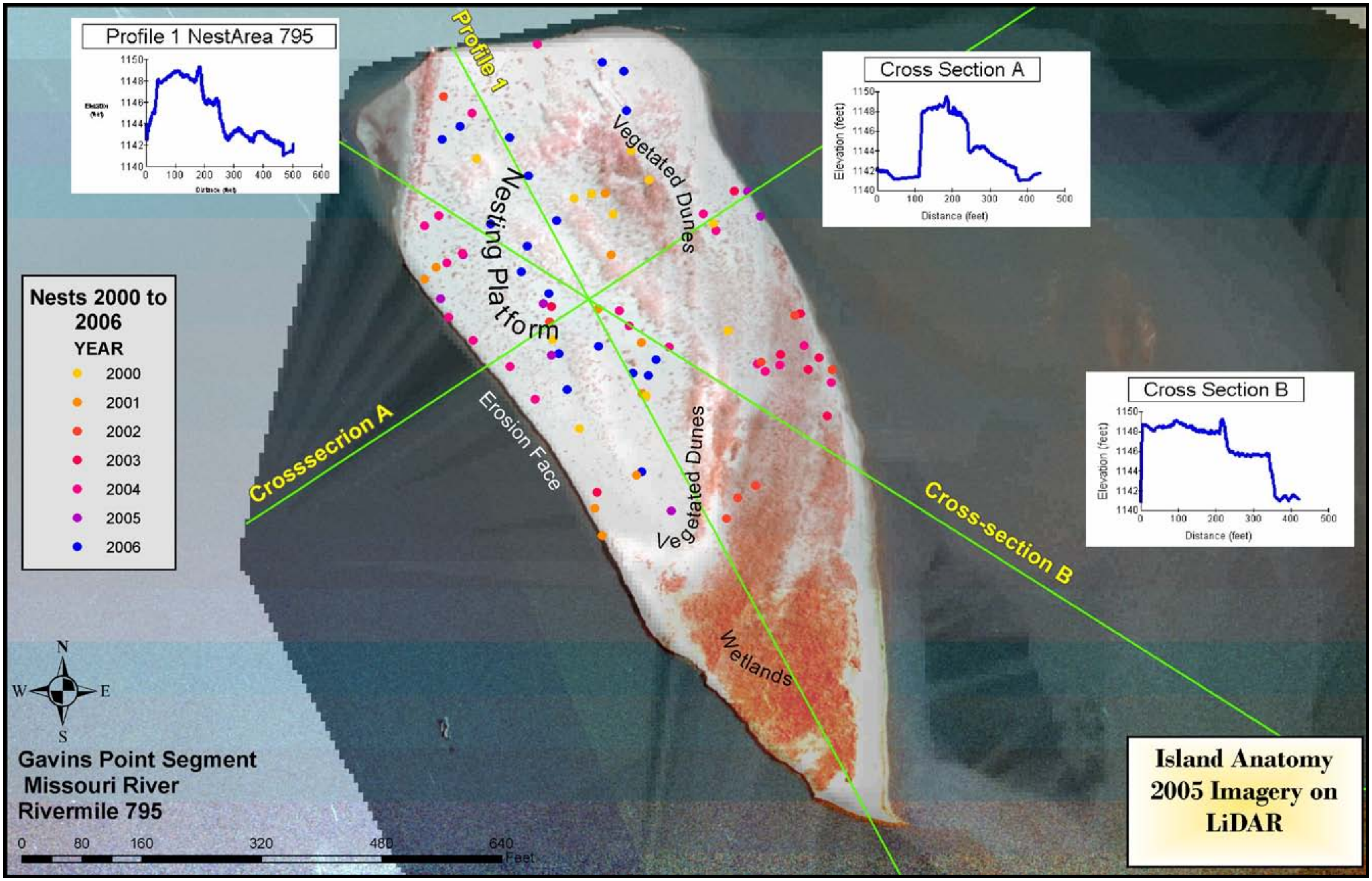


Figure 5.7
NestArea 770 Complex Area-Stage-Discharge Calculation: 15, 000 cfs

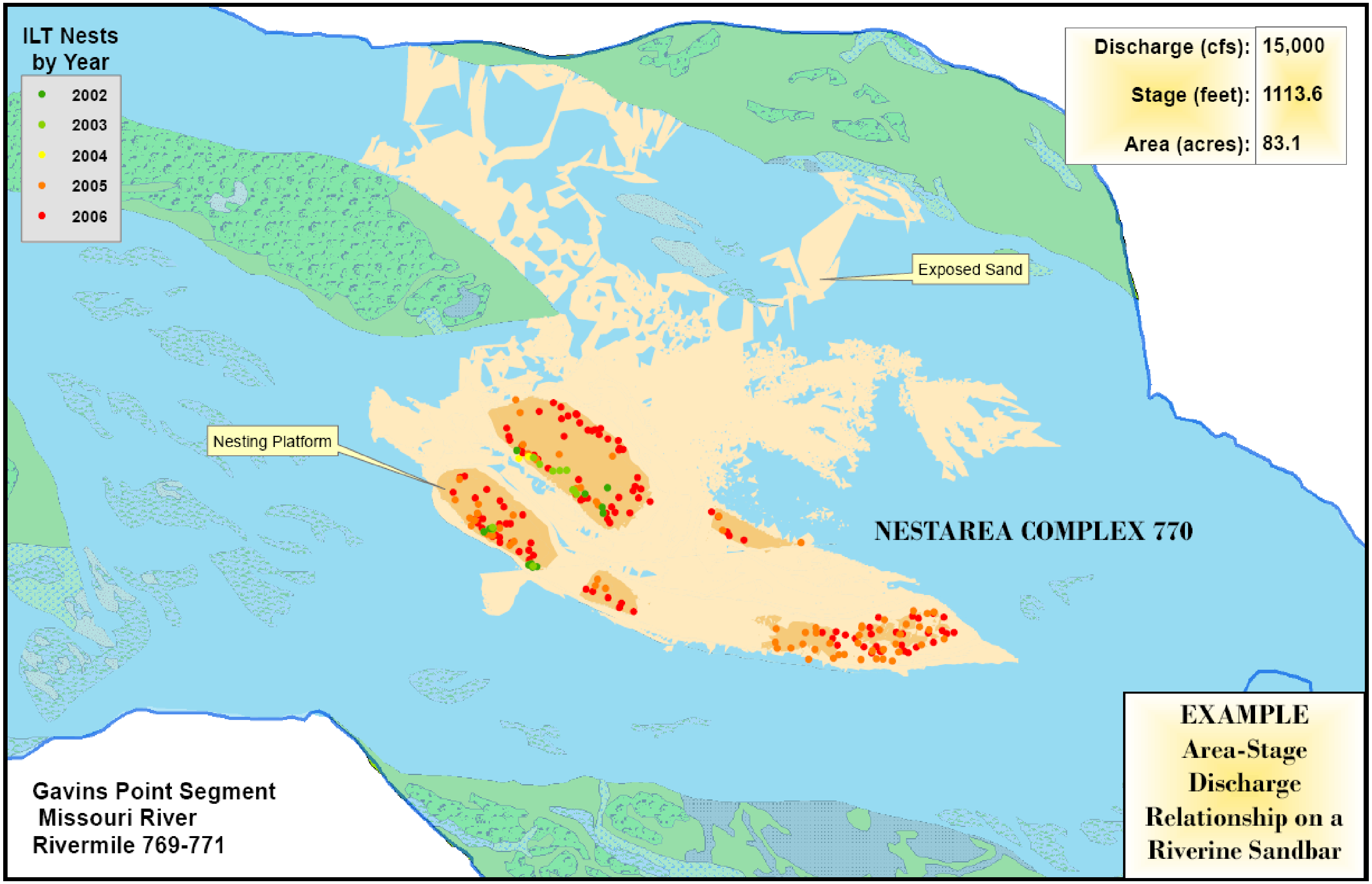


Figure 5.8
NestArea 770 Complex Area-Stage-Discharge Calculation: 20,000 cfs

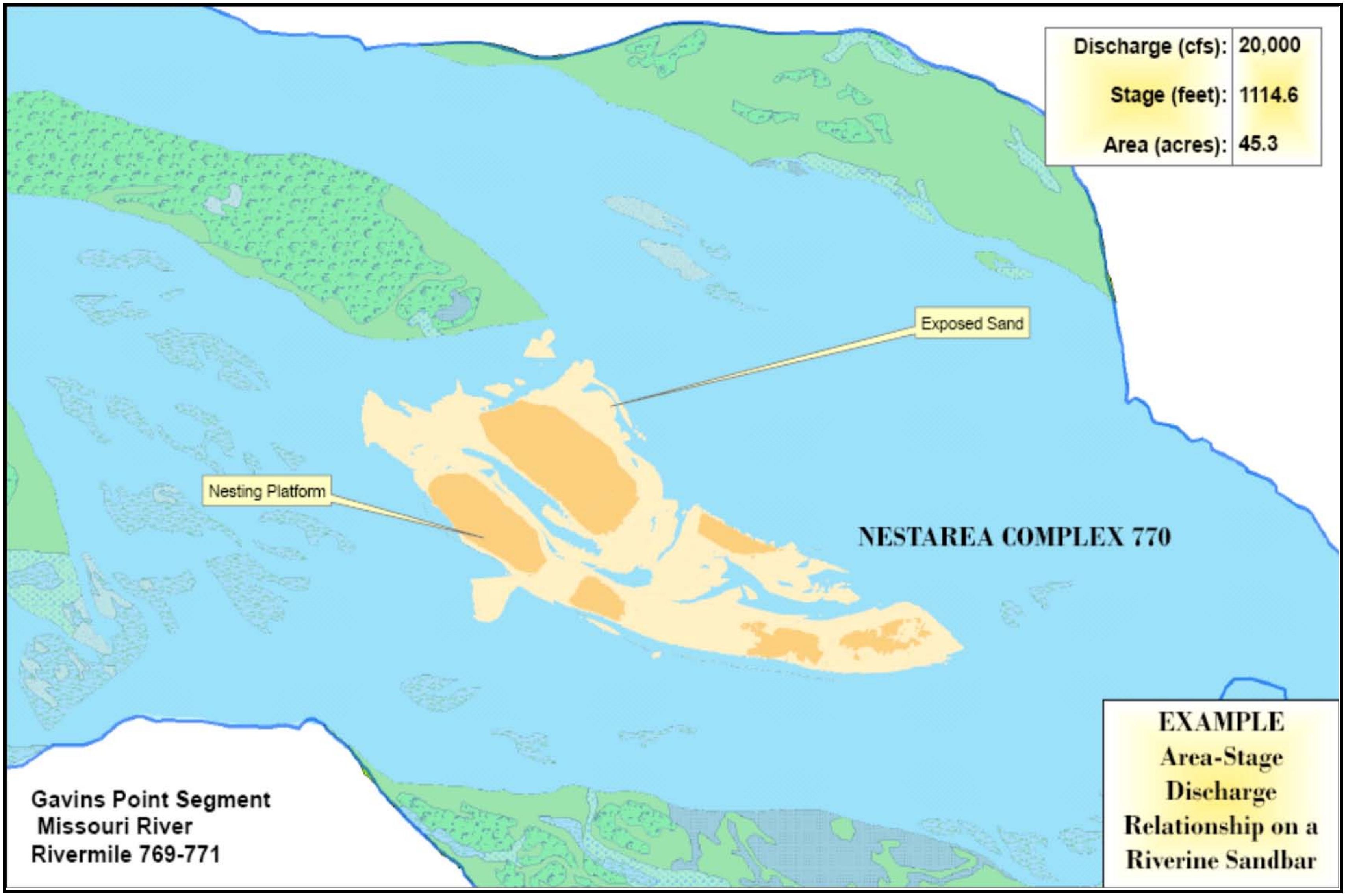


Figure 5.9
NestArea 770 Complex Area-Stage-Discharge Calculation: 25,000 cfs

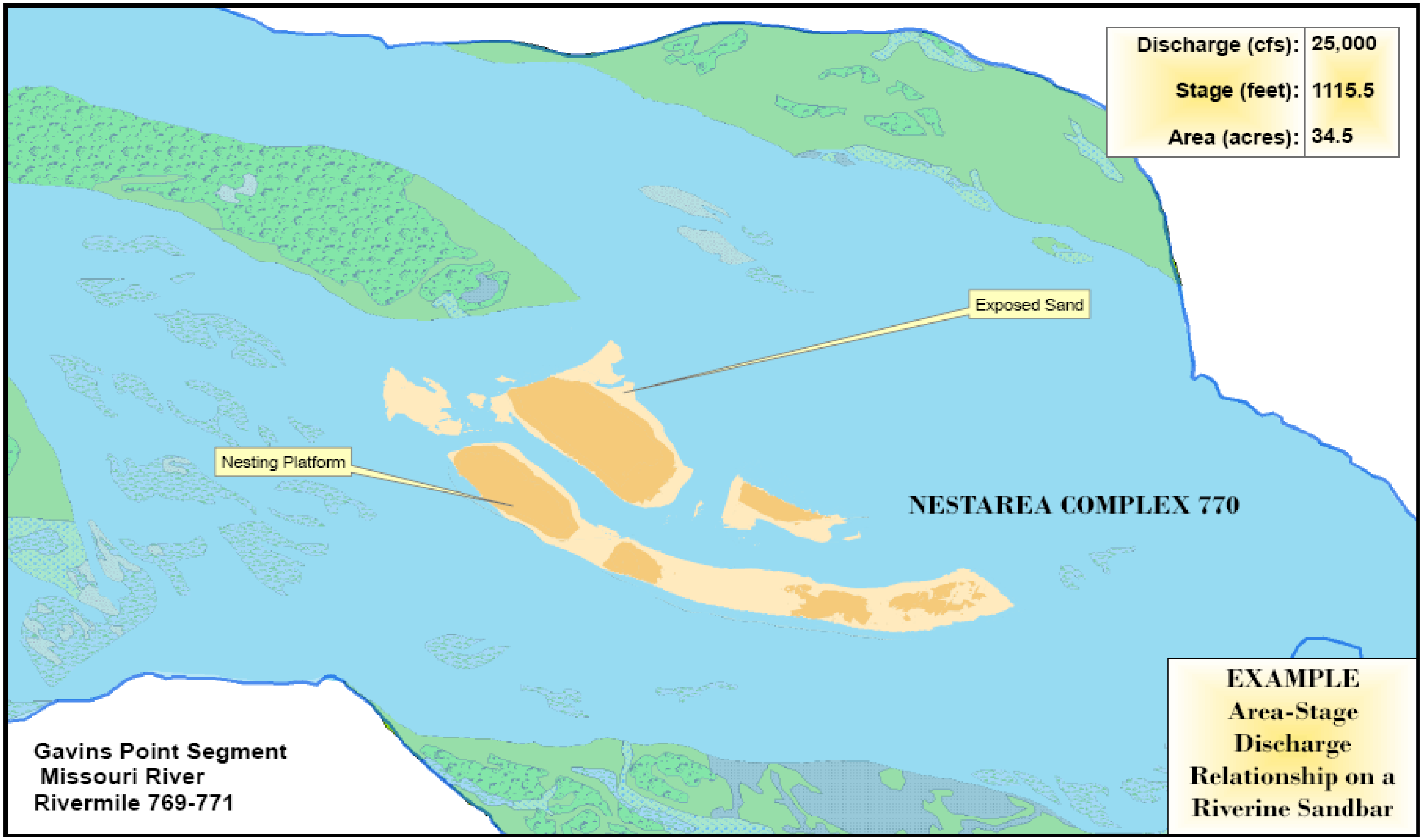


Figure 5.10
NestArea 770 Complex Area-Stage-Discharge Calculation: 30Kcfs

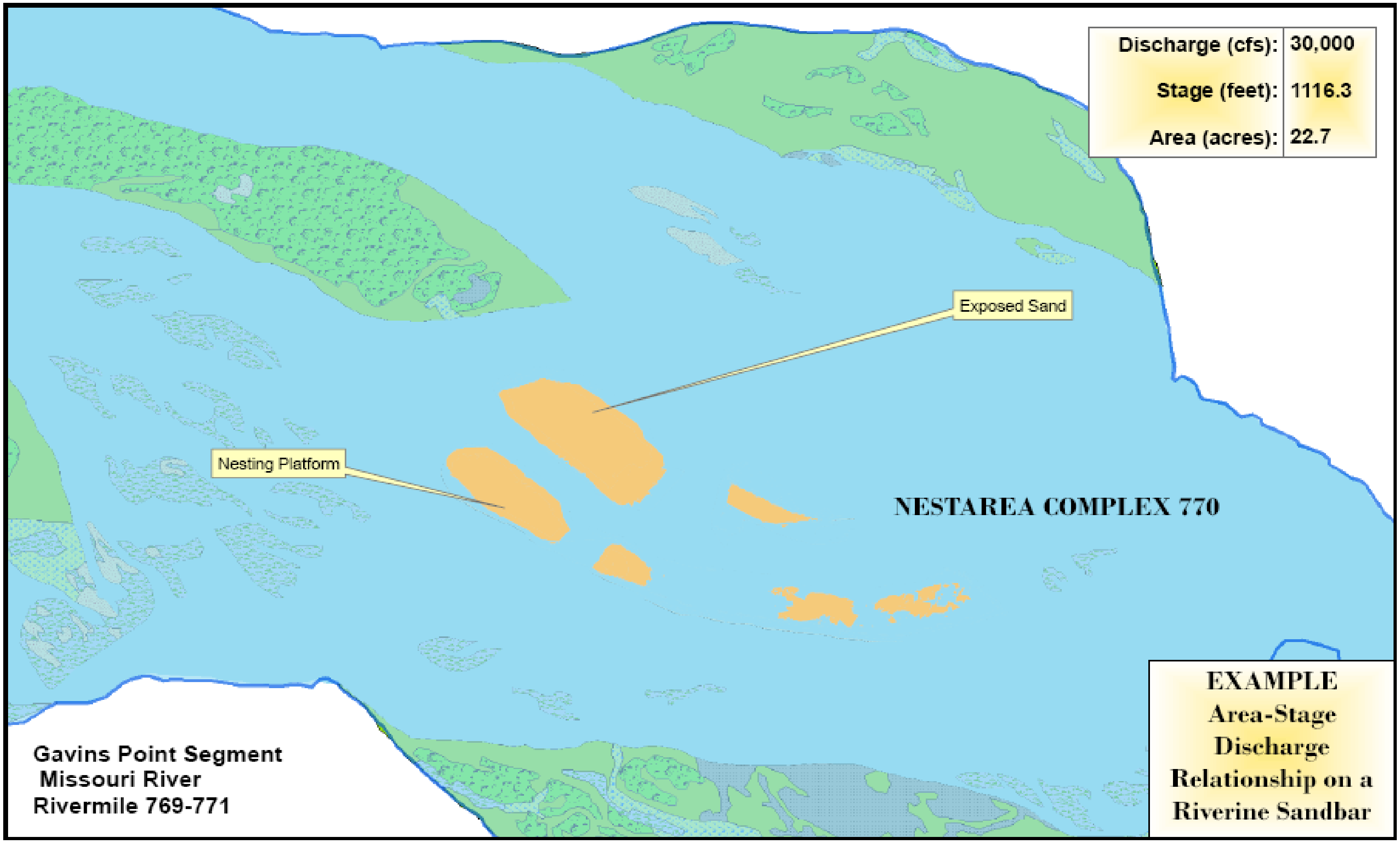


Figure 5.11
NestArea 770 Complex Area-Stage-Discharge Calculation: 40Kcfs

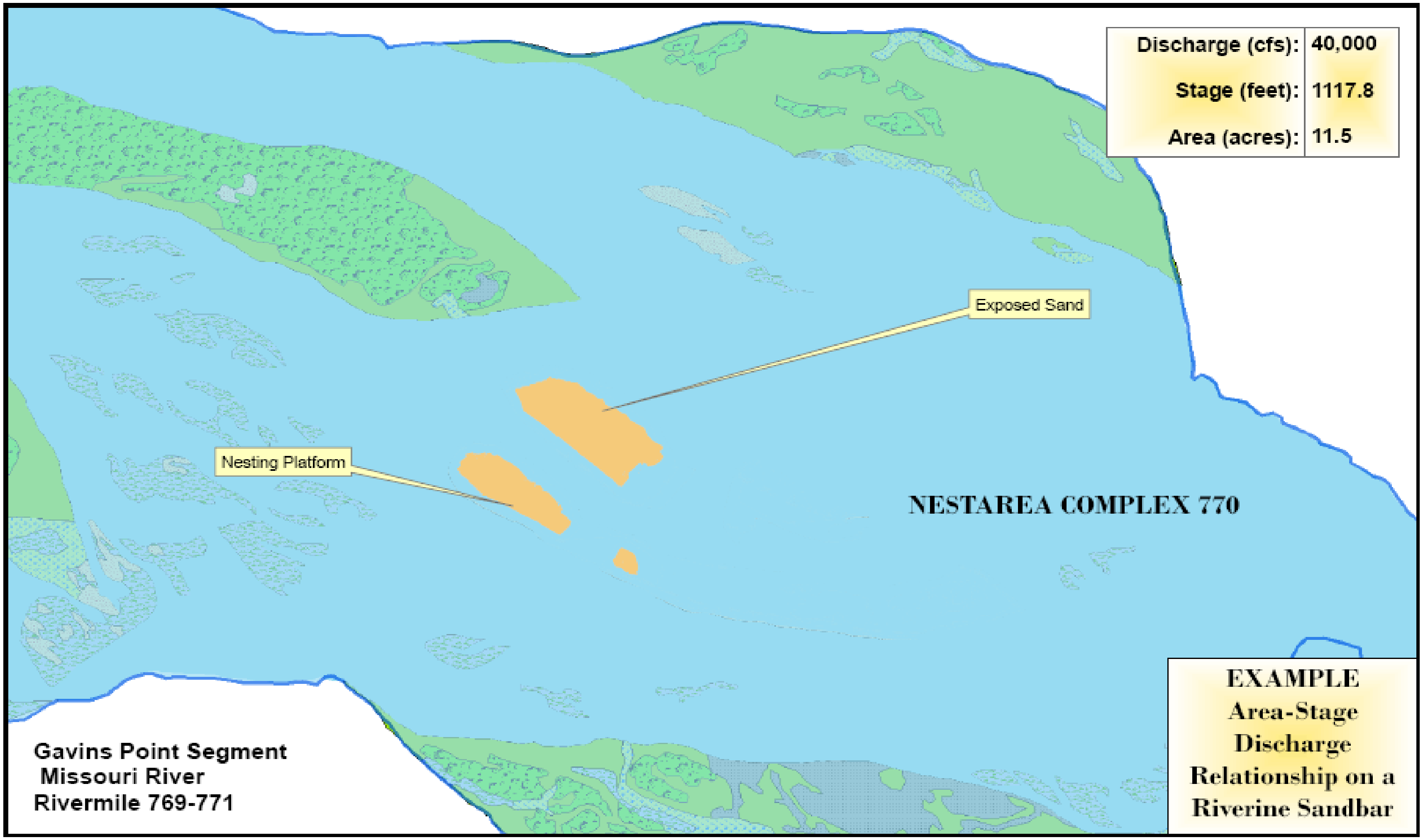
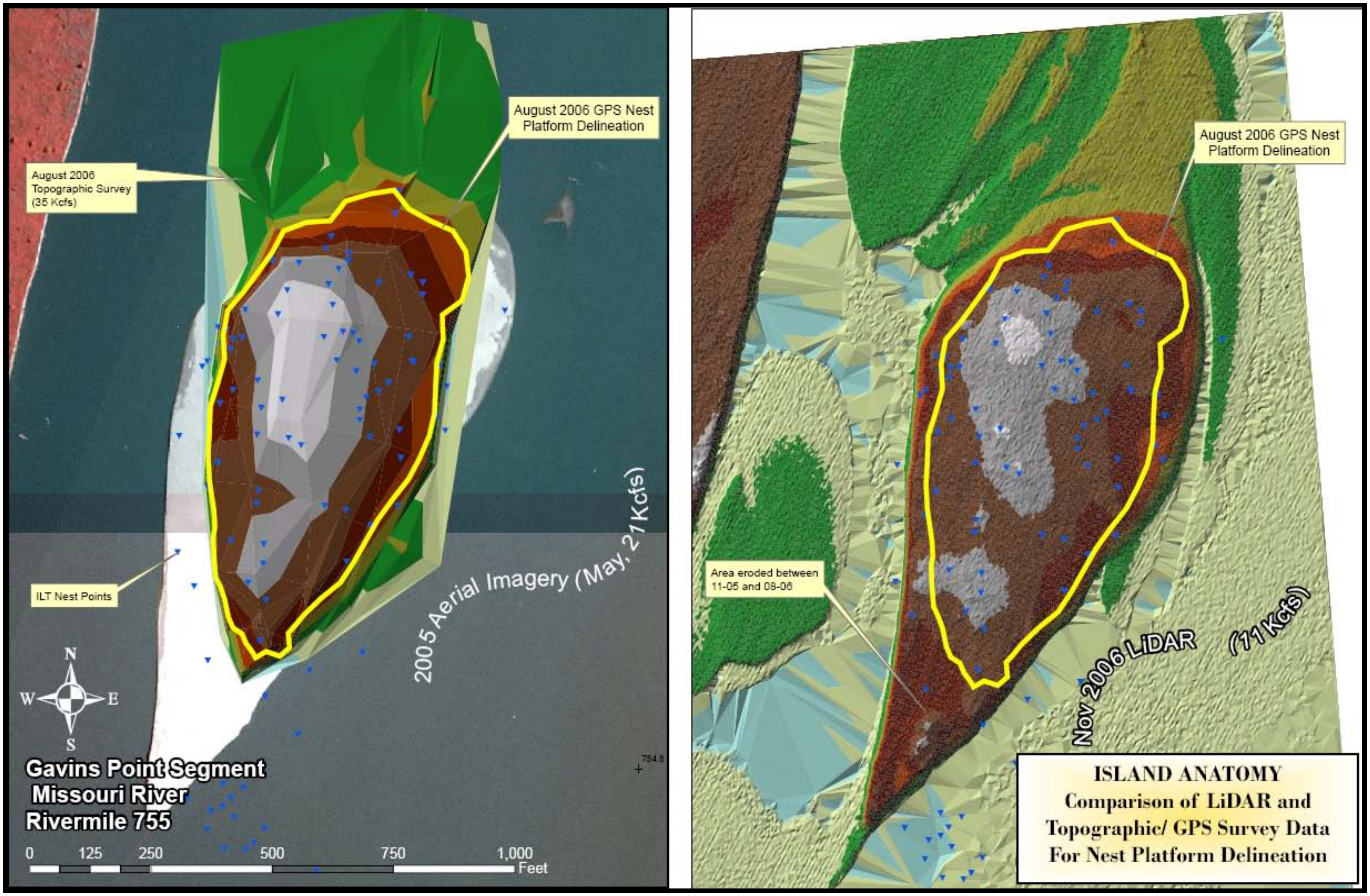


Figure 5.12
Comparison of Topographic Dataset TINs



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Attachment 4
Sandbar Geometry and Composition

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Sandbar Geometry and Composition: The Physical Characteristics of Nesting Habitat

Sandbars are composed of sand that has been freed by physical rock degradation processes, captured by erosion and transported by flowing water in suspension (wash load) or as bed load to some point of deposition (Knighton 1998). Sand is a particle size classification for chiefly quartzite rock fragments in the size range of 0.062 to 2 millimeters in diameter (Schoeneberger et al 2002). Sand occurs in rivers as result of the degradation of rocks and the winnowing and sorting of particle sizes under fluvial conditions, accounting for between 85 and 99 percent of the sedimentary material carried in rivers (Knighton 1998) supporting ILT and PPL breeding (Lott 2004). More than 90% of particle size classes found in the Missouri River channel area are fine sand (greater than 0.125 mm) or larger in diameter as shown in Table 1 (Biedenharn et al 2001).

Table 1
Bed and Habitat Bar D_{10} Gradation Values for Each Study Segment[1]

Segment	Habitat Bar Average D_{10} (mm)	Bed Average D_{10} (mm)	Representative Bed Material Size (mm)
Fort Peck	0.16	0.21	0.16
Garrison	0.14	0.18	0.14
Fort Randall	0.16	0.21	0.16
Gavins Point	0.20	0.23	0.20

Sandbars exist whether or not observed during an incident observation of a river with a channel composed of sand. Emergent sandbar is a portion of a sandbar visible and usually above water during any particular observation. Nesting habitat is defined in this document as the areas of barren sand occurring on interchannel sandbars that remain exposed above water levels nearly annually, for periods sufficient for interior least terns and/or piping plovers to establish nests. Nesting habitat is stable for periods of at least 30 days and usually longer than 60 days during the breeding season (Lott 2004). Its position and character are controlled by the planform and the hydrologic regime of the river (Knighton 1998, Rosgen 1996). Nesting habitat is primarily composed of clean, cohesionless, abundant sand and fine to medium gravel. All sandbar habitat and particularly nesting habitat, relies on the qualities and the quantities of sand available in the great rivers of central North America such as the Missouri.

Many riverine habitats are not used by ILT and PPL; such as gallery forest and dense her-shrub-sapling stands. Other low-lying habitats such as submerged sandbar in shallow water of daily-inundated sand in power-pulsed segment are subject to continual spatial change (Rosgen 1996, Knighton 1998) during the breeding season. While the character of nesting habitat may be modified annually or over several breeding seasons, a river continually reconfigures, modifies and re-modifies the geometry of all habitats lower in elevation than annual stage fluctuation

[1] Table excerpted from Chapter 4, Biedenharn et al 2001. The particle size classification for fine sand is 0.125-0.25 mm.

ranges on a daily, weekly and monthly basis throughout the year (Knighton 1998, Rosgen 1996) and during the breeding season. Shallow water habitats including sloughs, frequently-exposed mud flats, over-bank ponds, submerged sand planes and submersed aquatic vegetation beds (among others) all provide habitat for the small fishes and invertebrates critical to ILT and PPL foraging (BiOp 2003). All of these habitat types change in shape, capacity, volume, and position throughout the breeding season as river stage fluctuates and as the fluvial processes modify forms. The spatial and volumetric relationships of shallow water habitats to deep-water habitats can be observed to change in detail from minute to minute, particularly in segments affected by daily peak-surge cycles from power generation dams. River segments that retain some similarity in flow regime to the natural hydrograph change throughout the breeding season from much water and little exposed sandbar to little water and much-exposed riverbed (Knighton 1998). Since ILT and PPL populations are observed to carryout successful annual reproduction, variations in spatial details between deep water and shallow water habitat, or in other transitory features, the changes in the specific geometry is assumed be occurring within ranges acceptable for such processes to persist.

Natural vegetation succession processes work to establish vegetation on sandbars (Decamps and Tabacchi 1994, Douhovnikoff et al 2005, Sandercock et al 2007). The river and the wind deliver seeds and other propagules to freshly deposited sand. If conditions are suitable, the plants prosper; sandbars become vegetated and are no longer used by ILT and PPL for nesting. The absolute area occupied by vegetation changes both annually and throughout a growing season within the river corridor. Stands of herbaceous annuals seen in August have occupied the barren mud flat of May. Shrub and tree canopies change daily in size and configuration from growth or morbidity. These changes occur constantly between reconfiguring floods. Some vegetation persists to become new gallery forest; other stands are lost to erosion. Vegetation encroachment would eventually eliminate nesting habitat altogether, if not reconfigured by flooding.

Neither the geometry of initial conditions nor the changes in geometry from initial conditions can be accurately measured in a cost-effective, meaningful manner for the transitory habitats below water stage elevation ranges that occur during a breeding season. Persistent vegetation occurring at and above the elevation of nesting habitat can be accurately measured over periods of seasons or years. The nesting habitat can also be measured, at least during a given year and its area does correlate with nest numbers, nest success and other measurements of reproductive effort (See section 3 of the main Appendix B document).

1 Anatomy and Geometry of a Sandbar

Falling, rising and flowing water, carrying then loosing its burden of particles due to gravity and friction driven changes in flow velocity, creates the sculpted form of a riverine sandbar. The stage height at a constricting location controls the elevation of the standing wave of bedload material that will become the sandbar (Knighton 1998). The duration of high water flow at a given stage controls the potential extent of elevated sand, as bedload material deposition proceeds incrementally upstream as the standing wave builds in height and sand particles are trapped behind. The nature of the high water event decline (gradual or abrupt) appears to control the degree of edge erosion (the manner in which the standing wave dam breaches), yielding the initial post-flood platform of elevated sand observable above fallen water levels. A standing wave may breach through a single channel to carry the main flow of the river, or through multiple channels often creating islands and shoreline-attached sandbars (Rosgen 1996). The breach may occur through multiple channels, creating braided patterns of sandbars (Rosgen 1996). A single main flow channel usually develops through a braided feature, leaving back channels that may remain inundated throughout the most frequently occurring river stages during a nesting season. Sandbars that accrue and persist at locations separated from riverbanks by open channels (island) are the sites at which quality nesting habitat develops (Kruse 2004). The characteristics of subsequent flows (gradual to abrupt; deep or shallow) refine the sandbar form and area, controlling the rate of erosion and the lifespan of the sandbar.

River flow streamlines interchannel sandbars. Sandbars located near the center of a river, dividing flow energy nearly equally to both sides, will create a relatively symmetrical, upstream-point teardrop or lenticel form. Often, due to upstream tip erosion and downstream (trailing edge) aggradation, a shallow still-water pool is formed within the downstream end of the bar, resulting in a wishbone-shaped island. Sandbars more frequently occur asymmetrically closer toward a bank on an inside bend or developing a deltaic form in a broad depositional zone. There is high variability of the mass of the sand form in plan. There is somewhat less variability and irregularity for the more highly elevated portions supporting nesting. Under conditions of the normal flow, the form of the sandbar changes continually; although there is less change to more elevated portions due to a lower frequency of exposure to flow and erosion. While the specific planform of a bar will vary, a newly created sandbar will rapidly develop flow-driven features form.

1.1 Sandbar Descriptive Terminology

The terminology used for describing interchannel sandbars and discussing portions of it as habitat is used throughout this attachment and the main document. Following is a list of terms that are used to describe various sandbar and river features.

Main Channel: The portion of the overall "flow way" carrying the majority of the flow. The flow way would include the entire width of the channel between the high banks of the river. The main channel includes the "thalweg"; the underwater deepest portion of the channel cross-section. The "back channel" is a high flow braid or secondary channel located between the sandbar and the near high bank. The back channel may conduct perennial flow during most years or may dry to a string of muddy flats and pools, depending on river stage. Should a sandbar occur in a deltaic pattern, there may be numerous braid channels, variously referred as "chutes" and "distributaries". These usually support flow less often than the back channel.

Submerged Step: The main channel side of a sandbar may have a platform of sand or sand and gravel beginning at the annual low water line and extending outward toward the main channel. This feature may be a bench created during an annual low water period, that is inundated during an incident observation. The width of this feature varies from nearly zero to over 100 feet, as a function of magnitude of flow energy directed toward it. If a great deal of energy is directed toward it, it may be better defined as a "leading erosion edge". As it proceeds along the edge of the sandbar laterally and begins to curve away from the main channel its width increases to the point that it becomes the foundation of a "trailing edge". The low step often truncates abruptly channel ward with an angle of repose slope (45 degrees), dropping quickly to deeper water

Low Beach: A low beach is a gradual plane of usually fine sand (sometime silt, clay, or a clay gravel mix) that occurs along all low energy sides of a sandbar. It will emerge from the submerged step on the main channel side and form a very gradual trailing edge on the back channel side. The "ephemeral wrack line" will occur somewhere on its slope, depending on the magnitude of daily or recent fluctuation. The "coarse wrack line" will begin at its upper edge.

Leading Erosion Edge: The upstream end of a sandbar and perimeter facing the main channel may be configured by higher flow velocities into nearly vertical banks. This configuration begins as the bedload material mobilized by a high flow event breaches during falling water level. Lowered water level velocities erode the toe of the vertical slope causing continual slab failure. This process will continue until the erosive velocities are directed away or until the bar is fully degraded. The process of toe erosion and slab failure can frequently sacrifice enough material into the river to divert flow energy away from an unstable bank. Material may be provided to create a submerged step and initiate formation of a low beach.

Trailing Edge: The downstream, most distant from the main channel sides of the sandbar are the trailing edge. The trailing edge is generally a long gently graded slope that may be constructed during high flow on the bank side of the bar. It is formed, further graded and tapered downstream. A low beach usually follows its perimeter.

Ephemeral Wrack Line: The ephemeral wrack line is composed of herbaceous vegetation and light woody debris. It represents the most recent high fluctuation of river stage along the low beach, and may occasionally extend to the woody wrack line. If it is found to extend above this level, it will likely provide evidence that the nesting platform has flooded. During mid summer, lines of freshly germinated cottonwood and willow seedlings will be present in the ephemeral wrack line.

Coarse Wrack Line: The coarse wrack line is composed of relatively large and persistent woody debris, distributed as an irregular ring at the lower fringe of the elevated nesting platform. Size of woody material may range from a few inches in diameter to several feet. Following large storm flows, entire trees, including the root mass may be found to reside in the woody wrack line.

The location of this feature depends upon the mass and overall diameter of the fragment. Wood floats just at the water surface with 80 percent or more of its mass submerged. It becomes part of a wrack line when its lowest floating point becomes snagged on the highest bottom irregularity. Large fragments will be snagged at a higher stage, and thus settle at relatively higher elevations of a sandbar. Sometimes the largest logs are found well into the crown of the nesting area.

The variability in the settling location due to fragment diameter results in a highly irregular line between the wrack line and the nesting platform. Many bird population monitoring field personnel note that a few birds will nest among wrack material, but seem to avoid the very large pieces. Often, nesting terns will use wrack material to deflect winds, particularly when gravel pavement is only weakly developed and there is persistent wind-blown sand. Most field personnel have reported that chicks use woody wrack material for shade and wind protection.

When birds nest in the coarse wrack line, wrack line materials must be considered as part of the nesting area and included in the nest area measurement. Usually, the gravel pavement forms intermittently between wind-shaded areas, and can be used as a guide to nest area delineation.

Crown: Many persistent sandbar islands, particularly in the Mississippi River where bars are both very large and annually submerged, develop an overall dome-shape. The crown is the high point of this dome. The overall planform is oval, oblong-linear. Frequently it is located closer to the deposition side; however, a bar may be composed of several of these features suggesting that several separate islands have filled in and joined. The crown may represent the residual of deposition from an infrequent high flow event that has been smoothed and rounded by subsequent annual rise and fall cycles. Frequently, there is a very large log or root mass near the center. The crown becomes exposed first as the normal hydrograph begins to fall, thus birds will nest here first. The gravel pavement will be best developed on this elevated feature.

If too high, as created from a very infrequent flood event, the crown may serve as a colonization location for hydrophytic woody species such as willow (*Salix* sp.) and button-bush (*Cephlanthus occidentalis*). Should this occur, nesting use near the growing vegetation will likely decline in an annually-expanding ring that appears proportional to tree height. The establishment of a crown shrub-scrub community facilitates establishment of other plants, blocking wind, providing shade and allowing both fine sand and organic debris to collect. Dunes will form, with protected inter-dunal troughs, adding topographic diversity and greatly improved moisture retention. Habitat will be created for a wider range of increasingly upland vegetation. Plant species diversity will increase. Insects, small birds and small mammals will colonize. If left unmanaged, this process will occur with geometric progression.

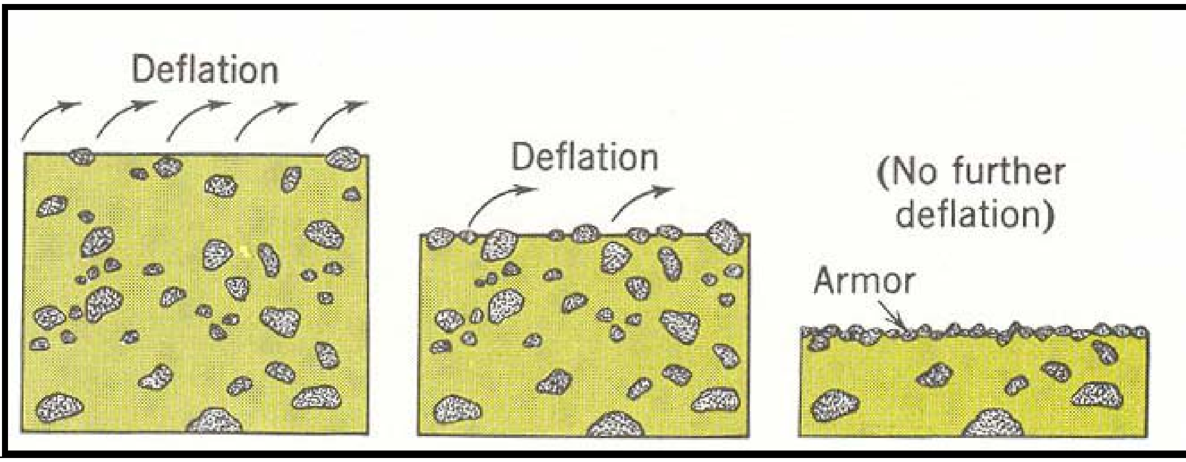
Nesting Platform: The nesting platform is that entire area within which nesting occurs during any given breeding season on an interchannel sandbar. It may include some of the coarse wrack line, all of the crown and most of the gentle slope between these features. It is the location usually presenting a gravel pavement surface, an area that can be easily and accurately measured during and after a breeding season using standard survey or GPS equipment.

1.2 Substrate Characteristics

The energy of flowing water moves and redistributes bed load sediments, forms and destroys sandbar habitat and creates elevated platforms suitable for nesting of ILT and PPL. The finish work on nesting habitat, that which makes it most suitable for ILT nesting and productivity, is the work of wind. Once water levels decline and sandbars dry, aeolian processes become the most effective geomorphological in the riverine corridor. River channels, especially large river channels where fetch may be great, are the flow corridors for the strong and frequently occurring winds. Prevailing northwesterly perform much of the work of redistributing deposited sand, however river valleys are nearly constantly subject to wind. Gravity (drainage) winds are created each evening as cooling air falls from uplands into the river corridor. Thermal winds are created as daily heating of the land surface causes rapidly rising air masses, pulling air back up river corridors. Wind exceeds threshold erosion velocities for fine sand particles as sandbars desiccate, leaving particles too large for the ambient wind energy level to move (Bagnold 1941, Chepil 1945).

Nesting habitat is most often immediately identifiable by the distinctive aeolian gravel “pavement” layer at it surface. Large surficial substrate grain size, relatively high elevation and retarded vegetation succession usually characterize the most frequently used nesting habitat. Gravel pavement occurs only on the elevated cap of the sandbar and is best developed on the desiccated crown of an individual bar. It is this pavement that provides the best opportunity for relatively easy field measurement of nesting habitat. The sites supporting the most successful nesting habitat have this distinctive substrate characteristic. The upper 0.5 to 1.0 centimeter of the substrate is dominantly composed of coarse sand and fine to medium gravel. Finer sand fragments have been eroded from the surface and transported by the wind deflation (see Figure 1).

Figure 1
Gravel Pavement Formation Example



Bedload materials, primarily composed of medium to fine sand include some fraction of entrained gravel. Wind erodes the and transports finer particle sizes, leaving those that cannot be eroded as an armor of "pavement" over the remaining surface.

In arid aeolian geomorphology, the process of "deflation" removes fine particles and results in an armor or pavement at the surface (Bagnold 1941). This process has been well documented in deserts (Wang et al 2006, Bagnold 1941, Naimikas and Sherman 1995), but occurs in any desiccated sand and gravel matrix soils that have been deposited by fluvial events, such as beaches, shorelines and river sandbars (Ruhe 1975). Below this wind-sculpted pavement lies undisturbed fine sand, protected from further wind erosion.

This characteristic gravel pavement was found to consistently present (in varying degrees of armor development) at over 100 GPS-relocated nest bowls during a 2006 field study conducted in the upper Missouri River. Photographs and laboratory analysis of surficial sediment samples were used to quantify and describe this phenomenon. Analysis of data from the upper Missouri River datasets illuminated a distinct and repetitive juxtaposition of nests with elevated sites that supported a gravel pavement. Many of these sites have been assessed through additional field data collection in August 2006 (see section 3 of this document), through stereoscopic use of the 2005 aerial photography and by use of the November 2005 LiDAR data provided by the USACE Omaha District and the state of South Dakota for some segments. Subsequently, field observations conducted in 2007 and 2008 on ILT nesting habitat in the Mississippi River, the Canadian River, the Arkansas River and the Red River produced similar findings; nesting birds showed strong preference for island positions with gravel pavement[2].

[2] ILT nesting preference for gravel pavement and the relationship between freeboard and gravel pavement formation were illustrated on a created sandbar site observed at Arkansas rivermile 348 in Robert S. Kerr Reservoir with Jerry Sturdy of the USACE-Tulsa District during a field visit in October 2007. An approximately 10-acre island had been created in 2005 to mitigate for habitat loss elsewhere. Most of the island has a freeboard of between 1 and 3 feet above lake elevation. A small (+/- 2000 square feet) conical hill had been created at the discharge point of a dredge, rising to approximately 6-feet above the lake level. Gravel pavement had formed only on the conical hill above 3 feet freeboard. Mr. Sturdy noted that only the hill had been reliably used for nesting. The remainder of the island supports 2-year willow seedlings. The conical hill is barren.

The most successful nesting sites were found to have a surface elevation 3 to 6 feet above the adjacent water elevation near the site (freeboard) at the end of the breeding season. Higher water stages during a breeding season reduces freeboard distance, and correspondingly, nest success, as demonstrated by a significant direct correlation between annual average maximum stage during the breeding season and annual nest failure rates. The most successful natural nesting sites are nearly barren (<1%) of vegetation and other surface obstructions. The most successful sites demonstrate both convex or linear topography and high exposure to the strongest prevailing winds (suggested by the longer fetch distances[3]).

Both riverine fluvial and aeolian (wind driven) geomorphic processes participate in the creation and maintenance of the coarse fragment pavements that dominate the surface of the most used (high-quality) nesting habitats throughout the breeding range of the ILT. Elevated sandbars composed of bed load and bank-captured sediments are deposited by high flow events accrue at elevations above local mean water elevations. Fine sand makes up the major portion of all materials available for water transport in most river channels[4]. Medium sand, coarse sand and fine, medium and coarse gravel make up much smaller, but ubiquitous portions of the transported sediment material (Biedenharn 2001, Appendix B). Coarse fragments are non-randomly distributed throughout the fine sand matrix in highly to somewhat segregated layers and lenses, resulting from the winnowing occurring from varying energy flow events.

Once a sandbar emerges above mean water level (or water levels return to average levels following a flow and deposition event), the deposited materials begin to drain and dry until sufficiently desiccated to release the adhesion forces between sediment particles, and make surficial fragments available for wind transport. The size of the particles transported, or the size of those that remain to create the resulting coarse pavement, are proportionally related to wind velocity and persistence; finer particles are transported more easily and more frequently than larger particles (Hagen 1996, Nickling 1988, Zingg 1053). The percentage of larger, less wind-erodible, partials increases until the remaining particles are all of a wind resistant size (Wang et al 2006). At this point, the residual larger fragments form an effective "pavement" that armors the finer fractions buried below. The composition of the pavement is a fine to medium gravel (2-15 mm)

The rate of desiccation is inversely related to particle size; the larger the sediment particles (thus the larger the interstices between particles) (Fisher 1926, McKenna-Neuman and Nickling 1989), the more rapidly drainage and drying occurs. Drainage (the lowering of water levels in soil by gravity) is resisted by capillarity, or capillary rise (Haines 1925). Capillarity, the rise of water

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[3] Fetch is the distance upwind from an object or position within which there are no effective obstructions to the flow of surface-parallel winds.

[4] A single and extensive exception was noted during site visits in the lower Red River in the company of Hubert Hervey and David Oliver (Lower Reds River ILT Monitoring Team) during October 29-31, 2007. Sandbars visited between Red River rivermile 244 and 281 appeared to be composed primarily of very fine sand (0.075 - 0.2 mm). This river segment is broad and very low in gradient. Mr. Hervey commented that during the recent flood (May through July 2007), "the water had come up and gone down like filling and draining a bathtub; flow was almost indistinguishable". As evidence, much of the island caps were still coated with fresh silt. Lacking gravel pavement formation, sands on islands in this segment were desiccated and highly mobile. On one particular island comprising approximately 200 acres and elevated more than 4-feet above the daily flow, Mr. Hervey noted that he had counted only 40 adults in recent years. Nests, he noted, "were few and always near and in the wind shadow of a stick or a bush". Both new and older aeolian features were common; such as surface ripples, lea-side dunes and barcan dune forms. Evidence of sand-blast effects were noted as eroded bark on live shrubs and deformed, in-curled leaves). The aeolian processes were clearly at work, but lacking gravel, no pavement was formed. Gravel pavement was found to return at Cash Island at RM 241. Channel constriction in this area increased river velocity above the erosion threshold for gravel.

through soil and against gravity, is the result of the molecular-level forces of adhesion (the attraction of water to soil particles) and cohesion (the attraction of water to itself) that tends to elevate water to some level above an adjacent free water surface (i.e., the ambient or mean water elevation in the river). The distance that capillarity can raise water through soil is also inversely related to particle size; the finer the grain size, the higher the capillary rise (Fisher 1926). This distance can be estimated in homogeneous materials using the standard equation for capillary rise, however for poorly sorted and stratified natural materials, only in situ measurements can overcome potentially large estimation errors. The height of capillary rise (*hc*) can be estimated by the formula $hc = C/(e*D10)$ where **e** is the void ratio, *D10* is the effective particle size and *C* is an empirical constant that depends on the shape of the grains and the surface impurities (Linsley et al 1975). A range for capillary raise in clean, fine river sands may be 8 to 24 inches, or more.

Figure 2

Typical Gravel Pavement from Deflation Compared to Non-deflated Sand[5]

These photographs were obtained on an island in the Gavins Point Segment of the Missouri River. The left photograph is nesting habitat. The right is wind deposited fine sand between established cottonwood saplings.

Since wind erosion cannot begin until soil becomes persistently desiccated and adhesive bonds broken (Azizov 1977, Hotta et al 1984, Namikas and Sherman 1995, Ravi et al 2006), it may be assumed that the best nesting habitat sites are usually elevated above water levels that would saturate the surface through either flooding or capillarity (Gardner 1970, Fisher 1926) and thus, resist wind erosion of finer particles. The wind-eroded surface created in such elevated and excessively well-drained sites is starkly different in color and mottling from water deposited fine sand matrices in low-lying areas, and from the very fine "sugar sand" deposited behind wind barriers. The presence of the gravel pavement phenomenon is evidence of the occurrence of well-drained conditions that rarely experience flooding or surface saturation during a given season (Klingeman and Emmett 1982, Ravi et al 2006). Birds may or may not recognize and preferentially select these sites for nesting. It is more likely that a coincidence occurs. Birds select the first exposed and highest sandbars; those that desiccate early and remain desiccated

[5] Several hundred additional photographs have been collected to demonstrate this finding at multiple locations in the Missouri River, the Mississippi, the Arkansas and the Red Rivers.

longest, which, again coincidentally, provide a reduced likelihood of nest failure due to flooding or egg saturation. It is probably not a coincidence that natural selection has responded to both coincidences by favoring the persistence of chick and egg color patterns that closely match the mottled patterns of the gravel pavement and favoring the genetics of those adults that select nest locations at time periods when water elevations can distinguish the highest sandbar elevations[6]. The mottled patterns of chicks and eggs so closely corresponds to the color patterns of the wind blown gravel pavement that the phenomena must be nearly ubiquitous in river systems used by this species. Birds not selecting wind pavement gravel sites are probably more likely to suffer nest loss from predation due to improved visibility for predators or from water-related failure, as might be expected in a wet site with sustained water to partial adhesion.

The time needed for formation of the gravel pavement (Cornelis etal 2004a and 2004b, Cornelis and Gabriels 2003, Fe'Can et al 1999) is controlled by:

- The specific grain-size composition of a near surface layer,
- Proximity to coarse sand and gravel lenses,
- Specific internal soil drainage characteristics of a site,
- Local precipitation and relative humidity,
- The persistent river stage relative to the sandbar elevation,
- The velocity of sufficiently erosive winds, and
- The duration and frequency of sufficiently erosive winds.
-

Under ideal conditions, perhaps only a day or two is needed for the proper surface to form through wind erosion (Dong et al 2002a, Dong and Li 1996). Ravi (2006), using wind tunnel experiments, suggested that sand would reach equilibrium with relative humidity conditions freeing surface partials for erosion, within 1 to 2 hours at a constant temperature. Increasing temperature would shorten this time. Persistent winds above the erosion shear threshold might also shorten the time for the deflation process to begin. Wang et al (2006) determined in wind tunnel experiments that time required for gravel pavement to form is directly related to sustained wind velocity experienced at the erosion surface. Further, Wang (2006) notes that the completeness of closure of the gravel pavement is also velocity dependent. This would account for local differences observed and measured in the relative percentages of surficial gravel at different nesting platforms.

The conditions that participate to create the gravel pavement used by the majority of successfully nesting terns strongly resist natural succession (colonization) by vegetation. There are several related reasons for this phenomenon. The majority of the high-quality nesting sites were found to be elevated well above normal water fluctuation levels. Seeds and other propagules are delivered to these sites only by wind, rather than both by wind and water, as occurs at lower

[6] The probability if the use of water levels by ILT to distinguish a nest site was underscored by an observation during a site visit with Rochelle Renken (Missouri DNR ILT Monitoring Team Leader) on July 1, 2007. Ms. Renken identified an island at approximate Mississippi rivermile 881 as a "new" island. The site, located in a dike field, had never been either seen during ILT surveys or used by birds during the previous 17 years of field observations by Ms. Renken. The reason suggested was the incidence of an unusually low water level in the river. The new island had only recently been exposed and was measured at 1 to 3 feet above the daily water level at the highest points. Lower elevations were still saturated as if exposed in the last day or so. There were many new nests with fresh eggs found on raised standing sandy-gravel wave-form crests, 1-1.5 feet high. The area available for raised nest placement was measurable as hundreds of square feet on a 20-30 acre island. Nearby (within a mile or less) there were thousands of acres of bare, dry, highly elevated sand, much of which had well-developed gravel pavement. Yet the late nesters had chosen the lowest, recently exposed sand ridges that would have been recently delineated by water.

relative elevations. Unless the surface is incidentally wet during a seed deposition event, it is unlikely that wind carried seeds will remain sufficiently long to germinate. Seed that catches and germinates in wet conditions and during high water, are less likely to develop an adequate root system before falling soil water levels cause desiccation of seedlings (particularly if a normal hydrological regime is present). The mortality of delicate seedlings is increased by abrasion from wind-borne sand particles.

Figure 3
Camouflaged ILT Chick and Eggs

Minerals that compose the residual gravel following aeolian deflation create a mottled and irregular color pattern that favors concealment of both chicks and eggs. Chicks and eggs with patterns that match the gravel and favor concealment would sustain a significant evolutionary advantage over those more easily perceived by predators.

2 A Field Survey of Nesting Habitat

One of the first findings during the habitat mapping and nest point data analyses presented in Sections 2.0 and 3.0, was the observation that nest points distributed over years clustered into very few locations. Several locations in each river segment were found to have supported nesting for 6 to 8 years of an eight period of record of the nest point data used. These relative few locations were the sites of establishment for between 60% and 90% of all nests in their respective segments. It was speculated that an evaluation of these demonstrated highly productive sites might yield information that could usefully inform the ESH Creation and Maintenance program. As result, additional field studies were undertaken in August 2006 to gather physical data from some of the most productive nesting sites in the Gavins Point and Fort Randall Segments as an example for other nesting sites throughout all segments[7].

The objectives of the field survey included the collection of accurate topographic, soil and vegetation data at least tern and piping plover NestAreas that were used most frequently, particularly those used for nesting and brood rearing during the 2006 breeding season. Data were also collected from locations that did not support nests during the period analyzed, both on separate sandbar islands and on the portions of nesting site islands that had not been used for nesting. Collected data was used to:

- compare nesting site characteristics with sites not used for nesting;
- validate spatial and topographic correlations emerging from the ongoing analysis of the tern and plover database and other spatial data available for 2005; and
- provide an initial basis for description of design, maintenance and construction of emergent sandbar habitat

Field sampling sites were pre-selected using GIS mapping of riverine habitats (see Section 2) and nest point data layers (see Sections 3.0 and 4.0). Table 2 shows the original sampling list. Field conditions required abandonment of some sites and the inclusion of others.

“Island” indicated whether the site was detached from the shoreline as observed in 2005 aerial imagery captured at approximately 21,000 cfs discharge from Gavins Point Dam. A “1” indicates an island. “Acres 2005” are from emergent sandbar habitat polygons delineated using 2005 low altitude, digital orthophotographs (Section 2). It was expected that most of these would have become reduced in area due to erosion and revegetation. “Created,” indicated whether a site had been created by USACE for ESH habitat using mechanical processes. “No” indicates a sandbar formed by flow.

[7] The study team included Coral Huber, USACE Yankton Field Office; GPS location of lines and points and the relocation of a random selection of 2006 nest points used in this sample, Robert Wiley; DMA, team leader, soil sample collection and vegetation data collection, Steve Gebhardt, DMA; survey data collection assistance, hydrological observations, Chief Surveyor Paul Hoebelhenrich Eisenbraun Surveyors; topographic data collection, sample site to sample site way-finding.

Table 2
Bird Cluster Survey Sites 2006

Sample	Rivermile	2005 Shape Length (ft)	2005 Shape Area (sf)	Island	Acres 2005	Created	Nest Count 2005
1	754.9	1018	50540	1	12.5	Yes	28
2	756.6	1840	152022	1	37.6	Yes	7
3	761.4	2405	210191	1	51.9	Yes	41
4	770.1	970	27255	1	6.7	Yes	13
5	770.1	2543	118136	1	29.2	Yes	28
6	770.1	1012	57631	1	14.2	Yes	16
7	782.6	993	29648	1	7.3	no	1
8	788.1	3063	157868	1	39.0	no	37
9	791.5	497	8226	1	2.0	no	4
10	801.4	1194	20266	1	5.0	no	0
11	793.2	335	3502	1	0.9	no	4
12	808.2	927	21863	1	5.4	no	8
13	795.2	740	23260	1	5.7	no	8
14	807.3	624	8142	1	2.0	no	0
15	804.6	576	9276	1	2.3	no	0
16	802.3	2521	85340	1	21.1	no	11
17	804.6	3619	73728	1	18.2	no	6
18	791.5	2014	77049	1	19.0	no	21
19	839.2	1077	30893	0	7.6	no	0
20	851.8	969	24129	0	6.0	no	0
21	853.9	383	5777	0	1.4	no	0
22	866.6	2716	34083	0	8.4	no	0
23	869.6	3563	75252	0	18.6	no	0
24	870.2	1016	35826	0	8.9	no	0

2.1 Substrate Sediment Sampling

Sandbar substrate was evaluated and samples collected at 103 nest locations established and used in 2006. Six nest sites ("sites" as used in the Tern and Plover Database) in the Fort Randal and 13 nest sites in the Gavins Point reaches were sampled. These sites include most of the major nesting clusters for 2006 within the Fort Randal and Gavins Point segments. The upper 5 to 10 millimeters (mm) of substrate was collected at each nest location. A 25 x 25 centimeter (cm) flat-bottomed scoop was used to collect the sample.

Between 3 and 10 nest-location samples were collected, composited, homogenized and approximately 800 gm bagged for laboratory mechanical sieve analysis. Composite surface substrate samples were similarly collected in areas not used by birds for nesting and bagged for laboratory mechanical sieve analysis. There were a total of 19 composite bird nest location samples and 24 non-nesting samples collected for analysis. Samples were then shipped to a certified soil analysis laboratory.

Visual observations of surface substrate characteristics were compiled using prepared menu-driven entries in Geoexplorer field data loggers at nest locations and in non-nesting areas where substrate samples were collected. Observations included:

- Surface grain size composition estimates in the prevalent three dominant texture classes[8] by relative abundance of each class (Clay, Silt, Fine Sand, Medium Sand, Coarse Sand, Fine Gravel, Medium Gravel, Coarse Gravel, Pebble),
- Drainage/frequency of inundation class (0 to 10, ranging from 0 = never inundated or saturated for prolonged periods to 10 = permanently inundated),
- Vegetation ground cover density (as total vegetation obscurance) as an estimated percentage areal cover within a 1 square meter area,
- Woody stem density as counted single stems within a 1 square meter area,
- Dominant wetland indicator status of the vegetation layer,
- Dominant plant species (1 to 5 species present at >20% of stand), and
- The presence of objects near nests (1m, 2m, 3m) (*i.e.*, stick, limb, rock, herb, shrub, man-made object).

All substrate sample collection locations and vegetation sampling points were GPS located using survey grade equipment (sub-meter accuracy). High-density (>8 mega pixel) digital images were obtained at each sediment collection site.

2.2 Sediment Grain-size Analysis

The 25 collected, composited substrate samples were packaged shipped to DLZ soils laboratory for mechanical sieve analysis, in accordance with ASTM C-117, C-136 and D-2216. The findings for grain size distributions were compared to the Biedenharn 2001 dataset. Biedenharn had collected and performed similar mechanical sieve analyses on 631 sediment samples from all segments of the Missouri River. Using the generated data samples (Biedenharn 2001, Appendix A) the particle diameter that represents more than 90% of the substrate material (D_{90}) is medium sand (0.25-0.5mm). The D_{50} (50% of particles finer) was found to be very fine sand. Only 2% of particles were found be larger than 2 mm (coarse sand). Based on these data, a finding of particle size distributions with greater than 2% coarse sand or greater would indicate the operation of a concentrating process.

Tables 3 and 4 present the summary findings for the mechanical sieve analysis of substrate data collected in 2006. Table 3 presents findings for samples collected from nest sites, while Table 4 is for sites not used for nesting. The mean value for the percentage of coarse sand in sites not used for nesting was 4%; double the mean for coarse sand in the Biedenharn dataset. It is suggested that this finding is based on sample locations at the surface that may have been nesting sites, and/or may have experienced a period of wind deflation prior to changes in moisture regime or revegetation. The mean percentage of coarse sand and larger particles for sediment samples from locations used for nesting in 2006 was however found to be nearly 49%.

[8] Textural and soil drainage descriptions were based on use of. Schoenberger, P.J., Wysocki, D.A., Bentham, E.C. and Broderson, W.D. (editors) 2002. Field Book for Describing and Sampling Soils, Version 2.0. USDA, NRCS. National Soil Survey Center, Lincoln, NE.

The grain size distributions for nesting sites differed strongly from the non-nesting sites in all grain size categories (49% to 4% coarse fraction), except for medium sand size particles (approximately 27% of each sample). The Biedenharn data indicate that medium sand comprises an average of 25.6% of substrate composition. This difference suggests that materials immediately at and under the surface layer are similar to the most common distributions throughout the river corridor.

The data shows high variability between samples and an overlap between nesting sites and non-nesting sites. Table 5 shows this more clearly. This suggests a high variability in conditions affecting surface deflation such as unobservable interior soil drainage, vegetation distributions, sand dune formation and position in the river relative to stage affects from a given flow.

A pattern emerged when field characteristics and topographic data collected at the time of the sediment collection were compared. Sites supporting nests demonstrated an average freeboard 1.5 feet higher than for non-nesting sites.[9] Field characteristics indicated that non-nesting sites were either saturated at the time of data collection, or were located between densely vegetated patches that provided wind-shadowing. The site “Burbank 770.1” in Gavins Point Segment is a created site that had supported nesting for two years at the time of data collection. Its coarse fraction is relatively low (10.9%). This site has the lowest freeboard of selected nesting sites (2.2 feet). It was saturated at the time of data collection as seasonally higher flows were resuming, raising stage and water levels into this site. It was also noted that this site was rapidly succumbing to cottonwood and sandbar willow seedlings.

Table 3
Sediment Grain Size Distributions for Nest Point Locations

Site Number	River Mile	Segment	% > Fine Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% =/<Fine Sand	Sum =/> Coarse Sand	Sum < Coarse Sand
3282.2	754.9	Gavins Point	11.0%	4.4%	2.9%	23.8%	57.9%	16.8%	83.2%
3281.1	756.6	Gavins Point	0.2%	32.3%	67.5%	0.0%	0.0%	99.8%	0.2%
3248.1	761.4	Gavins Point	14.3%	3.0%	3.0%	4.2%	75.5%	6.0%	94.0%
3153.1	770.1	Gavins Point	1.5%	5.9%	5.0%	23.6%	64.0%	10.9%	89.1%
3204.2	782.6	Gavins Point	0.4%	0.9%	5.4%	23.6%	69.7%	6.3%	93.7%
3279.1	788.1	Gavins Point	1.3%	0.8%	9.5%	37.7%	50.7%	10.3%	89.7%
3161.1	791.5	Gavins Point	1.1%	0.0%	69.5%	29.4%	0.0%	69.5%	30.5%
3161.2	791.5	Gavins Point	1.1%	0.0%	39.9%	59.0%	0.0%	39.9%	60.1%
3625.1	793.2	Gavins Point	2.3%	32.8%	64.9%	0.0%	0.0%	97.7%	2.3%
3625.2	793.2	Gavins Point	3.3%	4.6%	5.6%	30.0%	56.5%	10.2%	89.8%
3278.1	795.1	Gavins Point	0.1%	36.4%	63.5%	0.0%	0.0%	99.9%	0.1%
Duck-2	800.6	Gavins Point	2.4%	0.0%	20.6%	77.0%	0.0%	20.6%	79.4%
3533.2	801.4	Gavins Point	0.0%	39.4%	60.6%	0.0%	0.0%	100.0%	0.0%

[9] Freeboard was calculated based on distance above mean flow during the breeding season. See Section 5.1.

Site Number	River Mile	Segment	% > Fine Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% =/<Fine Sand	Sum =/> Coarse Sand	Sum < Coarse Sand
3180.1	802.3	Gavins Point	0.9%	0.4%	34.3%	64.4%	0.0%	34.7%	65.3%
3180.2	802.3	Gavins Point	0.1%	9.0%	20.9%	45.7%	24.3%	29.9%	70.1%
3047.2	804.6	Gavins Point	22.7%	6.0%	8.2%	39.9%	23.2%	16.2%	83.8%
3078.1	851.8	Fort Randall	1.8%	5.2%	93.0%	0.0%	0.0%	98.2%	1.8%
3364.1	853.9	Fort Randall	0.8%	24.2%	75.0%	0.0%	0.0%	99.2%	0.8%
3364.2	853.9	Fort Randall	0.9%	0.0%	29.9%	69.2%	0.0%	29.9%	70.1%
3183.2	869.6	Fort Randall	1.9%	34.8%	63.3%	0.0%	0.0%	98.1%	1.9%
3183.1	869.6	Fort Randall	5.1%	32.0%	62.9%	0.0%	0.0%	94.9%	5.1%
3076.1	869.6	Fort Randall	12.8%	5.8%	8.2%	33.2%	40.0%	14.0%	86.0%
3075.1	870.2	Fort Randall	0.8%	5.0%	9.0%	60.2%	25.0%	14.0%	86.0%
		Averages	3.8%	12.3%	35.8%	27.0%	21.2%	48.6%	51.4%

Table 4
Sediment Grain Size Distributions for Locations Not Used for Nesting

Site Number	River Mile	Segment	% > Fine Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% =/<Fine Sand	Sum =/> Coarse Sand	Sum < Coarse Sand
3282.1	754.9	Gavins Point	2.6%	0.9%	2.7%	28.0%	65.8%	3.6%	96.4%
3282.3	754.9	Fort Randall	4.5%	0.7%	3.8%	24.2%	66.8%	4.9%	95.1%
3248.2	761.4	Gavins Point	13.6%	0.5%	3.4%	8.3%	74.2%	3.9%	96.1%
3153.2	770.1	Gavins Point	11.4%	2.0%	3.3%	7.4%	75.9%	5.3%	94.7%
3204.1	782.6	Gavins Point	11.8%	0.2%	3.0%	4.5%	80.5%	3.2%	96.8%
3279.2	788.1	Gavins Point	10.7%	4.0%	0.9%	27.5%	56.9%	4.9%	95.1%
3278.2	795.1	Gavins Point	10.5%	4.9%	3.0%	29.6%	52.0%	7.9%	92.1%
Duck-1	800.6	Gavins Point	11.2%	0.7%	0.5%	47.0%	40.6%	1.2%	98.8%
3533.1	801.4	Gavins Point	10.1%	5.0%	3.3%	36.8%	44.8%	8.3%	91.7%
3047.1	804.6	Gavins Point	2.7%	0.0%	0.3%	57.0%	40.0%	0.3%	99.7%
3093.1	839.2	Fort Randall	10.3%	0.4%	4.5%	9.4%	75.4%	4.9%	95.1%
3076.2	869.6	Fort Randall	1.8%	0.0%	0.0%	43.2%	55.0%	0.0%	100.0%
		Averages	8.4%	1.6%	2.4%	26.9%	60.7%	4.0%	96.0%

Table 5
Generalized Findings of the Nest Site Sediment Analysis Gavins Point Segment

Site Number	NestArea	Nests Present	Sum Coarse or Greater	Note	Natural?	Freeboard (feet)
3533.2	Menominee 801.3	YES	100.0%	1, 7	YES	5.7
3278.1	St. Helena 795.1	YES	99.9%	7	YES	4.9

Site Number	NestArea	Nests Present	Sum Coarse or Greater	Note	Natural?	Freeboard (feet)
3281.1	Elk Pt. 756.6	YES	99.8%	7	YES	3.3
3625.1	St. Helena 793.2	YES	97.7%	1, 7	YES	2.8
3161.1	St. Helena 791.5	YES	69.5%	1	YES	2.3
3180.1	Menominee 802.3	YES	34.7%	2, 7	YES	2.2
Duck-2	Menominee 800.6	YES	20.6%	3, 7	YES	6.0
3282.2	Ponca 754.9	YES	16.8%	7	NO	6.3
3047.2	Menominee 804.6	YES	16.2%	5	YES	2.3
3153.1	Burbank 770.1	YES	10.9%	4, 5	NO	2.2
3279.1	St. Helena 788.1	YES	10.0%	5, 7	YES	3.9
3204.2	Meckling 782.6	YES	6.3%	4	YES	4.6
3248.1	Elk Point 761.4	YES	6.0%	4	NO	3.5
3161.2	St. Helena 791.5	NO	39.9%	4	YES	0.9
3180.2	Menominee 802.3	NO	29.9%	4	YES	0.4
3625.2	St. Helena 793.2	NO	10.2%	6	YES	2.0
3533.1	Menominee 801.3	NO	8.3%	6	YES	5.2
3278.2	St. Helena 795.1	NO	7.9%	4	YES	0.6
3153.2	Burbank 770.1	NO	5.3%	4	NO	0.8
3279.2	St. Helena 788.1	NO	4.9%	6	YES	3.4
3248.2	Elk Point 761.4	NO	3.9%	4	NO	0.6
3282.1	Ponca 754.9	NO	3.6%	6	NO	3.8
3204.1	Meckling 782.6	NO	3.2%	4	YES	1.4
Duck-1	Menominee 800.6	NO	1.2%	6	YES	6.2
3047.1	Menominee 804.6	NO	0.3%	6	YES	2.2

Average % Coarse Fraction for sites used for nesting:	**45.3%**	**Mean Freeboard for Nest Sites**	**3.8**
Average % Coarse Fraction for sites NOT used for nesting:	**9.9%**	**Mean Freeboard for Non-nesting Sites**	**2.3**

NOTE: Conditions at Time of Survey

1 Predation noted in nest dataset or by USACE field personnel
2 Site flooded by rising navigation flows
3 Evidence of recreational use
4 Site somewhat to very poorly drained
5 Site in somewhat wind-shaded area
6 Site in heavily wind-shaded area
7 Site barren

2.3 Discussion of Field Observations and Substrate Analysis

Approximately 85% of all reestablished nests observed had the following substrate characteristics:

- A medium gravel, fine gravel, coarse sand and fine sand matrix with a wind ablated pavement character dominated the surface. Gravel was dominated by medium to dark brown, sub-rounded fragments, resulting in a mottled appearance. Coarse sand tended to be lighter than fine sand by 1 to 3 Munsell color values and 1 to 2 chroma values. The resulting mottled color pattern seems to closely approximate the coloration and patterning of eggs and chick for both bird species.

- Most nest sites were excessively well-drained. Flooding positions were found to range from very infrequently inundated to persistently exposed (the created site at Gavins Point rivermile 770.1 was the exception).
- Herbaceous vegetation ground cover density was generally less than 10%. The majority was completely barren of vegetation.
- The majority of herbs in nest areas were annual weedy species that were likely not present during nest establishment.
- Woody stem density (where extant) for cottonwood canopies that consistently commenced about 1 meter above the substrate surface was estimated to be less than 20%. Canopies lower to the ground restricted nesting altogether.

The majority of nests not occurring in these conditions had been disturbed by ATVs or had been inundated or washed over. No nest sites occurred in fine wind-blown sand (sugar sand) areas.

The substrate where most nests occurred is created by wind and surface desiccation. The desiccation of the surface in well-drained and wind exposed areas eliminates moisture adhesion between substrate particles, allowing particles to be available for transport. Finer particles are eroded and transported downwind, leaving a pavement-like surface composed of particles sufficiently large to resist wind transport covering a compacted matrix of finer particles.

There were two substrate conditions where nests did not occur: 1) dominantly fine (sugar) sands in well-drained but higher density vegetation areas, and 2) fine sands to silts, found in perennially saturated wetlands. Both of these conditions resist wind erosion.

There was no significant visual difference in nesting substrates between naturally occurring nesting islands and dredge-created nesting islands. Any substrate differences appeared to be due to local differences in drainage, frequency of substrate saturation and incident wind exposure. This suggests that the source of substrate material may not matter to the development of suitable nesting substrate, so long as it contains material of sufficient grain size and is exposed to wind action.

The actual area of nesting habitat might be but by the area fully exposed to wind for the creation of the most suitable gravel pavement substrate. The area of island or bar sand measured remote sensing techniques is not representative of the extent of nesting habitat available. The most suitable gravel pavement area could be easily and relatively cheaply captured during any snow free period using the GPS in line or polygon collection mode for a walking delineation.

The present water control regime in the Gavins Point and Randall reaches, wherein stages are held low during the breeding season and high at other times probably benefits the rapid establishment of shoreline vegetation and the rapidity of loss of ESH habitat by improving seed delivery to higher and larger portions of islands and by improving germination and plant growth. The observations of substrate type at nesting sites indicate that, in addition to sandbar elevation, the presence of coarse substrate is also an important characteristic of nesting habitat. It is believed that this can be effectively achieved by removal of fine materials due to wind exposure.

It is also recommended that area of this “ablated pavement” be visually measured at sandbars for use in delineation of nesting habitat.

2.4 Other Notes

Nests in the most upstream two sites in the Gavins point reach and the most downstream three sites in the Fort Randall Reach experienced inundation due to higher water levels (as compared to the rest of their respective reaches). The two most upstream sampling sites in the Gavins Point reach were not sampled due to conditions of relatively deep inundation. Some nest locations appeared to have been disturbed by grazing animals, recreationists, foot travel, and all-terrain vehicles (ATV).

Wind and rain had mildly to profoundly altered nests pits. Survey-grade GPS relocation was within a sub-meter range. Frequently, a relict stick nest marker, the white-stone scree remains of the plover nest or the memory of field bird survey personnel were used to locate the nest precisely. Nest relocation accuracy most strongly affects the “presence of nearby objects” observations. Other observed characteristics of substrate did not vary significantly within a 1-meter radius of relocated nest location pins.

Vegetation control efforts have significantly affected the natural distribution of materials and vegetation in non-nesting areas. Control efforts mildly to profoundly perturbed vegetation structural characteristics in some remaining nesting areas used in 2006. Chemical control and combinations of chemical control and on-site chipping of vegetal matter did not create conditions similar to those observed at the most productive nesting sites.

3 Management Considerations

Based on the foregoing discussions several suggestions can be offered for initial design, construction and maintenance under the ESH implementation program.

1. The gravel/coarse sand surface resulting from wind erosion on substrate seems to be important to nest selection. This suggests that controlling factors that affect the beneficial erosive action of wind should be primary in design and maintenance considerations.
2. Exposed, well-drained sand is a harsh environment for the establishment of vegetation and vegetation is the primary reducer of wind effects. Settling seeds are easily blown away if the site is barren. Coarse residual substrate usually does not hold moisture sufficient for germination of seeds that do find a niche. The few seedlings emerging are usually fatally desiccated.
3. The sequence of vegetation establishment on recently created islands appears to be: a.) cottonwood seedlings established from seed delivered by both wind and water from abundant shoreline sources, and b.) herbaceous plants delivered by wind in dryer areas and by both wind and water in wetter areas. The herbaceous plant propagules are trapped and the seedlings nursed by rows of the cottonwood seedlings and saplings.
4. Vegetation is the primary factor that reduces wind erosion. The negative effects of vegetation on wind erosion begin when herbaceous ground cover exceeds 5 to 10 centimeters in height. Sugar sand deposition plumes are observed downwind of even single dense herbs. As vegetation becomes denser, individual plumes combine into dunes

of sugar sand. Sugar sand facilitates further vegetation establishment due to the improved moisture holding ability of finer particles and the protection of seeds and seedlings from further wind erosion. Control of vegetation at created and natural sites would increase wind ablation.

5. Cottonwood seedlings act like an erosion fence. Early and frequent removal of cottonwood seedlings would retard vegetation establishment in well-drained uplands and also in the more mesic areas (moderate moisture conditions). During the first growing season after island creation (and perhaps the second), it is possible to hand pull cottonwood seedlings. This approach to maintenance would be much more cost effective than the use of chemical or mechanical methods employed later in the cottonwood growth stage.
6. The establishment and maintenance of island geometries and elevations to facilitate surface desiccation and maximize wind exposure could improve habitat suitability in the observed river reaches for tern and plover nesting. The creation and maintenance of relatively elevated (above an effective river stage), dome shaped and steep-sided sand bars would facilitate the creation and persistence of better substrate conditions. Such dome shaped and steep-sided bars presumably require a significant percentage of the shoreline in gentle slopes to facilitate water edge access by plover chicks.
7. Nesting Habitat is found where the planform of the river creates depositional zones. These locations are typically near the downstream end of broad pools.
8. Habitat created by dredge or bulldozer is more uniformly usable than habitat created by removal of vegetation. Vegetation management is an essential part of the maintenance program, but (as currently implemented) is not an effective tool to create nesting habitat.
9. The process of vegetation succession on sandbars is governed by wind exposure sorting fine particles, elevation, flooding and soil moisture. Removal of first year cottonwood seedlings may be sufficient to significantly retard succession on created sandbars.
10. Vegetation succession and the favorability for successful nesting can be controlled to a high degree by construction specifications. Initial construction specifications should be based on local freeboard elevations, slopes, wind-exposure facilitation and positions within pools that have fostered the best nest success ratios.
11. Annual erosion losses from ESH will eventually require additional ESH construction. Reach-specific analysis of the loss of ESH provides a measured basis for the assumed rate of loss in the program. This assumed frequency of ESH replacement will allow the Corps to characterize the nature and extent of the actions and consequences under each PEIS alternative. The approach to creating, managing and replacing ESH will be the same for each of the alternatives; however, the acreage-goals and therefore the magnitude of the action to meet those goals differ between alternatives. This approach will also provide Corps project managers with a basis for identifying resources needed to accomplish ESH management goals in out-year planning. To establish the acres of ESH needed for each alternative, there would be a large effort in the first few years to create them with heavy equipment and dredge. However, the out-year effort needed to maintain the ESH would be considerably less, provided proper actions are taken annually and on a timely basis.

12. The most recent experimental vegetation control practices performed by the District (herbicide application, chopping and brush-hogging) appear to have not effectively restored ESH habitat.

    - Herbicide application alone seems to be more deleterious to habitat than brush-hogging alone or herbicide application and chopping or brush-hogging.
    - Herbicide application, where it has effectively killed cottonwood stems, has had a pronounced snow-fence effect and allowed the establishment of dense stands of annual herbs after application, by reducing nutrient and solar competition and by increasing moisture holding capacity in the fine sand accumulated in the lea of the relic stems.
    - Partially killed cottonwood seedlings and saplings (by either chopping or herbicide applications) have basal sprouted creating sugar sand dunes and nursery sites for herb and grass seedlings.
    - The technique to helicopter spray herbicide application missed rows of cottonwood saplings (sometimes for hundreds of feet across islands). This created extensive linear wind-shadow areas that became heavily colonized with both cottonwood seedlings and annual herbs and grasses.
    - The herbicide used often had no effect on leguminous herbs and many grasses. For example, partridge pea (*Cassia fasiculata*), tufted bent grass (*Agrostis exerata*) and sand drop-seed (*Sporobolus* spp.) have formed very dense monocultures in many treated areas. Cocklebur (*Xanthium strumarium*) and sand-spur (*Cenchrus pauciflorus*), neither of which was observed in dominance during the August 2005 field survey, also proliferated into dense stands in many herbicide sprayed areas.
    - Brush-hogging, while more effective than herbicides in general, left woody residue that shaded and occluded substrate, slowed surface desiccation, reduced wind erosion and served to nurse herb and grass seedlings.

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Attachment 5
Characterization of Study Area Vegetation

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Table of Contents

List of Tables

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Characterization of Study Area Vegetation

This section characterizes the vegetation observed within the Missouri River riparian area, its distribution into communities and habitat types, and natural succession processes important to ESH management. Vegetation includes the composition of native and introduced vascular plant species, ranging in life form from pteridophytes, to submersed and floating aquatic species, to emergent hydrophytes, and to upland herbs, shrubs, and trees. Species form repetitive groupings, or communities, the compositions and distributions of which are strongly defined along hydrologic and flooding regime gradients. Habitat types, as used here, are patterns based on growth forms and structural distributions discernible from aerial photographs. These do not precisely correspond to fixed-composition associations, particularly as changes in latitude and elevation along the river drive changes in species composition. The habitat mapping types defined in Section 2 are used for comparisons with of species groupings in this section.

Knowledge of natural vegetation succession processes is critical to management of sandbar habitat. While the successional processes of all species found in the riverine corridor may be important at some location or in some set of environmental conditions, the phenology of two ubiquitous species (cottonwood and sandbar willow) is featured in the section on natural succession. These species have very high fecundity and rates of revegetation of freshly exposed sand. The establishment of either of these species strongly affects the duration of use of sandbar habitat by interior least terns and piping plovers.

1 Species Composition

There were 181 species of vegetation observed within Missouri River habitat types during site visits and sampling events conducted in 2004, 2005, and 2006. Some of these species are listed from general field note observations and a running tally. Others are compiled from dedicated sampling events conducted for quality control of habitat type mapping, or conducted as part of the substrate sampling survey. Table 1 lists field sampling events and numbers of vegetation samples by river segment. Additional data for vegetation sampling locations are included in Attachment 6.

Vegetation sample data were collected at GPS-located points based on habitat structure as follows:

- Herbaceous, trailing herb, and trailing shrub layers: Percent estimated aerial coverage by species within a 1-meter circular frame.
- Low shrub and sapling layer (1): Stem count, by species, within a 1-meter circular frame, or for sparse stands; stem count by species within a 5-meter circle.
- Low shrub and sapling layer (2): Stem diameter classes, by species, within a 1-meter circular frame, or for sparse stands; stem diameter classes by species within a 5-meter circle.
- Trees: DBH and species by individual stem with a 10 meter circular plot.

Additional vegetation data included height class of overstory for the uniform stand and woody age estimates from stem cross-sections (shrubs and saplings) or increment cores (trees).

Table 1
Vegetation Samples Collected, Missouri River 2005/2006

Period	Segments: Fort Peck	Garrison	Randall - Lewis & Clark Lake	Gavins Point
Jul 6-18, 2005		32	31	29
Aug 18-23, 2005	75			
Aug 24-25, 2005				43
Aug 21, 2006 Sept 1, 2006			45	90
Segment Totals	75	32	76	162
			Total Samples	345

Listed vegetation was classified by Life Form, Wetland Indicator Status, and Nativity according to descriptions found in the following tables (2, 3, and 4). These ratings, and an estimation of relative importance of each species, provide a general basis for understanding the character of the riparian habitat. Relative importance, as described in Table 5, is assigned in for each species within each river segment in Table 6.

Table 1
Life Form

Life Form	Explanation	Code
SAV	Submersed Aquatic Vegetation - Any aquatic vascular plant rooted underwater, the body of which (except the reproductive structures) remains underwater during its entire life.	1
Floating Aquatic	Any aquatic angiosperm rooted underwater but bearing floating leaves and flowers.	2
Emergent Herb	Any herb adapted for and normally occurring in saturated soil conditions	3
Emergent Graminoid	Any species with erect, narrow, grass-like leaves; includes grasses, and wetland sedges, rushes, etc.	4
Terrestrial Erect Herb	Any non-aquatic angiosperm (annual or perennial) with a mostly non-woody stem.	5
Terrestrial Graminoid	Any species with erect, narrow, grass-like leaves; includes grasses, and non-wetland sedges, rushes, etc.	6
Trailing Herb	Any herbaceous climbing or trailing species	7
Vine	A woody or semi-woody climbing or twining liana.	8
Trailing Shrub	Any ground-hugging, creeping woody species; not climbing.	9
Tall Shrub	A woody species bearing multiple or branched stems, start from the ground or below breast height and exceeding 1 meter in height at maturity.	11
Tree	A woody species that typically forms a single stem or trunk at and above the standard “breast height” location (4.5 feet above ground emergence).	12
Fern	Ferns and fern allies (quillworts, lycopods, horsetails)	13

Life Form

This attribute categorizes species by physical structure and growth habit at maturity. This category also ranks the species by the normal vegetative strata within which it is found.

Wetland Indicator Status

Wetland indicator status, which is an estimation of a species frequency of occurrence in wetlands, is assigned using Reed (1988). Species not rated by Reed 1988 are non-wetland species and are scaled as "6". These plants are assumed to never occur in wetlands. The assigned values used for the species in Table 1 are explained in Table 2.

Table 2
Wetland Indicator Status Categories

Wetland Indicator Status	Description	Scale Value
OBL	Plants that occur usually (estimated probability > 99%) in wetlands under natural conditions.	1.0
FACW+	More frequently found in wetlands than that reported for FACW status.	1.5
FACW	Plants that usually occur in wetlands (estimated probability 67-99%), but occasionally found in non-wetlands.	2.0
FACW-	Less frequently found in wetlands than that reported for FACW status.	2.33
FAC+	More frequently found in wetlands than that reported for FAC status.	2.66
FAC	Plants that are equally likely to occur in wetlands or non-wetlands (estimated probability 34-66%).	3.0
FAC-	Less frequently found in wetlands than that reported for FAC status.	3.33
FACU+	More frequently found in wetlands than that reported for FACU status.	3.66
FACU	Plants that occur sometimes (estimated probability 1% to 33%) in wetlands but occur more often in non-wetlands.	4.0
FACU-	Less frequently found in wetlands than that reported for FACU status.	4.5
UPL	Plants that occur rarely (estimated probability <1%) in wetlands but occur usually in non-wetlands under natural conditions.	5.0

Nativity Index

This parameter considers the origin of the species and the growth habits of the species. A high nativity index indicates an alien species, invasive native species, or exotic species; collectively referred to as weeds. Alien species are plants which are not indigenous to the Missouri River Basin and/or North America. Alien species may be invasive or non-invasive. A prevalence of alien weeds suggests low quality habitat. Native species are species considered indigenous to the northern Great Plains. Invasive native species are indigenous plants that rapidly colonize or invade disturbed sites, often becoming dominants to the point of creating a monoculture. A prevalence of invasive weeds often results in habitats with low diversity and low quality as wildlife habitat. A scale ranging from 1 (most native/desirable) to 5 (non-native, invasive/less desirable) was used to rank each species by nativity. The selection of a nativity rating for each species relied on regional taxonomy texts such as Barkley, 1986; Stevens, 1969; Stubbendieck et al, 1992; Kannowski, 1989; Kershaw et al, 1998; Steyermark, 1996; and secondarily on Gleason and Cronquist, 1963; FNA, 1998; and Fernald, 1950.

Table 3
Nativity Status Scale

Nativity Scale	Status	Description
1	Noninvasive Native	A species indigenous to the Missouri River Basin and the State that is noninvasive and non-weedy.
2	Invasive Native	A species indigenous to the Missouri River Basin and the State that is invasive and/or weedy. These species are often found along roadsides or in heavily disturbed waste places or eutrophic wetlands.
3	Planted or Naturalized Hybrid	Species used for reclamation, soil stabilization, green manure, pasture, lawn, landscaping and organic material build-up, which may be naturalized, but may not persist in a dominant position without maintenance.
4	Noninvasive Alien	A species not indigenous to the State that is non-invasive and non-weedy. Includes most escaped exotics.
5	Invasive Alien	A species not indigenous to the State that is invasive and/or weedy. These species are often found along roadsides or in heavily disturbed waste places. They also often form moncultures

<u>Relative Importance Rating</u>

Each species listed is rated from 0 to 5 as an expression of a species presence within mapped association type, a defined unit of area or a defined stand. It is an approximated combination of dominance, frequency and biomass. The rating is qualitative and determined by rapid professional observation in the field and quantitative sampling. Relative frequency ratings are based on the considerations in Table 4. Subsequent species listing Table 5 may be sorted in descending order by segment and then by life form to reveal the dominant species.

Table 4
Relative Importance Ratings

Rating	Explanation
0	Not observed to be present in the River Segment.
1	Occurring very rarely or a single observation (</= 1% of stand)
2	Uncommon (</= 5% of stand)
3	Frequent but never common (</=10% of stand)
4	Common but never dominant (<=25% of stand)
5	Occupying a dominant position (>/= 25% of stand)

Table 5 lists vascular species recorded during the growing seasons of 2004, 2005 and 2006. This table is not a comprehensive flora of the Missouri River riparian zone, but it is likely to represent the dominant and most frequently occurring species that comprise the majority of vegetated habitats. An annual or multi-year vegetation survey would likely list 3 or 4 times this number of species, once the array of seasonal herbs and graminoids is accounted.

Table 5
Vascular Vegetation Observed in the Upper Missouri River Riparian Corridor

Missouri River Plants Database						Relative Importance				
CODE	Scientific Name	Common Name	Wetland Status	Nativity	Life Form	Gavins	Lewis & Clark Lake	Ft. Randall	Garrison	Ft. Peck
ACNE	*Acer negundo* L.	Boxelder	2	1	12	2	2	2	1	1
ACSN	*Acer saccharinum* L.	Silver Maple	2	1	12	1	1	1	0	0
ACMI	*Achillea millefolium* L.	Yarrow	5	1	5	2	2	2	2	2
ACHY	*Achnatherum hymenoides* (R&S.) Barkworth	Indian Ricegrass	4	1	6	2	1	2	1	1
AGTE	*Agalinus tenufolia* (Vahl.) Raf. Var parvifolia (Nutt.)	Slender-leaf Gerardia	2	1	5	3	1	3	1	0
AGFO	*Agastache foeniculum* (Pursh) Kuntze	Giant Hyssop	6	1	5	2	1	2	1	0
AGGI	*Agrostis gigantea* Roth	Redtop	2	3	6	3	4	3	3	1
AGSC	*Agrostis scrabra* Willd.	Rough Bentgrass	3	1	6	2	2	2	3	3
ALPL	*Alisma plantago-aquatica* L.	American Waterplantain	1	3	3	2	5	3	2	2
AMAR	*Ambrosia artemesifolia* L.	Annual Ragweed	4	1	5	4	3	3	2	2
AMPS	*Ambrosia psilostachya* DC.	Western Ragweed	3	1	5	3	3	4	5	5
AMTR	*Ambrosia trifida* L.	Great Ragweed	3	1	5	2	2	2	3	3
AMCO	*Ammannia coccinea* Rottb.	Red Ammannia	1	1	3	1	2	1	1	0
AMFR	*Amorpa fruiticosa* L.	False Indigo	2	1	10	2	1	2	1	0
AMCA	*Amorpha canescens* (Nutt.) Pursh	Leadplant	5	1	10	1	1	1	2	0
AMFR	*Amorpha fruticosa* L.	False Indigo	2	1	10	4	3	4	5	1
ANGE	*Andropogon gerardii* Vitman	Big Bluestem	4	1	6	3	3	3	3	3
ANCA	*Anemone canadensis* L.	Canadian Anemone	2	1	5	1	0	1	2	0
ANNE	*Antennaria neglecta* L.	Field Pussy-toes	6	1	7	2	0	2	2	1
APCA	*Apocynum cannibinum* L.	Indian-hemp	3	1	5	3	2	3	3	3
ARAN	*Argentina anserina* (L.) Rydb.	Silverweed	1.5	1	6	4	3	4	4	3
ARLO	*Aristida longiseta* Steud.	Three-awn	5	1	7	1	0	1	1	1
ARLU	*Artemisia ludoviciana* Nutt.	White Sage	6	1	10	2	1	2	3	2
ASIN	*Asclepias incarnata* L.	Swamp Milkweed	1	1	5	3	4	3	3	2
ASSY	*Asclepias syracea* L.	Common Milkweed	6	1	5	2	1	2	3	3
ASVE	*Asclepias verticillata* L.	Whorled Milkweed	4	1	5	1	1	1	2	0

Missouri River Plants Database						**Relative Importance**				
CODE	**Scientific Name**	**Common Name**	**Wetland Status**	**Nativity**	**Life Form**	**Gavins**	**Lewis & Clark Lake**	**Ft. Randall**	**Garrison**	**Ft. Peck**
ASER	*Aster ericoides* L.	White Prairie Aster	4	1	5	2	2	2	2	0
BASC	*Bassia scoparia* (L.) A.J. Scott	Kochia	4	4	5	3	2	2	2	2
BESY	*Beckmannia syzigzchne* (Steud.) Fern.	American Sloughgrass	1	1	4	2	3	2	2	2
BOCU	*Bouteloua curtipedula* (Michx.) Torr.	Sideoats Grama	5	1	6	2	1	2	3	1
BRAR	*Bromus arvensis* L.	Field Brome	6	4	6	0	0	0	2	2
BRIN	*Bromus inermis* L.	Smooth Brome	4	3	6	3	1	3	3	1
BRMO	*Bromus mollis* L.	Soft Brome	5	4	6	2	1	2	2	1
BRTE	*Bromus tectorum* L.	Downy Brome	5	4	6	3	1	3	3	2
BUDA	*Buchloe dactyloides* (Nutt.) Engelm.	Buffalograss	5	1	6	2	1	2	3	1
CACA3	*Cabomba caroliniana* Gray	Carolina Fanwort	1	4	2	0	0	0	0	2
CAST3	*Calamagrostis stricta* (Timm) Koel ssp. Inexpansa (Gray) C.W. Greene	Northern Reedgrass	2	1	6	2	3	2	1	1
CALO	*Calamovilfa longifolia* (Hook.) Scribn.	Prairie Sandreed	6	1	6	2	1	2	2	2
CASE	*Calystegia sepium* (L.) R. Br.	Hedge False Bindweed	3	4	7	3	3	4	4	2
CASA1	*Cannibis sativa* L.	Hemp	5	2	5	1	0	1	0	0
CAVU	*Carex vulpinoidea* Michx.	Fox Sedge	2	1	4	2	3	2	0	0
CEOC2	*Celtis occidentalis* L.	Common Hackberry	4	1	12	2	2	2	2	1
CHFA	*Chamaecrista nictitans* (L.) Moench	Partridge Pea	4	2	5	4	1	4	4	2
CHRU	*Chenopodium rubrum* L.	Red Goosefoot	1	1	5	3	3	3	3	3
CIMA	*Cicuta maculata* L.	Spotted Water Hemlock	1	1	5	3	4	3	3	2
CIAR	*Cirsium arvense* (L.) Scop.	Canada Thistle	4	4	5	4	3	4	4	3
CLLI	*Clematis ligusticifolia* Nutt.	Western Virgin's-bower	4	1	7	1	0	1	2	0
COCA	*Conyza canadensis*	Horseweed	4	1	5	4	3	4	3	4
COAM	*Corispermum americanum* (Nutt.) Nutt. Var. rydbergii Mosyakin	American Bugseed	4	2	5	4	1	0	0	0
COST	*Cornus sericea* L.	Red-osier Dogwood	2	1	11	2	3	2	4	3
CRGL	*Croton glandulosus* L.	Croton	6	1	5	3	1	2	3	0
CYAT	*Cycloloma atriplicifolia* (Spreng.) Coult.	Winged Pigweed	3	1	5	4	4	4	4	3
CYRI	*Cyperus rivularis* Kunth	Slender Flatsedge	2	1	4	3	3	2	1	0

Missouri River Plants Database						**Relative Importance**				
CODE	**Scientific Name**	**Common Name**	**Wetland Status**	**Nativity**	**Life Form**	**Gavins**	**Lewis & Clark Lake**	**Ft. Randall**	**Garrison**	**Ft. Peck**
CYST	*Cyperus strigosus* L.	Straw-colored Flatsedge	2	1	4	2	3	3	3	2
DYGL	*Dactylis glomerata* L.	Orchardgrass	5	3	6	2	2	2	2	2
DAPU	*Dalea purpurea* Vent.	Purple prairie clover	4	1	5	1	1	1	0	0
DEIL	*Desmanthus illinoensis* (Michx.) MacM. Ex B.L. Robins. & Fern.	Prairie Bundleflower	4	1	5	1	1	1	0	0
DICI	*Digitaria cilliaris* (Retz.) Koel.	Southern Crabgrass	6	2	6	1	1	0	0	0
DOUM2	*Doellingeria umbellata* (P. Mill.) Nees var. pubens (Gray) Britt.	Flat-topped Aster	6	1	5	2	1	2	1	0
ECCR	*Echinochloa crus-galli* (L.) Beauv.	Banyardgrass	2	3	4	2	3	2	2	2
ELAN	*Elaeaganus angustifolia* L	Russian Olive	3.33	4	11	4	1	5	5	4
ELAC	*Eleocharis acicularis* (L.) Roemer & J.A. Shultes	Least Spike-rush	1	1	4	5	5	5	5	3
ELEN	*Eleocharis engelmanii* Steud.	Engelman's Spike-rush	1	1	4	1	2	0	0	0
ELOB	*Eleocharis obtusa*	Blunt Spike-rush	1	1	4	2	4	1	1	2
ELPA	*Eleocharis palustris* (L.) Roemer & J.A. Schultes	Common Spikerush	1	1	4	4	4	5	4	3
ELNU	*Elodea nuttallii* (Planch.) St. John	Western Waterweed	1	1	1	2	4	2	3	3
ELCA	*Elymus canadensis* L.	Canada Wildrye	4	1	6	3	3	4	4	3
EPCO	*Epilobium coloratum* Biehler	Purple-leaf Willow-herb	1	1	5	2	4	2	2	3
EPGL	*Epilobium glandulosum* Lehm.	Glandular Willow-herb	2	1	5	2	4	2	2	3
EQAR	*Equisetum arvense* L.	Field Horsetail	3	1	13	3	4	3	3	3
EQHY	*Equisetum hyemale* L.	Scouring Rush	2	1	13	4	4	4	5	2
ERAS	*Erigeron asper* Nutt.	Rough Fleabane	6	1	5	3	3	3	3	2
EUPE	*Eupatorium perfoliatum* L.	Boneset	1	1	5	2	3	3	3	2
FRPE	*Fraxinus pennsylvanica* Marsh	Green Ash	2	1	12	3	1	3	3	2
GLLE	*Glycyrrhiza lepidota* Pursh	American Licorice	3.66	1	5	2	0	2	3	3
GRNE	*Gratiola neglecta* Torr.	Clammy Hedge-hyssop	1	1	3	3	4	3	3	2
GRSQ	*Grindelia squarosa* (Pursh) Dun.	Gumweed	4	1	5	2	1	2	3	3
HEPA	*Helianthus pauciflorus* Nutt.	Stiff Sunflower	5	1	5	2	1	2	2	3
HOJU	*Hordeum jubatum* L.	Foxtail Barley	2	1	6	4	2	4	4	4

Missouri River Plants Database						Relative Importance				
CODE	**Scientific Name**	**Common Name**	**Wetland Status**	**Nativity**	**Life Form**	**Gavins**	**Lewis & Clark Lake**	**Ft. Randall**	**Garrison**	**Ft. Peck**
JUBA	*Juncus balticus* Willd.	Baltic Rush	1	1	4	3	4	3	3	1
JUBU	*Juncus bufonius* L.	Toad Rush	1	1	4	4	3	4	4	2
JUDU2	*Juncus dudleyi* Wieg.	Dudley's Rush	2	1	4	2	2	2	2	2
JUEF	*Juncus effusus* L.	Soft Rush	2	1	4	2	5	3	3	1
JUIN	*Juncus interior* Wieg.	Inland Rush	2	1	4	4	5	4	3	2
JULO	*Juncus longistylis* Torr.	Longstyle Rush	2	1	4	2	3	2	0	3
JUTO	*Juncus torreyi* Colville	Torrey's Rush	2	1	4	4	4	4	3	2
JUCO	*Juniperus communis* L. var. depressa Pursh	Common Juniper	4	1	12	1	2	3	3	3
JUVI	*Juniperus virginiana* L.	Eastern Red-cedar	4	1	12	3	2	3	1	0
KOPY	*Koeleria pyrimidata* (Lam.) Beauv.	Junegrass	5	1	6	2	2	2	1	1
LECA	*Leonurus cardiaca* L.	Motherwort	4	4	5	1	1	0	0	0
LECA	*Lepidium campestre* (L.) Ait. F.	Poorman's Pepper	5	4	5	3	1	3	3	1
LYAM	*Lycopus americanus* Muhl. Ex W. Bart.	Water Horehound	1	1	3	4	5	3	3	1
LYAS	*Lycopus asper* Greene	Rough Bugleweed	1	1	3	4	5	5	5	4
LYQU	*Lysimachia quadrifolia* L.	Whorled Loosestrife	4	1	5	1	5	0	0	2
LYTE	*Lysimachia terrestris* (L.) B.S.P.	Yellow Loosestrife	1	2	5	1	3	1	0	1
LYSA	*Lythrum salicaria* L.	Purple Loosestrife	1	4	5	3	5	4	4	3
MAPO	*Maclura pomifera* L.	Osage-orange	4	1	12	1	1	0	0	0
MANE	*Malva neglecta* Wallr.	Common Mallow	5	4	5	2	1	3	4	2
MAVU	*Marrubium vulgare* L.	Horehound	3	4	5	2	2	2	3	2
MESA	*Medicago sativa* L.	Alfalfa	5	3	5	3	1	3	3	3
MEAL	*Melilotus alba* Medikus	White Sweetclover	3.66	3	5	5	1	5	5	5
MELU	*Melilotus lutea* L.	Yellow Sweetclover	5	4	5	3	1	3	2	4
MEAR	*Mentha arvensis* L.	Wild Mint	2	1	5	3	3	4	4	4
MIRI	*Mimulus ringens* L.	Monkey-flower	1	1	5	2	4	3	3	2
MOFI	*Monarda fistulosa* L.	Wild Bergamot	5	1	5	2	2	2	2	2
MORU	*Morus rubra* L.	Common Mulberry	5	1	12	2	2	2	0	0
OEFL	*Oenothera flava* (A. Nels.) Garrett	Yellow Evening-primrose	2	1	5	3	2	3	2	2
OESE	*Oenothera serrulata* Nutt.	Yellow Sundrops	6	1	5	2	1	2	3	2

Missouri River Plants Database						Relative Importance				
CODE	**Scientific Name**	**Common Name**	**Wetland Status**	**Nativity**	**Life Form**	**Gavins**	**Lewis & Clark Lake**	**Ft. Randall**	**Garrison**	**Ft. Peck**
OEST	*Oenothera strigosa* (Rydb.) Mack&Bush	Evening Primrose	4	1	5	3	2	3	2	4
OEVI	*Oenothera villosa* (Rydb.) ssp. Strigosa W. Dietr. & Raven	Rough Evening Primrose	4	1	5	3	1	3	4	0
PACA	*Panicum cappilare* L.	Witchgrass	3	1	6	3	3	3	4	4
PAVI	*Panicum virgatum* L.	Switchgrass	4	1	6	3	3	3	4	4
PEAR	*Pediomelum agrophyllium* (Pursh) J. Grimes	Silverleaf Indian Breadroot	4	1	5	2	0	1	1	1
PESE	*Penthorum sedioides* L.	Ditch Stonecrop	1	1	3	3	5	3	3	2
PHAR	*Phalaris arundinacea* L.	Common Reedgrass	1.5	1	6	4	4	4	4	4
PHPR	*Phleum pratense* L.	Timothy	4	3	6	3	2	2	2	2
PHVI	*Physalis virginiana* Mill.	Virginia Groundcherry	6	1	5	1	1	1	0	0
PLPA	*Plantago patagonia* Jacq.	Wooly Plantain	5	1	5	2	1	2	2	2
POPR	*Poa pratensis* L.	Bluegrass	3	3	6	2	2	2	2	2
POAV	*Polygonum aviculare* L.	Prostrate Knotweed	4	3	7	3	1	3	3	3
POLA	*Polygonum lapathifolium* L.	Pale Smartweed	1	3	3	2	3	2	2	2
POPE	*Polygonum persicaria* L.	Lady's-thumb	2	4	5	4	3	3	3	4
POMO	*Polypogon monspeliensis* (L.) Desf.	Annual Rabbitsfoot Grass	1	4	6	2	5	3	1	3
PODE	*Populus deltoides* Bartr. Ex Marsh	Cottonwood	2	1	12	5	4	5	5	5
POTR	*Populus tremuloides* Michx.	Quaking Aspen	6	1	12	2	0	1	1	1
POCR	*Potamogeton crispus* L.	Curly Pondweed	1	1	1	3	5	3	4	2
PONA	*Potamogeton natans* L.	Floating Pondweed	1	1	2	3	4	3	4	1
POAR	*Potentilla arguta* Pursh	Tall Cinquefoil	4	1	5	3	2	3	2	2
PRAM	*Prunus americana* Marsh.	Wild Plum	4	1	10	2	2	2	2	2
QUMA	*Quercus macrocarpon* L.	Burr Oak	4	1	12	1	1	1	0	0
QUST	*Quercus stellata* L.	Post Oak	6	1	12	2	2	2	1	0
RACY	*Ranunculus cymbalaria* Pursh.	Alkali Buttercup	1	1	3	2	4	3	4	3
RARA	*Raphanus raphanistrum* L.	Wild Radish	6	3	5	1	4	0	0	1
ROWO	*Rosa woodsii* Lindl.	Wild Rose	4	1	10	1	1	2	4	1
RUAC	*Rumex acetocella* L.	Sheep Sorrel	3	4	5	2	3	3	3	2
RUAQ	*Rumex aquaticus* L.	Western Dock	1	2	5	1	3	2	2	1
RUCR	*Rumex crispus* L.	Curly Dock	2	4	5	3	3	4	4	3

Missouri River Plants Database						Relative Importance				
CODE	**Scientific Name**	**Common Name**	**Wetland Status**	**Nativity**	**Life Form**	**Gavins**	**Lewis & Clark Lake**	**Ft. Randall**	**Garrison**	**Ft. Peck**
RUMAP2	*Rumex maritimus* L. var. persicarioides (L.) R.S. Mitchell	Golden Dock	1.5	3	5	2	3	2	0	0
SALA	*Sagittaria latifolia* Willd.	Broadleaf Arrowhead	1	1	3	3	5	4	4	3
SAAM	*Salix amygdaloides* Anderss.	Peach-leaf Willow	2	1	12	3	2	2	4	4
SACA	*Salix candida* Fluegge ex Willd.	Sageleaf Willow	1	1	11	0	0	0	3	2
SADI	*Salix discolor* Muhl.	Pussy Willow	2	1	11	2	4	3	3	1
SAEX	*Salix exigua* Nutt.	Narrow-leaf Willow	1	1	11	5	5	5	5	5
SAIN	*Salix interior* Rowlee	Sandbar Willow	2	1	11	5	5	5	5	5
SALU	*Salix lucida* Muhl.	Shining Willow	2	1	11	2	3	2	2	3
SANI	*Salix nigra* Marsh	Black Willow	1	1	12	2	1	1	0	0
SCPA	*Schedonnardus paniculatus* (Nutt.) Trel.	Tumblegrass	4	1	6	2	1	2	2	3
SCSC	*Schizacharium scoparium* (Michx.) Nash	Little Bluestem	5	1	6	3	1	3	3	4
SCAM	*Schoenoplectus americanus* (Pers.) Volk. ex	Cane-makers Bulrush	1	1	3	5	5	5	5	4
SCMA	*Schoenoplectus maritimus* (L.) Lye	Cosmopolitian Bulrush	2	1	4	2	3	1	1	0
SCPU	*Schoenoplectus pungens* (Vahl) Palla	Common Three1square	1	1	4	5	5	5	5	5
SCAT	*Scirpus atrovirens* Willd	Green Bulrush	1	1	4	2	2	2	2	2
SCCY	*Scirpus cyperinus* (L.) Kunth	Woolgrass	1	1	4	2	2	2	1	1
SCTA	*Scoenoplectus tabernaemontani* (K.C. Gmel.) Palla	Soft-stem Bulrush	1	1	3	5	5	5	5	4
SCLA	*Scutellaria laterifolia* L.	Maddog Skullcap	2	1	5	2	1	1	1	1
SEHE	*Senna hebecarpa* (Fern.) Irwin & Barnby	American Senna	5	2	5	2	1	2	3	0
SONU	*Sogastrum nutans* (L.) Nash	Indiangrass	3	1	6	3	2	2	3	2
SOCA	*Solidago canadensis* L.	Canada Goldenrod	4	1	5	4	3	4	4	3
SOGI	*Solidago gigantea* Ait.	Giant Goldenrod	2	1	5	4	3	4	4	4
SOGR	*Solidago graminifolia* (L.) Salisb.	Narrow-leaved Goldenrod	2	1	5	3	3	3	3	3
SOMI	*Solidago missouriensis* Nutt.	Missouri Goldenrod	5	1	5	3	3	2	2	2
SORI	*Solidago rigida* (L.)	Stiff Goldenrod	3.33	2	5	2	2	0	0	0
SPPE	*Spartina pectinata* Bosc. Ex Link	Prairie Cordgrass	2	1	4	2	2	2	2	3
SPAS	*Sporobolus asper* (Michx.) Kunth.	Tall Dropseed	4	1	6	3	1	2	2	2
SPCR	*Sporobolus cryptandrus* (Torr.) Gray	Sand Dropseed	4	1	6	2	1	2	2	2

Missouri River Plants Database						Relative Importance				
CODE	**Scientific Name**	**Common Name**	**Wetland Status**	**Nativity**	**Life Form**	**Gavins**	**Lewis & Clark Lake**	**Ft. Randall**	**Garrison**	**Ft. Peck**
STCO	*Stipa comata* Trin. & Rupr.	Needleandthread	4	1	6	2	2	2	1	0
STHE	*Strophostyles heluva* (L.) Ell.	Trailing Wild Bean	4	1	7	3	1	2	3	1
STEP	*Stuckenia pectinatus* (L.) Boerner	Sago Pondweed	1	1	1	3	3	3	2	1
SYAL	*Symphoriocarpus alba* (L.) Blake	Snowberry	3	1	10	1	1	2	3	2
TECA	*Teucrium canadense* L.	Germander	2	1	5	2	1	2	2	2
TRFR	*Trifolium fragiferum* L.	Strawberry Clover	3	3	5	0	0	0	1	3
TRMI	*Triptercalyx micranthus* (Torr.) Hook.	Small Sand Verbena	6	1	5	2	0	2	2	2
TYAN	*Typha angustifolia* L.	Narrow-leaf Cattail	1	4	4	5	5	5	5	5
TYLA	*Typha lattifolia* L.	Broad-leaf Cattail	1	1	4	4	5	3	2	3
VETH	*Verbascum thapsus* L.	Flannel Mullein	6	4	5	3	2	3	3	2
VEHA	*Verbena hastata* L.	Purple Vervain	2	1	5	3	5	4	3	2
VEST	*Verbena stricta* Vent.	Hoary Vervain	6	1	5	3	4	2	2	2
VEAN	*Veronica anagallis-aquatica* L.	Water Speedwell	1	1	3	4	3	4	3	3
VEPE	*Veronica perigrina*	Neckweed	2	1	3	4	3	2	3	2
VIRI	*Vitis riparia* Michx.	Riverbank Grape	3	1	8	3	3	3	3	0
XAST	*Xanthium strumarium* L.	Rough Cocklebur	3	1	5	5	3	5	5	5

2 Vegetation Assemblages: Communities, Associations, and Habitat Types

Appendix B classifies the land cover of the Missouri River Riparian corridor into eleven habitat types that were delineated in GIS. Some of these mapped habitat types supported no vegetation during the time of either the field survey or during the period of aerial photography acquisition. Table 6 lists the mapped habitat types from Appendix B, whether they supported vegetation and some general comments concerning composition and structure.

Vegetation occurs in repetitive associations or communities distributed along environmental gradients. Plants respond to all effective environmental influences simultaneously; however, the most compelling within a major riparian zone is the characteristics of the hydrologic regime, both during and outside of the growing season. During the growing season the frequency of inundation or saturation within the root zone and the duration of oxygen-free soil conditions; or conversely, the rapidity of desiccation and the persistence of drought, are powerful segregators of plant species. Throughout the year and over periods of years, changes in water level associated with flooding (particularly infrequent higher energy flood events) select for and segregate among species for those tolerant of or benefited by the effects of flooding. Flooding also deposits, removes, winnows and segregates soil materials by particle size and specific gravity. Soil particle size distributions affect water retention, nutrient availability and resistance or availability to water and wind erosion, reinforcing repetitive patterns.

Both the presence of water near the surface and the frequency and magnitude of effects of flooding operate along a topographic gradient. Lower relative elevations in a channel are subject to more frequent and more persistent inundation or saturation within the rooting zone. Lower relative elevations also are subject to more frequent, lower-energy flood events and are most susceptible to drastic substrate modification during high-energy flood events.

These elevation-mediated conditions result in distinctive vegetation zones that support repetitive species groupings (Noble 1979; Turner et al, 2004; Dykaar and Wigington 2000; Stella et al 2005). A number of species common throughout the project area are sufficiently dominant to define the zones they typically inhabit. Many of the species making up the zones or associations change along climatic and latitudinal gradients[1] along the Missouri River. Often the replacement is by a species within the same genus or plant family. Sometimes replacement is by another group altogether; however structure and form of the new group may be similar because of a similar tolerance to flooding, root anoxia or drought tolerance.

The repetitive distributions of plant groupings, forced into association by physical forces and processes, result in identifiable patterns that can be used as indicators of the importance and effectiveness of physical phenomena within a particular cross section of the riverine corridor. Local, relative elevation above a fluctuating river stage serves as the primary plant association segregating factor. Plant associations assemble and form over growing seasons and over years between flood events. Those associations dominated by annual herbaceous plants demonstrate a much shorter period of stability than a gallery forest. As result, the presence of particular vegetation associations expresses the frequency and importance of water stage, without regard to the stage during an instant observation. Local cross-sectional river stage changes in absolute

[1] Between Sioux Falls and Fort Peck Dam in Montana, the Missouri River passes through three distinct climates (Critchfield 1974) and up to five plant hardiness zones (USDA 1990).

elevation as the river falls in elevation. Vegetation association patterns follow the falling river. The Vegetation associations found within the Missouri River riparian corridor are summarized by position (relative elevation) and the dominant species in Table 7.

Table 6
Missouri River Riparian Corridor Habitat Types

Habitat Type	Vegetation Present	Comment
Open Water	No	One basis for mapping open water was the inability to see submersed vegetation on aerial imagery.
Emergent Sandbar Habitat (ESH)	Scant	Generally barren, however sparse vegetation was invisible in aerial imagery. Field surveys revealed annual herbaceous and low woody species at densities of 1 to 10 percent ground cover obscurance. This type is primarily upland vegetation, much of it suited to survival in harsh wind-blown and desiccated conditions. Some areas of wetland vegetation along shorelines are included due to uncertainties associated with water level fluctuation during acquisition of aerial imagery.
Herb-Shrub-Sapling Thickets	Yes	This type was described for mostly heavily vegetated, non-forest areas, however it includes willow and false indigo thickets and therefore includes both wetland and non-wetland vegetation communities.
Non-ESH Sand	Scant	Similar to ESH, this type is primarily barren and inadvertently included some shoreline fringes of scant wetland vegetation.
Riverine Forest	Yes	This forest type is primarily composed of non-wetland canopy species (cottonwood) and a fairly diverse non-wetland herbaceous and woody understory. Older stands include several other canopy species.
Agricultural Row Crop	Yes	Active agricultural practices favor introduced annual crop species and some important fraction of non-wetland agricultural weeds.
Wetland Matrix	Yes	This type is a mixture of herbaceous and graminoid-dominated emergent wetlands. Cattail (*Typha*, 2 species), rush (*Juncus*, 3 dominant species) and bulrush (*Schoenoplectus*, 4 primary species) make up the dominant persistent vegetation.
Shallow Water	Mostly	This type was mapped in inundated locations when either the bottom substrate or submersed vegetation was discernible. Pondweed (*Potamogeton* spp.) and waterweed (*Elodea* spp.) were found to be dominant.
ESH M&C Test Areas	Yes	These areas, identified remotely by a patterned linearity resulting from control practice patterns, supported dead, dying and recovering vegetation. Dense wind disseminated annual herbs generally strongly dominated ground sources between relict woody stems.
Daily-Inundated Sand Plain	No	Subject to relatively violent daily stage changes from peak power operations at upstream hydroelectric dams, this type was almost always barren and composed of well-washed coarse sand and fine gravel.
Lacustrine Fine Sediments	Scant	This habitat type occurs primarily in exposed upper reaches of dam lake pools, increasing in area during the dry years of 2002 through 2005. Vegetation included recently established hydrophytes and wind disseminated upland species. More newly exposed sites were dominated by spikerush, neckweed and ditch stonecrop. Areas in the second or third year of exposure supported cottonwood and willow seedlings.

Table 7
Vegetation Associations of the Missouri River Riparian Corridor Distributed by Relative Elevation in the Channel Cross-Section

Association	Position, Elevation Comments	Dominant Species
High Bank Gallery Cotton Wood Forest	Top of high bank, highest elevations in riparian corridor, level to moderately sloping, rarely flooded. Perennial, woody and semi-persistent Mapped as Riverine Forest.	Eastern or Plains Cottonwood
		Eastern Red Cedar
		Green Ash
		Box Elder
		Common Juniper
Late successional flood plain forest	Climatic climax forest. Ultimately replaces cottonwood forest with time and fire. Longest period since disturbance. Perennial, woody and persistent. Top of Bank and beyond. Mapped as Riverine Forest	Northern Hackberry
		Basswood
		Burr oak
		Red Cedar
		Post Oak
		Box Elder
		Green Ash
Low Floodplain Mixed-Mesic Forest	Forest in frequently-flooded to mesic conditions on slopes to the river, along low flood benches and side channel benches and upper deltas. Perennial, woody and persistent. Mapped as Riverine Forest.	American Sycamore
		Black Willow
		American Elm
		Silver Maple
		Boxelder
		Mulberry
		Wild Plum
		Cottonwood
Xeric Sandbar Crest Early Succession	Sparsely vegetated elevated sandbar and shoreline. Few species, often monocultures of drought tolerant (often succulent) plants. Mapped as ESH, Non-ESH Sand and Herb-Shrub-Sapling, depending on time of year.	Red Goosefoot
		Kochia
		Cockle-bur
		Evening Primrose
		Witch Grass
		Yellow-Sweet Clover
		White Sweet Clover
		Winged Pigweed
Mixed Perennial Upland Herbs	Perennial herbs and grasses in mesic to xeric conditions on sandbar and recently disturbed banks and shallow slopes. Long persistent but will transition to woody species with time. Occurs 2 to 10 feet above mean water elevation during the growing season. Mapped as Herb-Shrub-Sapling in late summer, but may be mapped as ESH in spring.	Yarrow
		Buffalo Grass
		Partridge Pea
		Flat-topped Aster
		Motherwort
		Indian-hemp
		Stiff Sunflower
		Big Bluestem
		Ragweed
		White Sage
		Silverweed
Woody Shrubs and Saplings	This type supplants mixed perennial upland herbs and precedes various upland floodplain forest types. Stand 4 to 10 feet in height are	Cottonwood
		Red Cedar
		Lead Plant

Association	Position, Elevation Comments	Dominant Species
	mapped as Herb-Shrub-Sapling types.	False Indigo-bush Shining Willow Peach-Leaf Willow White Sage Red-Osier Dogwood Wild Plum
Cattail Marsh	Strongly dominated by two species of cattail. Perennial and persistent. From 1.5 feet above to 1- foot below mean water level. Found in lacustrine backwaters, filled-in sloughs, ponds and protected shoals. Often eutrophic. Mapped as Wetland Matrix.	Broad-leaf Cattail Narrow-leaf Cattail Woolgrass Soft-Stem Bulrush Green Bulrush Soft Rush
Fringe Willow Clonal Beds	One-foot above to one-foot below mean water level during the growing season. Perennial, woody, persistent, often monocultures. Often clonal. Mapped as Herd-Shrub-Sapling and Wetland Matrix depending on apparent height of stand.	Narrow-Leaf Willow Sandbar Willow Peach-leaf Willow
Mixed Marsh	Found on low pool fringes, lower banks, filled-in backwater chutes, filled-ponds, depressions underlain by fine materials on sandbars. Can be persistent but may be replaced by cattail marsh. Mixed perennials and annual herbs and graminoids. Mapped as Wetland Matrix.	Soft-stem Bulrush Green Bulrush Woolgrass Monkey-Flower Swamp Milkweed Least Spike-rush Willow-herb Soft Rush Boneset Western Horehound Bugle-Weed Red Ammannia
Early-successional Rush and Sedge Fringes	Successional sandbar association found at 0.5 below to 1.5 feet above mean water level during the growing season. Perennial and annual, replaced by mixed marsh or cattail marsh with time and substrate stability.	Common Three-Square Inland Rush Water Horehound Green Bulrush Soft Rush Common Spikerush
Wrack Line Seedlings	Annual colonial association forming at the wrack line along sandbars and shorelines. Mixed annual and perennial woody and herbaceous species with mid-summer water-borne seeds. Elevated 0.5 feet above to 0.1 feet below mean late summer water elevation. Mapped as ESH.	Least Spikerush Stink-Grass Ditch Stonecrop Slender Flat-sedge Sandbar Willow Cottonwood
Frequently Inundated Mud Flat	Inundated most of year and growing season. Exposed mudflat at low water. Colonized by mostly annual and tuberous perennial species. Mapped as Open Water, Shallow Water, Lacustrine Fine Sediments and Wetland Matrix, depending on river stage.	Ditch Stone-Crop Water Speedwell Arrow-Head Clammy Hedge-hyssop American Water-Plantain

Association	Position, Elevation Comments	Dominant Species
Backwater Sloughs and Still water Habitats	Fringes of backwater sloughs and shallow persistently inundated pools. Rarely communicate by surface flow with river but contiguous through shallow inlets or through groundwater.	Arrow-Head
		American Water-Plantain
		American Waterweed
		Common Pondweed
		Soft-stem Bulrush
		American Slough Grass
		Cattail
		Clammy Hedge-hyssop
Submersed Aquatic Vegetation Beds	Lowest vegetated habitat. Perennially inundated. Persistent between scouring floods. Along low energy shorelines, back channel sloughs. Mapped as Shallow Water and Wetland Matrix	American Waterweed
		Curly Pondweed
		Common Pondweed

3 Natural Succession

Sandbar habitat created by fluvial processes or by mechanical means presents sites available for colonization by vegetation. A knowledge of processes and rate of vegetation colonization of freshly created sandbar is critical to maintenance of created sandbar for the ESH Creation and Maintenance Program implementation. Vegetation limits the use of sandbar for nesting terns and plovers. Various authors suggest that these species will nest in vegetation densities of up to 30%, but the means of estimation, the effective scale, and time of year for measuring are often unclear. A field study conducted for this evaluation found that out of 103 randomly selected, relocated tern and plover nests, all were in barren sand, 98 had no vegetation within 3 meters, and most were greater than 30 meters from vegetation. Field observations in the Mississippi River and the Red River in 2007 suggested that when available, least terns would nest as far as possible (hundreds of feet) from any vegetation present at the time of nest selection.

Colonization by vegetation increases the problem of native predator species. The primary nesting habitat for these birds is extensive and barren sand, (which is not conducive to predation) is hampered in these conditions. Nesting locations can sustain harsh conditions from flooding, wind, and temperature. These, and the distances from ground cover and suitable observation perches, become limiting from an energetics equation for the predator.

The equation changes in favor of the predator and in the likelihood of predation as sandbar sites become revegetated because the reestablishment of vegetation is followed by animal colonization. A sequence of small invertebrate herbivores is followed by larger herbivorous vertebrates, and then small predators, until a prey base is established. Once there is sufficient potential prey for a larger predator to hunt the site on a regular basis, the availability of nearby tern and plover nesters is a seasonally-available addition to their diets. Suppression of vegetation is then a major concern for maintaining ESH usability and minimizing predator take.

Plants distribute a continual rain of propagules (seeds, corms, tubers, live stems, and roots) to their surrounding environment through animal propagators, wind, and water. These propagules either immediately find conditions suitable for germination and growth or they do so at some time later when conditions become suitable. Suitability for germination, growth, and persistence includes temperature, soil moisture, nutrient availability, and presence of herbivores.

Primary succession on sandbars includes two dominant woody species in the willow family (*Salicaceae*) that rapidly colonize sandbars: cottonwood[2] and sandbar willow.[3] These are often the pioneer species on a sandbar due to their similarity of seed propagation and their staggering fecundity. Seeds are lightweight and tufted, and thus both wind and water borne for both short and relatively long distances. Seeds are produced in great quantities and their initial viability approaches 100 percent. Both species also reproduce vegetatively (clonally) through viable stem and root fragments. Willows are more effective at this latter reproductive strategy, since their viable fragments distributed by water are suited to relatively long endurance of anaerobic respiration.

The reproduction, growth, and phenological characteristics of cottonwood and sandbar willow (coyote willow) are selected for discussion due to their ecological function as "nurse" stands for the invasion of other vegetation on elevated sandbars suitable for nesting. Cattails are more fecund seed producers, better vegetative propagators, and more suited to successional revegetation in a moist environment. Cattails can be controlled by establishing sufficient elevation above water levels. A site for which cattail succession is a risk, is also a site with a high flooding risk and should not be a management location for nesting habitat.[4]

The establishment of cottonwood and willow performs four major "nursing" functions for other plant species.

- These woody species serve as wind and water flow energy reducers. Acting like snow fencing, the simple physical effect is to reduce flow, trap seeds and other propagules, and prevent them from being easily remobilized. This allows for the possibility of a stable germination or new root development period.
- Cottonwood and willow stands also trap both airborne and water borne sediments and organic detritus. The majority of these are the finer fractions (fine sand, silt, and clay size particles) and light fragments of vegetation. These materials improve water retention in sandy substrates and improve nutrient availability for growing propagules.
- The stems and canopies of cottonwood and willow offer physical protection to growing sprouts. Potentially damaging wind and water flow effects are buffered. Temperature changes and extremes are moderated. Succulent shoots are made more difficult to find for herbivores.
- Leaf drop by these deciduous woody species provides additional organic mass to the substrate, increasing nutrient availability and water retention.

All of these proceed geometrically in effectiveness over time. Lacking the establishment of these two woody species, other plants will eventually find a wet season or a crevice to establish themselves, however the time is usually greatly extended. The nesting sites that have demonstrably supported nesting since the 1996-97 high release event remained barren for more than 10 years because of their inhospitality to seed germination and growth. The characteristics

[2] Cottonwood includes eastern (*Populus deltoides* Bartr. var. *deltoides*) and plains (*P. deltoides* var. *occidentalis* Rydb). Var. *deltoides* ranges west in the study area to central South Dakota and Nebraska. Var *occidentalis* ranges from eastern Nebraska and South Dakota to central Montana; the ranges of the two overlapping by approximately 150 miles, including the three eastern Missouri River Segments Fowells (1965).
[3] Sandbar willow = *Salix interior* Rowlee and *Salix exigua* Nutt. Present classification combines these into a single species; S. interior Rowlee (http://plants.usda.gov/java/profile?symbol=SAIN3).
[4] Example of virtually all of the Lewis and Clark Lake Segment.

of these sites can be used to inform the ESH creation and maintenance program. The physical factors involved include a combination of local elevation (freeboard) above water levels during the growing season, sustained rapid substrate drainage and a topographic geometry that favors wind and reduces the ratio of mesic and saturated shoreline.

Cottonwood is a rapid colonizer of newly barren and well-drained substrate. Sandbar willow dominates in wetter, more frequently flooded areas; areas rarely usable for nesting. It is thus most important to the maintenance of ESH to understand the reproductive and ecological characteristics of cottonwood and sandbar willow.

Cottonwood

The dominant species throughout the upper Missouri Basin is Plains Cottonwood (*Populus deltoids* var. *occidentalis* Rydberg). Plains cottonwood is the primary successional species on the better-drained portions of riverine corridor, including sandbar habitat. Cottonwood is a keystone species for the development of riparian forest biomes, serving as a nursery species for other herbs, shrubs, vines and trees distributed by wind water and animal vectors. Cottonwood seedlings and saplings serve as traps for river flotsam during high water, which contains seeds and vegetative propagules. Cottonwood seedling and saplings catch wind-borne seeds of all species and also create wind resistance, which fosters deposition and retention of seed, organic debris and the accumulation of fine sand particles. Fine sand drains more slowly than coarse surface materials holding moisture longer and enhancing germination and growth. Accumulated vegetable debris (mulch) provides adequate conditions for developing seedlings, retaining moisture and releasing nutrients.

The overall process of cottonwood-induced succession typically proceeds geometrically. The sandbar successional process, initiated by cottonwood, is mechanically facilitated by the wind buffering effects of both stems and leaves and the debris collection ability (i.e., windrow) of ranks of stems. The early control of cottonwood is critical to restricting natural succession and enhancing the longevity of sandbar habitat. The essential characteristic reproductive and growth habits of cottonwood that must be understood for effective control.

Cottonwood[5] is common in pure stands on river sandbars and on overflow land in the bends of large rivers but is also found in the beds of intermittent streams. Plains cottonwood grows on soils of the order Entisols (infant or new soils). "Soil texture and fertility seem to be of lesser importance than moisture, however, in determining its occurrence and persistence." Plains cottonwood is dioecious with only occasional deviations. Staminate and pistillate flowers are borne on twigs of the previous year's growth, appearing in early spring (April and May) before the leaves develop. Pollination is by wind. Following anthesis, the staminate catkins dry and fall within 2 weeks. Four to 6 weeks, ranging from June through August, are required for seed maturation.

Minimum seed-bearing age of plains cottonwood is about 10 years, and fair to large seed crops can be expected annually. The seeds are very small, yet relatively large for the genus; 'they range from 551,000 to 1,056,000 seeds per kilogram (250,000 to 479,000 lb) (Bessey 1904). Seeds have a tuft of "cotton like" hairs attached and are dispersed primarily by wind, but also by water, over long distances a few days after ripening.

[5] Much of the discussion of cottonwood phenology is based on Fowells, 1965. "Silvics of Forest Trees of the United States". Agricultural Handbook No. 271. UDSA Forest Service, Washington D.C. Direct quotes are bracketed with quotation marks. Findings supplementary or contrary to this exhaustive publication are separately cited.

Seed fall among trees within a locality varies greatly and may extend for 6 weeks or longer. Amlin and Rood (2002) approximate this period to be June 1 to July 15 in a normal year. The viability of fresh seeds is high; 98 percent germination has been attained during the first 5 days following dispersal (reinforced by several authors). "Longevity of seeds under natural conditions has been reported to be 2 weeks to 1 month (Fowells 1956)." Vitality of fresh, unstored seed drops rapidly, if not kept moist. There is no evident dormancy.

Following germination, seed energy is applied to the quick presentation of photosynthetic cotyledons and leaves, rather than roots). Growth rate of the fragile seedlings is slow for the first 3 weeks but may be very rapid after that. "Seed germinates within 48 hours after dispersal on proven mediums such as moist silt, sand or fine gravel in full sunlight". In a controlled laboratory experiment (Amlin and Rood 2002) demonstrated seed germination within 1-2 days after placement on moist substrate and complete germination of a cohort within 3 days.

The above ground portion of the seedling develops rapidly and vigorously. Constant moisture is required for at least several weeks to ensure the establishment and survival of the slower developing root systems of the seedlings. Although initial establishment is usually good and growth is rapid on coarse sands and gravels of river bottomlands, periods of drought and fluctuating water tables reduce seedling numbers drastically (Amlin and Rood 2002). Survival and growth of cottonwoods is directly dependent upon availability of moisture. The rate of water table decline has been found to strongly affect the survival rate, the rate of stem elongation and the rate of root elongation of cottonwood (Amlin and Rood 2002). Water table lowering of as little as 1 centimeter per day may reduce all growth factors by 10% or more. Cottonwood stem development is greatest at water level declines of 1 cm/day but continues well beyond 8 cm/day due to the development of a deep tap root (Amlin and Rood 2002; Noble 1979). Rates of decline greater than 8 cm/day resulted in mortality within 24 days (Amlin and Rood 2002).

Reproduction by root suckers is not common. Propagation from 1-year-old wood from older trees is often difficult. "Root growth of new seedlings is so slow that the plants are easily dislodged by rain droplets". After the first 3 weeks, root growth accelerates and lateral root growth may exceed height growth for the first year. Most of the roots are in the uppermost, best-aerated layer of soil.

Growth and penetration of seedling roots immediately following germination is reported to be relatively slow (Fowells 1956; Noble 1979; Amlin and Rood 2002). About 5 days are required after germination for the primary root to begin downward growth, and after 12 days the root may be only 1.5 mm (0.06 in) long. Growth continues slowly for 3 weeks to 1 month, at which time taproots averaged only 2.5 cm in length under the most favorable growth conditions. This growth pattern explains the critical need for continuous moisture during the seedling stage. Subsequent root growth is much more rapid. The upper band of cottonwood establishment and persistence on a sandbar is limited when the influence of elevation and soil drainage rate allow exceedance of root growth rate (Mahoney and Rood 1998; Johnson 2000). The lower limit of the cottonwood band is controlled by soil anoxia and ice abrasion (Noble 1979)

Floods during the dormant season or floods of short duration during the growing season may benefit cottonwood trees by fully recharging subsoil moisture and providing some degree of vegetation control. Floods that overtop newly sprouting cuttings or established trees for prolonged periods during the growing season or that result in stagnant water pools quickly induce mortality. Cottonwood of all ages is very susceptible to fire. A very light burn kills younger trees, while burns of greater intensity kill or wound larger ones.

Sandbar Willow (*Salix interior* Rowlee ex. *S. exigua* Nutt), Coyote Willow, Narrow-leaf Willow

Sandbar willow may form extremely dense stands, essentially excluding other shrub species. In some areas, it develops more open, scattered communities with greater shrub diversity
Sandbar willow is a native, winter-deciduous shrub that grows up to 33 feet (10 m) tall but is rarely observed greater than 4 feet in height (Anderson, 2006). Individual stems arise singly or a few together and form large clonal colonies from spreading roots. Lateral roots of sandbar willow produce multiple root sprouts. These shoots elongate rapidly in spring Individual stems often only live 10 years, though some may reach 20 years.

Well-established Sandbar willow is reasonably drought resistant and very tolerant of flooding; it can withstand flooding for periods of 2 or more growing seasons (Anderson, 2006). Willow avoids anoxia during extended flooding through the growth of adventitious root growth at the top of the water stem interface. This ability to generate new roots on the stem has a secondary benefit to vegetative distribution of the species; making almost every fragment of live stem and root crown into a waterborne propagule. Permanently elevated soil-water tables result in severely restricted root development and eventual death of the root system. However, because of adventitious rooting, sandbar willow can sustain itself while competing species perish. Amlin and Rood 2001 determined that rooted cuttings of sandbar willow inundated with water for 152 days displayed 72% and 43% increases in shoot and root elongation, respectively. Amlin and Rood (2002) found gradual declines in the water table (0.4 to 0.8 inch (1-2 cm)/day) promote root elongation and shoot growth of sandbar willow compared to a constant water table, while abrupt declines in water table (>0.8 inch/day) reduce growth and survival.

Anderson 2006 notes that willows are very frost tolerant. Mature leaves and winter-dormant stems are capable of surviving temperatures of -4^{o}F (-20^{o}C) and -94^{o}F (-70^{o}C) respectively. However, frosts during the early growing season can cause severe damage to the fast-growing shoots. Temperatures <28^{o}F (-2^{o}C) will kill the elongation zone soon after exposure. Lateral buds below the damaged shoot rapidly form new shoots.

Sandbar willow shares many reproductive strategies and phenology with cottonwood and other members of the *Salicaceae*. The species initiates flowering and produces copious seed in synchrony with meteorological events such as high temperature and increasing degree-days (Stella et al, 2006). Seed production continues for extended periods during the growing season. Seed is immediately viable; however viability lasts, like cottonwood, for only a few days (Stella, 2006, Johnson et al, 1976). Viability may be less than 24 hours unless floating on water (Lamb, 1915). Seed is initially wind disseminated on long silky hairs that catch on moist substrates found at shorelines. These hairs also serve as floats for bearing seed to necessary moist substrates. Germination rates may be greater than 90 %, however seedling mortality rates are very high under natural circumstances of flood erosion, declining water levels and ice scouring.

There are also a number of phenological, metabolic and ecological differences between sandbar willow and cottonwood. Seed drop for sandbar willow begins 2-3 weeks after cottonwood and may extend 4-5 weeks beyond cottonwood (Amlin and Rood, 2002). Post-season growth period for willow ranges from 30 to 75 days before first killing frost, while cottonwood may have 60 to 90 days between seed drop and first frost.

Sandbar willow seedlings are extremely sensitive to the rate of water level decline. Seedbeds must be maintained in a moist condition for a week or more after germination (Moss, 1938). Rates of greater than 2 cm/day have found to be nearly 100% lethal (Amlin and Rood, 2002). Root development for sandbar willow is much less than for cottonwood in conditions of rapid water level decline. Very high seedling mortality under normal (unregulated) hydrological conditions is offset by a high reliance on effective vegetative reproduction by clonal growth (Douhovnikoff et al, 2005).

The ability of sandbar willow to sustain viability against flood damage and erosion appears to significantly exceed that of cottonwood due to much greater stem/root flexibility, greater lateral root development and enhanced vegetative reproduction from stem fragments (Noble, 1979; Ball, 1938). Stem/shoot development by sandbar willow is greatest under conditions of water level decline of 1 cm/day and ceases at greater than 3 cm/day.

Sandbar willow demonstrates a much greater tolerance to anaerobic soil conditions than cottonwood, which, among other factors, is responsible for occurrence of topographically lower bands of willow-dominated growth along riverine islands and stream banks. The width of willow bands appears to be related to the slope of banks and the rate of water level decline during the growing season.

Cottonwood and Sandbar Willow Management Considerations

The operation of various segments to support late summer navigation by increasing discharge and raising water levels would have the effects of enhancing vegetative succession of sandbars. Daily power-peaking in other segments would also enhance growth and expansion of the willow dominated zone by maintaining root saturation late in the growing season that does not occur in unregulated river hydrologic regimes. River flow management appears to provide the following beneficial effect to cottonwood and willow recruitment and growth.

1. increasing the saturated soil area available for seed germination,
2. concentrating wind and water-born seeds higher on stream banks and islands,
3. reducing the natural mortality of seedlings, and
4. enhancing the growth rate of stems and roots.

The reproductive and ecological characteristics of cottonwood and willow succession suggest the need for the following considerations for the long-term management of created sandbar anticipated by the ESH Program in the Missouri River.

- Primary cottonwood and willow succession should be controlled during the first growing season of sandbar creation and continued until loss of the sandbar due to erosion.
- Higher than normal flows during the cottonwood and willow seedling germination season (June through July) and during the growth season (May through October) improves recruitment and enhances the growth rate and establishment of existing cottonwood seedlings and saplings.[6]
- Raising water levels in late summer has the secondary effect of transporting viable cottonwood seeds high onto ESH sandbars. These seeds will likely germinate and have

[6] This effect is demonstrated in the Gavins Point Segment on both natural low-lying sandbar and at the created ESH site at rivermile 770. Rising water levels in late July (to support navigation) provide moisture to recently established seedlings. The majority of these would perish under an unregulated, normal hydrologic regime.

sufficient time to establish adequate heights and root systems during the more than two-month subsequent growth period before first killing frost. The elevated water level will transport other water-borne seeds to the interiors of sandbars and enhance the growth of sandbar willow and other hydrophytic species. The stage increase would also prevent any post-nesting mechanical or chemical control of vegetation below the elevated stage.

- Because first year cottonwood and willow seedlings are extremely sensitive to damage and invest relatively little growth energy in root tissue during the first season, it is unlikely that many seedlings would re-sprout following mowing in August and September. If left to the second year, mowing could actually enhance willow growth by providing viable stems for sprouting elsewhere.
- Islands presently occupied by cottonwood 3 to 6 feet in height must be completely denuded or habitat quality will rapidly decline due to the accumulation of sugar sand and the development of established weed populations in wind protected areas.
- Complete physical removal including tops and roots must occur to re-set natural succession to “zero” (i.e., employ a crawler mounted root rake). Removed material should be burned, buried, hauled off site, or disposed of in the river.
- Islands supporting cottonwood stands greater than eight feet or willow fringes greater than 2 feet in height may be beyond cost-effective mechanical or chemical control. Compare costs of new sandbar creation with vegetation removal on islands that support larger specimens of stands of woody vegetation.
- The form and final grade of created or reshaped sandbars should be configured in a smooth, convex form, lacking niches and wind barriers that would facilitate seed collection and germination. These forms should rise from the water as steeply as possible, while continuing to facilitate chick foraging in the rack line.
- Chemically induced mortality of cottonwood saplings does not reduce natural succession by other species, particularly from propagules delivered to a site once necessarily short-lived herbicides have decayed. Only complete mechanical removal of stems halts the successional processes.

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Attachment 6
Field Verification Details and Equipment

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Attachment 6
Field Verification, Sampling Details & Equipment

1 Introduction

Field verification sampling was conducted in the summers of 2005 and 2006. Field verification activities included the collection of topographic data, substrate/soils data, vegetation data, polygon geometry data and photographic data. Actual sample locations where data was collected were GPS-located. Points, lines and other data were linked in an ArcMap GIS project entitled, FieldSurveys.mxd; available from the USACE Omaha District office upon request. These data were collected to:

- Refine and/or confirm the remote sensing delineation of riverine habitat discussed in Section 2 of Appendix B,
- Characterize the site conditions for description of the existing environment,
- Develop a list of vascular plant species by habitat type, as presented in Attachment 5
- To collect substrate samples for comparison between nesting and non-nesting sandbars as presented in Attachment 5
- Measure relationships between habitat types, substrate conditions, site geometry and hydrological effects, and
- Develop a photographic record of the site conditions for linking to the GIS habitat delineation mapping.

Field sampling locations were selected using various procedures, restrictions, objectives and starting assumptions. The ability to collect field data and the number of sample locations was strongly affected by concerns for balancing the need to timely observe vegetation and flow characteristics close to the 2005 photographic collection date with the need to minimize potential stress on nesting terns and plovers. There were two separate field-sampling expeditions conducted. The 2005 expedition was conducted throughout the five river segments during the delineation and only within areas not actively used for nesting during the sampling period (May to August 2005). Sampling in 2005 was conducted to evaluate the accuracy of preliminary delineations and habitat classification assignments. Sample sites for 2005 were selected to avoid nesting bird colonies and to favor locations near stream flow gages. Field verification activities conducted in 2005 had the goal of confirming GIS-mapped polygon boundaries, polygon composition and refining understanding of the local, water-flow controlled topographic relationships between habitat types or substrate composition.

Sampling in 2005 was conducted throughout all five river segments in the study area. These sites were selected prior to going to the field based on:

- The identification of locations of uncertainties concerning the composition of an observable habitat or the nature of habitat edge conditions, as noted during the remote-sensing mapping process
- Known site accessibility (reasonable proximity public bridge and dock locations)

- Proximity to an established USGS flow/stage monitoring gage (for linking habitat distributions with stage and discharge data)
- The absence of known active nests for the 2005 breeding season
- The mapped presence of multiple habitat types in relatively close proximity

Given these restrictions and criteria, potential 2005 sampling sites were created as points in the GIS to derive the coordinates. Not all sites were found to be usable for various reasons. The coordinates of all potential sample sites were loaded as waypoints in the field GPS equipment for field location. Table 1 lists field verification sampling periods for various locations.

Table 1
Field Verification Sampling Periods

Date	Segment	Sampling Activity
July 06-18, 2005	Gavins Point River Segment Lewis and Clark Lake Segment Fort Randall River Segment Garrison River Segment	Vegetation, substrate, topographic samples and GPS lines on non-nesting habitats
August 18-23, 2005	Fort Peck River Segment	Vegetation, substrate, topographic samples and GPS lines on non-nesting habitats
August 24-25, 2005	Gavins Point River Segment	Vegetation, substrate, topographic samples and GPS lines on nesting sites
August 21 - September 6, 2005	Gavins Point River Segment Lewis and Clark Lake Segment Fort Randall River Segment	Vegetation sampling, sediment sampling and topographic surveys on successful nesting sites

The 2006 expedition was conducted to answer specific questions after the nesting season, only on emergent sandbar habitat used for nesting in 2006 and only in the Fort Randall, Lewis and Clark Lake and Gavins Point Segments. Field sampling conducted in 2006 was undertaken after completion of annual nesting to refine the understanding and delineation of ESH polygons. Sample sites selected for 2006 focused on habitat conditions at known nesting locations in the Gavins Point River Segment and the Fort Randall River Segment. Table 2 lists the type of sampling conducted by river segment.

Field surveys were conducted by crews composed of a botanist, soil specialist, surveying technicians, a registered surveyor, and a Threatened & Endangered Section specialist from the Omaha District. Data collected at each verification site included:

- topography;
- vegetation surveys, sampling, and community classification;
- substrate composition;
- habitat delineations recorded on GPS devices; and

- GPS-located photographs

Field samples varied in size from single point directed photographs to detailed topographic and vegetation assessments covering sites 1 to 25 acres in area. Samples included lines walked along habitat edges, arrays of geometrically distributed points, plot-based data collection and the physical collection of substrate and vegetation materials for later identification. There was no attempt to place sample points in any number of pre-selected habitat polygons. Surveys included data collection within all of those sites most heavily used for nesting in 2005 and 2006.

Table 2
Field Sample Data Sites by Study Area Segment, Type, and Period

Sample Type	Fort Peck River Segment	Garrison River Segment	Fort Randall River Segment Lewis and Clark Lake Segment	Gavins Point River Segment
		2005		
Topography	12	9	5	12
Vegetation/Substrate	31	19	10	29
Line Features	44	13	21	43
GPS Point Photographs	161	52	32	122
		2006		
Topography			5	12
Vegetation/Substrate			27	52
Vegetation Detailed			9	12
Laboratory Sediment			9	26
GPS point photographs			53	99
Total Samples	248	93	171	407

1.1 GPS Equipment and Accuracy Control

All data sampling, GPS navigation, and feature location was conducted with the aid of survey-grade GPS equipment. These were used almost exclusively in open, non-forested conditions, which provide the highest accuracy signal environment for the shortest residence time. The equipment used, and the accuracy range, are presented in Table 3:

Table 3
Global Positioning Equipment

Unit	Typical Horizontal Accuracy
Geoexplorer 3 data logger with external antenna	1 to 5 meters
Pro XL –DGPS or WASS	Sub-meter + 1 ppm
Pathfinder Pro XR – DGPS or WAAS	Sub 0.75 meter + 1 ppm
5800 TSC2 survey controller with base station	Sub 0.5 meter + 1 ppm

GPS data collected was either "real time" differentially processed or was post-processed using data from local, Continuously Operating Reference Stations (CORS) base data sets. The USACE links several CORS base stations along the Missouri River to obtain maximum accuracy needed for the tern and plover nest census program. CORS data for post-processing was obtained from numerous public satellite-recording stations for the time period during which field data were being collected. All data collected during field verification was post-processed using data from the closest base station.

1.2 Sample Sites Numbering and Data Collection

Sample sites for 2005 were numbered sequentially down river from Fort Peck Dam in Montana to Ponca, NE. Sample numbers were assigned as integers prior to going to the field for approximate locations. Additional field selected sample sites were identified by adding a letter (for example; 41, 41A, 42…). There were from one to four separate vegetation and substrate data collection points at each sample site. Identification of these added a decimal and sequential integer to the site number (for example; 41.1, 41.2, 41.3…). There were from 2 to 8 photographs collected at each vegetation/substrate sample point. These were numbered and catalogued by adding a dash and additional sequential integer to the point number (for example; 41.2-1, 42.1-2, 41.2-3…).

2 In-Field Habitat Delineations

GPS equipment was used delineate several thousand feet of habitat boundary lines in the field. These lines were later imported into the GIS project and compared with orthophotographs from the 2005 on-screen delineations, or used to clarify the meaning of certain linear features not indicative of habitat boundaries. Once set to the proper coordinates, deviation from mapped habitat boundaries could be measured.

Table 4
GPS Habitat Edge Delineation Extents

Reach	Data	Total
Fort Peck	Sum of GPS Length (feet)	7,304
	Count of Line Samples	44
Garrison	Sum of GPS Length (feet)	2,014
	Count of Line Samples	13
Gavins Point, Fort Randall	Sum of GPS Length (feet)	8,671
	Count of Line Samples	64
Totals	Total GPS Line Length (feet)	17,989
	Total Count of Line Samples	121

Figure 1 shows an example of habitat delineation lines and topographic measurements generated from field verification and data collection. Comparisons of the PEIS delineations with field data indicated a very high level of delineation accuracy (less than 5 feet) for habitats with boundaries distinguished by topographic differences and vegetation structural differences. In most cases, the drawn line obscures the variation between types as they are presented by the aerial imagery. This level of accuracy applies to more than 75 percent of discrete habitat polygons.

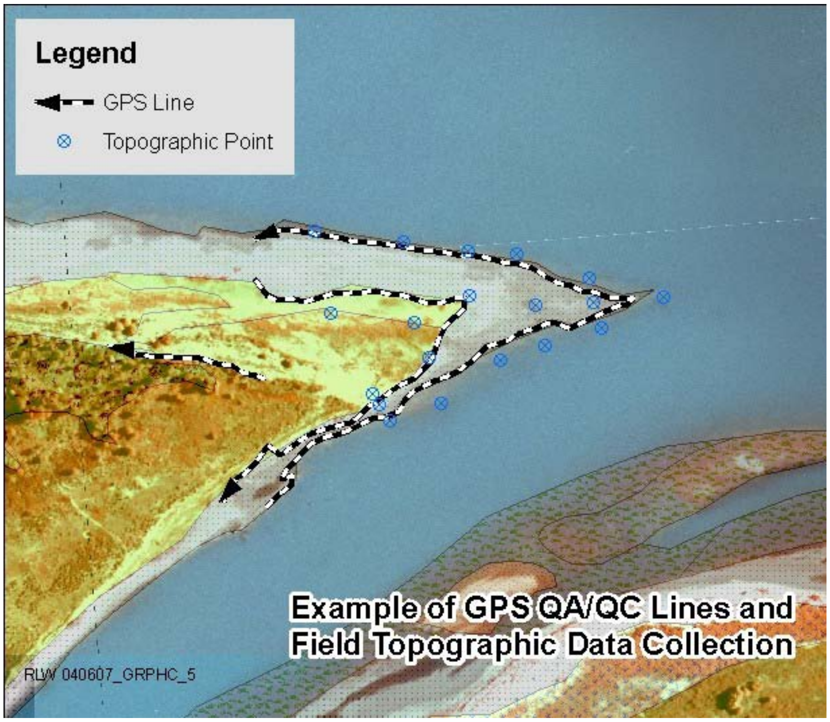
The accuracy of boundaries defined by water edges was also very high, but fluctuating water levels affected the ability to field-verify water edges. This is because a one-foot difference in stage results in a 100-foot difference in edge position on a one percent slope. Slopes of one percent or less are common in much of the areas surveyed that incur rapid stage fluctuations due to daily power peaking flow changes.

The boundary between ESH and early successional vegetation was found to be very difficult to delineate accurately. Edge accuracies range up to 50 feet or more, and could not be resolved by field verification. This problem has several aspects, as outlined below.

- The conceptual blending of vegetation density range-based habitat components (<10 percent for ESH nesting-habitat, >10 percent for brood rearing ESH habitat) assures that the transition between types is always gradual and usually visually subjective. This reduces the probability that a definitive edge decision can be achieved.
- The meaning and perspective (horizontal or vertical) from which vegetation density is measured are not uniformly defined.

- The time of year that aerial imagery is captured affects the perception of vegetation density. Field measurements conducted before or after a photographic event could yield substantially different outcomes.

Figure 1
Sample Field Habitat Delineation Lines



Waterlines typically varied much more due to differences in river stage between orthophotograph capture dates and field sampling dates. Several areas for which GPS field lines were collected were underwater, particularly in the Fort Randall River Segment and the Garrison River Segment because of daily power-peaking discharges. Daily power peaking changes river water surface elevations by up to five feet each day in the upper part of the Garrison River Segment and as little as 0.5 feet in the Lewis and Clark Lake Segment.

3 Topographic Data Collection

Topographic field data were collected from sandbars, shorelines, and islands during 2005 and 2006.[1] Surveys were conducted at 35 locations in 2005 and included all study area segments. After nesting was completed, a late-season survey in 2005 was conducted on three sandbars in the Gavins Point River Segment. Twenty to more than 100 survey readings were collected for each section of beach or small islands. The 2005 topography was collected using a Zeiss NI 40 surveyor's level and stadia-rod mounted Trimble survey-grade GPS data loggers. Stadia elevations were recorded at 0.1-foot increments and later attributed to a GIS point file for each site. Each stadia-rod reading was GPS-located and later adjusted to a local datum using incident

[1] To avoid disturbance of sandbars with nesting birds present, surveys during the breeding season were limited to habitat not used for nesting.

water line as the "0" elevation. Elevation points were collected at grade breaks across the surveyed feature and to a depth of more than 3-feet into the surrounding riverbed.

Additional survey work was conducted in 2006 on 17 sandbars in the Gavins Point River Segment and the Fort Randall River Segment. These 17 sites had been among the most highly used for nesting by least tern and piping plover. Reasons for collecting topographic data were to:

- measure nest heights above water level (freeboard);
- understand the effects of stage change on island or beach size; and
- identify the distribution of plant communities along the hydro-topographic gradient

The 2006 topography was collected using a GPS-linked Sokkia 1200 total station laser transit, operated by a South Dakota registered surveyor. A radio-linked base station was maintained with 20 miles of the data collection sites to maximize positional accuracy. Site numbers assigned for each survey were the same number used in the USACE Yankton T&E Field Office tern and plover database. Selected sites were all used for nesting by terns or plovers in 2006. Table 1 summarizes survey locations for 2006.

Topographic data were used to create 3-dimensional topographic models of each surveyed location and evaluate the effects of stage change on area and plant community distribution. When LiDAR data became available later in the delineation and quality control process, elevations in the LiDAR data set were compared to the topographic field surveys in order to evaluate the accuracy of the LiDAR data. Examples of these models are presented in Attachment 3 – Hydrology.

Table 5
Topographic survey Locations in 2006 in Fort Randall and Gavins Point Segments

SITE	Rivermile	Acres 2005	Created	Nest 2005	SD State Plane 1929, feet	
					X	Y
3282	754.9	12.5	Yes-D	28	734082.8878	663635.0
3281	756.6	37.6	Yes-V	7	735197.7508	665989.2
3248	761.4	51.9	Yes-D	41	729862.9931	667661.5
3274	770.1	6.7	Yes-D	13	720142.4932	673102.2
3153	770.1	29.2	Yes-D	28	720142.4932	673102.2
3152	770.1	14.2	Yes-D	16	720142.4932	673102.2
3204	782.6	7.3	no	1	705446.5717	676649.5
3279	788.1	39.0	no	37	697015.996	677160.8
3161	791.5	19.0	no	21	693998.4949	679349.1
3161	791.5	2.0	no	4	693998.4949	679349.1
3625	793.2	0.9	no	4	691004.0281	679786.7
3278	795.2	5.7	no	8	689898.3788	683025.4
3533	801.4	5.0	no	0	681827.1392	685190.6
3180	802.3	21.1	no	11	680730.7036	684227.8
3139	804.6	2.3	no	0	677229.4809	684190.9
3047	804.6	18.2	no	6	677229.4809	684190.9
3297	807.3	2.0	no	0	673451.8459	683859.2

SITE	Rivermile	Acres 2005	Created	Nest 2005	SD State Plane 1929, feet	
					X	Y
3159	808.2	5.4	no	8	672535.0784	682928.6
3093	839.2	7.6	no	0	630654.8459	669784.8
3078	851.8	6.0	no	0	613707.706	675144.6
3364	853.9	1.4	no	0	610501.4669	675863.1
3183	866.6	8.4	no	0	591990.5719	683613.5
3076	869.6	18.6	no	0	588389.1614	684319.6
3075	870.2	8.9	no	0	587755.7065	685063.3

4 Vegetation and Substrate Sample Points

An important element of field verification included the sampling of vegetation and substrate materials in 2005 and the collection of sediment samples in 2006 in highly successful nesting sites. This data provided useful ecologic characterization information and necessary linkages for photo interpreters between remotely observed and actual field conditions. Data on vegetation and substrate were collected at 1 to 4, 10-meter radius sample points at each topographic data collection site, depending on the number of different community types observed. Sample points were GPS located and imported into the GIS for checking the habitat delineations. Data collected at vegetation and substrate sites in 2005 included:

- Names of all vascular plant species, recorded by percent importance in the community and ground cover density,
- Woody species height, diameter class, importance class and ground cover density,
- Shrub/sapling age as determined by one or more stem cross-section ring counts obtained and assessed in the field,
- Identification of the plant community as a wetland or upland
- Estimates of dominant grain sizes and/or organic content of the surficial soil materials,
- Classification of the soil by USDA texture class,
- Drainage class of the substrate material, based on topographic position, texture and wetland index for dominant vegetation

During 2006, composite surficial substrates were collected within surveyed nesting colony sites. The sample included soil materials collected from the upper three (3) centimeters of the in situ substrate. Composite samples were analyzed for grain size by a certified soil laboratory. The area of substrate collection was located as line or polygon data using survey grade GPS equipment. Sample data collected in 2006 placed greater reliance on GPS data loggers. Menu-driven attribution used to record site data is used here as field headings. Data for the vegetation and substrate were collected like the 2005 sample data; however, notes concerning the effects of chemical vegetation control efforts were collected, along with explanatory photographs. Additional data collected during point capture included:

- Rivermile; from a field map

- "Hydro"; hydrologic regime; a ranking from "0" (no evidence of recent flooding) to "10" (inundated)
- "WI", wetland indicator status, as the mean for the entire stand sampled
- "Dom Strat." dominant stratum, the structural growth from for the most important vegetation layer

Vegetation data were collected at 10-meter radius sample points at each site. Up to four separate vegetation data collection points were established at each sample site. Sample points were GPS-located and imported into the GIS database for use in habitat delineation quality control. Vegetation data collected in 2005 included:

- names of all vascular plant species, recorded by percent importance in the community and ground-cover density;
- woody species height, diameter class, importance class, and ground-cover density;
- shrub/sapling age as determined by one or more stem cross-section ring counts obtained and assessed in the field; and
- wetland or upland identification of the plant community

Vegetation sample data collected in 2006 also included observations on the efficacy of chemical vegetation control efforts.

A list of vascular species identified during the vegetation surveys is provided in Attachment 5.

Findings were used to clarify uncertainties in the delineation and to develop a database for characterization of habitats. A list of all vascular species identified during the sampling was prepared and is provided as an appendix to this document. A summary list of the data collected for each site is presented in the vegetation section of this document. The following tables list characteristics of sample collection events and locations.

Tables 2, 3 and 4 list the vegetation samples for 2005. Included is the sample number, the date and time the point was collected, the vertical and horizontal precision of the point, the geographic coordinates and USGS quadrangle-rivermile concatenation used throughout this document as a place name.

Table 6
Vegetation Sample Sites for Gavins Point, Lewis & Clark Lake Headwaters and Fort Randal Reach-2005

Sample No	GPS Date	GPS Time	GPS Ht (ft msl)	Horz Prec (ft)	Vert Prec (ft)	Coordinates (UTM 14N NAD 1983, M)		
						Northing	Easting	Quad/Rivermile
37.1	7/13/2005	06:32:36pm	1151.2	3.6	5.6	4753313.3930	546282.2006	Marty867.9
37.2	7/13/2005	06:41:37pm	1136.5	2.9	4.5	4753307.4904	546298.6482	Marty867.9
38.1	7/13/2005	04:20:32pm	1133.5	3.7	6.3	4744904.6218	563960.7355	Verdel855.2
38.2	7/13/2005	04:36:37pm	1145.3	5.2	20.3	4744886.0276	563853.4728	Verdel855.2
38.3	7/13/2005	04:50:08pm	1132.7	3.8	6.1	4744858.0805	563897.8266	Verdel855.2
38.4	7/13/2005	04:55:09pm	1137.8	4.0	9.4	4744864.3471	563995.3390	Verdel855.2
41.1	7/13/2005	11:56:14am	1127.9	4.9	9.9	4735462.8682	582433.5899	Springfield841.0
41.3	7/13/2005	12:27:15pm	1150.5	2.7	3.8	4735457.8625	582593.7620	Springfield841.0
42.1	7/13/2005	09:16:15am	1119.5	3.0	5.0	4745618.3520	591853.7929	Santee831.5
42.2	7/13/2005	09:34:21am	1114.2	3.1	4.7	4745597.4986	591892.4624	Santee831.5
43.1	7/12/2005	01:43:35pm	1079.0	3.1	5.0	4745001.0031	626840.0526	GavinsPtDam809.3
44.1	7/12/2005	12:17:24pm	1074.2	2.9	4.2	4747224.9024	630308.0952	GavinsPtDam806.4
44.2	7/12/2005	12:34:41pm	1066.3	2.1	3.4	4747217.8513	630280.1321	GavinsPtDam806.4
44.3	7/12/2005	01:09:58pm	1088.7	2.6	3.8	4747210.3146	630124.2630	GavinsPtDam806.4
44.3	7/12/2005	12:46:56pm	1072.6	2.1	3.5	4747211.3896	630208.4052	GavinsPtDam806.4
45.2	7/12/2005	08:42:05am	1056.7	3.1	5.7	4746123.5356	641998.5739	Menominee798.3
45.3	7/12/2005	08:52:16am	1063.3	3.1	5.8	4746177.0385	642001.4144	Menominee798.3
46.1	7/12/2005	10:24:01am	1063.7	2.5	3.5	4740456.7471	649504.7373	StHelena791.2
47.1	7/11/2005	09:57:24am	1021.9	3.0	4.0	4726395.5143	681182.3123	Burbank763.6
47.2	7/11/2005	10:00:05am	1022.8	2.9	4.0	4726396.0195	681182.8330	Burbank763.6
48.3	7/11/2005	10:52:22am	1017.9	3.0	4.4	4726516.4804	681211.1367	Burbank763.6
48.4	7/11/2005	10:54:19am	1021.7	3.1	4.8	4726514.8724	681210.9390	Burbank763.6
49.1	7/11/2005	10:02:40am	1031.1	2.8	3.8	4726395.0501	681182.9015	Burbank763.6
49.2	7/11/2005	10:30:17am	1026.0	2.6	3.6	4726411.0910	681229.5608	Burbank763.6
49.3	7/11/2005	10:44:24am	1022.4	3.0	4.2	4726487.7493	681249.1139	Burbank763.6
50.1	7/11/2005	05:25:36pm	1042.6	3.0	4.9	4731900.0798	666866.9434	Maskell776.3
50.2	7/11/2005	05:32:56pm	1036.3	2.7	4.2	4731956.6943	666807.2266	Maskell776.3
50.3	7/11/2005	05:40:27pm	1037.2	2.9	4.5	4731968.3583	666734.2219	Maskell776.3
51.1	7/11/2005	11:45:15am	1023.1	2.6	3.9	4726334.3007	686343.5495	ElkPt760.0
60-1	8/24/2005	08:51:35am	1071.7	3.3	4.1	4741708.0422	646131.7080	StHelena793.5
60-2	8/24/2005	09:06:21am	1043.9	18.3	27.5	4741720.0789	646184.2341	StHelena793.5
60-3	8/24/2005	09:36:53am	1068.5	2.4	3.6	4741608.4958	646222.9536	StHelena793.5
61-1	8/24/2005	10:19:27am	1056.6	18.0	29.7	4744252.7634	645637.5129	StHelena795.2
61-2	8/24/2005	10:40:44am	1037.6	17.8	27.8	4744301.1158	645587.9042	StHelena795.2
61-3	8/24/2005	11:04:03am	1040.7	17.7	26.5	4744470.4113	645536.7684	StHelena795.2
							Total Site Count	35

Table 7
Vegetation Sample Sites for Garrison Reach-2005

Sample No	GPS Date	GPS Time	GPS Ht (ft msl)	Horz Prec (ft)	Vert Prec (ft)	Coordinates (Omaha Albers 1929 ft)		
						Northing	Easting	Quad/Rivermile
16.1	7/16/2005	08:54:32am	1748.0	1.9	1.1	320187.4328	1170758.3665	GarrisonDam1368.9
17.1	7/16/2005	09:54:33am	1726.0	1.2	0.8	326643.2272	1159430.5095	Stanton1378.2
17.2	7/16/2005	10:05:02am	1732.0	1.1	0.8	326647.6266	1159497.8121	Stanton1378.2
18.1	7/16/2005	11:31:30am	1727.1	1.3	0.9	328333.1959	1151479.6005	Stanton1372.7
18.2	7/16/2005	11:44:47am	1734.1	1.4	0.9	328180.2147	1151636.8555	Stanton1372.7
18.3	7/16/2005	11:55:51am	1726.3	1.4	0.9	328186.6139	1151648.7540	Stanton1372.7
21.1	7/16/2005	01:28:13pm	1726.3	1.1	0.7	339890.8657	1147424.8443	Washburn1364.9
31.1	7/15/2005	03:35:33pm	1703.1	1.3	1.1	363794.0515	1113480.5507	Harmon1324.3
31.2	7/15/2005	03:44:38pm	1699.4	1.3	1.1	363785.6196	1113433.6697	Harmon1324.3
33.1	7/15/2005	01:03:43pm	1688.6	1.3	0.9	371117.0145	1100049.6438	Bismarck1313.9
33.2	7/15/2005	01:14:09pm	1686.3	1.1	0.7	371111.4128	1100081.6290	Bismarck1313.9
33.3	7/15/2005	01:38:58pm	1694.2	1.1	0.7	371222.6751	1100089.8306	Bismarck1313.9
33A-sav	7/15/2005	01:33:06pm	1686.6	1.2	0.9	371170.0183	1100013.7635	Bismarck1313.9
34.1	7/15/2005	11:17:06am	1690.4	1.1	0.9	369702.8637	1095638.5570	Bismarck1310.9
34.2	7/15/2005	11:26:17am	1679.1	1.3	1	369761.3924	1095648.0005	Bismarck1310.9
34.3	7/15/2005	11:34:43am	1693.8	1.8	1.2	369778.6807	1095631.7252	Bismarck1310.9
34.4	7/15/2005	11:49:32am	1695.9	1.3	0.9	369822.5400	1095616.4777	Bismarck1310.9
							Total Site Count:	17

Table 8
Vegetation Sample Sites for Fort Peck Reach-2005

Sample No	GPS Date	GPS Time	GPS Ht (ft msl)	Horz Prec (ft)	Vert Prec (ft)	Coordinates (UTM 13N NAD 1983 M)		
						Northing	Easting	Quad/Rivermile
1	8/19/2005	03:05:57pm	1898.8	3.1	3.9	5323937.6836	459738.1883	Macon1701.7
2	8/19/2005	03:32:44pm	1898.9	5.1	7.8	5323943.3126	459700.6222	Macon1701.7
1-3	8/19/2005	03:55:14pm	1901.7	6.9	10.0	5323855.7823	459882.8044	Macon1701.7
2-1	8/20/2005	11:57:01am	1962.9	3.9	6.0	5322082.5864	399170.0397	MilkRiverHill1763.4
2-2	8/20/2005	12:06:31pm	1970.4	3.7	5.6	5322065.1615	399139.2845	MilkRiverHill1763.4
5-1	8/19/2005	05:10:30pm	1912.8	3.5	5.0	5324961.4063	452562.9952	WolfPt1707.3
5-2	8/19/2005	05:33:41pm	1913.6	2.9	4.7	5324882.7118	452756.0412	WolfPt1707.3
7-1	8/22/2005	02:40:29pm	1803.7	5.4	7.4	5315152.1443	575781.3311	Buford1581.5
8-1	8/21/2005	04:24:08pm	1825.0	3.6	6.8	5330180.0135	538990.8497	3Buttes1620.9
8-2	8/21/2005	04:32:13pm	1828.4	5.5	4.8	5330169.0167	538888.1157	3Buttes1620.9
8-3	8/21/2005	04:41:42pm	1824.2	4.4	9.7	5330137.1062	538826.6456	3Buttes1620.9
10-1	8/21/2005	03:02:58pm	1855.9	3.2	4.0	5332835.1463	506887.5298	Brokton1649.2
10-2	8/21/2005	03:08:33pm	1850.6	3.4	4.2	5332836.8106	506863.6388	Brokton1649.2
10-3	8/21/2005	03:15:23pm	1847.9	4.3	6.0	5332823.7749	506884.1376	Brokton1649.2
11-1	8/21/2005	01:24:22pm	1879.8	3.9	6.8	5323438.7711	497629.9987	Sprole1663.5
11-2	8/21/2005	01:36:46pm	1904.5	4.1	12.8	5323413.4936	497545.9746	Sprole1663.5
11-3	8/21/2005	01:49:31pm	1875.4	3.7	6.0	5323388.2203	497389.2972	Sprole1663.5
12-1	8/21/2005	11:13:31am	1891.2	3.7	4.5	5325379.6690	483716.2066	Poplar1683.0
12-2	8/21/2005	11:22:14am	1887.2	2.8	3.9	5325459.6197	483655.8649	Poplar1683.0
13-1	8/20/2005	06:33:45pm	1947.5	2.8	4.2	5318059.9616	422133.7124	Frazer1741.4
13-2	8/20/2005	06:31:47pm	1943.3	2.7	4.1	5318017.8522	422112.3921	Frazer1741.4
13-3	8/20/2005	06:42:18pm	1944.4	3.4	4.5	5317970.2216	422207.9155	Frazer1741.4
14-1	8/20/2005	04:02:06pm	1950.4	5.8	10.0	5319935.4391	409726.3093	Kintyre1755.4
14-2	8/20/2005	04:14:20pm	1952.6	3.7	5.6	5319911.2949	409744.9775	Kintyre1755.4
14-3	8/20/2005	04:26:24pm	1959.2	3.5	6.3	5319891.7719	409699.9236	Kintyre1755.4
15-1	8/20/2005	02:14:10pm	1948.5	3.7	6.2	5322237.1738	404624.2031	MilkRiverHill1759.1
15-2	8/20/2005	02:22:25pm	1960.8	4.7	10.4	5322213.6402	404628.1611	MilkRiverHill1759.1
15-3	8/20/2005	02:29:12pm	1960.8	3.3	5.4	5322165.5747	404639.3455	MilkRiverHill1759.1
8a-1	8/22/2005	10:45:17am	1825.5	3.3	5.1	5325393.0401	544016.9867	3Buttes1616.0
8a-2	8/22/2005	10:48:02am	1826.5	3.7	5.4	5325432.5817	544001.6561	3Buttes1616.0
8a-3	8/22/2005	10:56:28am	1827.0	3.3	5.3	5325456.2460	544058.8150	3Buttes1616.0
							Total Site Count	31

Composite surface substrate samples were collected in 2006 at up to four separate sites within each of the 17 surveyed nesting sites. Samples included soil materials collected from the upper three centimeters of the in-situ substrate. Composite samples were analyzed for grain size by a certified soil laboratory, and analytic metrics included:

- estimates of dominant grain sizes and/or organic content of the surficial soil materials;
- classification of the soil by USDA texture class; and
- drainage class of the substrate material, based on topographic position, texture, and wetland index for dominant vegetation.

Additional data on substrate composition is provided in Attachment 4: Sandbar Composition and Geometry. Table 9 lists the site from which vegetation and substrate data were collected during 2006.

Table 9
Vegetation and Sediment Sample Sites for Gavins Point, Lewis & Clark Lake Headwaters and Fort Randal River Segments-2006

Sample No	River mile	Hydro	WI	Dom Strat	GPS Date	GPS Time	GPS Height	Coordinates (Omaha Albers 1929 ft)	
								Northing	Easting
3282A	754.9	0	4.5	Herb	8/21/2006	10:45:30am	1014.7	126721.9300	2975883.539
3248A	761.4	7	2	Shrub	8/21/2006	03:07:24pm	1026.7	141028.2364	2962311.854
3248B	761.4	1	5	Shrub	8/21/2006	03:27:50pm	1024.2	141446.4682	2963777.338
3153A	770.1	6	3	Shrub	8/21/2006	05:12:10pm	1027.4	160470.0696	2933770.252
3204A	782.6	6	2.5	Herb	8/22/2006	09:39:52am	1052.6	175819.9966	2885099.968
3161A	791.5	5	3	Herb	8/22/2006	02:04:21pm	1051.4	187326.8625	2848077.707
3180A	802.4	7	2.33	Herb	8/24/2006	11:46:02am	1067.7	205705.8681	2805325.024
3047A	804.6	0	5	Herb	8/24/2006	12:37:34pm	1074.9	206366.9029	2794763.456
3047B	804.6	6	3	Herb	8/24/2006	12:55:46pm	1074.6	205656.8954	2795288.433
3078A	851.8	9	1.5	Herb	8/23/2006	11:55:05am	1142.8	190008.2595	2584212.342
3078B	851.8	6	3	Shrub	8/23/2006	12:01:48pm	1138.8	190056.3444	2584243.446
3078C	851.8	3	4	Shrub	8/23/2006	12:06:23pm	1140.3	190084.9609	2584275.524
3078D	851.8	0	5	Shrub	8/23/2006	12:12:38pm	1143.5	190089.8341	2584286.125
3078E	851.8	5	3	Herb	8/23/2006	12:17:10pm	1141.0	190118.3472	2584300.516
3078F	851.8	8	1.5	Herb	8/23/2006	12:19:24pm	1144.2	190140.0305	2584312.254
3364B	853.9	2	3.5	Herb	8/23/2006	01:16:33pm	1144.2	193198.3058	2573372.991
3364A	853.9	5	3	Herb	8/23/2006	12:58:33pm	1141.1	193344.2365	2573454.557
3076A	869.6	6	2.66	Herb	8/23/2006	02:40:50pm	1143.1	222485.9901	2514135.536
3076B	869.6	0	5	Herb	8/23/2006	03:04:49pm	1146.9	222541.4693	2514455.553
3076C	869.6	7	2.5	Herb	8/23/2006	03:07:17pm	1143.9	222452.6890	2514448.535
3076A	869.6	5	3	Herb	8/23/2006	04:16:27pm	1146.3	225852.4067	2502288.880

5 Sample Point Photography

Digital photography was an important data collection tool. Photographs were collected using a Nikon 8800 digital single-lens reflex camera, with a Nikkor ED 8.9 to 89.0 mm, 1:2.8-5.2 lens. Image density was set at 8.0 effective megapixels. Date and time stamp functions were activated at GPS-located photo points, allow later time synchronization with other sample data. Export of photo points to the GIS allowed linking of site imagery with remote sensing data during the delineation.

Several photographs of the plant community were taken at each sample point at cardinal directions and at both long-range and near fields of focus. Details are generally adequate for later species identification, due to the high-density image resolution. Substrate was also photographed using zoom and depth of field controls and a scale object to record dominant substrate grain-sizes for sites at which laboratory samples were not collected.

Findings were used to clarify uncertainties in the delineation and to develop a database for characterization of habitats. The ArcMap GIS project entitled, “FieldSurveys.mxd” was developed with hot links to site-collected photographic imagery. This GIS project, part of the project dataset record, could be made available by contacting the USACE Omaha District.

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US Army Corps
of Engineers
Omaha District

Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Appendix C

Emergent Sandbar Habitat Mechanical Creation and Replacement Assumptions

PREDECISIONAL DRAFT - DO NOT COPY OR CITE

October 2010

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1 Introduction

The National Environmental Policy Act (NEPA) and its implementing regulations require that federal agencies use an evaluative process before undertaking "major Federal actions significantly affecting the quality of the human environment." Among other things, agencies must analyze irreversible resource commitments involved in implementation of the proposed action, alternatives to the action under consideration, and the proposed action's environmental impact. This appendix describes the programmatic assumptions regarding the creation and replacement of emergent sandbar habitat (ESH) that will serve as the basis for describing the ESH program alternatives' environmental impacts in a comparative manner in the Programmatic Environmental Impact Statement (PEIS).

Mechanical creation and replacement of ESH on the upper Missouri River has been conducted and studied for nearly 15 years by various state and federal agencies as well as academics and non-governmental institutions. A wide variety of methods have been employed and outcomes have been highly variable.

The combination of ESH creation and replacement projects recently completed by the Corps of Engineers (Corps) (2004-2006), newly-developed spatial habitat information (GIS), and productivity data from interior least tern and piping plover (least tern and plover) nest monitoring over that same time period have provided compelling data regarding the efficacy of various methods. Detailed evaluations of the 1999-2006 bird database and recent habitat manipulation activities (USACE, 2003; USACE, 2004) indicate that dredge- and/or heavy-equipment-created sandbars have provided habitat extensively used for nesting. The majority of other attempts to create ESH via vegetation removal techniques have been sparsely used by least terns and plovers, based on data gathered to date.

The assumptions for the creation of ESH for the establishment of the ESH program will, therefore, rely primarily on the use of dredge- and heavy-equipment-created ESH. Other techniques for creating ESH will continue to be tested and evaluated through the Adaptive Management Program (see Appendix H) until such time as they are found to be effective at creating usable habitat.

Section 2 identifies and explains the programmatic assumptions for landside improvements (river access locations), habitat creation and replacement (referred to solely as construction, hearafter), and the spatial and temporal limits for ESH management activities. Section 2.1 identifies the assumptions for landside improvements necessary to support ESH construction actions and the actions necessary to build sandbars. The ESH design assumptions in Section 2.2 are based on the habitat requirements identified in the 2000 BiOp, as amended, 2003. As construction takes place to meet the initial goals for ESH, annual habitat construction will be necessary to replace areas lost to erosion and re-vegetation (i.e., succession). The assumed annual ESH construction rates are included in Section 2.

Estimates of the equipment and materials necessary to construct emergent sandbars have been developed from projects completed by the Omaha District (USACE; 2003a; USACE, 2004; USACE, 2005; USACE, 2005a) on the Missouri River and interviews with contractors that have built ESH for the Corps (Rowland, 2007). These completed projects and the experience gained serve as the basis for assumptions regarding how the work would be accomplished annually. This allows the Corps to quantify the magnitude of the habitat manipulation methods needed for the entire ESH program while not prescribing the detailed quantities or exact designs for site-specific evaluation.

Not all times of the year and locations within the river corridor are acceptable for ESH construction activities. To minimize the environmental effects of implementing the ESH program, construction activities are limited both temporally (i.e., time of year) and spatially (i.e., not all areas in the river corridor are feasible or permissible for construction). Section 2.3 describes the assumed spatial and temporal limits on ESH construction activities and the basis for those limitations.

Section 3 presents the total and reach-specific construction actions that would be necessary to implement each of the alternatives in the PEIS. These calculations are based on the alternative-specific acreages of ESH needed and the associated volumetric and construction assumptions to construct them from Section 2.

Section 4 identifies ESH manipulation methods still in the research and development phase because they are unproven based on the biological response reflected in the current nesting and reproduction dataset. The Corps views these methods as potential "tools in the toolbox" that will continue to be studied for future use on a large scale using the Adaptive Management framework.

The ESH construction designs and techniques described are based on programmatic assumptions. Future modifications and site-specific designs are expected to occur based on detailed engineering, cost evaluations, environmental considerations, public participation, and ongoing monitoring as it improves the scientific knowledge for the ESH program.

The programmatic construction assumptions have been developed to create a rational articulation of what implementing the entire ESH program under the different alternatives would require. This allows a consideration of the cumulative effects over the entire ESH program area and the comparison of ESH program alternatives. The assumptions regarding construction allow the PEIS to provide a comparison of estimated effects within which site-specific design modifications can be made without compromising the integrity of the assessment.

The description of the ESH construction within this appendix does not represent any formal commitment to final design, equipment for use, vendors for supply of materials or services, or detailed methods of construction but gives an approximation of how the features could be constructed and the associated construction requirements thereof. It is intended to provide an example of how the work could be accomplished and serve as the basis for comparing the potential environmental consequences of the ESH program alternatives.

2 Construction Assumptions

2.1 Landside Access, Staging, River Access, and Restoration

2.1.1 Overview

To construct interchannel emergent sandbars, river access for equipment would be needed at locations where ESH projects would be constructed and maintained. Where existing facilities enable the use of public access, the Corps would utilize existing sites. Where river access does not exist, the Corps would develop a safe and stable location for landside equipment access to and egress from the river as well as a staging area for equipment, materials, and temporary field offices. Access to the river and use of the property would be with the cooperation of willing landowners.

2.1.2 Assumptions for Landside Features

The landside features to be constructed at each location where new access is necessary could include the following components, depending on site-specific conditions:

- Access road (0.5 mi. x 40 feet wide),
- Three culverts (3’ diameter) on each access road,
- Equipment staging area,
- Ramp access to the river (200 ft x 50 ft with a 20-ft drop in elevation from staging area to water surface at 10% grade),
- D-50 (36”/max 48”) Rip-rap stone bank armoring to protect launch site into the river (5 cubic yards-CY),
- Petroleum storage area with 2-foot berm (20 ft x 30 ft),
- Two temporary office trailers,
- Two temporary toilets, and
- Floating dock secured to shore with a large anchor weight on shore tie-up.

To construct all components of the landside infrastructure, typical construction equipment would be used, such as dozers, excavators, cranes, compactors, hauling/dump trucks (10 CY), and other miscellaneous equipment. Materials would be transported to and from the site using normal size legal weight on-road hauling trucks. All surfaces to be driven upon (access road, staging area, ramp to river) will be cleared and grubbed to 0.5-ft depth. When cleared, geotextile filter blanket (fabric) would be placed down before placement and compaction of 0.5-ft depth of 2-inch crushed stone/gravel road surface material. All materials cut and filled for the access road, laydown and staging area, and ramp access to the river would remain on site and would not require the import of new fill or off-site disposal of excess materials. Within the laydown area, a petroleum storage area would be constructed to be a plastic-lined 20 ft x 30 ft area with a 2-ft earthen berm surrounding the area. This would provide spill containment for petroleum product storage.

When establishing the vessel launch area, the riverbank material would be pulled back landward and not pushed into the river. When the river access is prepared to the required lines and grade, geotextile filter cloth should be placed directly on the prepared slope, installed, and anchored.

Placement of the D-50 stone and crushed base should follow immediately after placement of the geotextile. Temporary docking would be secured to the shoreline with an anchoring and chain/cable. All of these features would be constructed within 5 working days.

Table 1
Summary for Landside Modification Assumptions

Quantities or Activities	Total
Area of Landside Disturbance (acres)	5
Excavated Material (CY)	15,000
Quantity of Stone Rip Rap (CY)	25
Quantity of Crushed Stone (CY)	1,956
Truckloads of Materials to Site (10 CY each)	199
Duration to Construct (Days)	5

The number of landside access points necessary for implementing the ESH program is related to the number of locations within that reach where ESH could be constructed. The number of locations suitable for construction is dictated by channel plan form and areas to be avoided, not the number of acres that would be constructed under any particular alternative. As such, the number of landside access points needed would be the same among the alternatives. Table 2 lists the reach-specific assumed number of landside access points needed to implement any of the action alternatives. Each of the access points in Table 2 would be constructed as summed in Table 1.

Table 2
Number of Landside Access Points for All Segments

Segment	New Access Points Needed
Fort Peck River	2
Garrison River	6
Fort Randall River	4
Lewis & Clark Lake	2
Gavins Point River	10
Total Number of New Access Points	**24**

2.2 Emergent Sandbar Habitat Construction

2.2.1 Overview

The habitat construction methods described are based on completed project experience, but minor design changes can and will be made. Future modifications in technique implementation are expected to occur based on more detailed engineering, cost evaluations, environmental considerations, and public participation as the ESH program proceeds and new information is learned.

The assumptions for design and construction of ESH are specific, consistent with the language of the 2000 BiOp, as amended 2003, and applied to each of the alternatives so that the effects of implementing the alternatives may be compared. The Omaha District has developed the design criteria based on pages 194-196 of the 2003 Amendment to the 2000 BiOp (USFWS, 2003). These assumptions are utilized as a uniform template based on the 2003 Amendment to the 2000 BiOp recommendations. Page 195 describes desirable ESH conditions as "*a complex of side channels and sandbars with the proper mix of habitat characteristics required by the birds*."

ESH construction has been successfully accomplished by using bulldozers, excavators, pan scrapers, and similar earth-moving equipment to stack up sand into emergent sandbars and by having hydraulic dredges dredge and pump substrate into emergent sandbars. Both methods have been used independently and in concert to achieve the same result (Rowland, 2007).

From a practical standpoint, each construction contractor would determine the most efficient use of equipment and determine the sequencing of the construction activities at a given location and taking advantage of ambient conditions. Based on interviews with ESH construction contractors (Rowland, 2007), the Corps assumes that a contractor would use both methods (heavy equipment and dredge) for each sandbar project. The construction assumption is that, for a given sandbar complex, 70% of the material will be mechanically removed and placed and 30% will be hydraulically dredged and placed. This assumption is applied to all of the quantities needed. There may be conditions where more of the quantity would be constructed with dredges, but the areal extent of river bottom modified by mechanical extraction exceeds that of dredging. Therefore, the effects of the mechanical construction analysis would be greater than that of dredging.

This section describes the assumptions for estimating the incremental and total areas (in acres) and earthwork (sand) volumes (in CY) from implementing each of the alternatives considered in the PEIS. The assumptions developed herein are intended to specify quantitative design thresholds based on use of representative equipment.

This estimate procedure has been prepared using spatial data, flow volumes, and topographic data from the Gavins Point River Segment. The assumptions developed herein will be used to estimate the acreage needed for the ESH program implementation under all of the alternatives and the volumes of sand to be moved. Acreages will be used to assign spatial area of effects to each of the alternatives. Volumes will be used to further estimate the time needed, the labor force, and the equipment needed to complete construction objectives to create and maintain the prescribed acreages. Both acreage and volume estimates will be used to contrast the material management requirements of the alternatives and the area available to construct ESH.

With a clear recognition that these programmatic assumptions are pre-construction and pre-design estimates, these calculations provide a broad description of the actions necessary to implement each of the alternatives as well as some detail to characterize the magnitude of the environmental consequences from implementing each of the alternatives. This depiction allows an informed comparison of the environmental consequences associated with implementing each of the alternatives and enables the predicted consequences to be contrasted with the anticipated benefits.

2.2.2 ESH Design Interpreted from the 2000 BiOp, as Amended (2003)

The following section identifies ESH criteria from the 2000 BiOp, as amended (2003).

From the 2000 BiOp, as amended (2003):

- Entire ESH complex must have (at least) 60% dry sand (p.194-195).
- Nesting area minimum size is 1 acre, preferably 10 acres, but not of a prescribed area with no maximum size identified. Nesting area is assumed to be within the purview of the design engineer (p. 195).
- Brood rearing habitat should be from 3 to 5 times the nesting area (p. 195-196).
- Plover foraging area is included within brood rearing habitat (p. 196).
- Plover foraging habitat should comprise 40% of the brood rearing habitat[1] (p. 196).
- Plover foraging area must be wet; therefore, it is assumed to occupy a band of the brood rearing habitat nearest the water interface.

Equation for total ESH Complex under the 1:3 nesting habitat to brood rearing habitat option = X (nesting area) + 3X (brood rearing area, including the plover foraging component).

- Thus, if a 100-acre sandbar complex was designed, then
- Total ESH complex is X (nesting area) + 3X (brood rearing area including the plover foraging component) = 100 acres of ESH.
- 4X = 100 acres, and
- X (nesting area) = 25 acres of the 100-acre complex.

If the nesting area is 25 acres (X = 25 acres), then the following habitat areas apply to a 100-acre ESH complex and may be used as proportional ratios for any size ESH complex as shown:

- Nesting area (X) = 25 acres.
- Brood rearing area (3X) = 75 acres.
- Nesting area (25 acres) + brood rearing area NOT plover foraging area (75 acres *(0.6) = 45 acres dry sand).
- 25 acres nesting area + 45 acres not plover foraging area = 70 acres dry sand.
- 70 acres dry sand > 60% dry sand for entire ESH complex.

[1] Plover foraging habitat does not have a separate spatial component in the ESH "complex" requirements; it is a subcategory of, and included within, the brood rearing habitat. The plover foraging area component of the brood rearing area = 40% of the brood rearing habitat, or brood rearing habitat acres *(0.4).

<u>If Brood Rearing Habitat Is Equal To 5 Times the Nesting Habitat:</u>

- If nesting area = X, then
- Brood rearing area = 5X.
- Equation for total ESH complex = X (nesting area) + 5X (brood rearing area including the plover foraging component).

  - If a 100-acre complex was designed, then
  - Total ESH complex is stated as X (nesting area) + 5X (brood rearing area including the plover foraging component) = 100 acres of ESH.
  - 6X = 100 acres.
  - X (nesting area) = 16.667 acres of the 100-acre complex.

If the nesting area is 16.667 acres (X = 16.667), then the following habitat areas apply to a 100-acre ESH complex and may be used as proportional ratios for any size ESH complex as shown:

- Nesting area (X) = 16.667 acres.
- Brood rearing = 5(X) = (16.667 x 5) = 83.3 acres.
- Nesting area (16.667 acres) + brood rearing area NOT plover foraging area (83.3 acres *(0.6) = 49.98 acres dry sand).
- 16.667 acres nesting area + 49.98 acres dry sand not plover foraging area = 66.65 acres dry sand.
- 66.65 acres dry sand > 60% dry sand for entire complex.

Table 3 provides a summary of the various specified ESH component areas.

Table 3
ESH Component Areas (acres)

Nest Area	3X Brood Rearing Area	3X Total ESH Complex	5X Brood Rearing Area	5X Total ESH Complex
X	3X	X + 3X	5X	X + 5X
1.0	3.0	4	5.0	6
2.5	7.5	10	12.5	15
5.0	15.0	20	25.0	30
7.5	22.5	30	37.5	45
10.0	30.0	40	50.0	60
12.5	37.5	50	62.5	75
15.0	45.0	60	75.0	90
17.5	52.5	70	87.5	105
20.0	60.0	80	100.0	120
22.5	67.5	90	112.5	135
25.0	75.0	100	125.0	150

2.2.3 Sandbar Elevation, Height, Slope, and Volume Assumptions

The following section identifies ESH criteria from the 2000 BiOp, as amended (2003).

Elevation and Height

- Substrate for nesting area and brood rearing area must be made from well-draining particles ranging in size from fine sand to stones < 1 in. in diameter (p. 195).
- Sandbar habitat will be constructed using locally available sand, dredged or graded from the riverbed, or with sand borrowed from adjacent banks or existing vegetated sandbars.
- Nesting habitat shape is to be circular to oblong (p. 195).
- Sandbar habitat areas and volumes calculation assumes the basis to be constructed from to be a smooth and regular circular or elliptic section of a cone; that is, a frustrum. The formula for the volume of a regular frustrum is $V = 1.0472h(R^2+Rr+r^2)$, where 1.0472 is equal to $\Pi/3$.
- The top of the frustrum section is nesting habitat.
- The side of the frustrum descending to its base is brood rearing and foraging habitat.
- Foraging habitat will occupy the rim of the base of the frustrum most frequently in contact and proximity to the water.
- Sandbar habitat will be constructed in depositional areas where the local riverbed is assumed to be an average of 1 foot below the local water stage at 25,000-cfs release from Gavins Point Dam.[2] The assumed mean height of the constructed fill from the riverbed is 4 feet. This height will position nesting habitat at least 1.5 feet above stage at a Gavins Point Dam release of 33,000 cfs (estimated peak navigation release from Gavins Point Dam).
- Side slope of the fill will vary with the increase in the absolute area of the top (nesting area) and the base of the cone, as long as the top-to-base ratio is maintained. As the nesting area and base become larger, the slope from top to base will become less steep.

Recommendations from the 2000 BiOp, as amended (2003), for Slope

- Nesting habitat and brood rearing habitat should have slopes not exceeding 1:10 (1 foot change in elevation over 10 feet of distance, or a 10% slope) and a recommended slope of 1:25 (1 foot change in elevation over 25 feet of distance, or a 4% slope).
- When the top/base ratios specified in the 2000 BiOp, as amended (2003), are used with the minimum 1-acre nesting area, at a minimum, 3 additional acres of brood rearing habitat are required.
- Slope is calculated as: $S = R/r$; where R = rise, or height, and r = run, or distance from the top to bottom of slope. For example,

[2] Elevation assumption based on review of 2005 LiDAR for Gavins Point Reach. Not specifically applicable for all reaches, but used for estimation basis.

- Assuming a regular frustrum, a 1-acre nesting area with 3 surrounding acres of brood rearing habitat has a 4-acre base area at the water surface.
- Rise (R) is the height of the feature: 3 feet from the top of nesting area to the base at the water surface.
- Run (r), or the horizontal distance from the top edge of the nesting area to the toe of the brooding area at the water surface, is calculated as r = (D-d)/2, or the diameter of the base minus the diameter of the top divided by 2. This is equal to radius of the nesting area ($r = \sqrt{A/\Pi}$) minus the radius of the base (approximately 236 feet minus 118 feet).
- Slope = r/R = 3/118) = 0.025, or 2.5%, which is flatter than the BiOp-recommended slope consideration of 4%.
- At the 1:5 ratio of nesting to brood rearing habitat, the slope is even less.

<u>Volume of Sand Needed for ESH Complex</u>

The frustrum volume formula was used to compute the volume of materials needed to build ESH complexes. Three feet of the 4-foot sandbar height was assumed to be above the water with the computed slope. The fourth foot, or the foot of fill from the sand bed to the water surface will have a side slope of 1:10 to represent a steeper underwater slope for the sandbar.

- Assuming the 1:3 nesting area to brood rearing area ratio, for a 4-acre sandbar complex, nesting habitat will be 1 acre (43,560 sf) and the brood rearing habitat would be 3 acres (130,680 sf). Feature height would be 3 feet above the water, with a second layer below the base to fill in the 1 foot between the water surface and the sand surface assumed to be that foot under the water.
- 1 acre of nesting habitat = 43,560 square feet.
- 4-acre base to the complex above the water = 43,560 square feet/ac x 4 ac = 174,240 square feet.
- The frustrum formula was used to compute the above-water volume and the below-water volume, which were added together to arrive at the total volume of fill required. The number of computed cubic feet was subsequently divided by 27 to arrive at CY.
- 11,293.4 + 6,7293.2 = 18,025 CY of sand.
- For a 4-acre ESH complex that is built on a riverbed located 1 foot below the surface of the river, approximately 18,025 CY of sand would be needed.
- The value computed for a 1-acre nesting area was then multiplied by larger nesting areas to arrive at the volume of sand required for the larger sandbars. This assumption resulted in a slight overestimation in the total volume because of the different slopes for the above- and below-water components of the sandbar. The difference grows for the 1:3 nesting area to brood rearing area ratio computations from zero for the 1-acre sandbar computation to plus 1.25% for the 25-acre sandbar computation. The differences are slightly lower on a percentage basis for the 1:5-ratio computations.

Results for the calculations for 1:3 and 1:5 nesting area to brood rearing area ratios are presented in Tables 4 and 5.

Table 4
Quantity for ESH Complex at 1:3 Nesting to Brood Rearing Ratio

Nesting Area (acres)	Total ESH Area (acres)	Material Needed for Complex (CY)
1.0	4	18,025
2.5	10	45,063
5.0	20	90,125
7.5	30	135,188
10.0	40	180,250
12.5	50	225,313
15.0	60	270,375
17.5	70	315,438
20.0	80	360,500
22.5	90	405,563
25.0	100	450,625

Table 5
Quantity for ESH Complex at 1:5 Nesting to Brood Rearing Ratio

Nesting Area (acres)	Total ESH Area (acres)	Material Needed for Complex (CY)
1.0	6	25,265
2.5	15	63,163
5.0	30	126,325
7.5	45	189,488
10.0	60	252,650
12.5	75	315,813
15.0	90	378,975
17.5	105	442,138
20.0	120	505,300
22.5	135	568,463
25.0	150	631,625

2.2.4 Area Disturbed for Sandbar Construction Material Borrow

Tables 6 and 7 present the summary of calculations for establishing the area of disturbance to construct ESH of varying size nest areas. Table 6 assumes habitat is built at the 1:3 nesting to brood rearing habitat ratio, and Table 7 assumes the 1:5 ratio. An example calculation is included below.

- 1 acre-foot = 1,613.33 CY.
- A 4-foot dredge cut over 1 acre of area would yield 6,453.3 CY of material. (4 foot cut x 1,613.3 CY = 6,453.3 CY).
- So, for every 6,453.3 CY of dredged material, 1 acre of river bottom will be removed 4 feet below the current river bottom. If less than a 4-foot cut of material is removed, the areal extent of the area of disturbance will be increased accordingly (e.g., 2-foot dredge cut = 2 acres to provide 6,453.3 CY of material).
- For 25 acres of nesting area as part of a 100-acre ESH complex (see bottom of Table 4) at the 1:3 nesting to brood rearing habitat ratio, approximately 450,625 CY of sand would be needed.
    - So, 450,625 CY/6,453.3 CY/acre = 69.8 acres of disturbed river bottom to provide the material for construction.
    - Total area of effects = 100-acre footprint for the constructed ESH plus approximately 69.8 acres for the material harvesting area footprint. So, 100 + 69.8 = 169.8 acres of disturbance for each 25 acres of nesting area constructed at the 1:3 nesting to brood rearing habitat ratio.
    - If the ESH constructed at the 1:5 nesting to brood rearing habitat ratio, then 631,625 CY of material would need to be moved disturbing 97.9 acres of river bottom for a total area of disturbance of approximately 248 acres (25 acres of nesting area + 125 acres of brood rearing habitat + 97.9 acres of river bottom disturbed = 247.9 acres of total area disturbed).

Table 6
Area Disturbed for 1:3 ESH Nesting to Brood Rearing Ratio

Nest Area (acres)	Total ESH Area (acres)	Area Disturbed With 4' Borrow Depth (acres)	Area Disturbed With 2' Borrow Depth (acres)	Total Area of Disturbance (acres) With 4' Borrow Depth	Total Area of Disturbance (acres) With 2' Borrow Depth
1.0	4	2.8	5.6	6.8	9.6
2.5	10	7.0	14.0	17.0	24.0
5.0	20	14.0	27.9	34.0	47.9
7.5	30	20.9	41.9	50.9	71.9
10.0	40	27.9	55.9	67.9	95.9
12.5	50	34.9	69.8	84.9	119.8
15.0	60	41.9	83.8	101.9	143.8
17.5	70	48.9	97.8	118.9	167.8
20.0	80	55.9	111.7	135.9	191.7
22.5	90	62.8	125.7	152.8	215.7
25.0	100	69.8	139.7	169.8	239.7

Table 7
Area Disturbed for 1:5 ESH Nesting to Brood Rearing Ratio

Nest Area (acres)	Total ESH Area (acres)	Area Disturbed With 4' Borrow Depth (acres)	Area Disturbed With 2' Borrow Depth (acres)	Total Area of Disturbance (acres) With 4' Borrow Depth	Total Area of Disturbance (acres) With 2' Borrow Depth
1.0	6	3.9	7.8	9.9	13.8
2.5	15	9.8	19.6	24.8	34.6
5.0	30	19.6	39.2	49.6	69.2
7.5	45	29.4	58.7	74.4	103.7
10.0	60	39.2	78.3	99.2	138.3
12.5	75	48.9	97.9	123.9	172.9
15.0	90	58.7	117.5	148.7	207.5
17.5	105	68.5	137.0	173.5	242.0
20.0	120	78.3	156.6	198.3	276.6
22.5	135	88.1	176.2	223.1	311.2
25.0	150	97.9	195.8	247.9	345.8

2.2.5 Annual Replacement of ESH Lost To Erosion

For the purposes of comparing the environmental consequences of the alternatives, the construction assumptions presume that a larger fraction of material erodes annually from the alternatives with the larger number of acres being maintained. This is based on observed rates of erosion over the period of 1998-2005. The larger the exceedence between the number of acres of interchannel sandbar being maintained under a particular alternative and the number of acres expected to persist under the current release schedules for the dams, the greater the need for annual replacement. The assessment assumes an annual loss/replacement rate of 40% for Alternative 1 (except for the Fort Peck River Segment where 30% was assumed), 30% for Alternatives 2 and 3, 15% for Alternative 4, and 10% for Alternative 5. The fluvial processes and, therefore, erosion rates within the Lewis & Clark Lake Segment are different from the other segments because this segment is within a reservoir. Within the Lewis & Clark Lake Segment, 50% of the created ESH is assumed to need to be replaced annually due to subsidence and the growth of vegetation. All PEIS alternatives will assume the 50% loss rate is uniformly applied to the Lewis & Clark Lake Segment. These rates were derived from analyses presented in Sections 2 and 5 of Appendix B of the PEIS.

2.2.6 Considerations from ESH Construction Contractor

In 2004 and 2005, Western Contracting Corporation (Western) constructed ESH complexes at Ponca, Nebraska; river mile 770; and river mile 761.4 on behalf of the Corps' Omaha District. In constructing these sites, Western moved in excess of 750,000 cubic yards of material using both dredges and mechanical earth-moving techniques; worked in spring, fall, and winter; and provided staging improvements and landside access. Because of this practical experience building emergent sandbar habitat, interviews were conducted with Devin Rowland of Western (Rowland, 2007) to provide important assumptions for the analysis. The following information is based on experience from constructing emergent sandbar habitat in the Gavins Point River Segment and provides important details for construction assumptions.

- Landside staging area of 5 to 10 acres should be sufficient as it takes approximately 3 acres to fuse the dredge pipe;
- Two 500-ton cranes are used to place and then remove the dredge from the river;
- Work schedule is 7 days a week, 24-hours a day once work begins;
- Three 8-hour shifts of laborers would be used if enough qualified labor is available;
- Light towers are used to illuminate work areas after nightfall;
- 12 pan scrapers (18 CY capacity) pulled behind farm tractors yield approximately 10,000 to 11,000 CY/day;
- Of the 10,000 to 11,000 CY moved, only 6,500 to 7,500 CY would stay where placed. The remainder eroded immediately to the river with a 25 to 40% loss of material;
- Pan scrapers should only be used to remove material from borrow areas to a depth of about 1.5 feet, beyond that depth damage to equipment is severe;
- Dredge productivity is approximately 250 to 300 CY/hr, and 20 hours out of the 24-hour workday are productive;
- Rather than mechanical equipment or dredges being used to make ESH, assume both techniques are used in concert from the onset of work. Easily moved material will be done with the pan scrapers, and the final materials will be supplied and placed by the dredge;
- Working later into the fall/winter has serious occupational risks for equipment and personnel;

- Gavins Point River, Fort Randall River, and Lewis & Clark Lake segments should be accessible for construction through December 1 but the recommended date for ending construction for the Garrison River Segment (Nov. 15) and Fort Peck River Segment (Nov. 1) are considerably earlier; and
- When daytime high temperatures do not consistently get over 30 degrees F, working in the river gets too difficult and should be shut down for the season.

These considerations inform key assumptions regarding landside improvements, workforce, equipment, production rates, working conditions, and seasonal limitations.

2.2.7 Mechanical Excavation and Placement

When releases from upstream dams are sufficiently low to expose construction sites and borrow areas (e.g., 11,000 to 12,000 cfs from Gavins Point Dam), the use of earth moving equipment to mechanically build sandbars is possible. During these conditions, both the areas for materials extraction (borrow) and deposition are exposed, permitting the use of typical road-building equipment. Access may simply be via driving the equipment onto the river bottom to the locations to be constructed or shuttled with a small barge from the access point to the location for construction. Where water must be crossed to access the construction and borrow areas, equipment will be transported to the site over a portable, sectional pontoon bridge or similar conveyance. The interlocking pontoons are designed for road transportation by standard highway trucks and trailers.

The mechanical excavation of riverbed sand would be done with large excavators (e.g., CAT 315), pan scrapers (e.g., CAT 615) and dozers (e.g., CAT DR7) (See Figures 1 through 3). The machines would be used to excavate sand and consolidate the material for the sandbar.

Based on interviews with ESH construction contractors (Rowland, 2007), the following assumptions were utilized for the assessment:

- Work will be done 24-7 once site access is granted;
- 20 of 24-hours in a day will be productive for moving materials, and the remainder is for repairs and equipment maintenance;
- Material will be extracted from borrow areas with 18 CY pan scrapers pulled by farm tractors in trains of two or three pan scrapers pulled by each tractor;
- Borrow areas will have material removed to a maximum depth of 1.5 feet (18 inches) to avoid excessive wear and damage to equipment;
- At least two bulldozers and a track excavator will be used to sculpt/place the material at the construction site;
- Twelve 18 CY pan scrapers yield approximately 10,000 CY/day; and
- There will be up to a 30% loss of material placed during deposition (i.e., material eroded from the sandbar during construction).

Figure 1
Excavation for Emergent Sandbar at River Mile 761.3

Figure 2
Pan Scrapers Constructing ESH

Figure 3
Dozers Constructing ESH

2.2.8 Removal and Placement with Dredge

The other method for moving large quantities of sand necessary to construct interchannel sandbars is using a hydraulic dredge. The dredge would be used to take sediment from the river bottom and pump it to the designated site to create an emergent sandbar. Hydraulic dredging uses a cutter-head dredge to break up river bottom sand and sediment and a pump to move it to the different location. In simple terms, the dredge operates like a giant underwater vacuum cleaner. Figure 4 is a photograph of a dredge being used to create sandbar near Ponca, Nebraska.

For the development of construction costs, a self-propelled Ellicott International "Dragon" Series 370-hp portable dredge was assumed for use (Ellicott International, 2000) with a 12-inch discharge pipe of 1,000-foot length (see Tables 8 and 9 for specifications and production assumptions). Any number of other dredges could be used, but would be expected to achieve similar rates of production (250-300 CY/hr). Each dredge used is assumed to be operated 20 hours per day with 4 hours of downtime for repairs yielding 5,000 CY/day.

ESH creation has been completed by the Corps near Ponca, Nebraska; at river miles 761.4 and 770; and in the headwaters of Lewis & Clark Lake (USACE; 2003; USACE, 2004; USACE, 2005a). Dredges have also been used to provide materials to the top of sandbars that were mechanically created by mechanical excavation of the river bottom during low flow with heavy equipment. Dredged material would be obtained from the river channel in the vicinity of the project area and suitable materials for dredging are assumed to be available. Per limitations placed on previous sandbar creation projects, dredge cuts are assumed to not be greater than 4 feet below the current river bottom at any location.

Figure 4
Dredge Moving Sediments near Ponca, Nebraska

Table 8
Ellicott "Dragon" 370-HP Dredge Specifications

Physical Attributes	Specification
Hull Length	36 feet
Hull Width	12 feet
Draft – max	2.76 feet
Weight (dry)	56,000 lbs
Prime Mover	CAT 4306 Diesel
Cutter Diameter	31.5 inches
Digging Depth (min-max)	3-20 feet
Fuel Capacity	800 gallons
Assembly Time	1 day

Table 9
Assumed Production Parameters for the Ellicott "Dragon"

Production-Related Assumptions	Specification
Cutter Head (Suction) Pipe	12 inch
Discharge Pipe	10 inch
Pump Impeller	27 inch
Terminal Elevation	10 feet
Pipeline Length	1,000 feet
Production Per Hour[3]	250 CY
Production Time Per 8-Hour Shift	6 hours

A total of 1,613.3 cubic yards of material would be removed per acre-foot (1 foot of depth over 1 acre of area) of dredged material. At the maximum depth of 4 feet of dredge cut, over 1 acre of river bottom would yield 6,453.3 cubic yards. Where less than 4 feet of material is removed during dredging, a greater areal extent of river bottom would be affected by the dredge. To calculate the areal extent of disturbance from dredging materials, the development of the construction costs will assume that, for each 6,453.3 cubic yards of material needed, dredging the material would disturb 1 acre.

After dredged material is placed, it would be contoured according to the design requirements. As described previously, a variety of tools including bulldozers, front-end loaders, scrapers, and excavators could be used to contour existing sandbars to create the desired habitat conditions. Sandbars would be altered to meet recommended slopes of 1 vertically to 100 horizontally (1%) to 1 vertically to 10 horizontally (10%) (USACE, 2005).

Based on interviews with ESH construction contractors (Rowland, 2007), the following assumptions were utilized:

- Work will be done 24-7 once site access is granted;
- 20 of 24 hours in a day will be productive for dredging, and the remainder is for repairs and dredge maintenance;

[3] Production read from calculated output curves assuming mix of fine and course sand (Ellicott International, 2000).

- Borrow areas will have material removed to a maximum depth of 4 feet below existing depth and in no case lower than the thalweg;
- Each similarly-sized dredge yields approximately 5,000 CY/day; and
- There will be a 30% loss of material placed during deposition (i.e., material immediately eroded from the sandbar being constructed).

2.2.9 Emergent Sandbar Habitat Vegetation Succession Management

Sections 2.2.9.1 and 2 summarize recommendations, findings, and observations of phenomena that inform the management of vegetation succession on emergent sandbars.

2.2.9.1 Cottonwood Management

- Primary cottonwood succession should be controlled on an annual basis.
- Higher releases and associated stages during the cottonwood seedling germination season (June through July) and during the growth season (May through October) improve cottonwood recruitment and enhance the growth rate and establishment of existing cottonwood seedlings and saplings. This increases the effort and associated costs for subsequent vegetation removal.
- Increases in discharge from Gavins Point Dam occur in some years at the end of the least tern and plover nesting season (approximately August), which raises water surface elevations and transports viable cottonwood seeds higher onto sandbars. These seeds likely germinate and have sufficient time to establish sufficient heights and root systems during the remaining growth period before first killing frost. The elevated water level also transports other water-borne seeds further onto sandbars and enhances the growth of sandbar willow.
- The aforementioned stage increases inhibit post-nesting control of vegetation below the elevated stage.
- Cottonwood recruitment is an annual management problem that, if not addressed during the first germination season every year, will cause the costs of subsequent control efforts to expand geometrically.
- First year cottonwood seedlings are extremely sensitive to damage. Up to 90% of cottonwood growth can be effectively removed if mowed during the first year of growth (USDA 1999). It is unlikely that many seedlings would re-sprout following simple and relatively inexpensive mowing in August or September of their first year.
- Islands presently occupied by cottonwood 3 to 6 feet in height must be completely denuded or habitat quality will rapidly decline due to the accumulation of fine-grained sand and the development of established weed populations in wind protected areas.
- Complete physical removal of cottonwood and all vegetation, including tops and roots, must occur to re-set natural succession to “zero.” Employing equipment such as a crawler mounted root rake to remove all organic material (i.e., clear and grub), burning collected materials or pushing them into the river may be effective methods. Vegetation tops or chips should not be left on site.

- Ideally for limiting cottonwoods on sandbars, the form and final grade of nesting area should be configured in a smooth, convex form lacking niches and wind barriers that would facilitate seed collection and germination. Those forms that rise from the water as steeply as possible will also inhibit cottonwood generation. However, sandbar smoothness and edge steepness must be weighed against the habitat needs of terns and piping plovers for shelter and foraging.
- Chemically induced mortality of cottonwood saplings does not reduce natural succession by other species, particularly from propagules delivered to a site once necessarily short-lived herbicides have decayed. Only complete mechanical removal of all organic material halts the succession processes.
- The majority of the high-quality nesting sites are elevated well above normal water fluctuation levels and the capillary fringe. Seeds and other propagules are delivered to these sites only by wind, rather than both by wind and water, as occurs at lower relative elevations.
- Unless the surface is incidentally wet during a seed deposition event, it is unlikely that wind carried seeds will catch or remain in place sufficiently long to germinate.
- Seeds that catch and germinate in wet conditions and during high water, even in niches, are less likely to develop an adequate root system before rapidly falling soil water levels cause desiccation and death of seedlings.
- The mortality of delicate seedlings, even in marginally lower areas where roots may reach perennial soil water zones, in increased by abrasion from wind-borne sand particles.

2.2.9.2 Sandbar Willow (*Salix interior* Rowlee ex. *S. exigu*a Nutt) Management

Sandbar willow shares many reproductive strategies and phenology with cottonwood and other members of the *Salicaceae*. The species initiates flowering and produces copious seed in synchrony with meteorological events such as high temperature and increasing degree-days (Stella et al, 2006). Seed production continues for extended periods during the growing season. Seed is immediately viable; however, viability lasts for only a few days (Stella et al, 2006; Johnson et al, 1976). Viability may be less than 24 hours unless floating on water (Lamb, 1915). Seed is initially wind disseminated on long silky hairs that catch on moist substrates found at shorelines. These hairs also serve as floats for bearing seed to necessary moist substrates. Germination rates may be greater than 90%; however, seedling mortality rates are very high under natural circumstances of flood erosion, declining water levels, and ice scouring.

There are also a number of phenological, metabolic, and ecological differences between sandbar willow and cottonwood:

- Seed drop for sandbar willow begins 2 to 3 weeks after cottonwood and may extend 4 to 5 weeks beyond cottonwood (Amlin and Rood, 2002). Post-season growth period for willow ranges from 30 to 75 days before first killing frost, while cottonwood may have 60 to 90 days between seed drop and first frost.

- Sandbar willow seedlings are extremely sensitive to the rate of water level decline. Seed beds must be maintained in a moist condition for a week or more after germination (Moss, 1938). Rates of decline greater than 2 cm/day have found to be nearly 100-percent lethal (Amlin and Rood, 2002)
- Very high seedling mortality under normal (unmanaged) hydrological conditions is offset by a high reliance on effective vegetative reproduction by clonal growth (Douhovnikoff et al, 2005).
- The ability of sandbar willow to sustain viability against flood damage and erosion appears to significantly exceed that of cottonwood due to much greater stem/root flexibility, greater lateral root development, and enhanced vegetative reproduction from stem fragments (Noble, 1979; Ball, 1938).
- Stem/shoot development by sandbar willow is greatest under conditions of water level decline of 1 cm/day and ceases at greater than 3 cm/day. Cottonwood stem development is also greatest at water level declines of 1 cm/day but continues well beyond 8 cm/day due to the development of a deep tap root (Amlin and Rood, 2002; Noble, 1979).
- Root development for sandbar willow is much less than for cottonwood in conditions of rapid water-level decline.
- Sandbar willow demonstrates a much greater tolerance to anaerobic soil conditions, which, among other factors, is responsible for occurrence of topographically lower bands of willow-dominated growth along riverine islands and stream banks. The width of willow bands appears to be related to the slope of banks and the rate of water level decline during the growing season.

2.2.10 Annual Vegetation Management Planning and Actions

Vigilant removal of first year cottonwood seedlings after each season's nesting may be sufficient to halt or significantly retard succession on created sandbars. The number of acres needing to have vegetation controlled would be a function of the age of the emergent sandbars in the ESH program, the reach-specific flow regime during the growing season, and the extent to which cottonwood generation had occurred. Reasonable expectations for productivity and acres/man-day are included below.

Manual vegetation removal involves hand pulling or the use of hand operated tools to cut and clear herbaceous and woody plant species. Non-powered hand tools that could be used include axes, brush hooks, hoes, hand girdlers, and hand clippers. Power tools include motorized brush cutters (i.e., weed-eaters with a saw blade) and tractor-pulled mowers. A comparison of chainsaws, brush cutters, and machetes used for thinning concluded that there was no significant difference in the rate of production between chainsaws and machetes, while brush cutter production was less efficient due to greater maintenance and down time (USFS, 1988).

The city of Tulsa, OK created two 3.1-acre islands (North and South Zink Islands) in the Arkansas River to provide nesting areas for least terns. To maintain an open habitat for the least terns and easy observation for people monitoring nests, one or two people worked for an hour before and after each nesting season in 1990 and 1991 hand clearing vegetation from the nesting area and the sloping east edge of the South Zink Island (Hill, 1993). This effort was sufficient to maintain suitable nesting habitat and allow off-island observers an unobstructed view of nesting birds.

Observations on the Missouri have been that manual vegetation removal was especially effective. Latka et al (1993) noted that mechanical vegetation removal (e.g., with a brush hog type cutter) alone did not prove very effective for creating usable ESH. The exception was hand-cutting or pulling 3- to 6-year-old perennials and cottonwoods during the fall. The following nesting season, least terns and plovers utilized several areas in which hand clearing had taken place (Latka et al, 1993).

Hand methods are relatively inexpensive due to the lack of machinery, easy mobilization to and from interchannel sandbars, and effectiveness in removing vegetation in early succession stages. In areas with sensitive plant species (i.e., wetlands), adjacent areas suitable for nesting birds could be denuded without damaging adjacent wetlands vegetation. This method is also useful in areas where river depth makes for difficult access to sandbars with equipment or machinery.

Another advantage of this method is that there is no special training of personnel or special equipment necessary to remove vegetation. The use of brush cutters and other handheld clearing equipment may be the most worthwhile for smaller-scale clearing projects. Although much more time consuming, the job is often done more effectively and more economically than heavy machinery and with minimal collateral environmental damage. The plant materials extracted from the surface should not be left on the sandbar.

Manual removal on a large-scale is labor-intensive and expected to be slower and more expensive (per acre) than herbicide application or mechanically removing vegetation. Plant species that re-sprout from the stem of roots pose greater difficulty for effective manual treatment unless their root systems are completely removed. On sandbars where woody vegetation is older and pulling up root balls by hand is not possible, other treatments may be necessary to ensure that they do not re-grow. Production rates (acres cleared/person-hour) for removing first to third year pioneering woody species (e.g., early growth cottonwood) are much better than for manually removing older woody vegetation.

With strictly manual removal (i.e., pulling the yearling trees) two people are assumed to be able to clear 1-year-old woody vegetation from approximately 3 acres per day. Using small mowers (e.g., self-propelled bladed mower/trimmer) 2- to 3-year-old woody vegetation would be removed at a rate of approximately 10 acres/day. Between 3- to 10-year-old succession areas will need to be stripped (i.e., cleared and grubbed) with large earth-moving equipment to remove all the organic material. In all cases the vegetation removed would be added to the allocthonous material in the river. To establish the areal extent of annual vegetation removal necessary, it is assumed that 20% of the surface of the sandbars will need to have annual vegetation removed in this fashion.

Costs for manually clearing land in the northeastern U.S. Pine Barrens have approximated $1,700 per acre, including: labor, maintenance, cost of fuel, and repairs (Raleigh et al, 2003). These costs were lowered by the use of volunteer labor; costs closer to $3,000/acre would be expected if labor costs were included (Raleigh et al, 2003). Hiring a student conservation association crew reduced costs to $1,400/acre (Raleigh et al, 2003).

Willow Management Considerations

The operation of Gavins Point Dam to support late summer navigation by increasing discharge and raising water levels enhances vegetative succession of sandbars in some years. Going to a higher daily power-peaking rate in some segments also enhances growth and expansion of the willow-dominated zone by:

- Increasing the saturated soil area available for seed germination,
- Concentrating wind- and water-born seeds higher on sandbars,
- Reducing the natural mortality of willow seedlings, and
- Enhancing the growth rate of stems and roots.

Reducing the effects of these flows to willow succession could be moderated by designing and maintaining constructed islands to:

- Maximize the extent of steep perimeter slopes,
- Raise island surface level 2 to 4 feet above navigation or daily peak flows,
- Annually cutting or pulling new seedlings before the least tern and plover breeding seasons.
- Cutting and removing new seedlings again at the end of the growing season to minimize re-growth of cut stems.

2.3 Temporal and Spatial Limits

An important component of the implementing strategy for the ESH program is the spatial avoidance of sensitive resources and features and restricting ESH construction activities during biologically important times of the year. Implementing the ESH program with spatial separation from sensitive features as well as limiting ESH construction activities during biologically important times of the year can minimize the environmental consequences of ESH program implementation. The ESH program is being developed, when feasible, to avoid significant environmental consequences through the use of temporal and spatial restrictions.

2.3.1 Temporal Limits: Environmental Windows

Environmental windows are used as a management tool for reducing the potentially harmful effects of various habitat manipulation activities on aquatic resources (National Research Council, 2002). Designated environmental windows are those time periods of a year when habitat manipulation activities (e.g., dredging/mechanical material placement activities) may be carried out because the threat of adverse environmental effects is minimal. Conversely, seasonal restrictions are often applied by resource management agencies when the risk of potential harm to biological resources is great.

Environmental windows are frequently imposed to minimize potentially adverse effects of sediment movement on sensitive aquatic resources, such as mussels, or on critical life-history stages of fish, amphibians, and reptiles. Windows are an intuitively simple means of reducing risk to biological resources from stressors generated during dredging/mechanical removal and material placement activities. Often, environmental windows are imposed where obtaining data on the environmental consequences of planned activities is impractical, is too costly, or includes so much uncertainty that informed decision-making is not possible and simple avoidance is preferred.

However, the excessive or unjustified use of windows as a management tool can have significant cost and other risk implications. For example, when the application of environmental windows constrain construction schedules, occupational risks to personnel and equipment increase by requiring 24-hour operations (i.e., night work) and continuing construction later into the fall/winter.

2.3.2 Spatial Limits: Environmental Buffers

Various features, habitats, engineering considerations and activities in the Missouri River channel limit the actual areal extent of the riverine habitat available for ESH program implementation. Spatial avoidance measures are implemented to maximize habitat effectiveness and to minimize or eliminate potential environmental consequences by keeping ESH activities sufficiently isolated from known locations of sensitive resources. Appendix B of the PEIS details the GIS methods used to assign these spatial restrictions, but the restrictions collectively triage the riverine acreage into three practicable categories:

1. Locations where construction of ESH is excluded. Because of their hydrologic characteristics, intrusion into these locations may cause significant geomorphic alterations to the river corridor and risk physical and economic damages to major public and private infrastructure or land uses. High cost and high impact engineering solutions (e.g., hardened structures) may be necessary to overcome challenges. Therefore, these areas are excluded from the ESH program.

2. Locations where ESH could be constructed at relatively low physical risk but are undesirable because the locations may either put nesting birds at risk from predation, recreational encroachment, or otherwise limit use and productivity.

3. Locations most suitable for protection of nesting birds with minimal physical risk, where ESH could be constructed as long as other high interest features are given due consideration and appropriate protection (e.g., Does the site have significant mussels beds?) during site reconnaissance and construction.

Identification of sensitive resources and establishment of buffer distances whereby resources could be physically avoided included input from the Corps as well as from state and federal resource agencies. An initial list of sensitive resources to be avoided was developed by the Corps and circulated to the U.S. Fish and Wildlife (USFWS), National Park Service (NPS), and the affected states with a request to review and comment (USACE, 2005b). Specifically, agencies were formally requested to review the Corps' suggested list and provide:

1. Any additional features or resources to be avoided,
2. The minimum buffer distance for the resources already listed as well as any additional resources recommended for avoidance, and
3. A reference or justification for each of the buffer distances provided.

Affected states and agencies were to indicate if the resources and associated buffer distances provided were a regulatory limit, published in the scientific literature, or based on best professional judgment (USACE, 2005b).

Federal agencies (e.g., NPS, 2005; USFWS, 2005a) and state agencies (Montana Water Center, 2006; Montana-Dakota Utilities, 2006; Montana DEQ, 2006; NDGFD, 2006; SDGFP, 2006; SD DENR, 2006; and NGP, 2006) provided responses and the resources and recommended separation distances have been compiled in Table 10. When the buffer area distances are applied to the reaches, substantial areas become unavailable for the implementation of the ESH program. Reproducing figures displaying the application of these buffers for all four reaches is not possible in this format because of the scale, but the net effect on the available area for each reach is provided in Table 11. Figure 5 is a screen capture of the GIS analyses performed to assess the environmental buffers and provides an example of what applying the buffers to a portion of the Gavins Point Segment looks like when the areas are excluded.

2.3.3 Segment-Specific Calendar Days for Construction

2.3.3.1 Gavins Point River, Lewis & Clark Lake, and Fort Randall River Segments

USFWS consultation with the Corps on ESH construction activities established an April 1 to September 15 restriction on construction activities within 0.25 mi. of an active least tern or plover nesting site and a similar April 1 to September 15 limit within 0.5 mi for the avoidance of bald eagle nests sites while they are "active" (USFWS, 2005a). Correspondence from the Nebraska Game and Parks Commission (NGPC, 2006) specifies no activities February 1 through August 30 within of 0.5 miles of bald eagle nests. It is noted, however, that recent guidance from the USFWS since the de-listing of the bald eagle states an avoidance buffer of 660 feet from active bald eagle nests that would likely be used for future construction.

Experience at ESH construction projects (USACE, 2004) has demonstrated that, if construction is ongoing when migrating least terns and plovers return to these river reaches, the birds will likely initiate nesting (or re-nesting) on created ESH before construction is completed. As such, it may be extremely difficult to construct the sandbar without birds trying to initiate nesting and before construction is completed. To avoid such conflicts, the entire breeding season was assumed to be unavailable for construction. From a practical standpoint, weather conditions prohibit the construction of ESH from approximately December through the end of February because of winter cold and ice-up (Rowland, 2007). However, it is noted that recent efforts have looked at initiating construction activities late in the breeding season (after July 15) following the period when the majority of nest establishment and re-nesting occurs. These changes may expand the construction window in the future. Nonetheless, for the purpose of this analysis and comparison among alternatives, the entire breeding season is assumed to be outside of the construction window.

By dividing the calendar year into half-months (Jan-1 = January 1 – January 15, Jan-2 = January 16 – January 31), the effect of these temporal constraints are shown in Table 12. Any half-month where construction may not occur is marked with an X and a half-month where construction is permissible is indicated with an O. For the Gavins Point River, Lewis & Clark Lake, and Fort Randall River Segments, the aforementioned temporal constraints limit ESH construction activities to approximately 2.5 half months (approximately 77 days) in any given year, from approximately September 15 to December 1.

Table 10
Summary of Features and Exclusions for ESH Construction

Feature	Source or Basis	Distance (ft)	Extent
Minimum Thalweg Width/Actual Active Thalweg	Practical Construction Consideration	Varies	Actual Area
Narrow Channel Width, High Erosion Potential	USACE Engineering Reports	Varies	River Width
Electrical Power Station Cooling Water Intakes	Infrastructure Protection	18,500	River Width
Electrical Power Station Cooling Water Discharge	Infrastructure Protection	18,500	River Width
Elevated Electric Power Line Crossing	Infrastructure Protection	2,000	River Width
Municipal Water Intakes	Agency	2,000	River Width
Natural Gas Pipeline Crossing	Infrastructure Protection	18,500	River Width
New Construction Near Active Nests	Agency	2,640	River Width
Cultural, Historical, Archaeological Features	Agency	Variable	Buffered Area
Bald Eagle Nest	Agency	5,280	River Width
Pallid Sturgeon Habitat	Agency	Variable	Actual Area
Sicklefin/Sturgeon Chub Habitat	Agency	Variable	Actual Area
Wetland Habitat	Agency	Variable	Actual Area
Predator Moat	Expert Advice	200	From River Bank
Blue Sucker Riffle Complexes	Agency	Variable	Actual Area
Paddlefish and other Native Rare Fish Habitat to Avoid	Agency	Variable	Actual Area
State Listed Species/ Protected Habitats	Agency	Variable	Actual Area
Boat Docks (both public and private)	Measured Minimum	550	From Point
Boat Ramps	Agency	1,200	River Width
Boat Ramps (both private and public)	Measured Minimum	750	From Point
Domiciles	Measured Minimum	850	From Point
Gallery Forest Edges	Measured Minimum	550	From Point
Industrial Facilities	Measured Minimum	550	From Point
Cabin or Cottage Areas (Recreation Areas)	Agency	2400	River Width
Cold Water Reaches (Dam to first major tributary)	Expert Advice	Variable +1,250	River Width
Irrigation Pump	Measured Minimum	850	From Point
Miscellaneous Man-made Structure	Measured Minimum	750	From Point
Municipal River Frontages	Agency	All	River Width
Recreation Areas	Measured Minimum	700	From Point
Mussel Beds	Agency	1,750	River Width
State-Listed Turtle Habitat	Agency	Variable	Actual Site

Table 11
Available Area Acreage

Segment	Total Riverine Polygon (acres)	Available Area After Exclusions Applied (acres)	% of Segment Available for ESH
Gavins Point River	23,228	3,881	17%
Lewis & Clark Lake	17,157	4,711	27%
Fort Randall River	13,790	2,784	20%
Garrison River	24,518	4,361	18%
Fort Peck River	39,009	3,324	8.5%

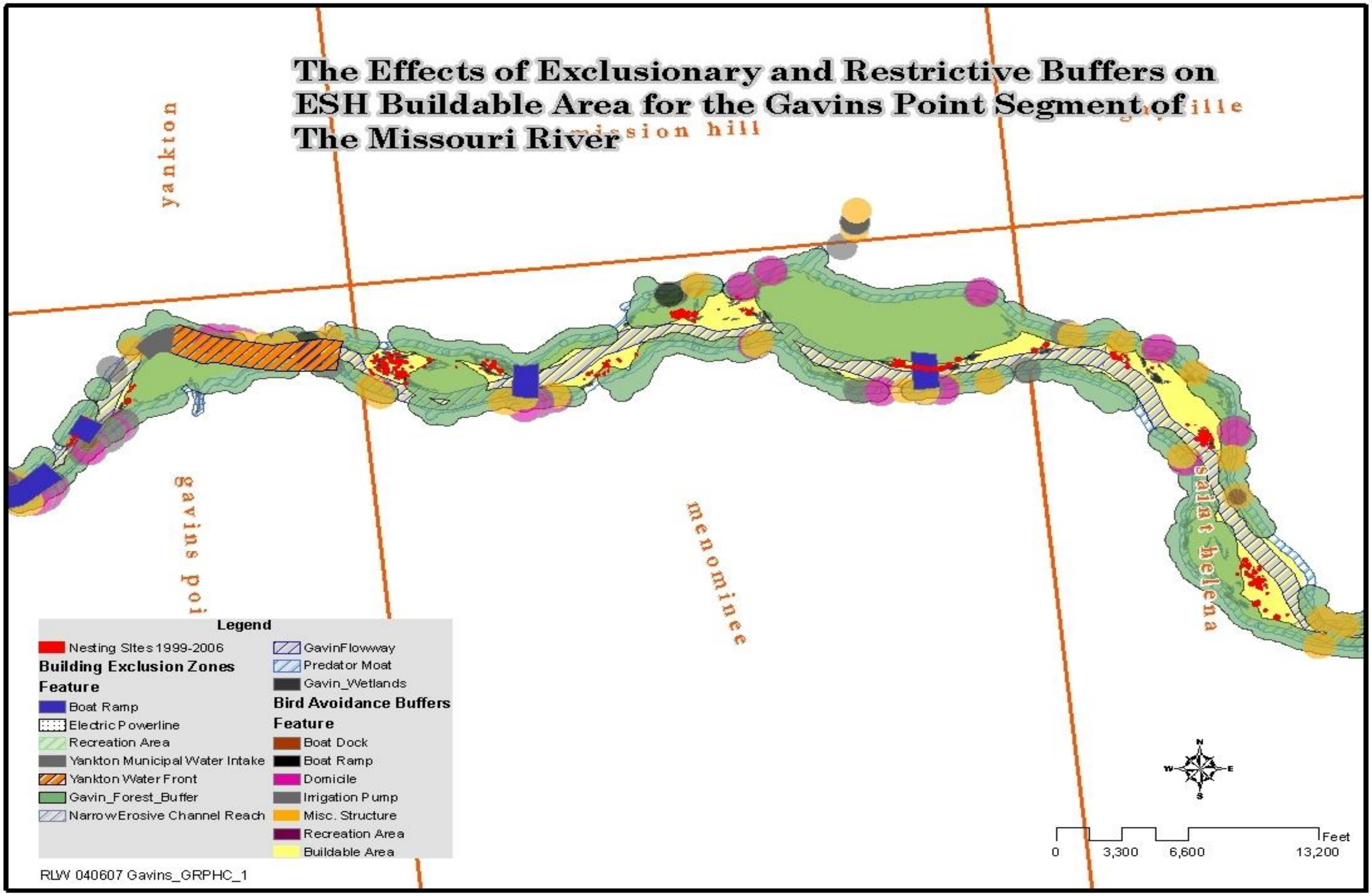
2.3.3.2 Garrison River and Fort Peck River Segments

The Garrison River and Fort Peck River segments share all the nesting date restrictions (least terns, plovers, and bald eagles) with the Gavins Point River, Lewis & Clark Lake, and Fort Randall River segments. Because these segments are at a more northern latitude, winter conditions arrive sooner in the year, and construction must be stopped sooner. Recommended annual dates for planning to be "off the river" are November 1 for the Fort Peck River Segment and November 15 for the Garrison River Segment (Rowland, 2007). The environmental windows for these segments leave the Fort Peck River and Garrison River segments with 47 days (September 15 to November 1) and 62 days (September 1 to November 15), respectively, annually for the construction of ESH.

Table 12
Environmental Windows: Gavins Point River, Lewis & Clark Lake, and Fort Randall River Segments

Half Month	Least Tern/Plover Nesting	Bald Eagle Nesting	Winter
Jan - 1			X
Jan - 2			X
Feb - 1		X	X
Feb - 2		X	X
Mar - 2		X	
Apr - 1	X	X	
Apr - 2	X	X	
May - 1	X	X	
May - 2	X	X	
Jun - 1	X	X	
Jun - 2	X	X	
Jul - 1	X	X	
Jul - 2	X	X	
Aug - 1	X	X	
Aug - 2	X	X	
Sept - 1	X		
Sept - 2	O	O	O
Oct - 1	O	O	O
Oct - 2	O	O	O
Nov - 1	O	O	O
Nov - 2	O	O	O
Dec - 1			X
Dec - 2			X

Figure 5
Example of Influence of Buffers on Available Area in the Gavins Point River Segment



3 ESH Total Creation and Annual Construction Quantities

This section quantifies various effects anticipated to create ESH within each of the segments and for each of the alternatives according to the construction assumptions articulated in Section 2. The total number of acres of ESH to be created under each alternative, the breakdown of these acres by segment, the corresponding quantities of sandbar materials, and the ultimate area of disturbance are presented. Also, the annual construction requirements for these same categories plus annual labor and equipment requirements are also presented in this section. The cumulative total values are presented as well as the reach-by-reach values. The annual values are based on the assumption that it will take 10 years to reach the total number of acres specified for each alternative except for alternatives 4, 5, and existing program, which will initially have their acreage goals met or exceeded as an assumption (acres measured in 2005). For all alternatives, the annual construction costs begin immediately, whether they are incurred to create the habitat or its replacement as it erodes annually. The primary variable affecting the amount of habitat to be constructed annually for the first 10 years or to continue replacing the habitat as it erodes to perpetuity is the annual erosion rate for each alternative, which varies among the alternatives and is identified for each alternative in Section 2.2.5 of this appendix. Construction levels would be subject to available funding and other program priorities.

3.1.1 All Reaches Combined

This section provides summaries of the numbers of acres needed to create the necessary ESH under each of the alternatives (Table 13); the areas of disturbance necessary to create the number of acres (Table 14); and the annual quantities of material, areas of disturbance, and days of mechanical and dredge work necessary to construct the number of acres under each of the alternatives (Table 15). The combined area of riverine habitat where ESH program activities could be implemented (high-bank to high-bank) for all five segments is 117,702 acres. Available area acres for the construction of ESH in all five segments, however, total only 19,061 acres. The exceptions to these total acres are for the alternatives that do not have any ESH constructed in all five segments (alternatives 2 and existing program).

The Existing Program alternative consists of annually constructing 125 acres of ESH in the Gavins Point River Segment and 25 acres of ESH in the Lewis & Clark Lake Segment. Assuming an annual loss rate of 15 and 50 percent, respectively, the ultimate habitat created would be 833 acres (down from 880 acres in 2005 to 843 acres 10 years later) and 50 acres, respectively. Table 14 reflects the ultimate values for this alternative.

Table 13
ESH Creation Goals for All Segments (acres)

Segment	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5[4]	Existing Program
Fort Peck River	883	--[5]	883	565	248	30	0
Garrison River	4,295	2,148	2,066	1,327	588	500	0
Fort Randall River	700	350	295	212	128	135	0
Lewis & Clark Lake	1,360	680	566	354	142	80	25
Gavins Point River	4,648	2,324	2,944	1,912	881	570	125
Total ESH Required	**11,886**	**5,502**	**6,754**	**4,370**	**1,987**	**1,315**	**150[6]**

Table 14
Total Area Disturbed Effects to Meet ESH Creation Goals for All Segments

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals (Four Segments)	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program (Two Segments)
Area Disturbed to Create Total Habitat to Meet Goals (acres)	33,857	15,619	19,458	12,606	5,748	3,821	2,569
% of Total Riverine Habitat Disturbed to Create Total Habitat	29	20	17	11	5	3	6
% of Total Available Habitat Disturbed to Create Total Habitat	178	99	102	66	30	20	30

[4] Create and Replace ESH Area Derived from Nesting Patterns. The basis for these targets is described in Appendix B of the draft PEIS.

[5] The 2000 BiOp, as amended (2003), did not specify ESH goals for the Fort Peck River Segment for 2005.

[6] All acreages for the Existing Program Alternative are annual, not cumulative, numbers.

Table 15
Annual Effects to Construct ESH Habitat for All Segments

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
CY of Material Moved	28,130,116	10,462.388	12,536,120	6,924,156	2,032,726	960,712	878,700
Area Disturbed (acres)	13,540	4,943	6,055	3,323	955	445	419
Days of Mechanical Work	1,926	656	891	481	131	56	56
Days of Dredge Work	2,451	961	1,096	621	196	95	73
% of All Riverine Habitat Disturbed Annually	12	4	5	3	0.8	0.4	1.0
% of Available Habitat Disturbed Annually	71	31	32	17	5	2	5

3.1.2 Estimated Cost to Construct ESH in All Segments

The following cost estimate is for relative comparison of construction costs of alternatives only. The cost estimate does not include estimated funding needs for environmental compliance, real estate, project design, or project management. This estimate is only intended to provide the reader with a concept of ESH program costs for construction.

Table 16
Annual Costs to Construct ESH in All Segments

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
Goal (acres)	11,886	5,502	6,754	4,371	1,985	1,315	883
Annual Work (acres)	4,802	1,786	2,140	1,182	347	164	150
Annual Cost[7] (millions)	$147.7	$54.9	$65.8	$36.4	$10.7	$5.0	$4.6

3.1.3 ESH Total Creation and Annual Construction for the Gavins Point River Segment

Table 17 identifies the alternative-specific ESH goals for the Gavins Point River Segment and summarizes the area disturbed effects necessary to implement each of the alternatives. The "Area Disturbed" row is the number of acres disturbed by the gathering of material (by dredge and heavy equipment) to build the required area of ESH and the footprint of the ESH to be constructed. Additional information is included in the table to provide some perspective regarding the extent of the area disturbed in this segment for each alternative.

[7] This analysis is presented only for the purpose of relative comparison of alternatives only. It is based on a model that assumes a static erosion and revegetation rate for all sandbars and alternatives and relatively stable water levels / dam releases. It does not assume any significant gain in ESH due to natural processes. Costs are based on the only methodology known to be reliably successful, mechanical creation and dredging.

Table 17
Area Disturbed Effects for ESH Creation in the Gavins Point River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres for Goal	4,648	2,324	2,944	1,912	880	570	125 annually
Area Disturbed (acres)	13,805	6,902	8,744	5,679	2,614	1,693	2,474
% of Total Riverine Habitat Disturbed to Construct	59	30	38	24	11	7	11
Available Area (acres) after Environmental Buffers Applied	3,881	3,881	3,881	3,881	3,881	3,881	3,881
Area of Surplus or Deficit (acres) to Implement ESH Program	(9,924)	(3,021)	(4,863)	(1,798)	1,267	2,188	1,407
% of Available Area (acres) Needed for ESH Program	356	178	225	146	67	44	64

The Gavins Point River Segment has a measured high-bank to high-bank area of approximately 23,228 acres. The "% of Total Riverine Habitat Disturbed to Construct" is the "Area Disturbed" under each alternative divided by the total high-bank to high-bank area (23,228 acres) of the segment. This number reflects the percent of the entire segment that would be affected by ESH activities under each alternative.

As described in Section 2.3 and summarized in Table 11, significant effort has been made to coordinate with federal and state resource agencies to identify sensitive riverine resources that should be avoided to the extent possible when implementing the ESH program. After application of the environmental buffers to exclude portions of the segment for ESH construction, 3,881 available area acres remained in the Gavins Point River Segment. The "Area of Surplus or Deficit to Implement ESH Program" is a subtraction of the "Area Disturbed" under each alternative from the "Available Area after Environmental Buffers Applied." Alternatives 1, 2, 3, and 3.5 have spatial requirements (Area Disturbed) that exceed the "available" area after applying the environmental buffers and would, therefore, require building ESH in large areas of the segment that were recommended to be avoided to minimize environmental consequences. The "Area Disturbed" to "construct" (replacement of lost ESH or limitations of ESH acreage diminishment are the only actions required for these three alternatives) Alternatives 4, 5, and Existing Program is less than the area available after applying the environmental buffers; therefore, they could be implemented while observing the buffers applied to avoid sensitive resources. The "% of Available Area Needed for ESH Program" provides a percent of the

"Available Area After Environmental Buffers Applied" needed given the "Area Disturbed" for each alternative.

Calculation of the annual construction rate is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total number of acres to be created but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 18 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year.

Table 19 summarizes the annual quantities and effort necessary to reach the ESH habitat acreage goal for each alternative over the initial 10-year period. Construction after that 10-year period will continue at the same annual rate and will consist solely of the replacement of the ESH acres lost to erosion, which ranges from 40 percent down to 10 percent depending on the alternative, under each of these alternatives for the Gavins Point River Segment. The temporal limits on construction discussed in Section 2.3.3 and summarized in Table 12 identify 77 days annually when ESH construction could be accomplished in the Gavins Point River Segment. The number of "Teams of Mechanical Operators" and "Number of Dredges" are the number of each category assumed to be working simultaneously in a given year to annually complete the necessary "Days of Mechanical Work" and "Days of Dredge Work" within the number of days available for construction (77) in the Gavins Point River Segment. The number of "Teams of Mechanical Operators" and the "Number of Dredges" presented are rounded up to the next whole integer.

Table 18
Gavins Point River Segment Annual Construction Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	880			880			880		
Create Goal Ac.	4648			2324			2944		
Ann. Loss Rate	0.4	**Create**	**Replace**	0.3	**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	1868	**New**	**Lost**	710	**New**	**Lost**	901	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	880			880			880		
1	2396	1516	352	1326	446	264	1517	637	264
2	3306	910	958	1638	312	398	1963	446	455
3	3851	546	1322	1857	219	491	2275	312	589
4	4179	327	1541	2010	153	557	2494	218	683
5	4375	196	1672	2117	107	603	2646	153	748
6	4493	118	1750	2192	75	635	2754	107	794
7	4564	71	1797	2244	52	658	2828	75	826
8	4606	42	1826	2281	37	673	2881	52	849
9	4632	25	1843	2307	26	684	2918	37	864
10	4647	15	1853	2325	18	692	2943	26	875

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	880			880			880		
Create Goal Ac.	1912			880			570		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	493	**New**	**Lost**	132	**New**	**Lost**	40	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	880			880			880		
1	1153	273	220	880	0	132	832	0	40
2	1358	205	288	880	0	132	789	0	40
3	1511	154	339	880	0	132	750	0	40
4	1626	115	378	880	0	132	715	0	40
5	1713	86	407	880	0	132	683	0	40
6	1778	65	428	880	0	132	655	0	40
7	1826	49	444	880	0	132	630	0	40
8	1863	36	457	880	0	132	607	0	40
9	1890	27	466	880	0	132	586	0	40
10	1911	20	473	880	0	132	567	0	40

Table 19
Annual Effects to Construct ESH in the Gavins Point River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres to Construct/Replace	1,859	697	883	478	132	57	125
CY of Material Moved	10,890,022	4,083,026	5,172,614	2,800,124	773,256	333,906	732,250
Area Disturbed (acres)	5,521	2,070	2,623	1,420	392	169	371
Days of Mechanical Work	761	285	361	196	54	23	51
Days of Dredge Work	653	245	310	168	46	20	44
Teams of Mechanical Operators	10	4	5	3	1	1	1
Number of Dredges	8	4	5	3	1	1	1
% of Available Area Affected	142	53	68	37	10	4	10

3.1.4 ESH Total Creation and Annual Construction for the Lewis & Clark Lake Segment

Table 20 identifies the alternative-specific ESH goals for the Lewis & Clark Lake Segment and summarizes the magnitude of the area disturbed necessary to implement each of the alternatives. Additional information is included in the table to provide some perspective regarding the extent of the area disturbed in this segment for each alternative.

The Lewis & Clark Lake Segment has a measured high-bank to high-bank area of approximately 17,157 acres. After application of the environmental buffers, 4,711 available area acres remain within the segment. The "Area Disturbed" to construct ESH is less than the area remaining after applying the environmental buffers for each of the alternatives.

Table 20
Area Disturbed Effects for ESH Creation in the Lewis & Clark Lake Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres for Goal	1,360	680	566	354	142	80	25 annually
Area Disturbed (acres)	2,594	1,297	1,080	675	271	153	95
% of Total Riverine Habitat Disturbed to Construct	15	8	6	4	1.6	0.9	0.6
Available Area (acres) after Environmental Buffers Applied	4,711	4,711	4,711	4,711	4,711	4,711	4,711
Area of Surplus or Deficit (acres) to Implement ESH Program	2,117	3,414	3,631	4,036	4,440	4,558	4,616
% of Available Area (acres) Needed for ESH Program	55	28	23	14	6	3	2

Calculation of the annual construction rate is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total number of acres to be created but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 21 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year.

Table 22 summarizes the quantities and effort necessary to reach the ESH habitat acreage goal for each alternative over an initial 10-year period. Construction after that 10-year period will continue at the same annual rate and will consist solely of the replacement of the ESH acres lost to erosion under each of these alternatives for the Lewis & Clark Lake Segment. These numbers include quantities necessary to replace erosion losses, which are 50 percent per year for all of the alternatives. The temporal limits on construction discussed in Section 2.3.3 identify 77 days annually when ESH construction could be accomplished in the Lewis & Clark Lake Segment. Because this segment would only be constructed with dredges, the number of “Teams of Mechanical Operators” is zero for all alternatives. The “Number of Dredges” is the number of dredges assumed to be working simultaneously in a given year to annually complete the necessary “Days of Dredge Work” within the number of days available for construction (77).

Table 21
Lewis & Clark Segment Annual Construction Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	142			142			142		
Create Goal Ac.	1360			680			566		
Ann. Loss Rate	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**
Ann. Const. Ac.	680	**New**	**Lost**	340	**New**	**Lost**	283	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	142			142			142		
1	751	609	71	411	269	71	354	212	71
2	1056	305	376	546	135	206	460	106	177
3	1208	152	528	613	67	273	513	53	230
4	1284	76	604	646	34	306	540	27	257
5	1322	38	642	663	17	323	553	13	270
6	1341	19	661	672	8	332	559	7	276
7	1350	10	670	676	4	336	563	3	280
8	1355	5	675	678	2	338	564	2	281
9	1358	2	678	679	1	339	565	1	282
10	1359	1	679	679	1	339	566	0	283

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	142			142			142		
Create Goal Ac.	354			142			80		
Ann. Loss Rate	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**	0.5	**Create**	**Replace**
Ann. Const. Ac.	177	**New**	**Lost**	71	**New**	**Lost**	40	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	142			142			142		
1	248	106	71	142	0	71	111	0	40
2	301	53	124	142	0	71	96	0	40
3	328	27	151	142	0	71	88	0	40
4	341	13	164	142	0	71	84	0	40
5	347	7	170	142	0	71	82	0	40
6	351	3	174	142	0	71	81	0	40
7	352	2	175	142	0	71	80	0	40
8	353	1	176	142	0	71	80	0	40
9	354	0	177	142	0	71	80	0	40
10	354	0	177	142	0	71	80	0	40

Table 22
Annual Effects to Construct ESH in the Lewis & Clark Lake Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres to Construct/Replace	680	340	283	177	71	40	25
CY of Material Moved	3,983,440	1,991,720	1,657,814	1,036,866	415,918	234,320	146,450
Area Disturbed (acres)	1,297	649	540	338	135	76	48
Days of Mechanical Work	0	0	0	0	0	0	0
Days of Dredge Work	797	398	332	207	83	47	29
Teams of Operators	0	0	0	0	0	0	0
Number of Dredges	11	6	5	3	2	1	1
% of Available Area Affected	28	14	11	7	3	2	1

Note: Material for ESH construction in the Lewis & Clark Lake Segment will be 100% by dredge.

3.1.5 ESH Total Creation and Annual Construction for the Fort Randall River Segment

Table 23 identifies the alternative-specific ESH goals for the Fort Randall River Segment and summarizes the magnitude of the area disturbed necessary to implement each of the alternatives. This segment has a measured high-bank to high-bank area of approximately 13,790 acres. After application of the environmental buffers to the Fort Randall River Segment, 2,784 available area acres, or 20% of the reach, remains. The “Area Disturbed” row is the number of acres disturbed by the collection of material to build the required area of ESH plus the footprint of the ESH to be constructed. The area needed to construct each of the alternatives is less than the area remaining after applying the environmental buffers.

Table 23
Area Disturbed Effects for ESH Creation in the Fort Randall River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres for Goal	700	350	295	212	128	135	0[8]
Area Disturbed (acres)	2,079	1,040	876	630	380	401	--
% of Total Riverine Habitat Disturbed to Construct	15	8	6	5	3	3	--
Available Area (acres) after Environmental Buffers Applied	2,784	2,784	2,784	2,784	2,784	2,784	--
Area of Surplus or Deficit (acres) to Implement ESH Program	705	1,745	1,908	2,154	2,404	2,383	--
% of Available Area (acres) Needed for ESH Program	75	37	31	23	14	14	--

Calculation of the annual construction rate is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total number of acres to be created but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 24 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year.

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[8] The Existing Program does not include construction in Fort Randall River Segment.

Table 24
Fort Randall River Segment Annual Construction Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	128			128			128		
Create Goal Ac.	700			350			295		
Ann. Loss Rate	0.4	**Create**	**Replace**	0.3	**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	281	**New**	**Lost**	107	**New**	**Lost**	90	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	128			128			128		
1	358	230	51	196.6	69	38	180	52	38
2	496	138	143	245	48	59	216	36	54
3	578	83	198	278	34	73	241	25	65
4	628	50	231	302	24	83	259	18	72
5	658	30	251	318	16	91	271	12	78
6	676	18	263	330	12	95	280	9	81
7	686	11	270	338	8	99	286	6	84
8	693	6	275	343	6	101	290	4	86
9	697	4	277	347	4	103	293	3	87
10	699	2	279	350	3	104	295	2	88

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	128			128			128		
Create Goal Ac.	212			128			135		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	54	**New**	**Lost**	19	**New**	**Lost**	14	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	128			128			128		
1	150	22	32	128	0	19	129.2	0	14
2	167	17	38	128	0	19	130	0	14
3	179	12	42	127	0	19	131	0	14
4	188	9	45	127	0	19	132	0	14
5	195	7	47	127	0	19	133	0	14
6	200	5	49	127	0	19	134	0	14
7	204	4	50	127	0	19	134	0	14
8	207	3	51	127	0	19	135	0	14
9	209	2	52	127	0	19	135	0	14
10	211	2	52	127	0	19	136	0	14

Table 25 summarizes the annual quantities and effort necessary to reach the ESH habitat acreage goal for each alternative over the initial 10-year period. Construction after that 10-year period will continue at the same annual rate and will consist solely of the replacement of the ESH acres lost to erosion, which ranges from 40 percent down to 10 percent depending on the alternative, for the Fort Randall River Segment. The temporal limits on construction discussed in Section 2.3.3 and summarized in Table 12 identify 77 days annually when ESH construction could be accomplished in this segment. The number of "Teams of Mechanical Operators" and "Number of Dredges" are the number of each category assumed to be working simultaneously in a given year to annually complete the necessary "Days of Mechanical Work" and "Days of Dredge Work" within the number of days available for construction (77). The number of "Teams of Mechanical Operators" and the "Number of Dredges" presented are rounded up to the next whole integer.

Table 25
Annual Effects to Construct ESH in the Fort Randall River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres to Construct/Replace	280	105	89	53	19	14	N/A
CY of Material Moved	1,640,240	615,090	521,362	310,474	111,302	82,012	--
Area Disturbed (acres)	832	312	264	157	56	42	--
Days of Mechanical Work	115	43	36	22	8	6	--
Days of Dredge Work	98	37	31	19	7	5	--
Teams of Mechanical Operators	2	1	1	1	1	1	--
Number of Dredges	2	1	1	1	1	1	--
% of Available Area Affected	30	11	9	6	2	2	--

3.1.6 ESH Total Creation and Annual Construction for the Garrison River Segment

Table 26 identifies the alternative-specific ESH goals for the Garrison River Segment and summarizes the magnitude of the area disturbed necessary to implement each of the alternatives. This segment has a measured high-bank to high-bank area of approximately 24,518 acres. After application of the environmental buffers to the segment, 4,361 available area acres, or 18% of the reach, remains. The "Area Disturbed" row is the number of acres disturbed by the collection of material to build the required area of ESH plus the footprint of the ESH to be constructed.

Alternatives 1, 2, 3, and 3.5 are the only alternatives with construction of additional habitat over the ESH that exists and have spatial requirements (Area Disturbed) that exceed the area available after applying the environmental buffers and would, therefore, require building ESH in large areas of the segment that were recommended to be avoided to minimize environmental consequences. The other three alternatives have annual construction efforts to provide exiting or reduced acres of ESH and, therefore, also disturb the area around the sandbars as well as the sandbars. The "Area Disturbed" to construct Alternatives 4 and 5 is less than the area available after applying the environmental buffers and, therefore, could be implemented while observing the buffers applied to avoid sensitive resources. The "% of Available Area Needed for ESH Program" provides a percent of the "Available Area after Environmental Buffers Applied" needed given the "Area Disturbed" for each alternative.

Table 26
Area Disturbed Effects for ESH Creation in the Garrison River Segment

	Alt 1 2015 BiOp Goals	**Alt 2 2005 BiOp Goals**	**Alt 3 Actual 1998**	**Alt 3.5 Average 1998-2005**	**Alt 4 Actual 2005**	**Alt 5**	**Existing Program**
ESH Acres for Goal	4,295	2,148	2,066	1,327	588	500	0[9]
Area Disturbed (acres)	12,756	6,380	6,136	3,941	1,746	1,485	--
% of Total Riverine Habitat Disturbed to Construct	52	26	25	16	7	6	--
Available Area (acres) after Environmental Buffers Applied	4,361	4,361	4,361	4,361	4,361	4,361	--
Area of Surplus or Deficit (acres) To Implement ESH Program	(6,395)	(2,019)	(1,75)	420	2,615	2,876	--
% of Available Area (acres) Needed for ESH Program	293	146	141	90	40	34	--

[9] The Existing Program does not include ESH construction in the Garrison River Segment.

Calculation of the annual construction rate is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total number of acres to be created but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 27 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year.

Table 28 summarizes the annual quantities and effort necessary to reach the ESH habitat acreage goal for each alternative over an initial 10-year period. Construction after that 10-year period will continue at the same annual rate and will consist solely of the replacement of the ESH acres lost to erosion, which ranges from 40 percent down to 10 percent depending on the alternative, for the Garrison River Segment. The temporal limits on construction discussed in Section 2.3.3 and summarized in Table 12 identify 62 days annually when ESH construction could be accomplished in this segment. The number of "Teams of Mechanical Operators" and "Number of Dredges" are the number of each category assumed to be working simultaneously in a given year to annually complete the necessary "Days of Mechanical Work" and "Days of Dredge Work" within the number of days available for construction (62). The number of "Teams of Mechanical Operators" and the "Number of Dredges" presented are rounded up to the next whole integer.

Table 27
Garrison River Segment Annual Construction Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	588			588			588		
Create Goal Ac.	4295			2148			2066		
Ann. Loss Rate	0.4	**Create**	**Replace**	0.3	**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	1727	**New**	**Lost**	658	**New**	**Lost**	633	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	588			588			588		
1	2080	1492	235	1069.6	482	176	1045	457	176
2	2975	895	832	1407	337	321	1364	320	313
3	3512	537	1190	1643	236	422	1588	224	409
4	3834	322	1405	1808	165	493	1745	157	476
5	4027	193	1534	1924	116	542	1854	110	523
6	4143	116	1611	2004	81	577	1931	77	556
7	4213	70	1657	2061	57	601	1985	54	579
8	4255	42	1685	2101	40	618	2022	38	595
9	4280	25	1702	2129	28	630	2049	26	607
10	4295	15	1712	2148	19	639	2067	18	615

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	588			588			588		
Create Goal Ac.	1327			588			500		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	343	**New**	**Lost**	88	**New**	**Lost**	45	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	588			588			588		
1	784	196	147	588	0	88	574.2	0	45
2	931	147	196	588	0	88	562	0	45
3	1041	110	233	587	0	88	551	0	45
4	1124	83	260	587	0	88	541	0	45
5	1186	62	281	587	0	88	531	0	45
6	1232	47	296	587	0	88	523	0	45
7	1267	35	308	587	0	88	516	0	45
8	1294	26	317	587	0	88	509	0	45
9	1313	20	323	587	0	88	503	0	45
10	1328	15	328	587	0	88	498	0	45

Table 28
Annual Effects to Construct ESH in the Garrison River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres to Construct/Replace	1,718	644	620	332	88	50	N/A
CY of Material Moved	10,064,044	3,772,552	3,631,960	1,944,856	515,504	292,900	--
Area Disturbed (acres)	5,102	1,913	1,841	986	261	149	--
Days of Mechanical Work	873	327	315	169	45	25	--
Days of Dredge Work	750	281	271	145	38	22	--
Teams of Mechanical Operators	15	6	6	3	1	1	--
Number of Dredges	13	5	5	3	1	1	--
% of Available Area Affected	117	44	42	23	6	3	

3.1.7 ESH Total Creation and Annual Construction for Fort Peck River Segment

Table 29 identifies the alternative-specific ESH goals for the Fort Peck River Segment and summarizes the magnitude of the area disturbed necessary to implement each of the alternatives. This segment has a measured high-bank to high-bank area of approximately 39,009 acres. After application of the environmental buffers to the segment, 3,324 available area acres, or 8.5% of the reach, remains. The "Area Disturbed" row is the number of acres disturbed by the collection of material to build the required area of ESH plus the footprint of the ESH to be constructed.

There are no ESH goals for Alternative 2 for the Fort Peck River Segment because there were no habitat requirements in the 2000 BiOp, as amended (2003, for this segment until the 2015 goals. The quantities for Alternatives 1 and 3 are the same because the 2000 BiOp, as amended 2003, did not assign an acreage goal for the segment but deferred the goal based on an actual delineation of the habitat visible in the remotely sensed photography from 1998 (1999 photography was used because 1998 was not available). Therefore, for this segment only, the acreage goals for Alternatives 1 and 3 are the same.

Table 29
Area Disturbed Effects for ESH Creation in the Fort Peck River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres for Goal	883	--	883	565	248	30	0[10]
Area Disturbed (acres)	2,623	--	2,623	1,681	737	89	--
% of Total Riverine Habitat Disturbed to Construct	7	--	7	4	2	0.2	--
Available Area (acres) after Environmental Buffers Applied	3,324	--	3,324	3,324	3,324	3,324	--
Area of Surplus or Deficit (acres) To Implement ESH Program	701	--	701	1,643	2,587	3,235	--
% of Available Area (acres) Needed for ESH Program	79	--	79	51	22	3	--

Calculation of the annual construction rate is dependent on the total number of acres to be created, the number of acres in place when the program is implemented, the annual ESH loss (erosion) rate, and the number of years to reach the acreage goal (10 years for Alternatives 1, 2, 3, 3.5) (reduced acreage goal for alternative 4). Because the annual construction is required to not only create a portion of the total number of acres to be created but also replace the acres eroded annually, the construction effort is a combination of ESH creation and ESH replacement. Table 30 presents the total number of acres in place at the beginning of bird nesting season each year, the number of the constructed acres that are newly created ESH, and the number of the constructed acres that are replacing the ESH that has eroded since the beginning of the nesting season the previous year.

[10] The Existing Program does not include construction of ESH in Fort Peck River Segment.

Table 30
Fort Peck River Segment Annual Construction Acreage Data

	Alternative 1			Alternative 2			Alternative 3		
2005 Acres	247						247		
Create Goal Ac.	883						883		
Ann. Loss Rate	0.3	**Create**	**Replace**		**Create**	**Replace**	0.3	**Create**	**Replace**
Ann. Const. Ac.	270	**New**	**Lost**		**New**	**Lost**	270	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	247						247		
1	443	196	74				443	196	74
2	580	137	133				580	137	133
3	676	96	174				676	96	174
4	743	67	203				743	67	203
5	790	47	223				790	47	223
6	823	33	237				823	33	237
7	846	23	247				846	23	247
8	862	16	254				862	16	254
9	874	11	259				874	11	259
10	882	8	262				882	8	262

	Alternative 3.5			Alternative 4			Alternative 5		
2005 Acres	247			247			247		
Create Goal Ac.	566			248			30		
Ann. Loss Rate	0.25	**Create**	**Replace**	0.15	**Create**	**Replace**	0.1	**Create**	**Replace**
Ann. Const. Ac.	146	**New**	**Lost**	37	**New**	**Lost**	3	**New**	**Lost**
	ESH Ac.	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**	**ESH Ac.**	**ESH**	**ESH**
Year	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**	**In Place**	**Acres**	**Acres**
0	247			247			247		
1	331	84	62	247	0	37	225	0	3
2	394	63	83	247	0	37	206	0	3
3	442	47	99	247	0	37	188	0	3
4	477	36	110	247	0	37	172	0	3
5	504	27	119	247	0	37	158	0	3
6	524	20	126	247	0	37	145	0	3
7	539	15	131	247	0	37	134	0	3
8	550	11	135	247	0	37	123	0	3
9	559	8	138	247	0	37	114	0	3
10	565	6	140	247	0	37	106	0	3

Table 31 summarizes the annual quantities and effort necessary to reach the ESH habitat acreage goal for each alternative over an initial 10-year period. Construction after that 10-year period will continue at the same annual rate and will consist solely of the replacement of the ESH acres lost to erosion, which ranges from 40 percent down to 10 percent depending on the alternative, for the Fort Peck River Segment. The temporal limits on construction discussed in Section 2.3.3 and summarized in Table 12 identify 47 days annually when ESH construction could be accomplished in the Fort Peck River Segment. The number of "Teams of Mechanical Operators" and "Number of Dredges" are the number of each category assumed to be working simultaneously in a given year to annually complete the necessary "Days of Mechanical Work" and "Days of Dredge Work" within the number of days available for construction (47). The number of "Teams of Mechanical Operators" and the "Number of Dredges" presented are rounded up to the next whole integer.

Table 31
Annual Effects to Construct ESH in the Fort Peck River Segment

	Alt 1 2015 BiOp Goals	Alt 2 2005 BiOp Goals	Alt 3 Actual 1998	Alt 3.5 Average 1998-2005	Alt 4 Actual 2005	Alt 5	Existing Program
ESH Acres to Construct/Replace	265	N/A	265	142	37	3	N/A
CY of Material Moved	1,552,370	--	1,552,3 70	831,836	216,746	17,574	--
Area Disturbed (acres)	787	--	787	422	110	9	--
Days of Mechanical Work	178	--	178	95	25	2	--
Days of Dredge Work	153	--	153	82	21	2	--
Teams of Mechanical Operators	4	--	4	3	1	1	--
Number of Dredges	4	--	4	2	1	1	--
% of Available Area Affected	24	--	24	13	3	0.3	--

4 ESH Creation and Replacement Methods in Research and Development

There have been many methods considered for creating and replacing ESH in the upper Missouri River. Many of these are unproven, but could have a prominent or lesser role for the ESH program after careful testing to evaluate their efficacy. The methods described below are still in the research and development (R&D) phase and are not ready for large-scale use until the methods are further refined. They are discussed here because they will be deployed on a pilot-scale and their effectiveness evaluated on an ongoing basis.

4.1 Chemical Vegetation Removal

Herbicides are a habitat management tool that has been used in an attempt to manage succession on interchannel sandbars of the Missouri River (Latka et al, 1993; USACE, 2003a; USACE, 2004a). Dirks (1990) documented successful least tern and plover nesting on herbicide-cleared interchannel sandbar concluding, "these preliminary findings indicate that least terns and plovers will use sandbars artificially cleared of vegetation for nesting."

The efficacy of herbicides as a management tool depends on many factors including herbicide toxicity, herbicide selectivity, applicator training, biology of the target and non-target plants, weather conditions, and their use in combination with other habitat management tools (e.g., mechanical removal of treated plants).

Options available for herbicide treatment to maintain least tern and plover habitat are limited. Herbicides that could be considered for use must be registered for aquatic use by the U.S. Environmental Protection Agency (EPA). Two herbicides are currently approved for aquatic use and that are applicable for ESH - glyphosate and imazapyr. Glyphosate must be applied to actively photosynthesizing plants and offers little capability for residual vegetative control. This is because pre-nesting season application occurs before complete leaf-out of woody perennials and before germination of annual vegetation. Post-nesting season application typically occurs after seed set in annual vegetation. The imazapyr product, a pre-emergent herbicide with residual control, provides an effective alternative for control of vegetation using either a pre- or post-nesting season application (USACE, 2004a).

The Omaha District has used glyphosate and imazapyr to treat vegetation on sandbars in the upper Missouri River (USACE, 2003a). For both herbicides, the formulations included the surfactant LI 700 and the drift retardant Chem-Trol (USACE, 2003a). If the Omaha District proposes to use another herbicide/surfactant/drift control/other ingredient, it would have to be EPA approved for aquatic use and would require coordination with the USFWS prior to use.

The behavior of each herbicide formulation and its effects on target plants are different. The purpose of this discussion is to describe the Corps' procedures and the information on the two herbicides being used.

For herbicide application, the Corps may utilize either herbicide individually, or in combinations of the glyphosate (e.g., Rodeo) and imazapyr (e.g., Habitat). To provide a conservative analysis (representing the most herbicide use), it is assumed that the herbicide will always be applied at the maximum allowable concentration and in a combination as shown in Table 32. The concentration assumed for use is also at the maximum of the manufacturer-specified mixture rate (7.5 pints of glyphosate per acre and 6 pints of imazapyr per acre). In addition to the "active ingredients" each 5 gallons of formulation is assumed to also include 0.4 pints of drift retardant (e.g., Chem-Trol) and 0.2 pints of surfactant (LI 700).

Table 32
Herbicide Formulation Use Assumptions

Ingredient	Purpose	Quantity Used Per Acre in a 5 Gallon Mixture
Imazapyr	Herbicide	6 pints*
Glyphosate	Herbicide	7.5 pints**
LI 700	Surfactant	0.2 pints
Chem-Trol	Drift Retardant	0.4 pints
Water	Deliver Herbicide	28.4 pints

* 6 pints imazapyr = 1.5 lbs imazapyr acid
** 7.5 pints glyphosate = 3 lbs glyphosate acid

Certain inert ingredients can contribute to the toxicity of herbicide formulations or herbicide/surfactant mixtures to selected aquatic organisms (Monheit et al, 2004). In some cases the toxicity of the inert ingredient may be greater than the toxicity of the active ingredient. There has been recent concern about the ecological consequences of herbicide use on non-target organisms (specifically, amphibians) and the effects of the inert ingredients in glyphosate herbicide formulations. Reylea (2005) documented the effects of glyphosate-based herbicide Roundup and its surfactant (polyethoxylated tallow amine surfactant--POEA) on tadpoles.

A major qualitative difference between the effect of glyphosate and glyphosate formulations on aquatic and terrestrial organisms concerns the POEA used in Roundup. For aquatic organisms, the surfactant POEA is much more toxic than glyphosate itself (USDA, 1997). As such, the results of Reylea (2005) only apply to formulations of glyphosate that contain the POEA surfactant and not to other forms of glyphosate. The glyphosate formulation Rodeo (as proposed for the ESH program) does not contain POEA and has been approved by the EPA for aquatic use. The toxicity of LI 700—the surfactant proposed for use in the ESH program—has been evaluated (Lapurga, 1996) and the review of the data (USDA, 1997; Monheit et al, 2004) suggests that the herbicide and surfactant mixture did not pose a risk to aquatic organisms at recommended concentrations.

There are three methods of applying herbicides that would be used on the Missouri River:

1. Aerial application by helicopter;
2. Mechanical equipment application, using quad-mounted or tractor-towed wand or boom sprayers; and
3. Pressurized backpack equipment.

4.1.1 Aerial Application

In comments on a site-specific herbicide application Environmental Assessment (USACE, 2003), the USFWS (2003a) recommended that the Corps implement the following project components for the control of vegetation with herbicides. The USFWS recommended that, in addition to strict applicator adherence to label instructions, including those that require herbicide application only during a narrow range of minimal ambient wind speeds:

a) The helicopter will fly slow and low, as slow speeds can be combined with lower pump pressures to produce larger droplets;

b) Nozzle orientation will be appropriately aligned to produce the desired droplet size;

c) Boom length will be no more than 75% of the rotor diameter of helicopters in order to reduce drift caused by wingtip and rotor vortices;

d) A microfoil boom, drift control system will be used;

e) The drift retardant Chem-Trol will be used as a standard part of the project; and

f) Aerial applicators will check equipment calibration and follow all practices (e.g., observe weather restrictions) to ensure proper delivery of herbicides.

On average, helicopter spraying treats approximately 25 acres per hour of flight time.

4.1.2 Mechanical Equipment Application

With mechanical equipment application, the herbicide is applied with an ATV or tractor equipped with boom-mounted spray nozzles. A buffer strip not less than 50 feet in width between the water and the treatment area is maintained on any side adjacent to water. Vegetation taller than approximately 5 feet is cut to 5 feet so that taller plants would not interfere with the spray pattern. An inert marker dye is used in the spray solution to aid in identifying the spray borders. With the use of this dye and maintaining an equal distance parallel to the ATV tracks of the previous spraying pass, a uniform spray application may be applied.

4.1.3 Backpack Equipment Application

The backpack sprayer can be used to wet the foliage for selective control in areas close to wetlands or other sensitive vegetation. A number of nozzle types can be used to alter spray patterns, and an extension tube can be added to provide additional reach. Marker dye can be used if needed to mark the vegetation to prevent skips or overlaps. Only a limited amount of area can be covered with each tank. The backpack sprayers can be re-filled without taking them off the back and are relatively trouble-free and simple to operate. Low-pressure (20 to 50 psi) backpack sprayers typically operate at a rate of 1 gallon or less per minute.

4.1.4 Summary

The herbicides, surfactants, and drift retardants used under the ESH program have received extensive research, testing, and human health and ecological risk assessment (WSDA, 2003; USDA, 1996; USDA, 2003; USDA, 2004; Henry et al, 1994). The risks associated with their use are minimal. Following the review of the proposed use of these chemical components in previous vegetation removal work on Missouri River sandbars, the USFWS has approved their use (USFWS, 2005).

The two herbicides used by the Corps' Omaha District under the ESH program provide different advantages. Both are intended to kill all vegetation on a site, but the length of time the herbicide can control the growth of competing vegetation varies. The glyphosate herbicide is designed to kill vegetation, including the underground root systems to reduce re-sprouting. The imazapyr remains temporarily active in the soil to reduce reinvasion of the plants.

Most herbicide applications do not greatly disturb the soil or its protective organic cover. With aerial application, large areas may be treated quickly with a small labor force. Direct application costs are low but the inability of herbicide application alone to adequately treat ESH reduces the cost-efficiency compared with other methods. Relatively few workers should be exposed to the chemicals when they are applied in accordance with the safety precautions required according to the manufacturer's guidelines. Aerial application of herbicides can be implemented in remote, inaccessible areas where access for other application methods may be difficult.

Tractor or ATV-mounted mechanical spray equipment has advantages similar to aerial application in timing, cost, low soil disturbance, and limited worker exposure. It is, however, a system limited to treatment of relatively flat, accessible areas. Hand application systems have a common set of advantages: targeting of individual unwanted plants is greater than with aerial and mechanical application; therefore, effects on non-target organisms and other elements of the environment can be reduced.

The most recent (2004-2005) vegetation control practices (herbicide application, chopping, and brush-hogging) have not created functioning ESH that supported nesting. Observations from these herbicide applications include:

- Herbicide application alone appears to be less effective than brush-hogging alone or herbicide application and brush-hogging;

- Effectively killed cottonwood stems have had a pronounced snow-fence effect (stopping the smallest sand particles, "sugar sand") and allowed the establishment of dense stands of annual herbs in their lea;
- Partially killed cottonwood seedlings and saplings (by either chopping or herbicide applications) have basal sprouted, creating sugar sand dune formation structures that served as nursery sites for herb and grass seedlings;
- Rows of cottonwood saplings (sometimes for hundreds of feet across islands) have been missed by herbicide spraying, creating extensive linear wind-shadow areas that have become heavily colonized with both cottonwood seedlings and annual herbs and grasses; and
- The herbicide used often had no effect on leguminous herbs and many grasses. For example, with competition eliminated, partridge pea (*Cassia fasiculata*), wild sunflower (*Helianthius sp.*), tufted bent grass (*Agrostis exerata*), and sand drop-seed (*Sporobolus* spp.) have formed very dense monocultures in many treated areas. Cocklebur (*Xanthium strumarium*) and sand-spur (*Cenchrus pauciflorus*), neither of which has been observed in dominance previously, have proliferated into dense stands in many herbicide-treated areas.

As noted, some plant species are naturally resistant to the herbicides used. Where these naturally resistant species exist, explosive growth of the herbicide-resistant annual and perennial plants occurs, degrading the habitat.

Rodeo herbicide was found to be effective for killing existing, leafed out vegetation but is comparatively slow-acting (2 to 3 weeks). Rodeo needs to be used after leaf-out while the plant is actively trans-locating and not stressed, and it is ineffective on seeds. Therefore, there is still annual plant germination from seed in the spring (Latka et al, 1993).

The costs associated with applying herbicides typically involve two factors: the purchase of the product and labor. A staff member who is certified to apply herbicides—or an outside contractor—may perform the actual labor. Recent experience contracting for herbicide spraying on interchannel sandbars provides good cost numbers on a per-acre basis but must be weighed against the efficacy of herbicide-only treatment techniques.

Actual cost from the spraying of sandbars for vegetation removal in 2005 included labor, materials, and equipment (helicopter with micro-foil or equivalent booms) necessary to perform aerial spraying of an estimated quantity of acreages not to exceed 657 acres of vegetation in the Gavins Point River, Lewis & Clark Lake, and Fort Randall River segments in South Dakota and Nebraska. The work, including all the herbicide for treatment, was completed for $127.50 per acre.

4.2 Burning

Where sufficient fuel exists on interchannel sandbars, fire can be used to remove vegetation and help retain habitat. This discussion is limited to the use of burning as a tool to remove vegetation from early and mid-succession habitats on sandbars (generally less than 8- to 10-year-old vegetation). If sandbars contain mature trees, they would not be modified to create ESH. The method has been used with some success as Nelson (1999) documented the successful use of controlled fires to rid uplands on sandbars of persistent kochia and clover.

Burning techniques that would be used are broadcast burning and pile burning. Broadcast burning is the burning of material scattered over an open area such as a vegetated sandbar. Broadcast burns are usually ignited with handheld drip torches. Mechanical pre-treatment is often done in combination with broadcast burning. Brush or saplings may be cut and scattered prior to burning. Pile burning is done after mechanically cut woody material is piled. Piling can be done by hand or with heavy equipment. Hand-held drip torches are used to ignite piles.

In deciding whether to burn and which technique to use, the quantity, type, distribution, and moisture contents of the burnable material are of primary importance. In addition, the quantity of combustible material on a sandbar must be considered as many may lack sufficient material to carry a broadcast-burning fire. Temperature, wind, humidity, and the recentness an area was treated with herbicides should be considered in the decision to burn. Predictions must be made of the likely pattern and extent of smoke dispersed, the flame length, and rates of fire spreading.

Broadcast burning dead vegetation has been tried on interchannel sandbars, but was not successful because the sandbars lacked sufficient combustible material to carry the fire (Latka et al, 1993). However, burning was accomplished successfully by the USFWS on grassy shorelines in Montana. However, there was no subsequent use of the burned areas by least terns or plovers (Latka et al, 1993). Burning vegetation from interchannel sandbars can provide a method for removal of combustible materials but should not be considered a stand-alone technique for the preparation of ESH.

With careful selection of burning conditions, burning can take advantage of the beneficial effects of fire while minimizing the risk of damage from uncontrolled wildfire. Burning could be effective on isolated islands, where gaining access for heavy mechanical equipment could be difficult or costly. When effective, it can also be less expensive than other methods.

Burning is a potentially property-damaging and life-threatening method of removing unwanted vegetation. With that in mind, vigorous safety procedures and monitoring can reduce the risk of injury, death, or property damage significantly. Selectivity is difficult to achieve consistently with fire. Also, burning may cause conditions that encourage the invasion of the treated site by other unwanted plants. Both of these effects depend on the heat tolerance, vigor, sprouting ability, and seed sensitivity of individual plant species and the duration and intensity of the fire. Smoke from burning reduces air quality, and the possible escape of a prescribed fire is always a serious consideration.

Where there is sufficient material to sustain a fire, costs are estimated at $250 per acre (Raleigh et al, 2003).

4.3 Other Methods

Numerous other methods have been proposed during the development of the ESH Adaptive Management Plan. These involve methodologies that have yet to be tested and will likely be evaluated through a series of pilot projects that will receive their own site-specific NEPA documents. These methods are described in Appendix H: Adaptive Management.

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US Army Corps
of Engineers
Omaha District

Draft
Programmatic Environmental Impact Statement
for the Mechanical Creation and Maintenance of
Emergent Sandbar Habitat in the Riverine Segments of the
Upper Missouri River

Appendix D

Recreation Analysis of the Riverine Segments from Fort Peck Dam, Montana to Ponca, Nebraska

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Revised October 2010

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Recreation Analysis of the Riverine Segments from Fort Peck Dam, Montana to Ponca, Nebraska

1 Introduction

1.1 Purpose and Scope

The Master Manual Final EIS (USACE, 2004) established baseline recreation use of the riverine segments of the Missouri River for the affected environment and as a basis for comparison of the alternatives (see Missouri River Master Water Control Manual Review and Update, Volume 6C: Economic Studies, Recreation Studies, USACE, 1994). The baseline data used for the Master Manual Final EIS was collected and established with early 1990s information. The purpose of this current analysis is to update and supplement existing recreation data with more current visitation data and information on the amount, timing, and characteristics of major recreation activities. This will provide adequate information for the Programmatic EIS to fully discuss the affected environment, identify effects of each alternative on recreation, and compare the effects of the alternatives on recreation in each riverine segment.

Based on the scoping comments, which usually referenced potential impacts to recreational activities and wildlife, this recreation analysis will identify the following, to the extent of the information available: 1) recreational attributes of the Missouri National Recreational River (MNRR) and other segments, including fishing, hunting, sightseeing, motor boating, canoeing, and the quest for solitude; 2) susceptibility of high noise levels to recreationists and wildlife; 3) periods when various recreation activities occur, the type of sites used, and available visitation data; 4) whether substitute sites may be available if access or use is limited for some activity areas such as sandbars or boat ramps; and 5) any attributes of the recreational activity (such as size and type of boats) that need to be considered when determining safety-related physical site criteria (such as channel depth/width for boating).

A data search was conducted concerning recreation opportunities and uses along the upper Missouri River from Fort Peck Dam downstream to Ponca, NE. The segments assessed in this analysis include:

- The Fort Peck River Segment – Fort Peck Dam, MT to Lake Sakakawea headwaters near Williston, ND (river mile (RM) 1771.5 – RM 1568.0, 203.5 river miles);
- The Garrison River Segment – Garrison Dam near Riverdale, ND to Lake Oahe headwaters south of Bismarck, ND (RM 1389.9 to RM 1304.0, 85.9 river miles);
- The Fort Randall River Segment – Fort Randall Dam near Pickstown, SD to upstream of Niobrara River confluence, NE (RM 880.0 – RM 845.0, 35.0 river miles);

- The Lewis & Clark Lake Segment – Upstream of Niobrara River confluence to Lewis and Clark Lake headwaters downstream of sandbar accretion islands, SD and NE (RM 845.0 – RM 828.0, 17.0 river miles)[1]; and
- The Gavins Point River Segment – Gavins Point Dam (SD and NE) to Ponca, NE (RM 811.1 – RM 753.0, 58.1 river miles).

The Master Manual Final EIS recreation baseline was based on a recreation analysis conducted in 1992 for the Missouri River Master Water Control Manual Review and Update (USACE, 1994). That recreation use analysis was based on extensive surveying, user interviews, and mathematical modeling and included characterizing the recreation within the mainstem reservoirs (e.g., Fort Peck Lake, Lake Sakakawea, Lake Oahe, Lewis and Clark Lake) as well as the river segments downstream from the dams. This current analysis is based on more recently published data gathered from analyses conducted at the federal, state, and local level. This updated information supplements the previous extensive research effort by being more recent and by focusing only on riverine recreation.

1.2 Data Gathering

Data for this analysis has been gathered from multiple sources including agency websites, reports, interviews, and site visits. Site visits were conducted at all of the publicly accessible areas for recreation in the aforementioned segments in two efforts, July 16 – 18 and August 8 – 14, 2006. This includes some 400 river miles of the Missouri River from Montana to Nebraska. Water-based recreation locations along the river were identified through consultation with tourism literature, state and federal Web sites, and discussions with federal, tribal, state, and local agency personnel and recreational site users. Information gathered during site visits provided insight into recreation site characteristics, scope and level of use, and alternative site opportunities. An example of the Site Survey Form used to document the characteristics of each recreational site is provided as Attachment I: Site Survey Form.

Discussions with tribal, state, and local agency personnel and users of recreation sites were also instrumental in providing information regarding characteristics, timing, and location of recreational activities along the Missouri River. Informal discussions were conducted with recreation site users whenever the opportunity arose during site visits. Information was obtained in person, by telephone, and/or by email from personnel representing the following agencies:

- Fort Peck Tribes;
- Yankton Sioux Tribe;
- Ponca Tribe of Nebraska;
- National Park Service, Yankton, SD;
- U.S. Army Corps of Engineers District Office: Omaha, NE;
- U.S. Army Corps of Engineers Field Offices:

[1] Because the Fort Randall River and Lewis & Clark Lake segments are not segregated by a physical boundary as with the other segments, the recreation data are typically combined in the reference material and will be similarly combined herein.

  - Fort Peck, MT,
  - Riverdale, ND,
  - Bismarck, ND,
  - Pickstown, SD, and
  - Yankton, SD;
- Montana Fish, Wildlife and Parks Department;
- North Dakota Game and Fish Department;
- North Dakota Parks and Recreation Department;
- City of Bismarck Parks and Recreation Department, Bismarck, ND;
- South Dakota Department of Game, Fish and Parks; and
- Nebraska Game and Parks Commission.

This recreation analysis did not employ original surveys or questionnaires to estimate site use or quality and is based on existing data and current information to characterize recreation use and quality. The availability of information on existing recreational uses is not consistent from segment to segment but is provided to the extent available. Future conditions may involve new recreational activities that are not addressed in this document. Additional emergent sandbar habitat will not result in any changes to reservoir operations or to in-pool elevations/fluctuations that could affect recreation activities in reservoir portions of segments. The following are the main data sources reviewed and used in this analysis. These sources were either accessed electronically or obtained in hard copy.

- 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation;
- National Park Service, Yankton, SD: Monthly vehicle counts, 2006-2008, at overlooks at Mulberry Bend, NE; Standing Bear Bridge, SD; and Niobrara State Park, NE;
- Montana Fish, Wildlife and Parks Department: 2006 Fish Stocking Plan;
- Montana Fish, Wildlife and Parks Department: Statewide Comprehensive Outdoor Recreation Plan, 2008-2012;
- Montana Fish, Wildlife and Parks Department: Montana Fisheries Information System;
- Nebraska Game and Parks Commission: Fish Stocking Report;
- Nebraska Game and Parks Commission: State Comprehensive Outdoor Recreation Plan 2006-2010;
- Nebraska Game and Parks Commission and South Dakota Department of Game, Fish, and Parks: Nebraska and South Dakota 2000 Missouri River Recreational Use Survey;
- North Dakota Game and Fish Department: Angler Use and Sport Fish Catch Survey on the Missouri River and Lake Oahe, North Dakota, April 1 through October 15, 2000; April 1 through September 30, 2003; and April 1 through October 31, 2006;
- North Dakota Game and Fish Department: Fishing Emphasis Area Report;

- North Dakota Game and Fish Department: Fish Stocking Report;
- North Dakota Parks and Recreation Department: North Dakota 2008-2012 State Comprehensive Recreation Plan;
- South Dakota Department of Game, Fish and Parks: Fish Stocking Report;
- South Dakota Department of Game, Fish, and Parks: 2005 Angler Use and Harvest Survey of the Missouri River in South Dakota and Nebraska from Fort Randall Dam to Gavins Point Dam;
- South Dakota Department of Game, Fish and Parks – Division of Parks and Recreation: Statewide Comprehensive Outdoor Recreation Plan 2002.

While many types of recreational activities take place on the riverine segments, particularly near population centers, the largest recreational use of these segments is fishing. As such, angler use data—collected by many state agencies to track fishing on important water bodies—is an important indicator of the extent of recreational use. Angler use data for the three segments from Fort Randall Dam to Ponca, NE was based on the angler use survey conducted in 2005 by the South Dakota Department of Game, Fish, and Parks and the 2000 Missouri River Recreational Use Survey jointly conducted by the Nebraska Game and Parks Commission (NGPC) and the South Dakota Department of Game, Fish, and Parks (SDGFP). The Montana reach of the Fort Peck River Segment also had available use data based on angler surveys conducted by the Montana Fish, Wildlife and Parks Department (MFWP). North Dakota angler use data is based on angler use and sport fishing catch survey reports between Garrison Dam and the traditional headwaters of Lake Oahe in 2000, 2003, and 2006 and paddlefish angling surveys upstream from Lake Sakakawea. The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, conducted by the U.S. Fish and Wildlife Service and U.S. Census Bureau (USFWS/USCB, 2002), was used to supplement segment-specific information with broader state-wide overviews.

1.3 Master Water Control Manual Review and Update Study, 1994

In July 1994, the Corps of Engineers published a technical report supporting the Missouri River Master Water Control Manual Review and Update (USACE, 1994). One component of the 1994 Review and Update Study was to estimate recreational use in the lakes and free-flowing reaches of the Missouri River from Fort Peck Lake downstream to St. Louis, MO. The purpose of the 1994 recreational use analysis was to assess changes in use and the economic impacts that would result from proposed alternative changes to the Master Water Control Manual, as these alternatives would result in different water levels and access conditions. The 1994 recreational analysis estimated recreational use for the study reaches that coincide with the scope of this analysis.

Table 1 presents the estimated number of annual recreation days–by study reach–as it appears in Table 12 of the 1994 Review and Update Study. The user estimates are meant to be inclusive of all river-related recreation, which includes activities such as camping, picnicking, and cabin use as well as more typical water-related uses such as boating, swimming, and fishing. There has not been a recreational analysis of these study reaches conducted at the same scope and level of detail since the 1994 Review and Update Study. Updated quantitative data presented in this 2009 analysis was available for only some types of recreational uses. Therefore, it does not approach the scope of the 1994 analysis, which was based on estimates using traffic counts and the Corps' Visitation Estimation Reporting System (VERS) surveys.

The reach designations identified in the 1994 Review and Update Study, and presented in Table 1 below, do not consistently match the segment designations used in this analysis. Two of the reaches from the 1994 study (Fort Peck Lake – downstream and Lake Sakakawea – downstream) closely match the Fort Peck River Segment and Garrison River Segment, respectively, used in the present study. On the other hand, two reaches from the 1994 study (Lake Francis Case – downstream and Gavins Point Dam to Sioux City) include more river mileage than the Fort Randall River and Lewis & Clark Lake segments and the Gavins Point River Segment, respectively, used in this analysis.

Table 1
1994 Review and Update Study – River-Based Recreation Use Estimates from Traffic Counts and the Corps' 1992 VERS Survey

Reach	Annual Recreation Days
Fort Peck Lake – downstream	55,000
Lake Sakakawea – downstream	216,000
Lake Francis Case – downstream	130,000
Gavins Point Dam to Sioux City	744,000

Source: USACE, 1994.

Table 2 presents the results of a separate analysis contained within the 1994 Review and Update Study that estimates 1990 recreation use by licensed anglers for the riverine reaches of the upper Missouri River. The geographic areas sampled in each of the five states (Montana, North Dakota, South Dakota, Nebraska, and Iowa) where these reaches are located were selected by the state agency that oversees fisheries based on their high proportion of anglers using Missouri River sites. The Montana sample was drawn from residents who fished the Missouri River, based on a recently completed statewide telephone survey, and also randomly selected non-residents with Montana fishing licenses. Most resident samples in the other states were from counties adjacent to the Missouri River (first tier counties). In North Dakota, counties that were located one county away from the river (second tier counties) were sampled if they had high Missouri River fishing rates. Non-adjacent counties with high populations were also sampled in Nebraska and South Dakota. For each reach, non-resident fishing license holders from adjacent states were also sampled; most of these non-resident licenses were purchased in the counties selected by the state fishery agencies for the resident samples. The number of user days for each reach was estimated by assuming that the responses regarding number and duration of trips to the Missouri River by resident and non-resident fishing license holders from each county's sample were representative of all resident and non-resident fishing license holders in that county, respectively. Because the survey was designed to maximize the proportion of Missouri River anglers in the samples, the number of Missouri River angler days may be underestimated because they do not include samples from (or extrapolations of angler days to) counties where fishing license holders have relatively lower Missouri River angler use.

Table 2
1990 Angler Recreation Use Estimates

	Mean Estimated Trips* and User Days		
Reach	No. of Resident Trips (Mean No. of Days/Trip)	Non-Resident Trips (Mean No. Days/Trip)	Angler Days Based on Mean Values
Fort Peck Downstream	7,175 (2.2) =15,785	11,460 (2.9) =33,234	49,019
Sakakawea Downstream (Garrison Reach)	80,905 (1.8) =145,629	4,776 (3.3) =15,671	161,390
Fort Randall Downstream	43,937 (1.9) =83,480	5,534 (2.6) =14,388	97,868
Gavins Point Downstream (South Dakota Only)	63,547 (2.0) =127,094	3,818 (3.4) =12,981	140,075
Gavins Point Dam to Sioux City (Nebraska Only)	118,605 (1.9) =225,350	5,576 (2.5) =13,940	239,290
Gavins Point Dam to Sioux City (Nebraska and South Dakota)	352,444	26,921	379,365
Totals	597,338	89,304	687,642

Source: USACE, 1994; Exhibit A-2, Appendix C. *Trips refers to number of persons, not vehicles.

The number of river-based recreation days by anglers in Table 2 and those by both anglers and non-anglers in Table 1 show the same relative ranking among the four study reaches: the reach downstream from Gavins Point Dam has the highest number of user days; the reach downstream from Garrison Dam is second; the reach downstream from Fort Randall Dam is third; and the reach downstream from Fort Peck Dam has the lowest number of user days. To some extent the number of user days reflects the presence or absence of large population centers nearby.

A direct comparison between the recreational use estimates presented in Tables 1 and 2 and the updated data presented in the following sections is not appropriate due to the differences in lengths of the study reaches, methods used to derive the numbers, and the differences in the purposes among the various studies used as source material for this document.

Overall, the following major themes were identified from the data collected for this analysis:

- Fishing appears to be the major recreational activity engaged in along all segments of the Missouri River studied.

- The Fort Peck River Segment has fewer recreational visitors than the other segments.
- Seasonality is an important component of recreation that needs to be considered in implementing the emergent sandbar habitat (ESH) Program. For example, a substantial proportion (16 percent) of all recreation on the Fort Randall River and Lewis & Clark Lake segments occurs during the autumn months. Except for hunting, however, the ESH construction and maintenance activities are scheduled to occur outside of the peak summer recreation season, which is similar to the least tern and piping plover nesting periods. These nesting periods can begin as early as April 15 and end as late as August 25. USFWS consultation with the Corps on ESH construction activities established an April 1 to September 15 restriction on construction activities within 0.25 mile of an active least tern or piping plover nesting site. Recreation is currently, and will continue to be, restricted by posting where and when these two species are nesting.
- Waterfowl hunting is a major recreational activity along the Fort Randall River, Lewis & Clark Lake, and Gavins Point River segments.
- Recreation is not evenly distributed within a segment. Instead, it is often highly concentrated in areas within a segment, such as in proximity to dams or around municipal areas such as in and around Bismarck, ND on the Garrison River Segment.

Qualitative (descriptive) information and quantitative data regarding the characteristics, volume, timing, and intensity of recreational use in the different Missouri River segments, sections or reaches within a segment, and at individual recreational sites are presented in the following sections of this appendix. This material provides information that can be used to assess the effects of the different ESH Programmatic Environmental Impact Statement (PEIS) alternatives on riverine recreation.

1.4 Organization of Report

This report is organized to characterize the recreational use of the upper Missouri River, by segment, from upstream to downstream. The general recreation characteristics of each segment and any outstanding recreational characteristics are identified. Information on characteristics of recreational activities, insights into recreational quality, and data on recreational use provided by state agencies are presented by reaches within segments wherever possible. A table providing river access sites visited in the segment in 2006 and their major facilities is presented near the end of each section and is updated to 2009 conditions. To identify trends in river-based recreation use in each segment in future years when no intensive visitor surveys are conducted, visitation data from Corps recreation areas within each segment for several recent federal fiscal years (FY; October 1 through September 30) through Fiscal Year 2008 (October 1, 2007 through September 30, 2008), are also presented for each of the segments. The Fort Randall River and Lewis & Clark Lake segments are combined in the same section of the report because they are the only segments in the ESH PEIS that are contiguous; they have surveyed reaches located in more than one segment; and many persons engage in the same recreational activities in both segments. Finally, important information and/or observations regarding recreation are also presented for each segment.

2 Fort Peck Dam to Lake Sakakawea Headwaters near Williston, ND (Fort Peck River Segment)

2.1 Fort Peck River Segment: General Setting

The Fort Peck River Segment extends over 200 river miles, flowing unchannelized from west to east from just downstream of the Fort Peck Dam in Fort Peck, Montana, to Williston, North Dakota, below the confluence with the Yellowstone River. Major tributaries include the Milk, Poplar, and Yellowstone rivers, although the latter enters the Missouri River just upstream of the Lake Sakakawea delta and influences only a short reach within the Fort Peck River Segment. Abandoned channels and several oxbow lakes remain in the flood plain. Upstream of Brockton, Montana (RM 1660), the flood plain is about 4 miles wide and is bordered by rolling grasslands, dry land crops, and rangelands. Downstream from this point, the flood plain narrows to a 1-mile-wide valley surrounded by badlands (USACE, 2004).

The 2000 Census (U.S. Bureau of the Census, 2000) reports the combined population for the four first tier[2] Montana counties (those adjacent to the Missouri River)--Valley, Richland, Roosevelt, and McCone-- was 29,939. By 2004, the estimated population was 28,817 (U.S. Bureau of the Census, 2006), representing a decrease of nearly 12 percent since the 1990 census. The population densities of Valley, McCone, Richland, and Roosevelt counties are 2, 0.75, 4.6, and 4.5 persons per square mile, respectively.

The Fort Peck River Segment also intersects two North Dakota counties (Williams and McKenzie). The combined population for these two counties in 2000 was 25,498 (U.S. Bureau of the Census, 2000). By 2004, the estimated population was 24,777 (U.S. Bureau of the Census, 2006), representing a decrease of more than 11 percent since the 1990 census. The population density of Williams and McKenzie counties in North Dakota is 10 and 2 persons per square mile, respectively.

The climate of this part of Montana is typical of the North American high plains. Winters are moderately cold, with average January minimums near zero degrees Fahrenheit (F) and occasional cold periods below –20 degrees F. Summers are generally pleasant, with temperatures averaging in the 80s during afternoon hours and occasional hot periods exceeding 100 degrees F. Low humidity, high temperatures, and moderate to strong winds cause rapid loss of soil moisture. Mean annual precipitation is 12-13 inches, with about 70 percent occurring from April to September. The average frost-free period is about 120 days. The area is also subject to intense lightning storms from July into September, often resulting in wildfires (USFWS, 1985).

The Fort Peck River Segment is in a sparsely populated area of the United States, with associated low levels of highway traffic. The largest road in the area is U.S. Route 2 that runs east-west on the north side of the Missouri River through the entire segment. State and local roads provide

[2] The Master Manual FEIS (USACE, 2004) defined the area of analysis for socioeconomic considerations to be "first tier" counties where the Missouri River intersected a county. The same convention will be used for this report.

access to homes, ranches, and communities in the area. Public access to the river is limited to the recreation sites listed in Table 6a. The prominent water-related activities along this segment are boating and fishing. Designated swimming areas exist at only two sites along this segment (the Floodplain Recreation Area and the Culbertson Bridge Fishing Access Site). It is important to note that the swimming area at Lewis and Clark State Park (ND), although in the pool of Lake Sakakawea and therefore outside of the free-flowing river segment, was unusable at the time of the site visit in 2006 because of drought-impacted low lake levels and had been unusable for a number of years.

Each recreation site along this segment included a boat ramp and parking facilities for boat trailers. The ramps at some locations were unimproved dirt or gravel, and a few sites had no facilities for picnicking or other activities. In 2006, drought conditions made the extensive boating facilities at Lewis and Clark State Park (ND) (including boat ramps, docks, gas dock, and a protected marina) inoperable because they were no longer inundated. The prolonged drought may have resulted in increased riverine recreation if boaters who would typically use the facilities at Lewis and Clark State Park use access points on the river instead because water levels in the riverine segment are more stable and boat ramp/recreation facilities remain accessible.

During the site visits in 2006, sandbars were visible from only one recreation site along this segment. Educational signage concerning the protected interior population of least terns (hereafter referred to as least terns) and piping plovers and their habitat were conspicuously located at most recreation areas along this segment.

The Montana Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2008 to 2012 identified the recreational activities that are most in need of additional facilities or sites in each planning region. For the two regions with counties located in the Fort Peck River Segment, the activities with greatest facility/area needs are: swimming, walking, and fishing in Region 6 (which includes first tier Valley, McCone, and Roosevelt counties); and swimming, fishing, and motorized boating in Region 7, which includes first tier Richland County (MFWP, 2008).

The North Dakota 2008-2012 State Comprehensive Outdoor Recreation Plan (SCORP) identifies trails, picnic areas, beaches/water access, and campgrounds as the top four recreation development needs for the entire state and also for Region 1, which includes all first tier counties in the North Dakota reach of the Fort Peck River Segment (NDPRD, 2007). The priority facility needs identified in the first tier counties in both Montana and North Dakota are commonly associated with river- and/or water resource-based recreation and highlight the importance of recreation along the Missouri River in this segment.

Wildlife-associated recreation activities are important to residents of Montana (MT). Approximately 40 percent of MT residents at least 16 years old participated in hunting, fishing, or both in 2001, and 31 percent in 2006. Despite the decrease in participation in 2006, due at least partly to drought-related conditions, MT had the second-highest percentage among the 50 states in both 2001 and 2006. In addition, approximately 28 percent of adult MT residents took trips away from home to observe, photograph, and/or feed wildlife in 2001, and 24 percent did so in 2006 (USFWS/USCB, 2002, 2008).

Adults spent about 4,068,000 days fishing in MT in 2001 and about 2,927,000 days in 2006. MT residents accounted for 86 percent of these adult fishing days in 2001 and 81 percent in 2006. Expenditures by adult anglers in MT totaled about $292,050,000 in 2001, of which about $148,824,000 ($36.58 per fishing day) was trip-related and the remainder was for equipment and other items. In 2006, although adult anglers spent fewer days fishing in MT than in 2001 and their total fishing-related expenditures in MT decreased to about $226,349,000, the trip-related portion of these expenditures actually increased to about $149,800,000 ($51.18 per fishing day) (USFWS/USCB, 2002, 2008).

Adults spent about 2,442,000 days hunting in MT in 2001 and about 2,142,000 days in 2006. MT residents accounted for 84 percent of these adult hunting days in 2001 and 83 percent in 2006. In 2001, adults targeted big game on 74 percent and migratory birds on 9 percent of their hunting days in MT; in 2006, these were targeted on 89 and 3 percent of the adult hunting days in MT, respectively. Expenditures by adult hunters in MT totaled about $237,605,000 in 2001, of which about $107,072,000 ($43.85 per hunting day) was trip-related and the remainder was for equipment and other items. Although adult hunting days in MT decreased between 2001 and 2006, total expenditures by hunters in MT in 2006 increased to about $310,540,000, of which about $132,808,000 ($62.00 per hunting day) was trip-related (USFWS/USCB, 2002, 2008).

Wildlife watching is popular in MT. Approximately 511,000 people 16 years of age or older (adults) took trips away from home, for a total of about 4,612,000 days (9 days per adult), to observe, photograph, and/or feed wildlife in MT in 2001. Of these, adult MT residents accounted for approximately 2,812,000 days (61 percent). Expenditures in MT related to wildlife watching in MT by MT residents and non-residents in 2001 totaled about $350,335,000, of which about $207,496,000 ($44.99 per day) was for trip-related expenses and the remainder was for equipment and other items (USFWS/USCB, 2002). In 2006, 512,000 adults took trips away from home to observe, photograph, and/or feed wildlife in MT, for a total of 3,081,000 days (6 days per adult), of which about 1,578,000 days (51 percent) were by MT residents. Expenditures in MT in 2006 related to wildlife watching totaled about $376,451,000, of which about $302,625,000 ($98.22 per day) was trip-related (USFWS/USCB, 2008).

2.2 Fort Peck River Segment: Fish Stocking

In 2006, the Montana Fish, Wildlife and Parks Department (MFWP) stocked the Montana reach of the Fort Peck River Segment (Montana reach) with 4,500 pallid sturgeon (1–9 inches long) from the Fort Peck Hatchery and 4,500 pallid sturgeon (1–9 inches long) from the Miles City Fish Hatchery (MFWP, 2007). The Fort Pack Hatchery is located at the tail waters of the Fort Peck Dam; and the Miles City Fish Hatchery is located at Miles City, MT, on the Yellowstone River. The pallid sturgeon is a federally listed endangered species. Montana’s 2006 Fish Stocking Plan does not identify any other species being stocked by the state in the Montana reach. Historically, the Montana reach has been stocked with both warm water game species (e.g., largemouth bass) and cold water game species (e.g., Arctic grayling and brown and rainbow trout).

On the North Dakota reach of this segment, from the Montana state line to Lake Sakakawea, the Missouri River had been historically stocked with paddlefish fingerlings by the North Dakota Game and Fish Department (NDGFD) in 1986, 1988, 1989, and 1990. However, no statesponsored fish stocking has occurred in the North Dakota reach of the Fort Peck River Segment (North Dakota reach) since 1990, with the exception of 40 pallid sturgeon fingerlings that were stocked at the confluence with the Yellowstone River in 1998 (NDGFD, 2008).

2.3 Fort Peck River Segment: Angler Use

Because of the relatively shallow river depths in the Missouri River downstream from Fort Peck Dam in Montana, approximately 95 percent of the fishing in this segment is done from shore. Most anglers are day users; only about 5 percent camp overnight. The majority of the angling along the Missouri River in the Montana reach is done near fishing access sites, which are listed in Table 6a; near bridges and population centers; and on private land where picnic areas have been constructed. The majority of boat anglers fish near the fishing access sites and tend not to travel far away due to the shallow nature of the river. The same main species are harvested by both shore and boat anglers: sauger, walleye, and paddlefish in the spring; catfish and sauger in the summer; and sauger and walleye in the fall. Trout are also caught near Fort Peck Dam. Most boats used by Missouri River anglers range from 12 to 18 feet long. Most of these boats, especially those used to catch channel catfish and sauger (Haddix and Fuller, pers. comm., 2009), are flat-bottomed jet boats. The motor on jet boats does not have the propeller hanging down like “jon boats” do, so there is less chance of boats running aground in shallow water or having propellers damaged by encountering cobbles or gravel on the river bottom (Ruggles, pers. comm., 2009).

Most anglers from the Fort Peck Tribes fish from shore. Over half of the Tribal shoreline anglers use a set line that extends 60 to 70 feet out into the river and has up to five hooks plus a weight at the end to “anchor” it to the river bottom. The lines are set out early in the morning and are checked for hooked fish in the evening. Fishing and hunting on the Fort Peck Reservation require only a Tribal license (Magnan, pers. comm., 2009a) and are engaged in as recreational activities rather than for subsistence (Magnan, pers. comm., 2009b). The most frequently caught species are walleye, Northern pike, paddlefish, and burbot (*Lota lota*), commonly called eelpout or ling; a few channel catfish are also harvested. There are a few boat anglers in the Missouri River along the Reservation; some boats are up to 25 feet long with outboard motors, but jon boats with flat bottoms and jet boats that have no propellers are more frequently used, as sometimes the Missouri River is only 16 inches deep and there may be fallen trees lying on the river bottom. Most fishing is day use; a few may camp near the shore, but most of those who camp use campgrounds at the Corps’ Fort Peck Dam and Lake project (Magnan, pers. comm., 2009a).

The MFWP estimates annual angler use of many of the state’s water bodies, including multiple reaches of the Missouri River, through a statewide mail survey. The reach of the Missouri River from just below Fort Peck Dam downstream to the North Dakota state line is classified by the MFWP as having “outstanding” fisheries resource value, which is the highest classification. Angler use of this Montana reach has become more variable in recent years, from an average of 7,962 user days in 1997, 1999, and 2001 to 4,459 in 2003, 8,589 in 2005, and 5,084 in 2007. The average annual angler days along this Montana reach from 1997 through 2007 is 6,993. Approximately 96 percent of this angler use is by Montana residents (MFWP, 2009).

Table 3
Fort Peck River Segment – Montana Reach Annual Angler Use

	Fort Peck Dam to Milk River		**Milk River to North Dakota Border**		**Totals**	
	Days	Trips	Days	Trips	Days	Trips
1997	2,978	60	5,337	127	8,315	187
1999	2,765	71	5,529	123	8,294	194
2001	5,200	107	2,017	34	7,217	141
2003	1,644	38	2,815	57	4,459	95
2005	6,165	110	2,424	44	8,589	154
2007	1,794	35	3,290	41	5,084	76
Average	3,424	70	3,569	71	6,993	141

Source: MFWP, 2009.

In the North Dakota reach, fishing occurs throughout the year between the confluence of the Yellowstone and Missouri rivers and the upstream end of Lake Sakakawea. Ice fishing in this riverine area begins when the river ices over, around December 1; 15 to 60 ice houses are sited here in addition to those on frozen Lake Sakakawea. Spring fishing begins when the river ice melts, around April 1; walleye and sauger are the major sport fish caught. The NDGFD and MFWP work cooperatively each year to establish appropriate paddlefish harvest goals. Because the 2-month paddlefish season ends when this goal is attained, often within 10 days after the season begins May 1, paddlefish angling pressure is short-term and intense (Luttschwager, pers. comm., 2009). Fall fishing, mainly for walleye and sauger (Ryckman, pers. comm., 2009), occurs from September until the river is ice covered. Approximately 30 percent of fall anglers fish from shore, and 70 percent from a boat. Most boats used are at least 16 feet long and have outboard motors; some also have trolling motors (Luttschwager, pers. comm., 2009). Most boat anglers launch from the two boat ramps in the North Dakota reach: at the U.S. Highway 85 Bridge near Williston; and the Confluence Recreation Area (RA). Boat anglers fish in both shallow and deeper areas of the Missouri River and will move to sites far from the ramp if needed to achieve harvest success. The confluence area is attractive to anglers because of its diverse fishery habitat. Several shore fishing access points are located along the Missouri River in the North Dakota reach. The most frequently used of these accesses is the Pumphouse Pedestrian Access, located 4 to 5 miles upstream from U.S. Highway 85. This access is used by many shore anglers and can become crowded in the fall, when the water has relatively high clarity (Ryckman, pers. comm., 2009).

Although the NDGFD has not published angler use data (other than paddlefish snagging data) for the reach of the Missouri River from the Montana State line downstream to Lake Sakakawea, data are available for the entire Missouri River system within North Dakota (NDGFD, 2007).

The NDGFD estimates that between 40 to 50 percent of North Dakota's licensed anglers use the Missouri River system, which includes the riverine segments and impounded waters of Lake Sakakawea and Lake Oahe. Table 4 presents estimated North Dakota resident angler use of the Missouri River system within North Dakota, based on a statewide angler questionnaire.

Table 4
Missouri River System[1] within North Dakota: Resident Angler Use

Years	Anglers	Angler Days
1980-1984	54,200	No Data
1985-1989	51,500	No Data
1990-1994	39,200	459,000
1995-1999	57,000	843,000
2000-2004	60,500	732,500

Source: NDGFD, 2007. [1] Includes lakes and pools.

The NDGFD conducts an annual telephone survey of paddlefish snagging in the North Dakota reach of the Fort Peck River Segment. Paddlefish snagging data is presented in Table 5.

Table 5
Fort Peck River Segment – North Dakota Reach: Annual Paddlefish Snagging Use

Year	Persons Snagging ≥ 1 Day	Mean Days per Snagger*	Total Snagging Days*	Mean Hours per Snagger*	Total Snagging Hours*	Total Paddlefish Harvested
2008	2,867	2.01	5,815	5.34	15,308	1,114
2007	2,860	2.29	6,538	6.09	17,421	829
2006	2,743	2.69	7,384	8.38	22,989	1,059
2005	2,521	2.43	6,118	5.01	12,636	1,100
2004	3,006	2.87	8,621	7.77	23,354	1,076
2003	3,063	2.65	8,120	11.90	36,447	1,041
2002	3,335	2.60	8,671	10.80	36,018	1,364
2001	4,016	2.60	10,442	11.50	46,184	1,566

2000	3,734	3.70	13,816	17.90	66,839	2,205
1999	3,434	3.80	13,779	18.80	68,169	1,309
1998	3,767	3.64	13,712	15.00	56,505	1,970
1997	2,598	3.67	9,535	15.10	9,230	800

Source: North Dakota Game and Fish Department (NDGFD), 2009.
*Snagging days and hours included efforts for snag & release (as well as snag & harvest) beginning in 2003, and included efforts for extended snag & release beginning in 2007.

2.4 Fort Peck River Segment: Other River-Related Recreation

Most hunting in the Montana reach is day use; few hunters camp overnight. Pheasants are hunted on foot along borders of grain fields and in riparian grasslands found between cottonwood-green ash-willow woodland riparian patches on the flood plain. Sharp-tailed grouse are hunted on foot on the uplands adjacent to the river bottomlands. White-tailed deer are hunted on foot in bottomland agricultural fields and riparian areas. Mule deer are hunted in foothills and breaks adjacent to the river. Deer also swim to islands in the river to escape hunters and to browse. Deer hunters access the islands in boats ranging from small flat-bottomed jon boats to boats 22 feet long (Wentland, pers. comm., 2009). Wild turkeys were re-introduced on the Fort Peck Reservation about 5 years ago, and soon their population will have grown enough to enable them to be hunted. Only Tribal members are able to hunt furbearers on the Reservation, and none of these game species are hunted along the Missouri River. Likewise, antelope and upland birds (pheasant, sage grouse, sharptail grouse, and Hungarian partridge) are hunted on the Reservation far from the Missouri River. On Reservation lands, Tribal members are allowed to trap bobcat, beaver, and muskrat (all of which are found along the Missouri River) as well as coyote (Magnan, pers. comm., 2009a).

The Fort Peck River Segment is a staging area for migrating geese and ducks in the spring and fall, where they rest and forage before continuing their migration. The reach of the Missouri River from Fort Peck Dam to Wolf Point also serves as a wintering area for Canada geese and mallards during most winters. Waterfowl are hunted as they forage in harvested fields, and when they return to the river to rest on gravel bars. Waterfowl hunters access islands and gravel bars with small jon boats and larger jet boats (Wentland, pers. comm., 2009). Most boats used in waterfowl hunting on the Montana reach are flat-bottomed jet boats, on which the propeller does not extend downward and so facilitates use in shallow water (Haddix and Fuller, pers. comm., 2009). The larger boats require boat ramps for launching (Wentland, pers. comm., 2009).

Hunting for white-tailed deer is extensive in the riparian woodlands along the Missouri River in the North Dakota reach of the Fort Peck River Segment. Most hunting trips are day use only, with no overnight camping. Bow hunting season extends from September 1 to January 3. Deer rifle season lasts 16.5 days, beginning the first weekend in November, and the Friday after that season ends, the 16.5-day deer muzzleloader season begins. Some hunting areas are accessed by walking, and some by boat from ramps at the Confluence RA or U.S. Highway 85 Bridge. Most waterfowl hunting is done using decoys and/or blinds in harvested fields where migrating ducks and geese (especially Canada geese) forage for residual grain, rather than near the Missouri River. Blinds and pre-dawn arrival of hunters reduce disturbance to the waterfowl until the feeding flock is large enough to maximize the chances of a successful shot. Because the waterfowl are easily disturbed by noise and human movements, loud noise and intensive human activity even some distance away may result in waterfowl abandoning a foraging area for another, quieter one (Luttschwager, pers. comm., 2009).

In the Fort Peck River Segment, a number of river access points are utilized for launching boats used for fishing, waterfowl hunting, and pleasure boating; other water resource-based recreational activities may also occur at these boat access areas. At Bridge Park, southeast of Wolf Point, MT, boating and other activities are enjoyed at the Lewis and Clark Fishing Access Site, where a semi-improved boat ramp and public restrooms are located. South of Poplar, MT, swimming in the Poplar River is enjoyed near the unimproved Dago Bend ramp, a launch site for Missouri River boaters about a mile upstream from the Poplar-Missouri River confluence. At Brockton, MT, boats can be launched into the Missouri River from an unimproved ramp on land owned by Jim Shanks, at RM 1651.0. Across the Missouri River from Culbertson, MT, just off MT Highway 16 is the Culbertson Bridge Fishing Access Site, which has an improved concrete ramp, and restrooms that is the focus for boat launching and other water resource-based recreational activities. Boaters also use the concrete Fort Buford Ramp at Fort Buford, ND, near the Lewis and Clark interpretive center at the Yellowstone-Missouri confluence (Shafer, pers. comm., 2009).

On the Missouri River in Montana downstream from the confluence with the Milk River (just downstream of Fort Peck Dam), canoe and kayak use constitutes approximately 20 percent of total boating use, and most of the non-motorized boating occurs in the summer (Haddix and Fuller, pers. comm., 2009). Pontoons that float on top of the water are also used (Magnan, pers. comm., 2009a). Motorized boating use here is relatively low because of the shallowness of the Missouri River downstream of the Milk River confluence (Haddix and Fuller, pers. comm., 2009). Boating activities commonly occur in flat-bottomed jet boats; the motor on these boats does not have the propeller hanging down like jon boats do, so there is less chance of boats running aground in shallow water or having propellers damaged by encountering cobbles or gravel on the river bottom (Ruggles, pers. comm., 2009). Jet boats are the most effective way to navigate long distances in the Montana reach because shallow depths may be frequently encountered. Most jet boats and boats with standard outboard motors used for pleasure boating have lengths ranging from 12 to 18 feet. Waterskiing is relatively rare in the section of the Montana reach downstream from the Milk River confluence, and relatively few boaters access islands to camp and/or engage in beach activities due to the mosquitoes and gnats that are found there (Haddix and Fuller, pers. comm., 2009).

Published data concerning boating, swimming, hunting or other river-related recreation along the Fort Peck River Segment is not available. The undercurrents on the Missouri River discourage many from swimming in the river. Although no hiking trails are located along the Missouri River, bird watching is popular, especially near the confluence with the Poplar River (Magnan, pers. comm., 2009a). The Review and Update Study (USACE, 1994) estimates 55,000 annual recreation user days along this segment. This segment does not have the facilities or nearby large population centers found in the other segments that accommodate more varied and intensive recreation use. For this reason, although current data on recreational uses other than fishing are not available, it is likely that the Fort Peck River Segment is used less intensively for non-angling river-related recreation activities than are the other segments. For those who recreate in the Fort Peck River Segment, however, the rural setting, naturalistic and scenic views, and relative solitude are important aspects of their recreational experience.

2.5 Fort Peck River Segment: Sites Visited

Locations of recreation areas and public river access points visited in the Fort Peck River Segment are identified by river mile in Table 6a. Information about facilities at each site visited is also provided in Table 6a. The number of visits to Corps water resource-based recreation areas downstream of Fort Peck Dam for several recent fiscal years is provided in Table 6b.

Table 6a
Missouri River Recreation Sites: Fort Peck River Segment

River Mile and Site Name	Boat Ramps	Boat Trailer Parking	Campsites (RV, Camper, Tent)	Swim Beach
1771 Fort Peck Floodplain RA (1)	2	20	6	Yes
1769.8 Roundhouse Point RA (1)	1	20	4	No
1768.7 Boy Scout RA (1)	1	15	None	No
1766.4 Nelson Dredge RA (1)	1	3	None	No
1764.1 School Trust Fishing Access Site * (1)	1	6	None	No
1701.5 Lewis & Clark Fishing Access Site (Wolf Point/Route 13 Bridge Access Site) * (1)	1	7 + overflow *	None	No
1678.9 Poplar River Access Point (1)	1	3 + overflow *	None	No
1620.8 Culbertson Bridge Fishing Access * (1)	1	5 *	None	No**
1589 Snowden Bridge Fishing Access Site* (1)	Canoe*	5 *	3 + tent *	No *
1581.4 Confluence RA (2)	1	60	None	No
1556 Pumphouse Pedestrian Access * (2)	None	None	None	No
1552.6 Lewis and Clark WMA Fishing Access** (2)	1	Some	None	No

RA = Recreation Area. WMA = Wildlife Management Area. (1) Montana. (2) North Dakota.

* Updated 2009. Sources of update: Baxter, personal communication, 2009; Fryda, personal communication, 2009; Ruggles, personal communication, 2009; Ryckman, personal communication, 2009.

** Updated 2010. Sources of update: Baxter, personal communication, 2010; NDGFD, Missouri River Boating/ Fishing Access Sites, accessed April 19, 2010 at http://www.gf.nd.gov/.

Table 6b
Corps Missouri River Recreation Area Visits: Downstream of Fort Peck Dam

River Mile and Site Name	FY2000	FY2002	FY2004	FY2006	FY2008
1771.0 Downstream Campground RA	40,900	25,155	25,023	28,987	58,352
1771.0 Floodplain RA	4,436	4,253	4,217	3,407	34,668
1769.8 Roundhouse Point RA	4,880	3,876	3,307	3,217	25,115
1768.1 Dredge Cut Fishing Access Site *	6,353	4,487	3,491	3,927	3,217
1770.0 First Dredge RA	3,086	3,044	1,789	5,822	11,329
1769.2 Second Dredge RA	2,050	2,610	2,319	2,108	11,025
1768.7 Boy Scout Park RA	2,385	2,637	1,813	5,883	6,179
1766.4 Nelson Dredge RA	2,079	2,416	2,433	4,877	23,115
Total d/s Water Resource-Based Visits	66,169	48,478	44,392	58,228	173,000

Sources: USACE, 2008a; USACE, 2008b.

RA = Recreation Area; all sites are in Montana. *Formerly known as Trout Pond RA.

2.6 Fort Peck River Segment: Observations

The Fort Peck River Segment has less recreational use than any of the other segments assessed in this analysis. The low number of recreational visitors on the Missouri River from Fort Peck Dam to Lake Sakakawea is very likely due to the relatively low population and population density in this area of Montana and North Dakota. The short warm season (120 frost-free days) and cold winters also would likely reduce the total number of days per year that recreationists can engage in certain outdoor recreational activities, such as camping or swimming, in this segment.

3 Garrison Dam to Lake Oahe Headwaters near Bismarck, ND (Garrison River Segment)

3.1 Garrison River Segment: General Setting

Below Garrison Dam, the Missouri River flows approximately 86 miles in a south-southeasterly direction, passing the cities of Bismarck and Mandan, ND before entering Lake Oahe. Significant tributaries include the Knife River near Stanton, ND and the Heart River just upstream of the Lake Oahe delta and downstream of Mandan. Within the Garrison River Segment, the floodplain terraces form a complex of different low-lying landforms, many at an elevation within three feet above the river. This segment is also restricted to one main channel with very few side channels, old channels, or oxbow lakes.

First tier counties in the Garrison River Segment (Burleigh, Morton, Oliver, McLean, and Mercer counties) had a 2000 population of 114,739 (U.S. Bureau of the Census, 2000). By 2004, the estimated population was 117,048 (U.S. Bureau of the Census, 2006), an increase of about 9 percent since the 1990 census. Burleigh County includes the City of Bismarck (population 57,000), accounting for the much higher population density there (42 persons per square mile) than for the other counties (13 per square mile for Morton County, 8 per square mile for Mercer County, 4 per square mile for McLean County, and 3 per square mile for Oliver County).

The region has a high latitude continental climate where there is little natural shelter from the climatic extremes. Winters are often long and cold, with occasionally severe blizzards. Cold spells with temperatures below zero degrees F for several days are not unusual (USACE, 1978). Summer temperatures near or above 100 degrees F are not uncommon, and clear to partly cloudy conditions prevail on 80 percent of the days during this season (USACE, 1978). The frost-free growing season averages 140 days per year and due to the northern latitude, long hours of sunlight occur in the summer months. During the summer season, thunderstorms bring a large share of the area's annual precipitation, with 75 percent of the area's precipitation occurring between April and September. Total annual rainfall averages between 14 and 15 inches per year (USACE, 1978).

This region of North Dakota, including Bismarck, is bisected by one U.S. highway, U.S. 83, and one interstate highway, Interstate 94, which runs through the northern part of the city. Access to the Missouri River along the Garrison River Segment is mostly limited to a small number of public access points, with the exception of the area surrounding Bismarck, ND. There is a major increase in accessibility, public and private, as the river approaches and proceeds through the Bismarck-Mandan area. The upper end of the segment--just downstream of Garrison Dam--provides camping opportunities at two very large campgrounds. These campgrounds also include boat ramps and other facilities. The stretch of river between the campgrounds and the outskirts of Bismarck has few access points, most of which consist of boat ramps with parking areas. In the vicinity of Bismarck there are numerous boat ramps, marinas, and an area of long sandy beach known as the Desert, which is a focal point for water-based recreation and off-road vehicle recreation.

Signage educating the public on the protected least terns and piping plovers was observed at only three locations: the Garrison Dam Downstream Recreation Area, the Garrison Dam Downstream Campground, and the Washburn Boat Ramp. Local boaters confirmed that sandbars are commonly used as beach areas and swimming access. The boaters were also aware that least terns and piping plovers use the sandbars for nesting.

The North Dakota 2008-2012 State Comprehensive Outdoor Recreation Plan (SCORP) identifies trails, picnic areas, beaches/water access, and campgrounds as the top four recreation development needs for the entire state and also for Region 7, which includes all first tier counties in the Garrison River Segment (NDPRD, 2007). These priority facility needs are commonly associated with river- and/or water resource-based recreation and highlight the importance of recreation along this segment of the Missouri River.

Wildlife-associated recreation activities are important to residents of North Dakota (ND). Approximately 35 percent of ND residents at least 16 years old (adults) participated in hunting, fishing, or both in 2001; this was the fifth-highest percentage among the 50 states (USFWS/USCB, 2002). Although this decreased to 29 percent in 2006 due partly to drought-related conditions, ND was fourth-highest of the 50 states (USFWS/USCB, 2008). In addition, about 10 percent of adult ND residents took trips away from home to observe, photograph, and/or feed wildlife in 2001, and 6 percent did so in 2006 (USFWS/USCB, 2002, 2008).

Waterfowl hunting, much of which occurs along the Missouri River system, was engaged in by over 35,000 ND residents during the 2001-2002 hunting season, for an average of 8 hunting days each. Direct expenditures for waterfowl hunting in ND were over $28.5 million for ND residents and over $20.9 million for non-residents in that season. For all types of hunting, direct expenditures in ND during the 2001-2002 season were over $132.4 million for ND residents and nearly $34 million for non-residents (Bangsund and Leistritz, 2003a, 2003b).

Adults spent about 1,635,000 days hunting in ND in 2001 and about 1,344,000 days in 2006. ND residents accounted for 83 percent of these adult hunting days in 2001 and 80 percent in 2006. In 2001, adults targeted big game on 35 percent of the hunting days and migratory birds on 25 percent of the hunting days; in 2006, these were targeted on 42 and 14 percent of their hunting days, respectively. Expenditures by adult hunters in ND totaled about $103,353,000 in 2001, of which about $53,723,000 ($33.06 per hunting day) was trip-related and the remainder was for equipment and other items. Although there were fewer adult hunting days in ND in 2006 than in 2001, expenditures by adult hunters in ND increased to about $129,114,000 in 2006, of which about $72,445,000 ($53.90 per hunting day) was trip-related (USFWS/USCB, 2002, 2008).

Adults spent about 2,186,000 days fishing in ND in 2001 and about 953,000 days in 2006. ND residents accounted for 90 percent of these adult fishing days in 2001 and 95 percent in 2006. Expenditures by adult anglers in ND totaled about $159,023,000 ($72.75 per fishing day) in 2001, of which about $57,703,000 ($26.40 per fishing day) was trip-related and the remainder was for equipment and other items. Expenditures in 2006 by adult anglers in ND totaled about $93,729,000 ($98.35 per fishing day), of which about $39,076,000 ($41.00 per fishing day) was trip-related (USFWS/USCB, 2002, 2008).

An economic activity multiplier for ND was estimated for expenditures in ND by non-resident hunters and anglers during the 2001-2002 period using data from a study by Bangsund and Leistritz (2003a, 2003b). To do this, direct expenditures were compared to the total economic activity generated by those expenditures. Direct expenditures in ND of $33,962,400 by residents of other states (non-residents) for hunting generated a total of $78,510,400 of economic activity in ND. The ratio/multiplier of direct expenditures to the total level of economic activity generated was 2.31; this means that for every dollar of non-resident expenditures, $1.31 of indirect economic activity was generated. The same computation was made for fishing. Direct expenditures of $31,897,700 in ND for fishing by non-residents during the 2001-2002 period generated an overall economic activity of $71,161,700. The multiplier for this activity was 2.23. Similar figures based on relatively recent data were not available for other recreational activities or other states. When combined, these multipliers average 2.27. This composite factor for non-resident hunting and fishing for the State of ND is believed to be representative of the Upper Missouri River states due to the similarity of their economies, and as such it is considered sufficient for the purposes of this analysis.

Approximately 93,000 adults took trips away from home, for a total of about 523,000 days (5.6 days per adult), to observe, photograph, and/or feed wildlife in ND in 2001. Of these, adult ND residents accounted for approximately 396,000 days (76 percent). Expenditures in ND related to wildlife watching in ND by ND residents and non-residents totaled approximately $27,100,000, of which about $9,361,000 ($17.90 per day) was for trip-related expenses and the remainder was for equipment and other items (USFWS/USCB, 2002). In 2006, partly due to drought conditions, these figures were reduced to approximately 39,000 adults for about 264,000 days (6.8 days per adult). Adult ND residents accounted for about 168,000 (64 percent) of these days. Expenditures by adults in ND in 2006 related to wildlife watching totaled about $22,913,000, of which about $4,952,000 ($18.76 per day) was trip-related (USFWS/USCB, 2008).

3.2 Garrison River Segment: Fish Stocking

The NDGFD regularly stocks the upstream end of this segment with trout (NDGFD, 2008). Each year since 1997, trout fingerlings (young fish 1 to 10 inches in length) have been stocked at the Garrison Dam tailrace and in some years at the Underwood Ramp at the Riverside Wildlife Management Area (WMA). In addition, a total of 153,572 Chinook salmon smolt (young salmon 4 to 6 inches in length) were stocked at the Garrison Dam tailrace in 2006, 2007, and 2008. Table 7 presents the NDGFD fish stocking data in this segment.

Table 7
Missouri River Fish Stocking: Garrison River Segment

Year	Location	Type	Size	Number
2008	Garrison Dam Tailrace	Brown Trout	Fingerling*	13,972
2008	Garrison Dam Tailrace	Chinook Salmon	Smolt**	50,000
2008	Garrison Dam Tailrace	Rainbow Trout	Fingerling	20,040
2007	Garrison Dam Tailrace	Brown Trout	Fingerling	4,500
2007	Garrison Dam Tailrace	Chinook Salmon	Smolt	53,572
2007	Garrison Dam Tailrace	Cutthroat Trout	Fingerling	17,640
2007	Garrison Dam Tailrace	Rainbow Trout	Fingerling	21,240
2006	Garrison Dam Tailrace	Brown Trout	Fingerling	22,400
2006	Garrison Dam Tailrace	Chinook Salmon	Smolt	50,000
2005	Garrison Dam Tailrace	Cutthroat Trout	Fingerling	40,582
2004	Garrison Dam Tailrace	Brown Trout	Fingerling	39,222
2003	Garrison Dam Tailrace	Cutthroat Trout	Fingerling	37,908
2002	Garrison Dam Tailrace	Brown Trout	Fingerling	45,522
2002	Garrison Dam Tailrace	Cutthroat Trout	Fingerling	5,000
2001	Garrison Dam Tailrace	Cutthroat Trout	Fingerling	30,451
2001	Underwood Ramp	Cutthroat Trout	Fingerling	10,836
2000	Garrison Dam Tailrace	Brown Trout	Fingerling	44,262
1999	Garrison Dam Tailrace	Cutthroat Trout	Fingerling	31,835
1999	Underwood Ramp	Cutthroat Trout	Fingerling	10,300
1998	Garrison Dam Tailrace	Rainbow Trout	Fingerling	39,967
1997	Garrison Dam Tailrace	Brown Trout	Fingerling	82,172

Source: NDGFD, 2008. * Fingerlings = young fish 1-10 inches long. ** Smolt = young salmon 4-6 inches long.

Note: An additional 20,854 brown trout fingerlings were stocked at an unidentified Missouri River location in 2006.

3.3 Garrison River Segment: Angler Use

Most Missouri River shoreline fishing access in this segment occurs near boat ramps; anglers park their vehicles in the boat ramp parking area and walk along the bank line to a good spot for shore fishing. Most shoreline fishing occurs during March, April, and May, especially near Bismarck and Mandan (Fryda, pers. comm., 2009). Boat anglers use a wide variety of boat sizes. Most angling consists of day use and does not involve camping. However, a small percentage of boat anglers camp on sandbars to enjoy the aesthetics and naturalistic setting provided by the island's location in the middle of the river. Islands are also much more accessible by boat for camping than the shore, especially in the riverine areas at the upstream end of Lake Oahe where banks have very steep slopes (Bailey, pers. comm., 2009). When surface elevations of Lake

Oahe are high enough, anglers fish from shore for walleye, Northern pike, catfish, and bullhead at General Sibley Park at Bismarck, and for walleye in the early spring and fall at and near Graner Park RA (formerly Sugarloaf RA) near Mandan. At these two sites, anglers can also avail themselves of the varied camping facilities. Little Heart RA and Graner Park RA have boat ramps from which boat anglers can launch (USACE, 2007b) when lake levels are high enough.

Hours per month spent fishing by boat and shore anglers were derived from data collected from creel surveys that were conducted from April 1 to October 15, 2000; April 1 to September 30, 2003; and April 1 to October 31, 2006 (Brooks and Hendrickson, 2001, 2004, 2007). The Garrison River Segment of the Missouri River was divided into two survey regions. The Upper Missouri River Region is about 46 river miles long and extends from Garrison Dam to the power line just south of the Steckel Boat Landing (Wilton Boat Ramp). The Lower Missouri River Region extends from there about 56 river miles downstream to what are typically the "headwaters" of Lake Oahe, near Huff. The boat angler hours and shore angler hours that were estimated for 2000, 2003, and 2006 in the Upper Missouri River Region are presented in Table 8a, and those estimated for the Lower Missouri River Region are presented in Table 8b.

Table 8a
Garrison River Segment, Upper Missouri River Survey Region - Angler Hours

Year and Fishing Mode	April	May	June-Aug.	Sep	Oct*	Total
2000 Boat Angler Hours	3,935	7,278	19,384	6,420	849	37,866
2000 Shore Angler Hours	1,717	1,035	3,102	1,117	143	7,114
2000 Total Angler Hours	5,652	8,313	22,486	7,537	992	44,980
2003 Boat Angler Hours	2,275	5,399	27,051	2,336	0	37,061
2003 Shore Angler Hours	1,404	2,010	8,877	1,246	0	13,537
2003 Total Angler Hours	3,679	7,409	35,928	3,582	0	50,598
2006 Boat Angler Hours	12,919	14,917	42,131	4,101	2,665	76,733
2006 Shore Angler Hours	5,429	2,232	5,438	2,296	968	16,363
2006 Total Angler Hours	18,348	17,149	47,569	6,397	3,633	93,096

Sources: Brooks and Hendrickson 2001, 2004, and 2007.
*Surveys were conducted until Oct. 15 in 2000, Sep. 30 in 2003, and Oct. 31 in 2006.

Table 8b
Garrison River Segment, Lower Missouri River Survey Region - Angler Hours

Year and Fishing Mode	April	May	June-Aug.	Sep	Oct*	Total
2000 Boat Angler Hours	29,870	52,408	33,220	24,870	1,289	141,657
2000 Shore Angler Hours	14,521	19,935	19,996	5,551	3,236	63,239
2000 Total Angler Hours	44,391	72,343	53,216	30,421	4,525	204,896
2003 Boat Angler Hours	9,674	30,672	45,193	7,350	0	92,889
2003 Shore Angler Hours	19,404	27,709	36,388	2,081	0	85,582
2003 Total Angler Hours	29,078	58,381	81,581	9,431	0	178,471
2006 Boat Angler Hours	63,254	38,136	37,436	6,246	9,223	154,295
2006 Shore Angler Hours	14,943	5,252	8,913	3,849	1,822	34,779
2006 Total Angler Hours	78,197	43,388	46,349	10,095	11,045	189,074

Sources: Brooks and Hendrickson 2001, 2004, and 2007.
*Surveys were conducted until Oct. 15 in 2000, Sep. 30 in 2003, and Oct. 31 in 2006.

In the Upper Missouri River Region, for each time period the number of boat angler hours exceeded the number of shore angler hours. This was also generally true for the Lower Missouri River Region in 2000 and 2006. In 2003, a drought year, shore angler hours were higher in April than boat angler hours and for April through September were much higher in proportion to boat angler hours than was the case in 2000 or 2006. The great increase in boat angler effort between 2003 and 2006 may have been related to the relatively small size of walleye in 2003 and the relatively high catch and harvest rates and the increased size of walleye in 2006 (Brooks and Hendrickson, 2004, 2007), as well as a lack of suitable boat access due to low water levels in 2003 (Brooks and Hendrickson, 2004). Of all sport fish harvested from boat and shore, walleye accounted for 89 and 72 percent, respectively, in 2000; 86 and 60 percent, respectively, in 2003, and 94 and 46 percent, respectively, in 2006 (Brooks and Hendrickson, 2001, 2004, 2007). The average number of hours that anglers fished per fishing trip was 4.0 hours per day, with the average trip lasting 2 days, in all three years surveyed. The average one-way trip distance was 74 miles in 2000, 49 miles in 2003, and 48 miles in 2006. The shorter trip distances after 2000 were consistent with the findings that non-resident anglers comprised 6 percent of an estimated 50,393 anglers in 2000 but only 4 percent of 43,070 anglers in 2003 and 3 percent of 46,990 anglers in 2006 (Brooks and Hendrickson, 2001, 2004, 2007). Because the average trip continued to last 2 days, however, trip-related expenditures in North Dakota, except perhaps for gasoline, continued to contribute to the regional economy.

3.4 Garrison River Segment: Hunting

Most hunting in this segment is day use; few hunters camp overnight. Pheasants are hunted on foot in riparian grasslands found between cottonwood-willow woodland riparian patches on the riverbank (Bailey, pers. comm., 2009). White-tailed deer are hunted on foot in these riparian woodland patches. Deer also swim to islands covered with vegetation to browse. Because deer are easily startled by loud noise (Fryda, pers. comm., 2009), deer hunters access the islands early in the morning, in boats ranging from small flat-bottomed boats to boats 22 feet long (Bailey, pers. comm., 2009).

This segment of the Missouri River is a staging area for migrating geese and ducks in the spring and fall, where they rest and forage before continuing their migration (Fryda, pers. comm., 2009). Within the Garrison River Segment, the reach from Garrison Dam to the mouth of Turtle Creek, near Washburn, is a waterfowl rest area closed to goose hunting but open to duck hunting in the fall (Halstead, pers. comm., 2009). Waterfowl may be hunted as they forage in harvested fields by hunters behind blinds that prevent their noise and movement from startling these birds. Waterfowl also use islands as roosting habitat where they rest and sleep before and after feeding, and so prefer relatively unvegetated islands with few places for predators to hide. Waterfowl hunters access these islands by boats, ranging from small boats with flat bottoms to those large enough to require boat ramps for launching. Trolling motors are used instead of outboard motors when nearing the islands. The hunters use their boats as blinds, lay out portable blinds, or attach blinds to their boat rims to minimize their noise and movements from disturbing the easily startled waterfowl (Bailey, pers. comm., 2009).

Hunters, like anglers, are concerned not only with their harvest but also with the aesthetic views from their hunting grounds, communing with and observing nature, and sharing the experience with their companions (Bailey, pers. comm., 2009). In the fall, hunters often use parking lots and campgrounds at recreation areas such as Graner Park RA (formerly Sugarloaf RA) and Little Heart Bottom RA at the upstream (riverine) end of Lake Oahe, in the Bismarck-Mandan area, as their base of operations while they hunt on adjacent lands for deer in riparian woodlands and pheasants in riparian grasslands or nearby croplands (USACE, 2007b).

3.5 Garrison River Segment: Boating and Other River-Related Recreation

Boating activities during the summer, mainly between Memorial Day through Labor Day, may involve boats up to 22 feet long. Some canoeing and kayaking also occurs during the summer (Bailey, pers. comm., 2009). One activity observed in this segment, which was not observed elsewhere, is a canoe drop off and pick-up service (canoe livery service). The proprietor indicated that she operated the only such service on the river for the past six years, but that another outfitter may have recently started in Pick City, ND. The proprietor indicated that the volume of canoe trips using this service averages less than one trip per week.

Boating is a major activity along this segment of the Missouri River. Within the Garrison River Segment, in the reach between Garrison Dam and the area north of Bismarck, public boat access sites are spread relatively far apart; if a boat access in this portion of the segment is not operable or not accessible, the next closest boat access is likely to be many miles away (Halstead, pers. comm., 2009).

In addition to the public boat ramps along the Garrison River Segment, there are a number of private marinas, especially near Bismarck. One new marina on the northern (upstream) end of Bismarck's left descending bank was recently built as a component of a residential complex and has dock space for more than 300 boats. Other newly constructed waterfront residential complexes, not quite as extensive, have also incorporated docks and a private marina in the area south of Bismarck with dock space for approximately 200 boats. There are also many private docks adjacent to homes along the river north and south of Bismarck. The incidence of private docks increases as the river approaches the Bismarck-Mandan area. Overall, the concentration of marinas, private docks, and boat access (see Table 9a) occurring in and around Bismarck is the greatest concentration of boating activity observed along any reach within any segment included in the ESH PEIS.

A riverfront and inland recreation area (RA), officially the Kimball Bottom RA but locally known as "the Desert", is about a 10-minute drive south of central Bismarck. The inland section of the RA is a combination of woods, sand dunes, and trails that are used for camping, all-terrain vehicle use, and dirt biking. There is also a concrete ramp with boat trailer parking area. The riverfront at the Desert is a unique sandy beach, often more than 100 feet wide and approximately half a mile long. The beach is easily accessible. Visitors are able to drive their cars, trucks, and boat trailers up to the water's edge, and hundreds of vehicles may be on the beach on summer weekends. The Desert's sandy beach is the largest recreation attraction in Bismarck and the surrounding area. Discussions with users indicate that on summer weekends, the entire stretch may be lined with cars and trucks and the water filled with jet skis and other watercraft. The beach is used for swimming, beach activities such as sunbathing and volleyball, and access to sandbars.

Bismarck Department of Parks and Recreation personnel indicated that campers come from as far away as Jamestown, ND (100 miles) to enjoy the unique recreation opportunities at the Desert. Visitation at the Desert has been increasing over the years. On summer weekends when water conditions make sandbars accessible, as many as 4,000 people have been estimated using the beach and adjacent sandbars at the Desert (City of Bismarck Department of Parks and Recreation, personal communication, 2007). On sandbars here and elsewhere in the Missouri River, recreational boaters beach their boats on a sandbar and spend the day on the sandbar picnicking, playing sand volleyball, sunbathing, and engaging in other beach activities (Bailey, pers. comm., 2009).

Hiking, bird watching, nature observation, outdoor photography, and enjoying scenic views are other outdoor recreational activities that are engaged in along the banks of the Missouri River in the Bismarck-Mandan area (Bailey, pers. comm., 2009). Bird watching, photography, and hiking are especially popular with day users and campers at several recreation sites located at the upstream (riverine) end of Lake Oahe near Bismarck and Mandan. Sibley Nature Park has a hiking trail 0.75 miles long. Two small nature trails, as well as facilities for individual and group picnicking and camping with recreational vehicles or tents are located at General Sibley Park. Graner Park RA has facilities for individual and group picnicking, a primitive camping area, and a campground with electrical hookups (USACE, 2007b).

3.6 Garrison River Segment: Sites Visited

Locations of recreation areas, public river access sites, and marina areas visited in the Garrison River Segment are identified by river mile in Table 9a. Information about facilities at each site visited is also provided in Table 9a. The number of visits to Corps water resource-based recreation areas downstream of Garrison Dam and at the upper end of Lake Oahe for several recent fiscal years is provided in Table 9b.

Table 9a
Missouri River Recreation Sites: Garrison River Segment

River Mile and Site Name	Boat Ramps	Boat Trailer Parking and (Boat Slips)	Camp Sites (RV, Camper, Tent)	Swimming Beach
1388 Garrison Dam Downstream RA	2	100+	114	Yes
1387 Riverdale WMA *	None	None	14	No
1372.6 Stanton (UPA) Boat Ramp **	1	30	None	No
1355 Washburn Boat Ramp	2	40	None	No
1346 Sanger Boat Ramp	1	15	15	No **
1344 Don Steckel Boat Landing	1	10	None	No
1324.4 Eagle Park	Canoe	None	None	No
1321.0 Hoge Island Park **	1	100	None	No
1320 Misty Waters* Marina	1	60+(204) *	None	No
1319.4 Kneifel Boat Landing *	1 *	30 **	None *	No *
1315.5 Grant Marsh Boat Launch **	1	75	None	No
1312.5 South Port Marina	1	(376) *	None	No
1311.9 Fox Island Boat Area	1	75	None	No
1307 General Sibley Park	1	50	120	No
1302 Little Heart Bottom RA	1	100	None	No
1299 The Desert (Kimball Bottom RA)	1+Beach	Hundreds	Yes	Yes
1296 Graner Bottom Park RA (1)	2	50+	45	No

RA = Recreation Area. WMA = Wildlife Management Area.
(1) One boat ramp inaccessible due to low water level.
* Updated 2009. Sources for updated information: Bailey, personal communication, 2009; Halstead, personal communication, 2009.
** Updated 2010. Sources for updated information: Gangl, personal communication, 2010; Smith, personal communication, 2010; Thompson, personal communication, 2010; Weixel, personal communication, 2010; NDGFD, Missouri River Boating/Fishing Access Sites, accessed April 19, 2010, at http://www.gf.nd.gov/.
Note: Entire segment is within North Dakota.

Table 9b
Corps Missouri River Recreation Area Visits: Downstream Areas near Garrison Dam and Upstream Areas of Lake Oahe near Bismarck

Site Name	FY 2000	FY 2002	FY 2004	FY 2006	FY 2008
1388 Downstream RA [1]	60,700	86,500	40,000	44,800	51,239
1389 Missouri R. Ramp/ Tailrace E. RA [1]	47,000	36,000	41,400	39,100	37,360
1302 Little Heart Bottom RA [2]	19,942	17,927	18,167	17,509	13,416
1296 Graner Bottom Park/Sugarloaf RA[2]	38,133	43,322	34,925	21,085	31,594
1307 General Sibley Park [2]	132,723	96,595	73,583	73,378	106,107
1299 Kimball Bottom RA ("the Desert") [2]	76,110	93,408	81,767	86,744	108,068
Total Water Resource-Based Visits	374,608	373,752	289,842	282,616	347,784

Sources: USACE, 2007a; USACE, 2008b.
RA = Recreation Area.
[1] Downstream of Garrison Dam, in North Dakota.
[2] Upstream end of Lake Oahe, in North Dakota.

3.7 Garrison River Segment: Observations

Recreation along the Garrison River Segment is largely affected by the relatively large population in the Bismarck-Mandan, ND area. Upstream of Bismarck, river access consists mostly of public boat ramps. Recreational use of the river increases in the vicinity of the Bismarck-Mandan area, which has numerous marinas and heavily utilized river access at the Desert and other areas. Bismarck is also home to four colleges, which influences the level of recreational use of the river, especially at the Desert. Observations and discussions with local Parks and Recreation Department personnel indicate that the unique river-recreation opportunities at the Desert draw users from across the state and make this location the single most intensively used recreation area among the segments assessed in this analysis.

4 Fort Randall Dam to Lewis & Clark Lake Headwaters (Fort Randall River Segment and Lewis & Clark Lake Segment)

4.1 Fort Randall River and Lewis & Clark Lake Segments: General Setting

This stretch of the Missouri River includes both the Fort Randall River Segment and the Lewis & Clark Lake Segment. The Fort Randall River Segment extends from Fort Randall Dam near Pickstown, SD (RM 880) to upstream of the Niobrara confluence (RM 845). The Lewis & Clark Lake Segment extends from RM 845 to RM 828, at the downstream edge of the accretion islands just downstream of the Sand Creek (SD) and Santee (NE) ramps. The Fort Randall River Segment and the upstream 4-mile-long reach (to Running Water, RM 841) of the Lewis & Clark Lake Segment are collectively designated as the 39-mile District of the Missouri National Recreational River (MNRR). This section is managed by the National Park Service (NPS) as a primitive recreational area to protect its fish and wildlife habitat, natural landscapes of the Lewis and Clark National Historical Trail, and cultural resources.

The following description of the general setting of the Fort Randall River Segment is derived from the NPS's 1997 General Management Plan and Final Environmental Impact Statement for the Missouri National Recreational River (NPS, 1997). This river segment is approximately 2,000 to 3,000 feet wide above the confluence with the Niobrara River, meandering through a valley that varies in width from 5,000 to 9,000 feet. The banks along this segment tend to restrict flow to one main channel; there are only a few side channels and backwaters (USACE, 2004). Much of the shoreline along the Nebraska banks is composed of forested chalkstone bluffs adjacent to gently rolling to flat bottomlands containing both croplands and livestock rangelands. The shore is occasionally bordered by cottonwood forests interspersed with several concentrated seasonal cabin developments. On the South Dakota side, the valley bottom is up to 1 mile wide and is bordered by forested chalkstone bluffs and rolling hillsides. Agriculture and grazing of the bottomland are the most common land uses, and this segment receives no significant inflow from tributaries.

The first tier counties for these two segments are Boyd and Knox counties in Nebraska and Gregory, Charles Mix, and Bon Homme counties in South Dakota. The combined population for the three first tier South Dakota counties was 21,402 in 2000 (U.S. Bureau of the Census, 2000). By 2004, the estimated population was 20,502 (U.S. Bureau of the Census, 2006), a decrease of over 5 percent since the 1990 census. The population densities of Gregory, Charles Mix, and Bon Homme counties are 5.25, 8, and 13 persons per square mile, respectively.

The combined population for the two Nebraska counties in 2000 was 11,812 (U.S. Bureau of the Census, 2000). By 2004, the population was estimated to be 11,262 (U.S. Bureau of the Census, 2006), a decrease of more than 10 percent since the 1990 census. The population densities of Boyd and Knox counties in South Dakota are 4 and 8 persons per square mile, respectively.

South Dakota and Nebraska experience a continental interior climate with great variation in seasonal temperatures. Summers are typically very hot and winters are cold, with the frost-free period averaging approximately 155 days (USACE, 2004a). Prolonged droughts of several years' duration and frequent shorter periods of deficient moisture, interspersed with periods of abundant precipitation, are typical (USACE, 2004a). Temperatures range from over 100 degrees F in summer to –20 degrees F in winter. Wintertime temperatures average 24 degrees F, with an average daily low of 14 degrees F. The average summer temperature is 72 degrees F, with an average daily maximum of 85 degrees F (USACE, 2004a).

Annual precipitation is approximately 25 inches, with 80 percent of this falling from April through September (USACE, 2004a). Thunderstorms occur on approximately 45 days each year, with tornadoes and severe thunderstorms occurring much less frequently. Average annual snowfall is 34 inches (USACE, 2004a).

There are no interstate routes providing access to these segments from either the South Dakota or the Nebraska sides of the river, and the only U.S. route providing access to either of the segments is U.S. Route 18/281 at the Fort Randall Dam. All other roads providing access to these two segments from the Nebraska or South Dakota side are state roads (SR 12 in Nebraska and SR 46/50 and SR 37 in South Dakota) and local roads. These state and local roads provide access to homes, farms, and communities in the area.

The South Dakota Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2008 identified no region-specific needs but included as statewide "high priority" local and state projects for Land and Water Conservation Fund Act funding the following: acquisition of land for park areas and open space; trails; campgrounds and associated facilities; and interpretive and educational facilities (SDGFP, 2008). The SD SCORP 2002 provided population-per-facility ratios for each of the eight planning regions. Region 3, which includes all first tier counties in the South Dakota portion of the Fort Randall Dam to Lewis and Clark Lake segments, appeared to have at least an average supply of boat ramps, campsites, fishing facilities, public hunting acres, beaches, and perhaps hiking trails compared to other regions. Activity participation rates were reported only on a statewide basis, however, and Region 3 residents may participate in these activities so often that there are actually deficiencies in the number of facilities. "High priority" was assigned to State development of new trails, camping facilities, nature areas, boat ramps and docks, picnic areas and shelters, swimming beaches, fishing areas and docks, and interpretive and educational facilities statewide (SDGFP, 2003). All these high-priority facilities can be associated with river- or water resource-based recreation, highlighting the importance of this type of recreation in South Dakota.

The Nebraska State Comprehensive Outdoor Recreation Plan (SCORP) 2006-2010 also reported participation rate data only on a statewide basis. Outdoor recreation activities in which the ten highest percentages of Nebraskans participate included walking, picnicking, visiting State Parks, swimming, viewing/photographing natural scenery, fishing, and boating (NGPC, 2006). All these activities can be enjoyed along the Missouri River in the Fort Randall River and Lewis and Clark Lake segments.

Waterfowl hunting is a popular activity along these two segments and also along the river segment downstream from Gavins Point Dam. Targeted species include Canada goose, snow goose, mallard, and other migrating waterfowl. Numerous permanent duck blinds were observed nestled in the wetlands and low vegetated sandbars along the river, whereas duck blinds were not observed in the two upstream river segments. The Fort Randall River and Lewis and Clark Lake segments appear to have more vegetated islands and more wetland areas than the Fort Peck and

Garrison river segments. A number of outfitters provide blinds and transportation to preferred hunting areas along the river.

Wildlife-associated recreation activities are important to residents of South Dakota (SD) and Nebraska (NE). The proportion of SD and NE residents at least 16 years old (adults) who participated in hunting, fishing, or both in 2001 was 31 and 24 percent, respectively; SD had the sixth-highest percentage among the 50 states, and NE was twentieth (USFWS/USCB, 2002). Due at least partly to drought conditions, in 2006 these proportions decreased to 23 and 17 percent, respectively; SD was twelfth and NE twenty-fourth among the 50 states (USFWS/USCB, 2008). In addition, about 14 percent of adults in SD and 12 percent in NE took trips away from home to observe, photograph, and/or feed wildlife in 2001; in 2006, these were 19 and 11 percent, respectively (USFWS/USCB, 2002, 2008).

Adults spent about 2,425,000 days hunting in SD in 2001 and about 1,719,000 days in 2006. SD residents accounted for 48 percent of these adult hunting days in 2001 and 69 percent in 2006. In 2001, adults targeted big game on 22 percent and migratory birds on 22 percent of their hunting days in SD; in 2006, these were targeted on 32 and 12 percent of adult hunting days in SD, respectively. Expenditures by adult hunters in SD totaled about $223,195,000 in 2001, of which about $112,817,000 ($46.93 per hunting day) was trip-related and the remainder was for equipment and other items. Although there were fewer adult hunting days in SD in 2006 than in 2001, expenditures by adult hunters in SD increased in 2006 to about $185,258,000, of which about $117,063,000 ($68.10 per hunting day) was trip-related (USFWS/USCB, 2002, 2008).

Adults spent a total of about 2,984,000 days fishing in SD in 2001 and about 1,697,000 in 2006. Adult SD residents accounted for 75 percent of these adult fishing days in 2001 and 83 percent in 2006. Expenditures by adult anglers in SD totaled about $182,480,000 ($61.15 per fishing day) in 2001, of which about $86,439,000 ($28.97 per fishing day) was trip-related and the remainder was for equipment and other items. Expenditures in 2006 by adult anglers in SD totaled about $131,089,000 ($77.25 per fishing day), of which about $58,624,000 ($34.55 per fishing day) was trip-related (USFWS/USCB, 2002, 2008).

Approximately 181,000 adults took trips away from home, for a total of about 1,923,000 days (10.6 days per adult), to observe, photograph, and/or feed wildlife in SD in 2001. Of these, adult SD residents accounted for approximately 1,409,000 days (73 percent). Expenditures in SD related to wildlife watching in SD by SD residents and non-residents in 2001 totaled approximately $91,958,000, of which about $53,556,000 ($27.85 per day) was for trip-related expenses and the remainder was for equipment and other items (USFWS/USCB, 2002). In 2006, the number of adults who took trips to observe wildlife in SD increased to about 270,000, but the total trip days decreased to about 1,382,000 (5.1 days per adult). Adult SD residents accounted for about 690,000 (50 percent) of these trip days. Despite the decrease in number of wildlife watching trip days by adults from 2001 to 2006, in 2006 total expenditures by adults related to watching wildlife in SD away from home increased to $183,304,000, and trip-related expenditures increased to about $129,930,000 ($94.02 per day) (USFWS/USCB, 2008).

In NE, adults spent about 2,204,000 days of hunting in 2001 and about 1,611,000 in 2006. NE residents accounted for 83 percent of adult hunting days in NE in 2001 and 97 percent in 2006. In 2001, adults targeted big game on 35 percent of the hunting days and migratory birds on 18 percent of the hunting days; in 2006, these were targeted on 36 and 25 percent of the hunting days, respectively. Expenditures by adult hunters in NE totaled about $198,120,000 ($89.89 per hunting day) in 2001, of which about $74,819,000 ($33.95 per hunting day) was trip-related and the remainder was for equipment and other items. Although adults hunted for fewer days in NE in 2006 than in 2001, expenditures by adult hunters in NE increased in 2006 to about $231,032,000 ($143.41 per hunting day), of which about $46,027,000 ($28.57 per hunting day) was trip-related (USFWS/USCB, 2002, 2008).

Adults spent about 3,204,000 days fishing in NE in 2001 and about 3,096,000 in 2006. NE residents accounted for 91 percent of adult fishing days in 2001 and 94 percent in 2006. Expenditures by adult anglers in NE totaled about $146,359,000 ($45.68 per fishing day) in 2001, of which about $60,283,000 ($18.81 per fishing day) was trip-related and the remainder was for equipment and other items. Although adults fished for fewer days in NE in 2006 than in 2001, total expenditures by adult anglers in NE in 2006 increased to about $181,280,000 ($58.55 per fishing day); of these expenditures, the ones that were trip-related also increased, to about $60,992,000 ($19.70 per fishing day) (USFWS/USCB, 2002, 2008).

In NE, approximately 186,000 people 16 years of age or older (adults) took trips away from home, for a total of about 2,240,000 days (12 days per adult), to observe, photograph, and/or feed wildlife in NE in 2001. Of these, adult NE residents accounted for approximately 1,538,000 days (69 percent). Expenditures in NE related to wildlife watching in NE by adult NE residents and non-residents in 2001 totaled approximately $129,747,000, of which about $18,413,000 ($8.22 per day) was for trip-related expenses and the remainder was for equipment and other items (USFWS/USCB, 2002). In 2006, the number of adults who took trips to observe wildlife in NE decreased to about 176,000, and their total trip days decreased to about 906,000 (5.1 days per adult). Adult NE residents accounted for about 808,000 (89 percent) of these trip days (USFWS/USCB, 2008). Despite the 60 percent decrease in wildlife-watching trip days by adults in NE between 2001 and 2006, total expenditures by adults in 2006 related to wildlife watching in NE increased to about $141,910,000, of which about $22,741,000 ($25.10 per day) was trip-related (USFWS/USCB, 2002, 2008).

4.2 Fort Randall River and Lewis & Clark Lake Segments: Fish Stocking

Fish stocking did not occur in these segments during 2005 through 2008 in Nebraska, as reported by the Nebraska Game and Parks Commission (NGPC, 2009) or during 2005 through 2007 in South Dakota, as reported by the South Dakota Game, Fish and Parks Department (SDGFP, 2007, 2009). One tributary in Nebraska, Steel Creek, was stocked with 200 nine-inch rainbow trout, but this creek has no public access.

4.3 Fort Randall River and Lewis & Clark Lake Segments: Angler Use

Fishing is an important recreational activity along these two segments. Shore fishing and boat fishing occur in the Fort Randall Dam tailrace, especially along the west side. Boats used by anglers here mainly range from 14 to 20 feet long and have outboard motors; in the summer, pontoon boats are also used. Walleye is the main sport fish, and it is illegal to harvest paddlefish in the tail waters. Bow hunting for carp, which like slow water, occurs in a bay at the Randall Creek RA (Nye, pers. comm., 2009).

The Upper River reach is commonly used in recreational surveys; it extends from the Fort Randall Dam tail waters to the mouth of Bazile Creek, which is 2 miles downstream from the downstream end of the 39-mile District of the MNRR, and so is located in both the Fort Randall River and Lewis & Clark Lake segments.

The Yankton Sioux Reservation is located on the SD side of the Upper River reach of the Fort Randall River Segment. Because no boat ramps access the Missouri River within the exterior boundaries of the Yankton Sioux Reservation, most Tribal members who fish do so from shore; walleye and catfish are the major catches (Abdo, pers. comm., 2009a). In the Upper River reach, some shore angling occurs near the public boat ramps on the Nebraska side of the river (Schuckman, pers. comm., 2009b). Ponca Tribal Land is located in Nebraska, at the Niobrara confluence. Members of the Ponca Tribe of Nebraska fish from shore at the mouth of the Niobrara using set lines as well as rod and reel and do not engage in much boat fishing; the main species caught are carp and catfish, with some walleye and drum (Robinette, pers. comm., 2009a). Nearly all fishing by Yankton Sioux and Ponca Tribal members is recreational rather than for subsistence; if a particular site can not be used or accessed, many substitute sites exist that offer good fishing success (Abdo, pers. comm., 2009b; Robinette, pers. comm., 2009b).

Boat anglers in the Upper River reach of both segments fish for white bass, largemouth and smallmouth bass as well as walleye, and catfish are found at scour holes (Nye, pers. comm., 2009). Some regional bass fishing tournaments are held in the Upper River reach (Schuckman, pers. comm., 2009b). Many of the boat anglers live in seasonal cabins on the Nebraska shore. Most fishing boats are 16 to 18 feet long; longer boats are also used but must navigate carefully to avoid being grounded or having propellers damaged by hitting rocks or gravel in the lower half of the Upper River reach (Nye, pers. comm., 2009).

In the Upper River reach of the Lewis & Clark Lake Segment, shore anglers of the Ponca Tribe of Nebraska fish at the mouth of Bazile Creek and near the Niobrara Village (Townsite) and Ferry Landing ramps (Robinette, pers. comm., 2009a). Shore angling is very popular at the Niobrara Townsite ramp, where a chute adjoining the boat ramp provides excellent sauger habitat. At the Ferry Landing Boat Ramp, which is concrete with a gravel parking area, shore angling takes place at the landing abutment, which is adjacent to the river channel; on the riverbank along the old road leading west from the ramp; and on the east side of the ramp, at a backwater where Northern pike are commonly found. Shore anglers fish from the Bazile Creek boat ramp parking lot for catfish in the Bazile Creek chute that abuts the ramp and also fish for smallmouth bass at a backwater just east of the ramp. Boat anglers also use the Bazile Creek ramp; in mid to late summer, they often find smallmouth bass at the edge of sandbars. The Springfield boat ramp is used by boat anglers fishing for walleye, sauger, largemouth bass, smallmouth bass, black crappie, and white crappie (Schuckman, pers. comm., 2009a).

The Islands reach of the Lewis & Clark Lake Segment that was included in the 2000 Survey extends from Bazile Creek to the downstream end of the segment (just downstream of the accretion islands, around RM 828). The main sport fish in the Islands reach are walleye, catfish, largemouth bass, and smallmouth bass; some crappie and white bass are also caught. Anglers in the Islands reach tend to be day users, eating their lunch on the shore or in their boat; those who camp overnight often take advantage of the excellent camping facilities and cabins at Niobrara

State Park. Shoreline anglers park their vehicles at boat ramps and fish from the shore near the ramp (Schuckman, pers. comm., 2009a).

Boat anglers in the Islands reach launch from ramps in the Upper River reach of the Lewis & Clark Lake Segment previously discussed as well as from ramps in the Islands reach. In the Islands reach, boat anglers launch from the Sand Creek (Apple Tree) boat ramp to fish in a myriad of chutes and backwaters. The Navratis Cove boat ramp area has good bank fishing access and spear fishing, as well as boat angler use. The Santee boat ramp is used by some shore anglers, but mainly boat anglers; its importance is pivotal because the next boat ramp to the east on the Nebraska shore, Miller Creek, is many miles downstream (Schuckman, pers. comm., 2009a). Boat anglers fishing in marshy areas in the Lewis & Clark Lake Segment use flat-bottomed aluminum boats. Boat anglers fishing in open water areas near islands use aluminum and fiberglass boats 12 to 16 feet long, with both an outboard motor to get out to the sandbar islands and a trolling motor to use when the boat is near islands. They launch from a number of boat ramps in both Nebraska and South Dakota, located within and just downstream from the segment. Aesthetics and communing with nature are an important part of the fishing experience (Crownover, pers. comm., 2009).

The South Dakota Department of Game, Fish, and Parks conducted an analysis of angler use along the Missouri River from Fort Randall Dam to Gavins Point Dam in 2005 (Wickstrom and Schuckman, 2006). The angler use study collected and reported data for a 2-mile-long reach at the Fort Randall Dam tail waters and a 40-mile-long reach from the tail waters downstream to Bazile Creek, which together are roughly equivalent to the 39-mile District of the MNRR. Fishing on Lewis and Clark Lake between Bazile Creek and Gavins Point Dam was also analyzed.

Similar analyses, using the same reach boundaries as the 2005 study, have been conducted in the past. Table 10 presents historical angler use for the two 2005 river reaches downstream of Fort Randall Dam. The relatively low use observed in 2005 has been attributed to low release levels from Fort Randall Dam in March, May, June, and July 2005. Minimum daily discharge levels during these months were: March, 600 cubic feet per second (cfs); May, 0 cfs; June, 500 cfs; and July, 600 cfs (Wickstrom and Schuckman, 2006). In addition, high gasoline prices and unstable weather conditions in the summer of 2005 were also cited as having a negative influence on visitation (Wickstrom and Schuckman, 2006).

Table 10
Annual Angler Hours: Fort Randall River and Lewis & Clark Lake Segments

Year	Fort Randall Dam Tail Waters Reach	Reach from Tail Waters to Bazile Creek	Total
1984	41,499	40,888	82,387
1994	35,222	36,332	71,554
1995	30,533	60,697	91,230
2000	48,401	85,879	134,280
2001	36,201	57,331	93,532
2005	24,228	38,009	62,237

Note: 1995 data are for May-September; 2005 data are for March-November.
Source: Wickstrom and Schuckman, 2006.

The 2005 angler use data for the 2005 study reaches provided fishing pressure from March 1 through November 30 by month and by fishing mode: either boat fishing or shore fishing. Table 11 presents the 2005 angler hours by fishing mode as well as by months grouped as seasons. The reach from Bazile Creek to Gavins Point Dam includes angler hours for the open-water portion of Lewis & Clark Lake, which is not included in the ESH PEIS analysis, as well as angler hours for the reach of the Lewis & Clark Lake Segment downstream of Bazile Creek.

Table 11
Angler Hours for 2005: Fort Randall River and Lewis & Clark Lake Segments

Reach	Mar 1 to Apr 30	May 1 to Sep 30	Oct 1 to Nov 30	Total Angling	Boat Angling	Shore Angling
Fort Randall Dam Tail Waters	5,499	17,017	1,714	24,228 (100%)	16,451 (67.9%)	7,777 (32.1%)
Dam Tail Waters to Bazile Creek	9,875	24,058	4,076	38,009 (100%)	31,603 (83.1%)	6,406 (16.9%)
Bazile Creek to Gavins Pt. Dam	8,152	71,588	23,052	102,791 (100%)	82,644 (80.4%)	20,147 (19.6%)
Total	23,526	112,653	28,842	165,028 (100%)	130,698 (79.2%)	34,330 (20.8%)

Source: Wickstrom and Schuckman, 2006. Total hours may not equal the sum of seasonal hours due to rounding.

From March through November 2005, Wickstrom and Schuckman (2006) interviewed anglers along the Missouri River from Fort Randall Dam to Gavins Point Dam. These anglers came from 15 states; the percentage of anglers from states other than Nebraska and South Dakota in 2005 was 13.5 percent for the Fort Randall Dam Tailwaters, 5.8 percent for the reach between Fort Randall Dam Tailwaters and Bazile Creek, and 9.2 percent for the reach between Bazile Creek and Gavins Point Dam. An estimated 37,737 angler trips occurred between March and November 2005, of which almost 23,000 were to the reach between Bazile Creek and Gavins

Point Dam (Wickstrom andSchuckman 2006). At a cost of $75 per trip (USFWS/USCB, 1997), trip-related expenditures of anglers between Fort Randall Dam and Bazile Creek (which combined comprise most of the Fort Randall River and Lewis & Clark Lake segments) totaled over $1,100,000 in 2005.

4.4 Fort Randall River and Lewis & Clark Lake Segments: Hunting

The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation for South Dakota and Nebraska indicate that there were 300,000 hunting days in South Dakota and 290,000 hunting days in Nebraska for geese. Similarly, there were 335,000 hunting days in South Dakota and 334,000 hunting days in Nebraska for ducks. While these numbers are state-wide and the vast majority of these hunting days were not spent on the Fort Randall River and Lewis & Clark Lake segments, these two segments of the upper Missouri appear to have the most waterfowl hunting.

Very little hunting occurs in the Fort Randall Dam tail waters section. Much of the west bank of the river between the tail waters and the Nebraska state line is occupied by the Karl E. Mundt National Wildlife Refuge. The State of South Dakota does not allow waterfowl hunting on the river between Fort Randall Dam and the point about 5 miles downstream at which the Missouri River forms the Nebraska-South Dakota boundary (Nye, pers. comm., 2009). Some waterfowl hunters, including Yankton Sioux Tribe members, hunt from a bluff about 2 miles below the dam (Abdo, pers. comm., 2009). The hunters wait for waterfowl to fly up from the river, where they roost between feedings (Nye, pers. comm., 2009).

In the Fort Randall River Segment, the eastern bank of the Missouri River, from Fort Randall Dam to the Choteau Creek confluence, is within the exterior boundaries of the Yankton Sioux Reservation. A Tribal hunting permit is required to hunt on Reservation lands. The Tribe affords refuge protection from hunters to waterfowl in the Missouri River adjacent to the Reservation. Although some Tribal members hunt for waterfowl behind blinds on Tribal-owned islands in the river, most waterfowl hunting on the Reservation occurs in fields on the riparian uplands near the river. On the Reservation, deer are hunted with rifles in the riparian woodlands along the river and by bow hunting on Tribal-owned islands in the river; the islands are accessed by jon boats ranging in length from about 14 to 18 feet, or by wading or walking if the river is low enough. Pheasant, quail, greater prairie chickens, and some lesser prairie chickens are hunted in riparian grasslands along the Missouri River. Hunting by Yankton Sioux Tribal members is predominantly recreational rather than for subsistence, and good hunting success is found at a number of sites (Abdo, pers. comm., 2009b). Some trapping for raccoons also occurs along the riverbank on the Reservation (Abdo, pers. comm., 2009a). Trapping for mink, muskrat, and beaver is conducted along the banks of the Missouri River and its tributaries in Nebraska by members of the Ponca Tribe of Nebraska and others (Robinette, pers. comm., 2009a). Trapping is not conducted primarily for subsistence, and there are a variety of riverbank sites where traps can be set (Abdo, pers. comm., 2009b; Robinette, pers. comm., 2009b).

In the Upper River reach of the Fort Randall River Segment downstream from the state refuge area, hunters set out decoys near sandpits found on the South Dakota side of the river and dig holes and set up portable blinds, or construct piles of branches and other vegetation to lie behind, so their movements and noise will not scare away the easily disturbed waterfowl. The hunters need blinds for concealment because they can not dig very deep before encountering the water table, but very few of the blinds on the shoreline are permanent. Many hunters access the gravel pit areas by boats launched from several ramps nearby on the Nebraska shore, as the only public ramps on the South Dakota side are just below Fort Randall Dam. Hunters use boats ranging from 14 to 18 feet in length, and the majority are flat bottomed because the river is fairly shallow in many places (Nye, pers. comm., 2009).

Most hunting along the banks of the Missouri River in the Fort Randall River and Lewis & Clark Lake segments is day use (Crownover, pers. comm., 2009). Those who wish to camp often take advantage of the excellent camping facilities and cabins at Niobrara State Park (Schuckman, pers. comm., 2009a). Hunting for deer and pheasant in the riparian areas along the riverbank is similar for the Upper River and the Islands reaches. Hunters park their vehicles and proceed on foot to hunt deer and pheasant in the riparian woodland areas interspersed with tall grassland areas along the river (Crownover, pers. comm., 2009). Members of the Ponca Tribe of Nebraska hunt coyotes, turkeys, and rabbits as well as deer, mainly in the Niobrara and Bazile Creek areas (Robinette, pers. comm., 2009a). They hunt at a variety of sites, primarily for recreation rather than for subsistence (Robinette, pers. comm., 2009b), and they prefer to shoot waterfowl flying over land rather than on the water (Robinette, pers. comm., 2009a). Hunting waterfowl in the fields is much more common, however. Waterfowl hunters often set decoys in harvested fields adjacent to the riparian vegetation (or near wildlife food plots on publicly owned/managed lands). They hide behind blinds to hunt foraging ducks (mainly mallards) and geese (mainly Canada geese). The blinds keep the easily startled waterfowl from being disturbed enough by noise or movements of the hunters that they abandon that foraging area for another, quieter one (Crownover, pers. comm., 2009). Because waterfowl deplete foraging areas near the river as the fall progresses, late in the hunting season the waterfowl tend to use fields that are much farther from the river (Nye, pers. comm., 2009). Snow geese are hunted in the fall also, but more so during the spring snow goose season, which ends before May 1. Snow geese are usually found in the fields during both spring and fall, but in the Islands section they spend a bit more time near the river in spring than they do in the fall (Crownover, pers. comm., 2009).

In the Islands reach of the Lewis & Clark Lake Segment, waterfowl hunters use boats to access sandbar islands, which extend to 0.5 mile downstream of Santee. The Santee boat ramp is one of the most popular ramps used by duck hunters. Waterfowl hunters also commonly use the Bazile Creek, Springfield, Navratis Cove, and Sand Creek/Apple Tree ramps. Trappers of muskrat and beaver also frequently use the Sand Creek/Apple Tree ramp (Schuckman, pers. comm., 2009a). The boats are usually 12 to 18 feet long and flat bottomed because the water is so shallow. If the sandbar has grass 2 to 3 feet high and the water is 1 foot over the sandbar or lower, hunters may walk on the sandbar to flush waterfowl for a good shot. Hunters also set out decoys to attract waterfowl and use their boat as a hunting blind by crouching behind it or sitting in it behind blinds erected along the sides of the boat. Hunters also can apply to the Corps for a $10 permit to erect permanent blinds for a season (Crownover, pers. comm., 2009).

In 2000, the NGPC and the South Dakota Department of Game, Fish, and Parks collaborated on a Missouri River Recreational Use Survey (the 2000 Survey; Mestl et al., 2001). The 2000 Survey was conducted in six zones. Zones 1 – 3 (Fort Randall, Upper River, and Islands) correspond to the Fort Randall River and Lewis & Clark Lake segments, with Fort Randall being the Fort Randall Dam tail waters reach, the Upper River being the reach between the tail waters and the confluence with Bazile Creek, and the Islands being the reach from Bazile Creek (RM 838) to the downstream extent of the accretion islands, at approximately RM 828, just downstream of the Sand Creek (SD) and Santee (NE) ramps. Zones 5 and 6 (Gavins Point and Lower River) are in the Gavins Point River Segment. Zone 4 is Lewis and Clark Lake, which is not included in this analysis. Hunting is defined in this survey as including spring turkey, waterfowl, and deer (archery and rifle). However, the survey was limited to activities occurring on the water, at boat ramps, and along the bankline areas, which indicates that most of the hunting was for waterfowl. Hunters who also fished were included only in the angler use survey. Time spent by non-fishing hunters on boating, camping, picnicking, observing wildlife, outdoor photography, and other recreational activities are included in the hunting hours (Mestl et al., 2001).

In 2000, hunters spent an estimated 8,111 hours during 1,419 hunting trips along the Fort Randall River and Lewis & Clark Lake segments (Table 12). All of these trips took place between mid-September and early December. Approximately 95 percent of the hunting conducted on these two segments took place below the Fort Randall Dam tail waters; 34 percent occurred in the Upper River reach, and 61 percent occurred in the Islands reach (Mestl et al., 2001).

Table 12
Fort Randall River and Lewis & Clark Lake Segments – 2000 Hunting Hours

Fort Randall Dam Tail Waters Reach	393 (Sep 16 – Nov 10)
Upper River Reach	2,739 (Oct 14 – Dec 8)
Islands Reach	4,979 (Oct 14 – Dec 8)
Total	8,111 (Sep 16 – Dec 8)

Source: Mestl et al., 2001.

4.5 Fort Randall River and Lewis & Clark Lake Segments: Boating & Other Activities

Boating includes motorized and non-motorized vessels. Canoeing between the Running Water and Springfield boat ramps is common. A canoeing/kayaking outfitter based in Vermillion, SD conducts canoeing and kayaking expeditions between Pickstown, SD and Springfield or Yankton (Crownover, pers. comm., 2009). These canoeing and kayaking trips are well suited to the MNRR because they are engaged in by people who enjoy traveling more slowly on water to enjoy the outstanding views, without intrusive noise from boat engines to impede their listening to bird calls.

In the Upper River reach, boating activities utilize boats varying in size from 14- to 16-foot-long jon boats to 22-foot-long fishing vessels and pleasure craft, but those using larger boats must navigate carefully where and when the river is shallow (Schuckman, pers. comm., 2009b). Most of the motorboats towing water-skiers and tube riders launch from the Nebraska shore, either at the public ramps or from docks near riverside cottages rather than from the ramps near Fort Randall Dam (Nye, pers. comm., 2009). The highest riverside cabin densities are just upstream of Verdel Landing and just upstream of the Sunshine Bottom ramp. The Sunshine Bottom ramp and 5 acres surrounding it was purchased from Boyd County by the NGPC, which desires to replace the deteriorated concrete ramp; this will aid recreationists using boats for pleasure, angling, hunting, and viewing scenic vistas in the MNRR, as well as facilitate Corps' monitoring efforts regarding least terns and piping plovers (Schuckman, pers. comm., 2009b). Several boats at a time may pull up to a sandbar island in the river, play volleyball, sunbathe, and enjoy the scenic views in the MNRR (Nye, pers. comm., 2009).

Yankton Sioux Tribe members do not generally engage in boating activities on the Missouri River because there are no boat ramps within the exterior boundaries of the Reservation, and the distance to the river is too great to portage a canoe or kayak. However, the Yankton Sioux Tribe desires to install a concrete plank boat ramp at Buffalo Run Park, Greenwood, SD, where the Tribe has already installed a memorial to the 1858 Treaty signing and a pasture area for its herd of 120 buffalo. The Tribe has applied for a Section 404 permit and an EPA Tribal Wildlife Grant to remove 40 to 50 car bodies on the river bottom near the park to improve aquatic habitat and facilitate boat launching and boating safety (Abdo, pers. comm., 2009a).

Although jet skiing is illegal in the Upper River because it is in the MNRR, it does occur in the Islands reach of the Lewis & Clark Lake Segment. Most motorboats using the Islands reach are fiberglass, 16 to 24 feet long, with outboard motors. Only a small percentage of motorized boating in the Islands reach includes waterskiing. Boating to sandbar islands to enjoy beach-related activities is popular. Boaters creep their boats up to a sandbar and then spend the day on the island picnicking, playing sand volleyball or frisbee, sunbathing, and exercising their dogs as well as enjoying the naturalistic views from the island setting (Crownover, pers. comm., 2009). People also swim from shore to sandbars in the Niobrara River above the Highway 12 Bridge and along the Nebraska shore near the Standing Bear Bridge; sand volleyball is popular on the island by the Standing Bear Bridge (Robinette, pers. comm., 2009a).

The 2000 Survey identified boating as a separate activity. In the 2000 Survey, fishing or hunting from a boat was identified as fishing or hunting, respectively. To be identified as boating, the activity could not include fishing or hunting. In the 2000 Survey, boating hours include time that boaters who did not fish or hunt spent on camping, picnicking, observing wildlife, outdoor photography, and other recreational activities. Table 13a shows that most boating (75 percent) takes place in the Upper River reach. Only a small percentage (3 percent) of boating on the Fort Randall River and Lewis & Clark Lake segments takes place in the Fort Randall Dam tail waters reach. In 2000, all of the boating on the Fort Randall River and Lewis & Clark Lake segments took place between early April and mid-November.

Table 13a
Fort Randall River and Lewis & Clark Lake Segments – 2000 Boating Hours

Reach	April 1 to April 28	April 29 to May 26	May 27 to Sep 15	Sep 16 to Nov 10	Total Hours
Fort Randall Dam tail waters	0	0	664	0	664
Upper River	0	484	15,490	994	16,967
Islands	0	506	3,733	790	5,029
Boating/other hrs by boaters	0	990	19,887	1,784	22,660

Source: Mestl et al., 2001. Total hours may not equal the sum of seasonal hours due to rounding.

Persons without boats who engaged in camping, picnicking, sightseeing, observing wildlife, outdoor photography, and other activities (other than hunting or fishing) were also included in the 2000 Survey. Camping in the Fort Randall River and Lewis & Clark Lake segments nearly always takes place in designated campgrounds (Crownover, pers. comm., 2009). In the Yankton Sioux Tribal Reservation, swimming, sunbathing, shoreline fishing, and picnicking are engaged in at the Yankton Sioux Tribe RA (also known as Woods Beach), which was recently purchased by the Tribe and contains toilet facilities and a shade shelter; morel picking also occurs in the woods adjacent to Woods Beach (Abdo, pers. comm., 2009a). Hiking, wildlife watching, and outdoor photography is common along the 39-mile District of the MNRR. The Lewis and Clark Trail, on which people walk and ride bicycles, runs along the north and east side of the river between Springfield, SD and Pickstown, SD; it adjoins Buffalo Run Park. From the Lewis and Clark Trail, visitors can fully appreciate this MNRR through enjoying scenic views, engaging in outdoor photography, observing wildlife, bird watching, and sightseeing. Eagles are frequently seen on the upstream end of the Upper River reach, where 3 to 4 active eagle nests are located on the Reservation and many eagles can be seen roosting at the Karl E. Mundt National Wildlife Refuge across the river from the Lewis and Clark Trail (Abdo, pers. comm., 2009a). An increasing number of Ponca Tribe of Nebraska members living elsewhere are returning to the area to visit; they camp in tents and recreational vehicles at Niobrara State Park, near the Bazile Creek ramp, and near Verdel Landing (Robinette, pers. comm., 2009a). Off-trail hikers can see bald eagles eating prey in fields, and wildlife watchers and outdoor photographers enjoy sights of bald eagles roosting in riparian trees and nesting on Jones Island, north of the Niobrara-Missouri River confluence. Much sightseeing is also done from two overlooks in this MNRR: at Niobrara State Park in Nebraska; and the overlook just west of SD Highway 37, at the Chief Standing Bear Memorial Bridge on the South Dakota side of the river (Crownover, pers. comm., 2009). In January 2009 alone, 500 vehicles stopped at this bridge overlook so their occupants could view the outstanding scenic beauty near the downstream end of the 39-mile District of the MNRR (Wilson, pers. comm., 2009).

Table 13b shows that most of these “other” activities in 2000 took place in the Upper River during the summer (Mestl et al., 2001). Although the 2000 Survey shows that “other” activities along the river are engaged in much less frequently than fishing, hunting, and boating activities, they are focused on by visitors to the MNRR for whom aesthetic views, solitude, and communing with nature are very important aspects of the recreation experience. Furthermore, because the surveys were distributed at public boat ramps, recreational activities by non-boaters may have been underestimated (Wilson, pers. comm., 2009). To highlight the importance of sightseeing in this section of the MNRR, Table 13b also includes vehicle counts at the Niobrara State Park Overlook and Standing Bear Bridge Overlook near Springfield, SD averaged over 2006 through 2008 (NPS, 2009), which were not included in the 2000 Survey. Vehicle counts for April 1-30; May1-31; June1-September 30; and October 1-November 30 are shown in Table 13b.

Table 13b
Fort Randall River and Lewis & Clark Lake Segments – Visitation by Non-anglers, Non-hunters, and Non-boaters

Area Visited	April 1 to April 28	Apr 29 to May 26	May 27 to Sep 15	Sep 16 to Nov 10	Total (Apr-Nov)
Ft Randall Dam tailwater reach (1)	125 hrs	179 hrs	0 hrs	0 hours	304 hrs
Upper River reach (1)	98 hrs	0 hrs	5,590 hrs	0 hours	5,688 hrs
Islands reach (1)	310 hrs	0 hrs	1,046 hrs	0 hours	1,356 hrs
Total "Other"* Activities in 2000 (1)	533 hrs	179 hrs	6,636 hrs	0 hours	7,348 hrs
Niobrara State Park Overlook (2)	184 cars	570 cars	2,886 cars	962 cars	4,602 car
Standing Bear Bridge Overlook (2)	549 cars	973 cars	3,882 cars	1,149 cars	6,553 car

* "Other" activities of visitors along the Missouri River include camping, picnicking, sightseeing, observing wildlife, outdoor photography, and other outdoor recreation activities except hunting, fishing, and boating.

(1) Hours in 2000; Source: Mestl et al., 2001.

(2) Average vehicle counts, 2006 - 2008; Source: NPS, 2009 (data subject to revision).

4.6 Fort Randall River and Lewis & Clark Lake Segments: Sites Visited

Locations of recreation areas and public river access points visited in the Fort Randall River and Lewis & Clark Lake segments are identified by river mile in Table 14a. Information about facilities at each site visited is also provided in Table 14a. The number of visits to Corps water resource-based recreation areas downstream of Fort Randall Dam and at the upstream end of Lewis and Clark Lake for several recent fiscal years is provided in Table 14b.

Table 14a
Recreation Sites: Fort Randall River and Lewis & Clark Lake Segments

River Mile and Site Name	Boat Ramps	Boat Trailer Parking	Camp Sites (RV, Camper, Tent)	Swimming Beach
878.8 Fort Randall Dam Spillway RA[1]	1	50	None	No
879.5 Randall Creek RA [1]	1	20	130	No
867.0 Yankton Sioux Tribe/Woods Beach RA [1]	None	None	None	Yes
865.0 Buffalo Run Park	Proposed	None	None	No
840.9 Standing Bear Bridge [1]	1	4	None	No
840.2 Running Water Public Access [1]	1	30	None	No
831.9 Springfield RA [1]	1	50+	40	No
866.1 Sunshine Bottom WMA [2]	1	15	None	No
851.5 Verdel Landing [2]	1	100	None	No
843.0 Niobrara Village Boat Launch [2]	1	30	None	No
841.0 Ferry Landing Boat Ramp [2]	1	Some	None	No
839.0 Bazile Creek Boat Ramp [2]	1	20	None	No

RA = Recreation Area. WMA = Wildlife Management Area. [1] South Dakota. [2] Nebraska.

Table 14b
Corps Missouri River Recreation Area Visits: Downstream Areas near Fort Randall Dam and Upstream Areas of Lewis & Clark Lake

River Mile and Site Name	FY 2002	FY 2004	FY 2006	FY 2007	FY 2008
878.8 Fort Randall Dam Spillway RA [1]	10,845	9,933	9,846	9,536	6,729
879.5 Randall Creek RA [1]	19,284	39,254	25,342	23,945	17,912
840.2 Running Water Public Access[2]	7,228	7,324	9,485	7,044	6,659
831.9 Springfield RA [2]	51,444	52,766	53,836	53,453	53,011
844.0 Niobrara State Park [3]	13,000	13,000	13,000	13,000	13,000
Total Water Resource-Based Visits	101,801	122,277	111,509	106,978	97,311

Source: USACE, 2008b. RA = Recreation Area. [1] Downstream of Fort Randall Dam, in North Dakota.
[2] Upstream end of Lewis & Clark Lake, in North Dakota. [3] Upstream end of Lewis & Clark Lake, in Nebraska.

4.7 Fort Randall River and Lewis & Clark Lake Segments: Observations

The Fort Randall River ad Lewis & Clark Lake segments are heavily used as a recreation resource (see Table 15). The 2000 Survey indicates that more than 96 percent of users would visit the river more than once, and 67 percent indicated that they would access the river more than eight times that year. Total recreation use in 2000 was estimated at approximately 187,000 hours between April 1 and December 31. More than 16 percent of river recreation took place between mid-September and the end of December (30,441 hours). The Lewis & Clark Lake Segment is an extremely important recreational resource for waterfowl hunting. This segment contains extensive wetlands, vegetated islands, and protected areas of open water essential for migrating waterfowl. As such, this area attracts many thousands of migrating birds and waterfowl hunters throughout the fall.

Table 15
Fort Randall River / Lewis & Clark Lake Segments – Total 2000 Recreation Hours

Recreational Activity	Fort Randall Dam Tail Waters Reach	Upper River Reach	Islands Reach	Total
Fishing	55,121	54,597	39,014	148,732
Hunting	393	2,739	4,979	8,111
Boating	664	16,967	5,029	22,660
Other	304	5,688	1,356	7,348
Total	56,482	79,991	50,378	186,851

Source: Mestl et al., 2001.

5 Gavins Point Dam to Ponca, NE (Gavins Point River Segment)

5.1 Gavins Point River Segment: General Setting

The 58-mile stretch of river between Gavins Point Dam (RM 811.1) and Ponca, NE (RM 753.0) is known as the Gavins Point River Segment. This segment is a meandering channel with many chutes, backwater marshes, sandbars, islands, changing shorelines, and variable current velocities. On average, this segment is about one half mile wide and 6 feet deep, with maximum depths rarely exceeding 20 feet (USACE, 1994). It is also the only river segment downstream of Gavins Point Dam that has not been channelized or modified by dikes and revetments. Major tributaries in the Gavins Point River Segment are the James and Vermillion rivers. This segment is also designated as the 59-mile District of the MNRR under the Wild and Scenic Rivers Act.

The first tier counties for this segment are Cedar and Dixon counties in Nebraska and Yankton, Clay, and Union counties in South Dakota. The combined population of the three first tier South Dakota counties was 47,773 in 2000 (U.S. Bureau of the Census, 2000). By 2004 the population was estimated to be 47,937 (U.S. Bureau of the Census, 2006), an increase of over 11 percent since the 1990 census. This is one of the few areas of the upper Missouri River with a growing population. The population density of Yankton, Clay, and Union counties is 42, 33, and 27 persons per square mile, respectively, reflecting a relatively high regional population density.

The two Nebraska counties (Cedar and Dixon) are along the right descending bank of the Gavins Point River Segment. The combined population for these two counties in 2000 was 15,954 (U.S. Bureau of the Census, 2000). By 2004, the population was estimated at 15,169 (U.S. Bureau of the Census, 2006), a decrease of more than 7 percent since the 1990 census. Both Cedar and Dixon counties have a population density of 13 persons per square mile.

Climate and weather conditions along the Gavins Point River Segment are similar to those found along the Fort Randall River Segment. The seasonal weather impacts on recreation along this segment are discussed below.

Interstate access to the downstream end of the Gavins Point River Segment is provided by the north-south running I-29 where it is within a few miles of the Missouri River at Elk Point, SD. Two important U.S. routes also provide access to the Gavins Point River Segment. U.S. Route 81 runs north-south through Yankton and connects South Dakota and Nebraska via the recently constructed Discovery Bridge. U.S. 20 runs east-west within Nebraska, providing access to the Nebraska side of the river and connecting to Sioux City, IA. All other roads providing access to the segment from the Nebraska or South Dakota side are state or county roads (SR 12 in Nebraska and SR 50 and CR 10 in South Dakota) and local roads. These state, county, and local roads provide access to homes, farms, and communities in the area.

Recreation areas along this river segment are somewhat more developed than recreation areas along the Fort Randall River Segment. This higher level of development, including more picnic tables, bathrooms, paved parking areas, and extensive state park camping facilities, reflects the fact that a larger population lives and recreates in this segment than in the Fort Randall River Segment. The combined population of Yankton (SD), Vermillion (SD), and Sioux City (IA) is approximately 100,000 people. Population centers of this size are not found along the Fort Randall, Garrison, or Fort Peck river segments.

The South Dakota SCORP 2002, the latest available, provided population-per-facility ratios for each of the eight planning regions. Region 2, which includes all first tier counties in South Dakota along the Gavins Point River Segment, appeared to have a below-average supply of boat ramps, campsites, fishing facilities, public hunting acres, beaches, and hiking trails compared to other regions. "High priority" was assigned to State development of new trails, camping facilities, nature areas, boat ramps and docks, picnic areas and shelters, swimming beaches, fishing areas and docks, and interpretive and educational facilities statewide (SDGFP, 2003). All these high-priority facilities can be associated with river- or water resource-based recreation, highlighting the importance of this type of recreation in South Dakota.

The Nebraska SCORP 2006-2010 also reported participation rate data only on a statewide basis. Outdoor recreation activities with the ten highest percentages of Nebraskans participating included walking, picnicking, visiting State Parks, swimming, viewing/ photographing natural scenery, fishing, and boating (NGPC, 2006). All these activities can be enjoyed along the Missouri River in the Gavins Point River Segment.

Emergent sandbar habitat was visible from several recreation areas along this segment. Signage concerning piping plovers, least terns, and pallid sturgeon were evident at nearly all locations visited.

5.2 Gavins Point River Segment: Fish Stocking

The Nebraska Game and Parks Commission (NGPC, 2009) reports stocking the following at Ponca State Park in 2006 and 2007:

- 300 eleven and a half-inch channel catfish in 2007;
- 300 ten-inch channel catfish in 2006;
- 150 twelve-inch channel catfish in 2006;
- 300 ten-inch rainbow trout in 2006; and
- 600 eleven-inch rainbow trout in 2006.

The SDGFP 2005 Stocking Report indicates that 44,440 adult fathead minnows were stocked at Gavins Point and 22,500 largemouth bass fingerlings were stocked at Burbank, SD (SDGFP 2007). No fish were stocked in the segment in 2007 (SDGFP 2009).

5.3 Gavins Point River Segment: Angler Use

The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation for Nebraska and South Dakota provide an overview of river-recreation potential. The 2001 National Survey for Nebraska indicates that there were 3.2 million total angler days in Nebraska and that 657,000 of those days (20.5 percent) were spent fishing on streams or rivers state-wide. The 2001 National Survey for South Dakota shows 2.98 million angler days within the state, of which 1.04

million (35 percent) were spent fishing on streams or rivers state-wide. The 2001 National Survey also reports that 24 percent of Nebraska residents and 31 percent of South Dakota residents either fish or hunt, which is substantially above the national average of 18 percent. The close proximity to population centers, the high participation rate for fishing and hunting, and the amenities available at recreation areas along this segment provide the potential for intensive water-based recreation.

Fishing is very popular in the Gavins Point Dam tail waters. Main sport fish species caught in the tailrace are walleye, catfish, and paddlefish. Most shore fishing and boat fishing in this 2-mile-long section takes place within 0.5 mile of the dam (Schellhaus, pers. comm., 2009). Anglers who wish to camp have available to them (in season) the developed campgrounds at the Gavins Point Project. Paddlefish season, which begins October 1, attracts both shoreline and boat anglers; on opening day of the season in 2008, there were at least 100 boats in the tailrace. Boats enter the river from the two boat ramps at the tail waters. Fishing occurs year-round in the tail waters; on one relatively warm weekend day in February 2009, 30 boats with anglers were in the tail waters (Schellhaus, pers. comm., 2009).

In the Lower River reach of the Gavins Point River Segment, approximately 30 percent of angling occurs from shore, and 70 percent by boat. The main species caught are catfish and walleye, and smallmouth bass and crappie are also harvested (Schellhaus, pers. comm., 2009). Most shoreline fishing takes place at riverside cabins; at Clay County Park, which has a fish cleaning station; and near the Myron Grove Boat Launch and the Bolton Landing river access sites. Shoreline fishing is also popular just upstream of the Vermillion-Newcastle Bridge, at both a created/ restored backwater and along the Missouri riverbank about 150 to 200 yards from a sandbar island that was constructed using material excavated when the backwater was created. SDGFD is in the process of planning and investigating the availability of Dingell-Johnson funding for installing a concrete ramp, a small boat-trailer parking area, and a vault toilet at Bolton Landing, which would aid both shore and boat anglers (Keeton, pers. comm., 2009). Fishing boats range from 10-foot-long boats with flat bottoms to 19-foot-long fiberglass boats, but approximately 75 percent of the boats are 14 to 17 feet long with flat bottoms. Approximately 30 percent of fishing boats are launched from a public or private boat dock, but 70 percent are launched from (and moored at) a dock at the boat angler’s riverside home (Schellhaus, pers. comm., 2009).

The 2000 Survey (Mestl et al., 2001) also included the Gavins Point River Segment, which was split into two reaches: Gavins Point Dam tail waters, and the Lower River. The Lower River designation extends from the tail waters of Gavins Point Dam to Sioux City, IA, which is located approximately 15 miles beyond the scope of this analysis (which ends at Ponca, NE). Fishing along the Gavins Point River Segment is very popular, with approximately 210,000 angler hours spent between April and December 2000 (Table 16) These angler hours may be overestimated with respect to the Gavins Point River Segment because angler use between Ponca, NE and Sioux City, IA were included. Approximately 85 percent (177,170 hours) of angler use occurred between early April and mid-August and 15 percent (32,550 hours) occurred between mid-August and early December. Table 16 presents the total 2000 angler hours for each reach of the Gavins Point River Segment; totals may reflect rounding of hours for time periods and reaches.

Table 16
Gavins Point River Segment – 2000 Angler Hours

Reach	April 1 to April 28	Apr 29 to May 26	May 27 to Sep 15	Sep 16 to Dec 8	Total Hours
Gavins Point Dam tail waters	16,775	29,412	82,260	19,097	147,545
Lower River *	1,736	7,386	46,560	6,494	62,176
Total *	18,511	36,798	128,820	25,591	209,721

Source: Mestl et al., 2001. Total hours may not equal the sum of seasonal hours due to rounding.

*Angler hours may be overestimated because Lower River reach extends 15 miles beyond Ponca, NE.

5.4 Gavins Point River Segment: Hunting

Hunting in the riparian areas of the Lower River reach is similar to that previously described for the Upper River reach. Deer are hunted on foot in the cottonwood-willow riparian woodlands along the Lower Rive reach. The wooded riparian corridor is a few to 100 yards wide. Behind the riparian woodland are harvested fields where foraging geese and ducks are hunted with blinds to prevent the waterfowl from being disturbed (Schellhaus, pers. comm., 2009).

Most waterfowl is hunted by boat, which provides access to islands in the Lower River reach. In the fall, flows in the Missouri River below Gavins Point Dam are reduced and sandy islands become exposed in the reach upstream of the Vermillion-Newcastle Bridge; on these new sandbars, hunters set out decoys and set up blinds to conceal their movements to avoid startling the waterfowl (Keeton, pers. comm., 2009). A count from an airplane in November 2008 revealed that 47 blinds (some permanent and some temporary) had been erected on islands between Yankton, SD and Ponca, NE. No permit is required to erect a hunting blind in this reach of the Gavins Point River Segment (Schellhaus, pers. comm., 2009).

The 2000 Survey indicates that hunting is a popular activity along this segment and takes place mainly between mid-October and mid-November. A small number of hunting hours (93) was reported for April in the Lower River reach of the segment as part of recent spring snow goose seasons. The low-lying flood plain and wetland areas along this segment provide waterfowl hunting opportunities, as do the inter-channel sandbars and their associated wetlands. Table 17 presents the estimated 2000 hunting hours for the Gavins Point River Segment.

Table 17
Gavins Point River Segment – 2000 Hunting Hours

Gavins Point Dam Tail Waters	587 total (all Oct. 14 – Nov. 10)
Lower River	791 total (698 Oct. 14 - Nov. 10; 93 April 1-28)
Total	1,471 total

Source: Mestl et al., 2001.

5.5 Gavins Point Dam to Ponca, NE: Boating and Other Activities

Non-motorized boats (kayaks, canoes, and inner tubes) comprise approximately 5 percent of total boating in both the Gavins Point Dam tail waters and Lower River reaches, and this percentage is increasing over time. People floating in inner tubes from the tail waters often go ashore when they reach Yankton. Canoes and kayaks are launched from the two boat ramps in the tail waters to ply the MNRR (Schellhaus, pers. comm., 2009). Ponca State Park also has a canoe/kayak launch and take-out area (NGPC, 2009a). The canoeists ply their watercraft on the MNRR silently, with no boat engines to interfere with their hearing bird calls or disturb their solitude. Because canoes travel more slowly than motorized boats, the paddlers have time to observe and commune with nature. Most of the islands in the river are sandy, with little or no vegetation. Canoeists may access one of these islands in the Lower River and explore the sandbar, engage in beach-related activities, or even camp overnight there (Schellhaus, pers. comm., 2009) while continuing to commune with nature and enjoy scenic natural beauty from the perspective of the middle of the river.

No waterskiing occurs in the tailrace. Jet skiing is not allowed in the MNRR. Boat owners use the same boats for motorized boating on the river as they use for boat fishing or waterfowl hunting; therefore they range in size from 10 feet to approximately 19 feet. Boats enter the Missouri River from docks by riverside cabins and from a number of public boat ramps. In the Lower River reach, approximately 5 percent of boats pull waterskiers or persons in inner tubes. Up to 80 percent of the boats access a sandbar island, and boaters disembark to enjoy beach-related activities such as picnicking, sand volleyball, sunbathing, swimming, and enjoying the scenic beauties of nature from the vantage point of an island in mid-river (Schellhaus, pers. comm., 2009). Boaters launching from the Missouri River boat ramps near Gavins Point Dam, at Ponca State Park, and at Clay County Park may also participate in camping, picnicking, and trail hiking using the excellent facilities there; many of the facilities at Clay County Park were recently developed (Keeton, pers. comm., 2009).

The 2000 Survey indicates that boating took place on the Gavins Point River Segment from early April through mid-November. Boating hours are presented in Table 18a; totals may reflect rounding of hours for time periods and reaches. Most boating (84 percent, 50,380 hours) took place from the end of May through mid-August. The Lower River reach of the Gavins Point River Segment was by far the most popular boating area among the reaches within Missouri River segments in South Dakota or Nebraska. The high boating use of this area may be influenced by the proximity of two population centers (Sioux Falls, SD, with a population of 140,000; and Sioux City, IA, with a population of 83,000), both situated on Interstate 29, which runs perpendicular to the lower end of the segment. Many boats using this segment are moored at private docks or slips near riverside residential developments (Wilson, pers. comm., 2009; Schellhaus, pers. comm., 2009) and do not use the public boat ramps where the survey cards were distributed in 2000. Therefore, even though the 2000 survey results showed Lower River boating visitation to be very high, Lower River visitation by boaters may still have been underestimated.

Table 18a
Gavins Point River Segment – 2000 Boating Hours

Reach	April 1 to April 28	April 29 to May 26	May 27 to Sep 15	Sep 16 to Nov 10	Total Hours
Gavins Point Dam tail waters	232	1,281	1,667	0	3,179
Lower River *	0	968	49,049	6,641	56,658
Boating/other hours by boaters *	232	2,249	50,716	6,641	59,838

Source: Mestl et al., 2001. Total hours may not equal the sum of seasonal hours due to rounding.

*Boating hours may be overestimated because Lower River reach extends 15 miles beyond Ponca, NE

Persons without boats who engaged in camping, picnicking, sightseeing, observing wildlife, outdoor photography, and other activities (other than hunting and fishing) were also included in the 2000 Survey. Campers take advantage of the developed campgrounds at the Gavins Point Dam tail waters area, Clay County Park, and Ponca State Park. Some Boy Scout troops camp on the public islands and may obtain permission to camp on privately owned riverside lands. Bird watchers see many eagles in the cottonwood trees in the riparian areas along the shorelines of the tail waters and the Lower River reaches. Much bird watching occurs in the vicinity of Ponca State Park in late April and early May, the peak time for songbird migration; during the spring and fall waterfowl migration; and to see bald eagles roosting in winter. Ponca State Park also has 20 miles of trails, which provide scenic views from the top of the bluffs and from the bottomlands along the river (NGPC, 2009a). The remainder of the river bluffs are privately owned, so no other hiking trails have been developed in this segment (Schellhaus, pers. comm., 2009) except the short trail at Clay County Park (Keeton, pers. comm., 2009).

Table 18b shows that most activities other than fishing, hunting, and boating in 2000 in the Gavins Point River Segment took place in the Lower River reach during the summer (Mestl et al., 2001). Although the 2000 Survey shows that "other" activities along the river are engaged in much less frequently than fishing, hunting, and boating activities, they are focused on by visitors to the MNRR for whom aesthetic views, solitude, and communing with nature are very important aspects of the recreation experience. Furthermore, because the surveys were distributed at public boat ramps, recreational activities by non-boaters may have been underestimated (Wilson, pers. comm., 2009). To highlight the importance of sightseeing in this section of the MNRR, Table 18b also includes vehicle counts at the Mulberry Bend Overlook on the Nebraska side of the

Vermillion-Newcastle Bridge averaged over 2006 through 2008 (NPS, 2009), which were not included in the 2000 Survey. The vehicle counts for April 1-30; May1-31; June1-September 30; and October 1-November 30 are shown in Table 18b. The data suggest that more visitors may have enjoyed scenic views and perhaps engaged in outdoor photography at the Mulberry Bend Overlook from April through November during the years 2006 through 2008 than engaged in "other" activities at other areas along the Gavins Point River Segment in 2000.

Table 18b
Gavins Point River Segment – Visitation by Non-anglers, Non-hunters, and Non-boaters

Area Visited	April 1 to April 28	Apr 29 to May 26	May 27 to Sep 15	Sep 16 to Nov 10	Total (Apr-Nov)
Gavins Point Dam tail waters reach (1)	232 hrs	0 hrs	3,311 hr	0 hrs	3,542 hr
Lower River reach (1)	505 hrs	520 hrs	4,977 hr	569 hrs	6,571 hr
Total Other* Activity Hours, 2000 (1)	737 hrs	520 hrs	8,288 hr	569 hrs	10,113 hr
Mulberry Bend Overlook, NE at Vermillion-Newcastle Bridge (2)	995 vehicles	1,221 vehicles	4,521 vehicles	1,912 vehicles	8,649 vehicles

* "Other" activities of visitors along the Missouri River include camping, picnicking, sightseeing, observing wildlife, outdoor photography, and other outdoor recreation activities except hunting, fishing, and boating.

(1) Hours in 2000; Source: Mestl et al., 2001. Total hours may not equal the sum of seasonal hours due to rounding.

(2) Average vehicle counts, 2006 - 2008; Source: NPS, 2009 (data subject to revision).

5.6 Gavins Point River Segment: Observations

The 2000 Survey results showed that 50 percent more recreation hours were spent on the Gavins Point River Segment (Table 19) than on the Fort Randall River and Lewis & Clark Lake segments (Table 15). However, when length of segment is considered, both segments had similar levels of total recreation in hours per river mile (4,846 recreation hours per river mile for the Gavins Point River Segment, and 4,791 recreation hours per river mile for the Fort Randall River and Lewis & Clark Lake segments). More fishing and boating occurred on the Gavins Point River Segment, but nearly six times more hunting occurred on the Fort Randall River and Lewis & Clark Lake segments than on the Gavins Point River Segment. This reflects a much more important fall recreational season in the Fort Randall River and Lewis & Clark Lake segments because of waterfowl hunting. Most of the recreation in the Gavins Point River Segment occurs during the summer.

Table 19
Gavins Point River Segment – Total 2000 Recreation Hours

Activity	Gavins Point Dam tail waters	Lower River	Total
Fishing	147,545	62,176	209,721
Hunting	587	791	1,378
Boating	3,179	56,658	59,837
Other	3,542	6,571	10,113
Total	154,853	126,196	281,049

Source: Mestl et al., 2001.

5.7 Gavins Point River Segment: Sites Visited

Locations of recreation areas and public river access points in this segment are identified by river mile in Table 20a. Information about facilities at each site visited is also presented in Table 20a. The number of visits to Corps water resource-based recreation areas downstream of Gavins Point Dam for several recent fiscal years is provided in Table 20b.

Table 20a
Recreation Sites: Gavins Point River Segment

River Mile and Site Name	Boat Ramps	Boat Trailer Parking	Camp Sites (RV, Camper, Tent)	Swimming Beach
809.5 Nebraska Tailwaters Boat Ramp [(1)]	2	40	52	No
798.8 St. Helena Public Boat Launch [(1)]	1	100	None	No
787 Weisman Boat Ramp [(1)]	1	50	None	No
775 Mulberry Bend Boat Launch [(1)]	1	50	None	No
810 Chief White Crane State RA [(2)]	2	100	146	Yes
805 Yankton Riverside Park [(2)]	2	40	None	No
780.6 Clay County Park * [(2)]	1	30	30 *	No
787 Myron Grove Boat Launch [(2)]	1	30	None	No
784.9 Brooky Bottom Boat Launch [(1)]	1	N/A	None	No
763.5 Bolton Landing [(2)]	Canoe	None	None	No
753.5 Ponca State Park RA [(1)]	1	Many	Many	No

RA = Recreation Area. [(1)] Nebraska. [(2)] South Dakota.
Note: Brooky Bottom boat launch site was inaccessible due to road conditions; Bolton Landing is a dirt access.
* Updated 2009. Source of updated information: Keeton, personal communication, 2009.

Table 20b
Corps Missouri River Recreation Area Visits: Downstream near Gavins Point Dam

River Mile and Site Name	FY 2002	FY 2004	FY 2006	FY 2007	FY 2008
811.0 Pierson Ranch RA [(1)]	14,574	15,228	15,502	15,593	15,832
811.0 Cottonwood RA [(1)]	33,788	35,384	32,370	35,268	44,335
810.0 Chief White Crane RA [(1)]	37,548	40,276	41,557	39,574	39,199
810.1 Training Dike RA [(2)]	235,591	264,619	228,012	233,138	259,014
809.5 Nebraska Tailwaters RA [(2)]	84,690	79,222	77,898	80,243	88,341
Total Water Resource-Based Visits	406,191	434,729	395,339	403,816	446,721

Source: USACE, 2008b. RA = Recreation Area. [(1)] North Dakota. [(2)] Nebraska.

6 Conclusions

This analysis concurs with information presented in the Review and Update Study (USACE, 1994) and provides additional information that will be useful in the evaluation of the effects of the ESH alternatives on recreation. In the Missouri River segments analyzed, more recreationists participate in fishing than in any other recreational activity. This analysis concurs with the previous finding that less recreation occurs on the Fort Peck River Segment than on the other segments. However, lower recreational volumes are more conducive to the enjoyment of solitude. This analysis cannot be used to estimate total levels of recreation on any segment; however, the available angler use data is suitable for comparison purposes.

The additional information provided by this analysis indicates that recreation is concentrated in certain areas within some segments. The area around Bismarck, ND on the Garrison River Segment has a concentration of riverine recreation due to numerous marinas, private slips, and excellent public access. The Desert near Bismarck also provides a unique opportunity for beach-related recreation, which is not found anywhere else on this scale along the other segments.

Waterfowl hunting is a recreation activity having both area concentration and seasonal aspects. Along the Fort Randall River, Lewis & Clark Lake, and Gavins Point River segments, waterfowl hunting is concentrated in the fall (during the ESH construction period) in areas offering inter-channel sandbars with wetlands and vegetation or island and bank areas that provide foraging and loafing areas for migrating waterfowl and vegetated cover. These areas occur along the downstream reaches of the Fort Randall River and Lewis & Clark Lake segments, especially downstream of the Niobrara River and in the central reaches of the Gavins Point River Segment.

Many substitute recreational sites exist within each segment. Therefore, temporary restrictions on access to or use of a particular recreational site would tend to shift recreational activities and expenditures to other nearby areas in the segment offering similar recreational opportunities rather than significantly reduce visitation and expenditures.

The Missouri River segments analyzed are wildlife corridors as well as destinations for recreationists. The quality, quantity, and diversity of fish and wildlife habitat in the Missouri River segments studied affects the abundance and diversity of fish and wildlife species, including threatened and endangered species, using the segment. Most participants in recreational activities along the Missouri River consider naturalistic, scenic views and communing with nature an important part of their recreational experience. Fish and wildlife are not only essential for angling, hunting, bird watching, and other wildlife observation, but they also add greatly to the enjoyment of recreational activities such as camping, picnicking, hiking, outdoor photography, and sightseeing. Tribes, federal agencies, and state agencies are continuing to work to improve fish and wildlife habitat, including wildlife food plots and no-hunting refuge designations, to ensure that future generations can experience at least the same level of enjoyment in water resource-based recreational activities along the Missouri River that occurs at the present time.

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Attachment I: Site Survey Form

PHYSICAL CONDITIONS:

Reach:	State/ County:
Local Site Name:	Time of Visit:
Date of Visit:	Weather Conditions:
Water Level:	Signage Regarding Avoiding Terns/Plovers:
Immediate Observable:	Evidence of ESH Nearby:

ACTIVITIES:

What Activities Are Being Conducted?	Number of People:
Boating:	Boat Trailers in the Lot:
Shore Fishing:	Water Skiing:
Boat Fishing:	Tubing:
Picnicking:	Jet Skiing:
Canoeing:	Swimming:
Hunting: n	Bird Watching:

FACILITIES:

Parking Facilities:	Number Vehicles in Lot:
Bathrooms:	Boat Ramp:
Beach/Swimming:	Fishing Access:
Camper Parking:	Garbage Receptacles:
Fish Cleaning Station:	Picnic Tables:
RV Hook-Up:	Playground:
Tent Sites/Overnight:	Concession:

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of Engineers
Omaha District

Draft Programmatic Environmental Impact Statement for the Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Appendix E

Summary of Scoping Comments on the Programmatic EIS

(Original Date October 2005)

Including Comments on

2003 Public Notice for ESH Program

2004 Programmatic EA Notice and Public Meetings

2004/2005 Site Specific ESH EAs

2005 Notice of Intent to Prepare Programmatic EIS

October 2010

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Alternatives

1.1 Alternatives Proposed in the NOI

We are also concerned about several of the other alternatives proposed. Proposed Alternative 1 is an RPA in the 2003 Amendment to the BiOp, Alternative 3 would likely result in approximately the same acreages as required in the 2003 BiOp and Alternative 6 (No Action) is required by NEPA, but the other alternatives (2, 4, and 5) would likely requires extensive consultation with the USFWS since they don not meet the goals set out in the 2003 BiOp. In this context, we are not convinced they can be considered reasonable alternatives. (ND Dept. of Game, Fish and Parks September 7, 2005)

It appears that proposed alternatives 2,4, and 5 in the NOI do not meet the purpose and need for the project. The draft PEIS should explain how Alternatives 2, 4, and 5 meet the purpose and need for the project or, if they do not, why they are being carried forward. (USFWS, September 16, 2005)

1.2 Captive Rear

I was disappointed that the USFWS was not standing beside you people taking the heat for their program. My feelings are that these birds could be hatchery raised at a much cheaper cost to the public. Maybe their mismanagement record with other things makes them a risk to manage these birds. I don't hear much anymore about the sturgeon-they can be hatchery raised to same them, but I guess this proven method doesn't totally fit them. I did notice that the Fish and Wildlife was there, but didn't have on their official clothing. I guess they can't take the plucking like the Corps. (Private Citizen)

1.3 In-Lake Habitat

At the January 20th meeting, you reported the shores of Oahe and Sakakawea are excellent habitat, but this would disappear when high lake levels return. Would it be more productive for the COE to spend their efforts coping with the predictable changing shores rather than the highly errodible [sic] sandbars? This also obviously would have much less negative effect on the river users. The COE owns these shorelines therefore ROW would not be a problem. We insist this proposal be part of the EIS. (Private Citizen)

Build habitat on shore of Lake Sakakawea. (Private Citizen)

The Corps owns miles of shoreline on the Lake Sakakawea that the birds are already using. Expand on that and stay off the Missouri River. (Private Citizen)

You have all the room needed to create sand bars on the North side on Garrison Dam – by creating sand bars along shoreline of areas not used by boaters due to no access. (Private Citizen)

Tern and plover habitat can easily be built on Garrison Dam at a much more affordable price. I will not support your existing plan. (Private Citizen)

1.4 Use of Flow

The Fact Sheet indicates that methods to create ESH using flow from the main stem dams are being evaluated under separate studies and therefore, will not be considered in the EA. We are unaware of any separate studies. The purpose of NEPA is to analyze alternatives for accomplishing the project goal, fully disclose impacts to the public and promote sound environmental decisions by action agencies. Flow alternatives are viable means for accomplishing the project objectives and should be considered in the NEPA document. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Most importantly, the EIS must include a detailed examination of the use of flow modifications from mainstem dams as an alternative to mechanically create ESH**.** Further, the EIS needs to address where mechanical ESH work has been done before, and the successes and/or failures of this work over time. The EIS must include the amount of work the Corps itself will conduct, versus the number and type of contractors that will be utilized. This information will lend itself to providing the public with important information as to the viability of different options for creating ESH. (American Rivers, Nov. 18, 2004)

The Dacotah Chapter of the Sierra Club has submitted comments to the USACE regarding the revision of the master manual during each opportunity presented. We have emphasized the fact that the USACE needs to change how they manage the flow of the Missouri River. A healthy river needs to complete some of the natural seasonal cycles that occurred before the dams were constructed. A spring rise would create and maintain sandbar habitat and provide spawning cues for fish. Low summer flows would expose sandbars for tern and plover nesting habitat. We have also supported the recommendations in the Final Biological Opinion of the US Fish and Wildlife Service, which provided substantial fish and wildlife benefits compared to the current water control plan or the preferred alternative. (Sierra Club, Dacotah Chapter, Feb. 11, 2005)

I wish to voice strong opposition to the current Corps intention to create nesting habitat for interior least terns and piping plovers through mechanical maintenance and creation of emergent sandbar habitat. To be clear, I would support the promotion of protection of endangered species where the likely benefit to such species can be shown to be significant as long as even more destruction of habitat for other native (including other endangered) species will not occur. That is not the case in the current situation. The original recommendation from biologists (assuming my information and understandings are correct or at least nearly so) was to attempt to create this habitat through a couple of spring/early summer high flow releases followed by steady dewatering through summer and into the fall. This would seem to me to be the least destructive to native species and the most cost effective tack to follow. Based upon my observations of activity at the RM 761.4 site, the destruction of natural habitat and of other native species could only be called massive. You already know the numbers of unionids (not to mention other species about which neither you nor I know anything at all) and I include a copy of my initial (and probably final) report on this survey. All this in a reach of river that still is home to significant numbers of these birds. (Keith Perkins, usiouxfalls.edu November 20, 2004)

We all want to put in a pitch for leaving the cfs as is for next summer. At these releases the amount of sandbars available for the birds to use next spring would be fantastic. The birds will be confused as to which sandbar they should use. The corps will incur zero expenses creating new sandbars if they reduce the cfs. Let' give the birds the joy of their life. Let the down stream folks experience a true plains drought. (Private Citizen)

We are concerned about the potential changing of the river flows because of the Corps possible changing and or grooming of existing sand bars for the two birds in question. Any tampering of the existing make up of the "river" can affect multiple problems for others usually down stream. For example one needs to only watch the river in the late fall, spot and locate sandbars etc. and then see freeze up and the river covered with ice for the winter. Next spring unbelievable amounts of sand are moved downstream by miles and where there was a sandbar in the fall it is far down stream. This now causes currents to change and effect the banks further down stream. Ultimately, considerable amounts of sand move south of Bismarck to the "delta". These are real and factual concerns. Please keep in mind any sandbar changed by the corps will usually effect someone downstream as you make your plans. (Missouri River Adjacent Landowners Association, November 18, 2004)

If you could create more sand bars and keep the river levels at Bismarck 6.5’ this may be more acceptable (50 acres per mile is a stretch) (Private Citizen)

Our main concern is that flow management, including the release of spring scouring flows followed by a declining summer hydrograph, to enhance and maintain tern and plover habitat on the Missouri River is not going to be considered in the Programmatic EIS. We must emphasize that non-flow or mechanical creating and maintenance of ESH should only be considered as a supplementary approach, and consideration for flow management, as an alternative should be addressed in this EIS. (Nebraska Game and Parks Commission, 11/19/04)

The NPS requests the Corps to directly link flow regulation used for restoration of pallid sturgeon habitat with off-channel construction (which is largely outside the jurisdiction of the NPS). Once flows and off-channel alternatives have been developed to obtain a maximum benefit, the need for a magnitude of proposed in-channel construction can be better understood. (National Park Service, October 29, 2004)

SDGFP is concerned that he Corps does not plan to include an alternative examining the use of flow to create the required habitat goals. An EIS should examine ALL reasonable alternatives. Since the flow alternative has been promoted by a number of scientists and agencies, including the National Research Council (2002) and the USFWS (2000), we believe that use of flow to create habitat is a reasonable alternative that should be considered. While flow may have not been considered in the development of the Master Manual, this analysis is being conducted in a different context, and a comparison of the environmental and economic costs and benefits for this project may yield different results. (South Dakota Game, Fish and Parks September 7, 2005)

The Corps' attempts to avoid implementing flow changes on the Missouri River and instead engage in efforts like the ESH work will result in significant and long-term annual burdens on the American taxpayer. (American Rivers, Nov. 18, 2004)

1 Bank Stabilization

The 2000 Biological Opinion also called for no bank stabilization in this stretch of the river to protect cottonwood forestry. The bottom line is the USFWS wants no stabilization because that is the source of sediment for the islands. This creates an impossible situation on this stretch of the river. (Private Citizen)

Negative impact to high bottomland - The source of sediment for the new sandbars and islands will be bed and bank of the river. The USFWS opposes bank stabilization because they need the sediment to achieve its targeted goals. Since 1954 more than 5 square miles of land have been lost to bank erosion. The valuable bottomland is lost forever. (Private Citizen)

The permanent loss of high bottomland is not tolerable. The primary source of the silt is the bed and bank of the river. More than 5 square miles of land have been lost since 1954. This cannot be allowed to continue. (Private Citizen)

2 Cost

The economic costs for the various alternatives should be fully disclosed and contrasted with the costs of flow-based habitat management, including both plans that would create sandbars, and those that would expose existing sandbars by lowering releases during the nesting season. These analyses should include costs per bird fledged and likely long-term costs based on expected longevity of the habitat and continual relocation of the habitat due to increased predation pressure. (Missouri River Natural Resources Committee, Nov. 16, 2004)

The EIS must fully evaluate the costs of this work, including the long-term management costs of building and maintaining ESH acres year after year. Cost evaluations should include comparisons between artificial habitat creation and using flow modification to build and maintain the same habitat. (American Rivers, Nov. 18, 2004)

The cost of mechanically and chemically creating sandbar habitat is a waste of taxpayers' money and amounts to one huge subsidy for an almost non-existent barge industry. The cost of creating a more seasonal, natural flow of the Missouri River would be relatively inexpensive. The river is capable of taking care of itself if we allow it to flow as nature intended. Therefore, the Dacotah Chapter of the Sierra Club does not support the proposed methods of creating sandbar nesting habitat through mechanical and chemical means, but we do support creating sandbar habitat through higher spring flows and lower summer flows. (Sierra Club, Dacotah Chapter, Feb. 11, 2005)

The cost of mechanically and chemically creating sandbar habitat is a waste of taxpayers' money and amounts to one huge subsidy for an almost non-existent barge industry. The cost of creating a more seasonal, natural flow of the Missouri River would be relatively inexpensive. (Private Citizen)

Costs/benefits of herbicide vegetation removal, mechanical vegetation removal, and dredging are very suspect. The overall program's cost/benefit seems suspect. The dollars could be much better used protecting habitat or shore adjacent to the main channel. (Private Citizen)

What are the costs for such a program? Will significant and long-term annual financial burdens be placed on the American taxpayer? Will cost evaluation analyses be used to compare dollars spent on artificial habitat creation versus achieving ecological function using flow modifications to build and maintain viable habitat for an array of species beside the T&E species? (Sierra Club, Nebraska Chapter, Feb. 11, 2005)

The public will demand your cost estimates of this proposal and your estimates of the benefits. Also, what priority will it have over the many other users of the river? (Private Citizen)

From the methods to be considered on the fact sheet, moving, heavy equipment bulldozers, scrapers, front-end loaders, etc. to sandbars to raise, lower, contour, and smoothen surfaces seems like a very very costly endeavor. (Morton County Parks, Nov 18, 2004)

Present the costs associated with the various alternatives for constructing ESH, including the costs envisioned for in-channel construction work alone; variations of in-channel, off channel, and flow modifications that achieve the necessary targets; and flow modifications alone. (NPS, 10/29/04)

3 Dam Operation Changes

Changes in reservoir releases to facilitate dredging or access to the channel by heavy equipment and their impacts to reservoir storage, river fauna, and river recreation should be discussed. Last march, the river was lowered substantially below Fort Randall dam to allow heavy equipment access for tern and plover habitat work. This action not only delayed a planned fish stocking by South Dakota Game, Fish and Parks, but likely killed mussels and benthic invertebrates due to the rapid stage decline. (Missouri River Natural Resources Committee, Nov. 16, 2004)

In the past, the Corps has varied releases from dams like Ft. Randall to allow heavy equipment operators to access the channel from the bank to complete other tern and plover habitat work. Such releases have a negative impact on river species like mussels and benthic invertebrates. The EIS must include a detailed evaluation of what, if any, dam operation changes will be utilized to allow equipment access to work sites, and what impact these release changes will have on Missouri River species. (American Rivers, Nov. 18, 2004)

4 EA vs. EIS

There is no question that a project of this magnitude deserves a full-scale EIS. The proposal includes dredging, spraying and drastically altering an otherwise natural landscape. This project certainly deserves an examination of all potential consequences. (Private Citizen)

If, by a programmatic EA, you mean a single document covering areas in 4 states and which spans many hundreds of miles cannot possible cover all the specific issues of all the areas. (North Dakota Water Users, Jan 20, 2005)

I encourage the COE to step back and take a very hard look at this proposal. At a minimum a full-blown environmental impact statement needs to be prepared. (Private Citizen)

A full-blown Environmental Impact Statement needs to be prepared. The economic and social impacts need full attention. The tern and plover habitat concern is a problem but should not be solved at the expense to the other listed concerns. (Private Citizen)

The public and agency meetings held on October 19, 2004, were not properly advertised or agencies notified. Key state agencies were not in attendance and the public was completely unaware of the meeting. Less than six people representing the public were in attendance. Proper notification and new meetings need to be held. (Private Citizen)

We believe personal letters to area stakeholders (communities with intakes, adjacent landowners, irrigators, and fishing and sportsmen's clubs who use the River) should be issued. We can and will assist you in preparing a mailing list if you so wish (North Dakota Water Users Association).

5 Effects

Air Quality

The review of the proposed project to build and maintain habitat along the Missouri River for the nesting of the interior least tern and piping plover has been completed. The ambient air quality concentration in the project area of South Dakota are in compliance and are better than the EPA national standards. It appears that all proposed options for habitat building and improvements in general would not have an impact on the ambient air quality of the State. (South Dakota Dept of Environment and Natural Resources, 10/27/04)

Aquatic Ecology

Native fish, including paddlefish and sturgeon, use sandbar pools and shallow water edge habitat around sandbars as important nursery and refugia for larval and juvenile fish and young of the year softshell turtles. These areas also provide invertebrate colonization areas and may harbor large freshwater mussel beds. The assessment should discuss how impacts to these habitats will be avoided and mitigated, how artificial bar creation will provide for these habitats, and how the geomorphological and biological effects will be measured. (Missouri River Natural Resources Committee, Nov. 16, 2004)

The manipulation of sandbars in the Missouri River clearly has the potential to alter important aquatic habitat important to game fish such as the walleye. (Friends of Lake Sakakawea, Oct. 28, 2004).

Besides impacts to federal T&E species, we believe that the mechanical activities associated with ESH creation have significant and likely adverse impacts to other aquatic and semi-aquatic organisms such as reptile and amphibian species and benthic invertebrates. Indeed, we contend that he Corps ESH program is sacrificing certain native species (some of which are state listed species) and their habitats for short term, non-viable gains of federally listed species. (Sierra Club, Nebraska Chapter, Feb. 11, 2005)

Although I am told that this habitat was the Corps' plan to protect "endangered" species, this is a concern to the Friends of Lake Sakakawea. The manipulation of sandbars in the Missouri River clearly has the potential to alter important aquatic habitat important to game fish such as the walleye. (Friends of Lake Sakakawea, Feb. 3, 2005)

Identify and analyze the spawning, foraging, and/or loafing habitats for pallid sturgeon in the respective MNRR segments, and identify and analyze the potential impacts of ESH construction on that species and its habitat. (NPS, 10/29/04)

Damage to spawning areas by dredging. (Private Citizen)

Lake Sakakawea and Lake Oahe have already suffered greatly from the drawdown of the Missouri River reservoirs. It has had a devastating impact on our walleye fishery. Any further deterioration of habitat needs of aquatic species, even as an unintended consequence of your proposed project is unacceptable. If alteration of fish habitat occurs as a result of your proposed project we believe this is a significant environmental impact. (Friends of Lake Sakakawea, October 28, 2004)

Cultural Resources

Alternative methods being considered include some activities that have very slight possibility of impacting cultural resources (e.g. cutting with loppers, saws or sickles) to those that could have high impacts were cultural resources to be present (e.g., slope reduction and substrate modifications). Included also are methods for which the possibility for impact to unknown sites would be difficult to assess in the absence of inventory prior to inundation (e.g., use of dredges to enhance submerged bars). As such, we recommend that the possibility of effects to cultural resources exists with the use of some of the methods proposed. (Montana Historical Society, 10/01/04)

A COE cultural resource specialist should be able to assess the potential for effect at specific project locales on the basis of 1) class 1 file search, 2) site inspection or report of current and past use and disturbance including natural erosion/deposition and 3) the specific method proposed. It is our belief that internal review including a COE cultural resource specialist (archeologist) should be able to identify the majority of proposed action loci as unlikely to effect cultural resources – but just as strongly believe that an archeologist is critical in that assessment. (Montana Historical Society, 10/01/04)

I advocate for protection of historic sites along the Garrison reach. (Private Citizen)

We strongly suggest that you coordinate with all Native American tribes with interest in the Missouri River. As the proposed work may involve excavations, we suggest that surveys for cultural and paleontological resources be conducted prior to such excavations. These surveys should consider the areas to be used for borrow and potential erosion from the formation of the sandbars due to fluvial changes. (USDOI, Bureau of Indian Affairs, 10/22/04)

The methodologies for the treatment of cultural resources, particularly human remains, must be addressed in accordance with the provisions of NAGPRA, ARPA of 1979, and all other pertinent legislation and implementing regulations with regard to all cultural resources now known or yet to be discovered. (USDOI, Bureau of Indian Affairs, 10/22/04)

Identify and analyze the impacts to submerged steamboats and ferries, and to recorded and unrecorded historic and archeological remain, in coordination with the NPS. Pay particular attention to the rural agricultural landscape of the park as a cultural resource, which would include the untrammeled natural river setting in the contest of Lewis and Clark, the Yankton Sioux Tribe's embrace of the natural river, and the MNRR as a WSR. (NPS, 10/29/04)

Present the project-specific consultations with the SHPOs of SD and NE and with the Yankton Sioux Tribe, and repot their findings. Include the NPS as a consulting party to the Section 106 consultation process associated with your NEPA documentation as provided in 36 CFR 800 in accordance with the NHPA as amended. (NPS, 10/29/04)

Economic

The river conditions and the river uses, and the associated economic impacts to the various areas need detailed analysis and review and not just a cursory effort. (Private Citizen)

I am a Water Resource Consultant with nearly 40 years experience in water-related projects. I have directed the preparation of numerous Environmental Impact Statements. The process needs to adequately address the social and economic impact that will occur in North Dakota. (Private Citizen)

Erosion

Tesoro has concerns regarding the impact of erosion on the Missouri River banks. The source of sediment for the new sandbars and islands will be the bed and bank of the river. Tesoro property adjacent to the river has experienced large erosion losses. The valuable bottomland is lost forever. The economic and social impacts need full attention.(Tesoro Mandan Refinery, 11/30/04)

Observations and discussions with the NE Game and Parks Commission indicate that ESH created at Ponca St. Park appears to be causing a channel shift and rapid erosion of the NE bank. While that can be considered restoration of cut and fill alluvial processes, if a similar effect occurs on private or certain public lands, this could create additional problems. Therefore, the Service recommends that local hydraulics be carefully considered during project planning to avoid unacceptable erosion and requests for further bank stabilization in that area. (USFWS, 12/3/04)

Identify and analyze impacts from in-channel island construction on adjacent riverbanks and analyze alternatives for mitigating any stressed banks that may result. Keep in mind the NPS does not wish to see any additional bank armoring within the MNRR duo to this action. (NPS, 10/29/04)

In order to achieve the targets it is very evident that bank erosion will either be accelerated or will remain the same. Either situation is not acceptable because of the negative impacts outlined above. (Private Citizen)

It is expected that a shift in flows will occur with the construction of future sandbars resulting in impacts to adjacent landowners. Prior to our full evaluation of future sandbar creation, the Corps should analyze how construction of sandbars within the channel will impact adjacent riverbanks as a result of sandbar creation. Additional bank armoring as a result of sandbar creation should not be considered as a viable alternative. Furthermore, we require that a third party be contracted to conduct a hydrological analysis in order to determine the impacts that will potentially occur as a result of future sandbar construction on river processes in the entire Nebraska reach. [NE Game and Parks Commission, 11/19/04).

The Corps needs to determine how they are going to address river bank erosion as a result of sandbar construction within the channel, and contract for a hydrological analysis to determine how future sandbar creation will impact river processes and present the information to NGPC and the other resource agencies for review. Once the above issues have been addressed to our satisfaction, we will be able to fully comment on any proposed future construction of emergent sandbar habitat. (Nebraska Game and Parks Commission, 11/19/04)

Identify and defend the rationale for armoring all or selected ESH complexes; present and analyze the type an projected sources of armoring material. (NPS, 10/29/04)

The COE's geomorphology report indicates that more than 90% of the sediment is coming from the bed and banks of the river. Modification of the islands and sandbars and the bed of the river will impact the riverbanks significantly causing further loss of land. Water board efforts to stabilize banks have been thwarted by the COE and USFWS because of undetermined cumulative impacts that could result. The COE correspondence documents concerns about any in-river modifications and the impacts that might result. These same concerns should apply to the ESH efforts. (Morton County Water Resources District, 9.2.05)

Flooding

Your proposal to increase the number of islands and sandbars and your plans to excavate shallow water channels to manipulate the creation of sandbars and islands have the potential to encroach on the floodplain and affect the base flood elevation in the Bismarck-Mandan area. This also has the potential to increase flooding, increase flood insurance costs, and accelerate deposition of sediment in the headwaters of Lake Oahe. These impacts must be quantified and compensation provided to the adjacent river landowners. You must not lose sight of the fact that you cannot alter the floodway conveyance without incurring serious impacts. (Morton County Water Resource District, 9/2/05)

The City of Mandan has spent, just this past summer [2004], well in excess of $1 million on structures to remove property from the floodplain. Sediment from additional sandbars will simply migrate south to the Oahe delta and floodplains will rise again. Is the corps going to fund additional structures to keep property out of the floodplain? Where is your plan for the impact on houses from the delta you are creating in south Bismarck? Why no long term plan? (City of Mandan, Jan. 18, 2005)

The most serious consequence making the flows high and then lowering it will create larger deltas that threaten south Bismarck. Every time the flood plain is raised perspective homeowners have to pay thousands of dollars extra to raise their new homes out of the flood plain. Even worse the chance of south Bismarck flooding someday is increasing which would cost millions and could even take lives. This threat is not taken lightly. (Private Citizen)

The increase in islands will impact the floodplain in south Bismarck-Mandan. Houses now out of the flood plain will come into the flood plain. There will be costs for flood insurance and most likely costs for eventual buyouts. (Private Citizen)

Negative impact to floodplain - The Morton and Burleigh County floodplains will rise because of this effort. Flood insurance costs will go up and landowners not now impacted will become impacted. The potential for housing buyouts due to the increase in Oahe delta sediments is a real possibility. (BOMMM Joint Water Resources Board, January 27, 2005)

Analyze and report the direct and indirect changes to the riparian and floodplain conditions within the MNRR from ESH construction. (NPS, 10/29/04)

Another potential concern relates to the floodplain in the Bismarck-Mandan area and how it may be impacted by the proposed habitat creations. With the delta south of Bismarck-Mandan already growing at an alarming rate, the creation of additional sandbar habitat (by chemical or mechanical means) has the potential to send an increased sediment load downstream, exacerbating the delta formation process. The portion of the Missouri River located in the Bismarck/Mandan area is within the jurisdiction of a floodplain management program, which includes a regulatory floodway. According to North Dakota statute, "…uses shall be permitted within the floodway to the extent that they do not cause any measurable decrease in the hydraulic conveyance in the affected area." (NDCC 61-16.2-07). Thus, any activity within the regulatory floodway would need to be evaluated according to this standard. (North Dakota, Office of the State Engineer, September 12, 2005)

Geomorphology

An analysis of project-caused change to channel morphology resulting from the construction of the ESH is material because changes in hydraulic and hydrologic variables have direct bearing on the creation, maintenance, rejuvenation, and destruction of habitats for fish and wildlife species. Given the scale of the proposed ESH construction project, such habitat changes could have a tremendous impact on species diversity and abundance of fish, freshwater mussels, amphibians, and reptiles on the four segments of the upper MR where ESH is proposed to be constructed. The Corps should collect quantitative information about expected changes to hydrology and hydraulic variables in the footprint of the proposed project and in upstream and downstream locations. Information in that regard is especially important given that some ESH construction projects, especially those proposed to be completed through dredging and dredged material re-deposition, presents an obstruction to flow, which would be reasonably expected to alter fluvial-geomorphological processes. Further information would be useful in the development of measures to avoid, minimize, and where appropriate, compensate for impacts resulting from these activities. (USFWS, 12.3.04)

Analyze and report the direct and indirect changes to riverine functions and processes and channel geomorphology in the MNRR segments resulting from ESH construction. Include appropriate aerial photography, staff gauge, and bathymetric measurements to support the analysis. (NPS, 10/29/04)

Hydropower

The rivers reduced capacity will impact hydroelectric generation by reducing the maximum allowable discharges in the winter months. We have seen flows diminished each year from the delta and channel buildup, and this will create a bigger problem. There will be a loss in dollars from reduced hydroelectric generation. These impacts must be quantified by modeling the river regime to assure the creation of ESH does not further reduce the hydroelectric generation. (Morton County Water Resource District, 9/2/05)

Negative impact to hydroelectric generation during the winter months - The river capacity to carry flows at the same stages will be reduced. Flooding will occur therefore the discharges will need to be lowered impacting the amount of electricity generated and income derived from the power. (BOMMM Board, Jan 27, 2005)

Lower hydroelectric power output in the winter months! Do the power grid people know about this one? This should be an important consideration before sandbars take precedence over heat and electricity availability for the nation. (Private Citizen)

The hydroelectric generation from the Garrison Dam has already been reduced by low flows. If this clean source of energy would be further reduced by addition of more islands and sandbars in the river, the changes should be rejected for that reason alone. (Mercer County Water Resource Board, Sept. 9, 2005)

Mussel Protection/Avoidance

Significant concentrations of mussels occur in the Gavins Point reach at the James River confluence and from the dam down to about RM 807.4. A fresh-dead federally listed endangered scaleshell (*Leptodea leptodon*) was collected in 1987 one km east of Gavins Point Dam making it likely that other individuals of this species reside in the reach. On October 27, 2004, South Dakota Game, Fish, and Parks personnel collected a fresh dead, federally-endangered Higgin's eye, (*Lampsilis higginsi*), near the outlet of Lake Yankton below Gavins Point Dam. (Missouri River Natural Resources Committee, Nov. 16, 2004)

In late October 2004, the Corps began building emergent sandbar habitat in the Missouri National Recreational River stretch below Gavins Point Dam. During the course of this work, a Higgins' eye mussel, a federally endangered species, was discovered. The presence of this species on the Missouri River will likely require a new round of ESA consultation between the Service and the Corps, the results of which will likely again reinforce the need to restore more natural flows on the Missouri. The fact that a new endangered species was discovered at the exact ESH project site – not before, but during, actual construction – points to the urgent need to complete a full EIS before proceeding on further ESH projects. (American Rivers, Nov. 18, 2004)

On October 27, while collecting shells with Jeff Shearer (SDGFP) and Steve Wilson (NPS), I collected a shell below Gavins Point Dam, near the outlet of Lake Yankton, that has been positively identified as *Lampsilis higginsi*, the Higgin's Eye mussel, a federal endangered species. The shell was fresh dead, it still had some hinge ligament attached. Identification was confirmed by Keith Perkins III at the University of Sioux Falls and also by Dr. G. Thomas Watters, Curator of Molluscs, Museum of Biological Diversity, Ohio State University. The specimen is at Ohio State University. (Doug Backlund, SD Dept. of Game Fish and Parks, November 9, 2004)

This is the second federally endangered freshwater mussel species documented in the MNRR below Gavins Point Dam. In 1982 Ellet Hoke collected a specimen of the Scaleshell, *Leptodea leptodon*. (Hoke, Ellet. 1983. Unionid mollusks of the Missouri River on the Nebraska border. American Malacological Bulletin 1:71-74.) (Doug Backlund, SD Dept. of Game Fish and Parks, November 9, 2004)

We now have documented the presence of 19 species of freshwater mussels in the river segment between Gavins Point and Ponca, NE. There are two federally endangered species documented in that river segment. Unlike other rivers in SD, we find an abundance of live clams rather than an abundance of old, dead shells. The MNRR between Gavins Point and Ponca NE is an amazing and important freshwater mussel resource. A copy of our survey work from 1999 is online at http://www.nwo.usace.army.mil/html/pd-e/RecRiver/MNRRClamreport.pdf (Doug Backlund, SD Dept. of Game Fish and Parks, November 9, 2004)

The presence of Higgin's Eye mussel on this reach of the Missouri River, indeed at an ESH project site, makes us wonder if take of this species has occurred. The presence of an additional federally listed species will require a new round of consultation with the Service. (Sierra Club, Nebraska Chapter, February 11, 2005)

Prior to the continuation of current sandbar construction utilizing dredges and heavy equipment, we recommend the Corps conduct an extensive survey of the entire construction area to identify and locate all individual freshwater mussels and/or mussel beds in the area. The survey should include the use of scuba divers to document species in deepwater areas. The Corps should then determine how these specie scan be avoided and minimized. (NE Game and Parks Commission, 11/19/04)

Property Ownership and Rights

As a landowner adjacent to the river, I'm concerned when you make these sandbars in the river and erosion starts along the high banks are you going to b e sympathetic and allow bank stabilization? I can see graphs and all kinds of rhetoric not to stabilize. Would you like to purchase 3.12 acres? (Private Citizen)

The removal of vegetation from sandbar by use of herbicides or mechanical means will have a direct impact on the riparian rights of the State of North Dakota and private landowners. The removal of vegetation will slow the process of island building and the accretion of land to adjacent lands. Islands become the property of the State of North Dakota and accretion lands become the property of abutting private landowners. This is a serious property rights issue because the "beds" of navigable stream were given to the states and not the federal government. The EA needs to address this specific property rights issue. (Private Citizen)

Please keep in mind the landowners in your plans. Remember we are the owners and taxpayers of the land to the ordinary high water mark. I believe I heard a commitment by the presenters at the meeting there would be only willing landowners affected if equipment, access, and uses are required. This will would acceptable to the landowners. (Private Citizen)

Mechanically cutting channel (removal of lad bridges) between adjacent uplands and potential sandbars will have serious implications for adjacent landowners. I believe this could be considered a "taking" without just compensation because over time these lands may become accreted lands. (Private Citizen)

The state [ND] holds title to the bed of the Missouri within North Dakota and the state's title extends from ordinary high water mark to ordinary high water mark (NDCC 61-33). As the owner of the river, North Dakota has the right to control activities on the river that occur below the high watermark. Thus, if the Corps intends to construct habitat on the river or its shore, the Corps must obtain either a sovereign lands permit or an easement from the Office of the State Engineer (NDAC 98-10-01). We do not mean to imply that we will oppose habitat construction on the Missouri River. But, we do want to apprise you of the state's view that habitat construction on the river cannot proceed without state consent and the Corps' adherence to the application and permitting process prescribed by the State Engineer. (North Dakota State Engineer, Office of the State Engineer, 10/19/04)

We would also like to remind you that the land beneath navigable waters and their accretions that are held in trust by the US for individual Indians or Indian tribes area excepted [sic] from the Submerged Lands Act (43 USC Part 1313). The respective tribal fish and wildlife department, or its equivalent, would have jurisdiction over the fish and wildlife on those lands. Therefore, we suggest that you review the ownership of lands as a part of the process of site selection and coordinate with tribal fish and wildlife departments. (USDOI, Bureau of Indian Affairs, October 22, 2004)

An important aspect of this habitat creation effort is the issue of who will own, and therefore manage, these areas. Riparian land law in the project area varies by state, which would greatly affect the Corps' ability to create and maintain ESH to meet the resource objectives. In ND and SD, such crated habitats within the river are considered sovereign lands administered by the state. In NE, landowners adjacent to the river own to the center of the river. Not only could landownership affect management activities, but additional regulations for non-federal interests other than the Corps (which is covered under the 2003 Amended BiOp) might be applicable when conducting activities that could affect a federally listed species. While that should not be viewed as a hurdle to habitat creation, it could entail extra coordination on specific sites, or throughout states. The EA should fully disclose the extent to which land regulations in the study area could affect the Corps' ability to manage those sites and the potential mechanisms to address this. (USFWS, 12/3/04)

Recreational River/Wild and Scenic River

As a WSR, the NPS must evaluate the proposal in accordance with the WSRA. The NPS, as administering agency, reviews all proposals for consistency with the Act. Through this formal response, the NEPA alerts the Corps of the requirement for securing a determination pursuant to the WSRA for all activities within the WSR. (NPS, 10/29/04)

Since there are river segments targeted for ESH creation within areas federally designated under the Wild and Scenic Rivers Act, what legal dichotomies emerge as a result of the Corps disturbing natural features administered by the NPS? Will this require special attention for evaluating the effects of the federal actions? (Sierra Club, Nebraska Chapter, Feb. 11, 2005)

This is a very special reach of the Missouri River. Three federally endangered species are known to currently inhabit this reach and two more have been shown to potentially (perhaps even probably) still be present. Agreed-the river here cannot be said to be pristine or even natural in the strictest sense of the word but it is also clear that for several reasons (some known, others not even suspected) that this reach contains a rich diversity of native (potentially including five federally listed species) fauna. Some of the reasons that in spite of massive alteration of the natural river that this diversity remains include: 1. It is far enough upstream that pollution levels are lower than lower reaches simply because of low upstream human population; 2. Water coming out of Gavins Point has dropped its silt load behind the dam and this maintains a riverbed not subject to the stifling siltation seen in the impoundments; 3. Lewis and Clark Lake is shallow enough that the water released is warm enough to allow unionids to reproduce (unlike what has been found in the tailwaters of deeper, cold water discharge impoundments) and 4. Since Gavins Point is the lowest of the mainstem dams, its tailwaters are potentially available to all fauna (in the case of unionids, especially to host fish) from the Gulf of Mexico including all of the Mississippi and Missouri drainages. For all of these reasons and probably more this reach of river has and is serving as a refugium for many animals, especially unionids, and will continue to do so as long as these animals exist. My point is that this reach of river is clearly known to be of special ecological significance and should be treated as such. (Keith Perkins, UsiouxFalls.edu, November 20, 2004)

Given the acreage targets prescribed by the 2003 BiOp for the years 2005 and 2015, the rather small amount of sandbar habitat created near Ponca State Park in March of 2004, and that to be built at the two proposed locations this year, and the limited amount of acres of habitat that can be created from existing sandbars by de-vegetation, the NPS is greatly concerned with the apparent need to mechanically create as much as 4,600 acres of new habitat just within one river segment alone. We are concerned that this level of construction activity, the construction and maintenance of islands with a rather short 3- to 5-year lifespan, will lead to unacceptable impact to the values of the MNRR and to its designation as a WSR. (NPS, 09/26/05)

The NPS requires this information so that we may prepare all future determinations pursuant to section 7(a) of the act:

- Present the fact the MNRR, consisting of 2 districts, totaling 126 mils of river, will be directly impacted by this proposal. Include a discussion of the intent and requirements of the Act.
- Identify and analyze the results of any plans or programs, draft or final, proposed or in place, designed to make modifications to river flows for the purposes of ESH creation as stated by the Corps at the joint meeting between the Corps, FWS, and NPS at the Midwest Regional Office (8/12/04). The Corps stated in that meeting that flow modifications alone would not achieve the total targeted ESH acreage requirements, but the implication of that statement was that some habitat creation would be achieved.
- Identify and analyze the direct and indirect impacts associated with the natural or mimicked spring and summer flow modifications from Gavins Point Dam to be prescribed for pallid sturgeon, with an analysis for the potential for creation of ESH as a result. Identify and analyze the potential for off-channel ESH acreage creation in both MNRR segments. Then identify and analyze the need for and the amount of in-channel construction within the MNRR in light of the potential results from flow modification and off-channel efforts. Identify and analyze the cumulative effects of each scenario in the context of total surface acreages in the respective river segments. (NPS, 10/29/04)

Identify and analyze the direct and indirect impacts, including cumulative impacts, from ESH construction to the recreational attributes of the MNRR; including fishing, hunting, sightseeing, motor boating, canoeing, and the quest for solitude. Identify and analyze the noise levels from dredges and other construction machinery and the length of construction seasons, of such intrusions on recreationists and wildlife species. Present and analyze the expected results from mitigation to minimize these impacts. (NPS, 10/29/04)

Provide a viewshed analysis focusing on in-channel ESH construction locational [sic] probabilities and associated staging areas and the probable on-site, upstream, and downstream impacts to river recreationists. (NPS, 10/29/04)

River Use/Recreation Impact

We expect that most of the river segments identified for habitat creation will likely require new bars and maintenance on an annual basis. This has the potential to disrupt fishing, hunting, and boating. Potential conflicts with, and interruption to, river recreation should be thoroughly discussed. If areas of the river will be off-limits to boat and foot traffic during construction, the area or length of river affected, the season, and duration should be described. (Missouri River Natural Resources Committee, Nov. 16, 2004)

In your document you indicate that the islands and sandbars will be off limits from mid-May to mid-August. This is the peak period for island and sandbar use by recreational boaters. The cumulative economic and social impact of your proposal to restrict access must be part of the cumulative impact assessment. (Missouri River Joint Water Board, September 19, 2005)

Negative impact to island and sandbar use by people - The 2000 Biological Opinion of the U.S. Fish and Wildlife Service calls for accelerated enforcement and fines for people who disturb the terns and plovers during nesting. People may not be able to play sand volleyball, picnic or other activities during May, June and July on the sandbars.

Negative impact to recreational boating - The increase from an average of 12.5 surface acres of islands and sandbars to an average of 50 per mile will change the character of the river to mimic the Platte River in Nebraska. Boating will be difficult at best. The increase is equivalent to a sandbar 310 feet by 1 mile in length average per mile. (BOMMM, Jan. 27, 2005; Missouri River Joint Water Board, September 19, 2005)

The increase in islands and sandbars will have destructive impacts on recreational boating. The river will be transformed into a river like the Platte in Nebraska, shallow with braided channels. This will curtail recreation boating. (BOMMM, Jan. 27, 2005)

What reaches of the river are targeted for ESH creation? Are these reaches used for hunting, fishing, and boating and other forms of recreation? How will these uses be impacted by ESH creation? What will be the economic impact to individuals, as well as local communities that depend on recreation dollars?(Sierra Club, Nebraska Chapter, Feb. 11, 2005)

The aggressive enforcement of no public use of the islands during nesting will have severe recreational impacts in the Bismarck-Mandan area. (Private Citizen)

Negative impact to recreational boating is a concern if the required habitat is created and maintained. (Private Citizen)

Evaluate the effect of habitat creation on recreation in the Bismarck/Mandan area on boat traffic and sandbar use. (Private Citizen)

Care should be given to evaluate the recreational use of the Bismarck/Mandan area "between the bridges" to determine these traffic areas before committing to these projects. (Private Citizen)

The EIS must detail how this ESH work will impact other river uses, particularly recreational uses such as hunting, fishing, and boating. The proposed locations for this work in the upper Missouri River system are prime locations for a host of recreational activities that are likely to be negatively affected by this work. (American Rivers, Nov. 18, 2004)

Since the proposed ESH work will take place in the upper Missouri River where recreational use is high, actions with heavy equipment and significant disturbances of the river environment will clearly negatively impact use of these river reaches for hunting, fishing, boating, and other forms of recreation. Recreation is a priority use of the river in the upper basin, and disturbances to recreational activities will have a subsequent impact on the economies of local communities that depend on recreation dollars. (American Rivers, Nov. 18, 2004)

I am very concerned about adjusting the river flows to create more sandbars in the Bismarck area or limiting access on any more existing sandbars due to bird nesting. At this time some sand bars are signed for plover nesting increasing them is not conducive to boating and recreating on the few sand bars out there. (Private Citizen)

Terrestrial Ecology

A second concern is the loss of terrestrial habitat when scarifying vegetated islands. Some of the larger islands in the Garrison Reach have considerable tree and grass cover. This vegetation provides habitat for numerous species (e.g., whitetail deer, pheasants, Canada goose, beaver, etc.) and provides some level of public recreation. These islands are sovereign land. Removing vegetation from these islands would decrease the amount of habitat for most species. While most of the species that utilize these vegetate islands are not rare, they are desirable game species. Any effort in this area will require state approval. (North Dakota Game and Fish Department, September 26, 2003)

What will the environmental impacts to other species residing in the Missouri River? What effects will ESH creation activities have on invasive species; will such activities promote the spread of invasives? How will biological community composition be affected by such activities? (Sierra Club, Nebraska Chapter, Feb. 11, 2005)

The removal of vegetation on existing sandbars will impact other species such as ducks, geese, deer, etc. If a project were going forward under our sponsorship, we would be required to mitigate for those impacts. The same should hold true for the ESH program. Those impacts and required mitigation should be quantified using the USFWS Habitat Evaluation Process (HEP) or something similar. Again, I must remind you that this must not be a double standard because this is a wildlife project. (Morton County Water Resource District, 9/2/05)

Mowing down the vegetation on the sand bars just ruins the nesting cover for geese. (Private Citizen)

The NOI refers to the bald eagle as "then-threatened" in 1989, suggesting that it no longer has the threatened designation. Note that the bald eagle is still a federally threatened species with RPAs identified in both the 2000 and

2003 BiOp. Potential impacts to bald eagles by the proposed project should be included in the EIS. (South Dakota Dept. of Game, Fish and Parks, September 7, 2005)

Vegetation Removal

We would like to see any data that may support this specific vegetation removal technique and its short and long-term effectiveness. We would also be interested in any vegetation data and plover and tern use data for each of the sandbars targeted for vegetation removal. Please also describe the monitoring plan for pre- and post- chemical application. (North Dakota Parks and Recreation, Feb. 10, 2005)

Another concern the Department has is the duration or longevity of the proposed vegetation removal project. When asked about this issue, the Corps was ambiguous about how long or how frequently they intend to manipulate individual islands. We contend that spraying sandbars for a year or two has far different ramifications than doing it for 10 to 15 years. (North Dakota Game and Fish Department, February 3, 2005)

6.15 Water Quality and Supply

Several of the proposed ESH creation methods (e.g., mechanical work with heavy equipment, dredging, use of pesticides, etc.) have potential to introduce or remobilize contaminants in the river that may affect riverine fish and wildlife species or their forage base. In addition to direct effects, there may be offsite impacts from sediment-borne contaminants or pesticide-laden runoff that could extend into nesting, foraging, nursery, and refugia habitats. To avoid effects to fish and wildlife resources, the Service will work with the Corps and the NPS to ensure project design and implementation fully protects and supports our collective resource objectives. (USFWS, 12/3/04).

The mechanical creation of sandbars (dredging or by machines) has the potential to reintroduce chemical elements back into the water column. Some chemical that might be reintroduced into the river water are lead, arsenic and other heavy metals along with organic compounds such as phenols which are associated with naturally occurring coal deposits in North Dakota. The reintroduction of these elements into the Missouri River water could have serious consequences for cities along the Missouri River in North Dakota. The Corps should have to address this issue as part of the EA process and not just say they will test or monitor for the reintroduction of chemicals into the water during construction. This is not an acceptable way to deal with this issue. (Private Citizen)

The Missouri River is listed as a Class I stream in North Dakota. The designated uses of the MR have numeric and narrative criteria to support them. Each method should be thoroughly evaluated in the context of water quality. The water quality parameters of particular concern are trace metals, persistent synthetic organic compounds and nutrients. The PEIS should provide enough information on water quality for this department to make an informed decision on subsequent regulatory actions under Section 401 of the Clean Water Act. (North Dakota Department of Health, September 12, 2005)

The increase from an average of 12.5 to 50 acres per river mile will change the character of the river. The river's capacity to carry flows at the same stages will be reduced. The impact this will have on the availability and reliability of our water supply is unknown. (Private Citizen)

Water supply intakes will be negatively impacted. In fact it appears there is a double standard on this issue. The COE required all sediment to be removed from the system when they cleaned out the Tesoro Refinery intakes and you plan to add to the system. (Morton County Water Resource District, 9/2/05)

In the past few years, dredging work has been necessary to assure an adequate water supply. As a part of the permitting process, the Corps required that removed sand be deposited in upland areas, verses in the river channel, resulting in increased project costs. The Corps' proposed plan to dredge and place sand in the river channel appears to set a double standard. (Private Citizen)

Negative impacts to water supply intakes - The increase in islands and sandbars could potentially impact municipal, power plant, irrigation, and industrial water supply intakes. The created islands will erode during high flows and will be transported to the lower reaches of the river where intakes can be adversely impacted. (BOMMM, Jan. 27, 2005)

We have been fighting the Corp to keep our water levels higher for many years and now you wish to maintain permanent sandbars. My biggest concern is that once you place this requirement of sandbars, there will be no way we can maintain the higher water levels we need in this area without wiping out your sandbars! Is this the plan so we would have no recourse to maintain our water levels any longer? (Private Citizen)

Jeopardizing municipal water supply intakes. This has been a big concern. Several water supplies in the area have been ruined because of sand in their intakes. I feel that is HUGE, even bigger than the recreational emphasis, when our drinking water supplies are jeopardized. (BOMMM, Jan. 27, 2005)

I am in favor of the sandbar proposal with a willingness to keep area water systems safe. The lake is a multiple use area and wildlife restoration should be part of that mix. It seems like tourist industries and departments are more interested in economics and give wildlife habitat reform and restoration only lip service. Sandbars were part of the system before the dams and they should be a part in some capacity now. (Private Citizen)

Minnkota Power Cooperative is concerned about alterations to the river, which could directly or indirectly impact our ability to draw water from the Missouri River. The dredging of the river and the creation of new or the expansion of existing sandbars could impact many water supply intakes located on the Missouri River.(Minnkota Power Cooperative, Nov. 30, 2004)

6.16 Wetlands

Present information on how permitting for future construction activities will occur under Section 404 of the CWA. (NPS, 10/29/04)

The Service looks forward to working with you to determine appropriate protective measures pursuant to Section 404 of the CWA and Section 10 of the Rivers and Harbors Act of 1899. (USFWS, 12/3/04)

7 Environmental Impact Assessment

This document should disclose how many acres of sandbars will be created/treated annually, the total footprint of the created habitat, the percentage of the river surface area this entails, and how this level of construction will affect the aquatic community as well as fishing, hunting and other fish and wildlife related recreation. (Missouri River Natural Resources Committee, November 16, 2004)

Included in the EIS should be an identification of State and local permits that will be needed and the actual obtaining of such permits. (Private Citizen)

The EA should identify fish and wildlife resources, their habitats, and potential impacts (both beneficial and negative) of the proposed construction on these resources. Both federally threatened and endangered species (i.e., least tern, piping plover, pallid sturgeon, bald eagle, and designated critical habitat, as well as non-listed species of importance to the States of ND, SD, and NE including but not limited to freshwater mussels, soft-shell turtles, and paddlefish should be addressed. As a cooperating agency with special expertise in this area, the Service looks forward to further discussions with the Corps and, ultimately, provision of detailed technical assistance (e.g., survey protocols on the above species). (USFWS, 12/3/04)

The document should disclose how many acres of sandbar habitat will be created/treated annually, the total footprint of the created habitat, the percentage of the river surface area this entails, and how this level of construction will affect the aquatic community as well as fishing, hunting, and other fish and wildlife related recreation. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Assessment of the environmental impact from the Corps' ESH work must address the amount of acres to be created or maintained annually, the exact river reaches where work will occur, the type of work involved, the length of time equipment will be in the river working, and the expected impact on the ecology of the Missouri River. The EIS must address the impacts on existing species of concern such as the pallid sturgeon, least tern, and piping plover, but also species such as the Higgins' eye mussel. There should be a rigorous evaluation of the expected impact on tern and plover fledge ratios and overall production. Comparisons to fledge and productions numbers resulting from high flows in 1997 should also be included. Overall, there should be an accounting of impacts on the full range of native riverine species. (American Rivers, Nov. 18, 2004)

It seems that a majority of the work proposed by the Corps will be completed through dredging, bulldozing, and other mechanical means. Such efforts will disturb a large portion of the riverbed, require movement of materials and equipment through the channel and on barges, and have significant and likely adverse impacts on the full Missouri River aquatic community, including fish, benthic invertebrates, turtles, and other species. (American Rivers, Nov. 18, 2004)

More information needs to be provided on the specific target goals and implementation details in order to properly assess impacts. (Private Citizen)

Prepare and defend specific measures to avoid or offset adverse impacts to fish and wildlife species identified in the various construction alternatives, from minimal (assuming substantial off-channel construction and percentages of ESH achieved through flow modification) to maximal (assuming some or all of the targeted acreage is to be achieved through in-channel construction). Identify and analyze the potential to spread non-native aquatic and terrestrial species, including zebra mussels and purple loostrife, from each alternative, and prepare and analyze the likely success of means to avoid the spread of these exotics. (NPS, 10/29/04)

8 Evaluation of Habitat Manipulation Methods

The Service recommends that the EA include a thorough description of each method including:

- Complete description of each method and anticipated habitat results (e.g., how large sandbars will be cut to create shallow water habitat).
- Acres affected by the proposed action and anticipated habitat to be created by each method in each river reach.
- Direct and indirect impacts of each method (e.g., dewatering, dredging and its effect to turbidity, sedimentation, erosion, and alternation of submerged habitat, etc.)
- Complete description of assumptions and uncertainties associated with both the actions and the anticipated outcomes.
- List of herbicides and surfactants proposed to be used and their potential effects on small fish, invertebrates, reptiles, amphibians, and other Missouri River fauna.
- List of all measures (e.g., BMPs, buffers, timing, etc.) to avoid/minimize potential adverse effects to fish and wildlife that will be included as part of the action.
- Timing, schedule, and frequency of actions.
- Special considerations/planning objectives used in selecting creation methods and locations for proposed projects.
- Relative efficacy of each habitat creation method in meeting goals identified in the 2003 Amended BiOp. This should include an evaluation of longevity and cost to better understand the long-term effects and limitations of each method. (USFWS, 12/3/04)

The Corps' Endangered Species Office in Yankton has presented preliminary information on riverine habitat monitoring in 2003, including habitat available below Gavins Point Dam for least terns and piping plovers at various flows. This information reflects a trend of habitat degradation due to vegetative encroachment and erosion. The Service recommends that the Corps include this information in the EA to assist the Service, State game and fish agencies, and the public in evaluating various methods (i.e., mechanical, chemical, hydrologic) to create and maintain habitat. In addition, we understand the Corps has conducted a number of habitat creation projects with various methods over the past 15 years. The EA should describe those efforts, the knowledge gained, and how that knowledge can be applied to future ESH creation. (USFWS, 12/3/04)

The impacts the use of herbicides will have on other species using the sandbar besides the piping plover and least tern must be addressed and the impacts the herbicides will have on small organisms in the sand and in the water adjacent to the sandbars needs to be thoroughly addressed. I do not believe the chemical the Corps proposes to use are as benign as you would have us believe. I personally believe this is an unacceptable way to create habitat for the terns and plover. (Private Citizen)

Mechanical and chemical habitat creation and maintenance for terns and plovers, both in and off-channel, has been attempted in the past on the Missouri and Platte Rivers and perhaps elsewhere (Arkansas River) in the species' range. The successes and failures of these ventures should be thoroughly disclosed and discussed. Long-term management costs should also be disclosed. These costs should include not only mechanical and chemical costs, but labor costs. It is our experience that off-channel habitat projects perform poorly unless large labor and equipment investments are made to reduce predation problems. Objective measures of success should be used including total production and fledge rates. Past outcomes from mechanical and chemical habitat creation should be compared to outcomes using river flows such as occurred post-1997. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Stabilization of created sandbars will likely create habitat for mink, which are nest predators for terns and plovers, and erect barriers for piping plover chicks and turtles to access and egress sandbars. (Missouri River Natural Resources Committee, Nov. 16, 2004)

I do not support the proposed methods of creating sandbar-nesting habitat through mechanical and chemical means. The USACE needs to change how they manage the flow of the Missouri River. The idea of building manmade sandbars rather than allowing the river to create them naturally is very disturbing. Spraying sandbars with herbicides is equally disturbing. We must not alter the existing sandbars, especially those that are more permanent in nature. Many of these sandbars are becoming islands and hold groves of established cottonwood trees that may be more than 25 feet tall. They provide habitat for a variety of wildlife and often contain small ponds and patches of wetlands habitat. It would be a crime to kill the native flora by indiscriminately spraying the river corridor with herbicides. (Dacotah Chapter of the Sierra Club, 12/1/04)

Many of these sandbars are becoming islands and hold groves of established cottonwood trees that may be more than 25 feet tall. They provide habitat for a variety of wildlife and often contain small ponds and patches of wetlands habitat. It would be a crime to kill the native flora by indiscriminately spraying the river corridor with herbicides. The less permanent sandbars are constantly in a state of metamorphosis. We cannot begin to understand the impacts to riparian habitat resulting from the massive redistribution of sand should the proposed dredging process be implemented. (Dacotah Chapter of the Sierra Club, 12/1/04)

Before any project as destructive of native species as this one demonstrably is (stripping vegetation from existing sandbars should be included here) we should be very sure of what we're doing and have, at least, exhausted all less invasive possibilities. The idea of building man-made sandbars rather than allowing the river to create them naturally is very disturbing. Spraying sandbars with herbicides is equally disturbing. A natural sandbar is like a piece of sculptured art and the dynamics of a healthy sandbar are really quite complicated. The USACE is attempting to compensate for one alteration of the river by further altering the river. This seems to be a reoccurring pattern. We must not alter existing sandbars, especially those that are more permanent in nature. (Dacotah Chapter of the Sierra Club, 12/1/04)

Herbicide application that close to the River stream is potentially very dangerous. (Private Citizen)

Identify and analyze in detail the proposed maintenance and replenishment protocols for all alternatives for ESH to be implemented after construction. (NPS, 10/29/04)

The Corps indicates that ESH will be dynamic and expects that sandbars will last only a short period of time (3-4 years). The Service has become aware through discussions with the Corps staff of proposals to stabilize the islands with rock, etc. While the Service understands the desire to prolong the created habitat, such stabilization can significantly reduce the habitat value and function of these areas for terns, plovers, and many other species. While there may be some benefit to incorporate large woody debris in some areas, specific attempts at stabilization should be extremely limited and very carefully considered. (USFWS, 12/3/04)

9 Feasibility

Missouri River Natural Resources Committee …the acreage goals for the Garrison, Fort Randall, Lewis and Clark Lake, and Gavins Point reaches represent 39, 25, and 30 percent of the total river surface area for these reaches. If the majority of this habitat is to be created and maintained in perpetuity by dredging and bulldozing, obviously a significant amount of the riverbed will be disturbed with likely negative effects to the aquatic community including fish, benthic invertebrates (mussels and aquatic insects), turtles, and other fauna. Given the large amounts of riverbed and river surfaced area to be affected by dredging and heavy construction equipment, less intrusive measures such as vegetation clearing should be tried first. If dredging is implemented, it should be tried on a limited basis and impacts monitored closely before large-scale efforts are undertaken. (Missouri River Natural Resource Committee, Nov. 16, 2004)

The Department has reviewed the aforementioned solicitation and offers the following comments. This solicitation contained no information on proposed timelines for construction, project duration, target acreage of islands per river mile, locations of islands to be created, maintenance issues and the cost of the various measures or alternatives to be considered. Accordingly, it is difficult to provide technical assistance to a project with the paucity of information provided. (North Dakota Game and Fish Department, October 21, 2004)

The vegetative removal technique being proposed is largely experimental. The Corps admitted this at the interagency meeting, as they have not tried many of the proposed techniques in this latitude [ND]. For example leaf out for many of our trees is mid May, a period when the birds in the Garrison Reach are initiating nest site selection. As the herbicide selected for vegetation removal (i.e., Rodeo) requires the plant to be leafed out and actively growing to be effective, we question when the Corps proposes to spray? If work is deferred until later in the growing season, how much re-growth can be expected in the fall or the following spring? (North Dakota Game and Fish Department, February 3, 2005)

You can only put so much in the Missouri River you have 300 new homes being built at McCormick's new development as well as a new 200-slip marina at Mitzel builder…who want to put in at Kist Area in South Mandan. (Private Citizen)

There is no justification for the cost and exercise of the proposal presented. There are more terns and plovers on the river in this area than ever before. The removal of vegetation and replacement of sand will cause other problems to nature. (Private Citizen)

There is more than enough sand out there right now for all the plovers and terns in the world and all that vegetation clearing would do is destroy the nesting for geese, etc. Kind of making it better for one species at the expense of another. (Private Citizen)

As I recall there is a factor proposed of 50 acres per mile as a milestone. That just does not seem reasonable. What about half or one fourth of that amount? Fifty acres just seems very excessive. There is a much different river in the area then there is south in Nebraska. Also consider some past releases during high water years when releases have been approximately in the area of 65,000 cfs. The result of that type of release after grooming 50 acres of sandbars per mile would be devastating for all concerned in our opinion. (Private Citizen)

Based on information, it appears there is a target increase from an average of 12.5 surface acres per mile to 50 surface acres per mile. Such a drastic change will have major impacts on the following:

1. Floodplain elevations and flood insurance costs.
2. Recreational boating, fishing, and recreational use of the sandbars.
3. Hydroelectric generation lost revenues.
4. Could require major buyout of properties in south Bismarck and Mandan due to the accelerated rise in floodplain elevations.
5. Enormous economic impacts to be assessed.
6. Water supply intakes. (Private Citizen)

The acreage goals set appear to high for the Garrison Reach. The IP indicated that there are approximately 12.5 acres of island per mile at the present time. The projected goal for 2005 is 25 and 2015 is 50 acres per mile. Portions of the Garrison reach are highly developed with residential houses lining the banks, and considerable boat traffic and recreational use of sandbars, especially in the Bismarck area. There are also approximately 20 public boat ramps in the Garrison Reach that receive fair to heavy use depending upon the time of year. We are skeptical that the habitat goals can be achieved with the amount of development and public use that exists in the Garrison

Reach. Specifically, we question the wisdom of creating tern and plover habitat in a setting that receives this amount of daily disturbance. (North Dakota Game and Fish Department, September 26, 2003)

Flows in 1997 were extremely high and created a very large number of sandbars It does seam a bit unreasonable to use this event as a base for determine the acreage of sandbars required to protect the plover and tern in the long run. It will be extremely expensive to maintain 50 acres/mile of sandbars over a long haul. The Corps needs to look at the economic consequences of this proposed program. It would appear that money is no problem when it enhances habitat for terns and plovers. Other obligations of the Corps will have go wanting so they can create habitat for the birds. Indian Tribes, Cities and irrigator will have to deal with there lack of water because the Corps does not have the money to help, but they can always find money some place to help the US Fish and Wildlife Service build habitat. (Private Citizen)

It does not appear to be good public policy, or good river management policy to undertake a program which will decrease user ability to boat, fish, and water-ski on the river (which additional sandbars certainly will do), and to increase sediment in the river in the creation of such sandbars (at the direct expense of eroding banks), and to create conditions favorable to raising groundwater and floodplain conditions of South Bismarck (which we believe will happen by more sand in the river and less flow capacity). (North Dakota Water Users Association, Nov. 22, 2004)

Define and present the adaptive management approach proposed for the creation, maintenance, and modification of habitat. (NPS, 10/29/04)

A final concern is with the effectiveness of these techniques. During a previous demonstration project in the Williston Reach of the Missouri River in the late 1990s, the Corps scarified islands for improving tern and plover habitat. It's our understanding that the process was very expensive, labor intensive, required repeated follow up work, and may have created raptor perches for predators, which may have resulted in creating a sink for terns and plovers. We question if the methods outlined will create similar situations in the Garrison reach. In summary, we believe that water level manipulation offers the best option for creating plover and tern habitat in the Garrison Reach. If artificial methods are considered, we would favor increasing the height of existing submerged sand bars utilizing dredges to pump and place material to create exposed sandbar conditions. Scarifying islands should only be considered if all other options are deemed infeasible. (North Dakota Game and Fish Department, September 26, 2003)

10 Mitigation and Avoidance Measures

The EIS must provide an explanation of activities designed to lessen the impact of the Corps' proposed work on existing river habitat and species. Timing of the work, kinds of habitat not to be disturbed, inspection of equipment for invasive species, and other activities need to be addressed in the EIS. (American Rivers, Nov. 18, 2004)

Oil, grease, and fuel spills from in-channel dredges and other heavy equipment are possible. The potential affect of these pollutants on the aquatic community, water quality, and sandbars and mitigation and avoidance measures to be taken for negative effects should be described. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Removal of woody debris and snags should be avoided, as these habitats are vital to fish, invertebrates, and as basking sites for turtles. (Missouri River Natural Resources Committee, Nov. 16, 2004)

No dredging should occur from October 1 – March 31 to avoid killing over wintering softshell turtles. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Treatment of existing sandbars should not occur from June – October to avoid impacts to nests of false map turtles, spiny softshell turtles, and smooth softshell turtles. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Dredges, barges, and other water-based construction equipment should be thoroughly inspected prior to being placed in to the river for zebra mussel veligers and post-veligers (settled stage) and disinfection protocols implemented if zebra mussels are discovered. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Dewatering of river habitat should be avoided. If dewatering is implemented, stage declines should occur slowly to allow mobile aquatic organisms to migrate to deeper water. We recommend a stage decline that has the rate of fall that occurred historically in the summer and fall. Areas to be dredged or dewatered to provide for land-based equipment access should be thoroughly surveyed for the presence of freshwater mussels, including the federally endangered scaleshell and the recently discovered Higgin's eye. Areas that may be dewatered during the winter should also be surveyed for the presence of over wintering turtles. If significant mussel beds are encountered, the area should be avoided or mussels relocated by a competent malachologist experienced in mussel relocation. (Missouri River Natural Resources Committee, Nov. 16, 2004)

We are particularly concerned about activities during the fall, when the river level is often low enough to cause concern about sufficient water levels at the intake. (Montana-Dakota Utilities, Co. Feb. 9, 2005)

We request that the Corps take the Heskett Station intake into account when creating new sandbar habitat. It is preferred that no mechanical disturbance occur upstream of the Heskett Station, as we believe it will increase the deposition of sand in front of our intake. Alternatively, we encourage the Corps to use the areas directly in front of our intake for a borrow source for sand, thus increasing flow in this area. (Montana-Dakota Utilities, Co. Feb. 9, 2005)

Sibley Island State Park in South Bismarck, ND the delta formation is causing the channel to the park boat ramp to silt in. This was dredged previously in about 1982-84. Maintaining the channel would help to isolate a huge wetland/sand bar complex from the shoreline. Currently my kids can walk to the sandbars. The maintenance of the channel may be a win/win situation. (Private Citizen)

Suggested mitigation:

- Provide bank stabilization to protect the riverbanks from further erosion.
- Provide landowner compensation for increased flood levels (i.e., cost share on flood insurance).
- Provide a 10-mile corridor in the Bismarck-Mandan area for open public access to islands and sandbars during the nesting season.
- Provide cost share assistance to keep water intakes free from sediment buildup for the life of your project.
- Establish a funding pool to pay for home and business relocation resulting from increased floodplain levels.
- Provide appropriate wildlife mitigation to compensate for vegetation removal and manipulation of islands and sandbars. (Morton County Water Resource District, 9/2/05)

11 Monitoring

In addition to a rigorous monitoring and assessment program of tern and plover fledge rates, production, and fitness (chick weights), water quality and abundance and species diversity of mussels, benthic invertebrates, and larval and juvenile fish should be measured pre- and post-construction around bars created by dredging or heavy equipment. It is doubtful that any reach effects can be detected in the short-term; however, the Corps' pallid sturgeon monitoring and assessment program may prove helpful in the long-term in the reaches below Fort Randall and Gavins Point Dam. Below Garrison Dam, reach effects from dredging may require additional monitoring in addition to site-specific efforts. (Missouri River Natural Resources Committee, Nov. 16, 2004)

Motoring is on e of the cornerstones of sound adaptive management, and the only way to evaluate the effectiveness of management actions, the need for modifications, and potential for other appropriate measures to achieve resource goals. The need for a scientifically sound and statistically valid monitoring plan is particularly evident given the significant scientific uncertainty of creating/restoring biologically functional ESH on a large scale through non-flow methods. Additionally, monitoring is needed to assess impacts from ESH creation on federally listed and other riverine specie and their habitats. As part of this effort, the Service recommends the Corps include a monitoring plan that outlines an appropriate level of monitoring for baseline and post-construction conditions, both physical conditions of the created habitat and biological response. Onsite, baseline monitoring of habitat creation sites, including staging areas, access areas, dredge/disposal sites, etc. for species of special concern including freshwater mussels, turtles, and paddlefish should be a priority. In addition, it would provide the opportunity for the Corps to identify potential pallid sturgeon spawning habitat requirement in the 2003 Amended BiOp (RPA V). The Corps should coordinate with the Service, NPS, USGS, and MRNRC to develop a monitoring approach, specifically addressing monitoring for impacts on these and possibly other riverine species. (USFWS, 12/3/04)

A separate effort related to monitoring of ESH for the benefit of least terns and piping plovers is to be developed cooperatively by the Corps, Service, and USGS. A preliminary list of ESH monitoring needs for least terns and piping plovers is outlined in Enclosure 1. Both monitoring efforts should include hydrologists for the Corps, Service, USGS, and NPS because of the importance of hydraulics and hydrology in this system. Ideally these two efforts should be integrated into a comprehensive monitoring effort. Based on preliminary coordination with the Corps' ESA office in Yankton, the Service believes the draft plan for monitoring of ESH being developed should be included as an appendix to the EA. (USFWS, 12/3/04)

Prepare and defend monitoring plans needed for pre- and post-construction for fish and wildlife species. (NPS, 10/29/04)

At the scale of habitat restoration required, dredging will be expensive and has high potential for negative impacts to the aquatic community. This makes it imperative that a rigorous monitoring and assessment component, addressing both the birds and the aquatic community is included in the overall program and funded adequately. (Missouri River Natural Resources Committee, Nov. 16, 2004)

No work should proceed without a rigorous monitoring program in place. The EIS needs to include a detailed explanation of monitoring plans for all native species that will be impacted, particularly the threatened and endangered species. This includes an assessment of tern and plover fledge ratios, overall production, and fitness. Obvious targets for monitoring include mussels, benthic invertebrates, larval and juvenile fish, water quality, and predation rates on the newly created sandbars. (American Rivers, Nov. 18, 2004)

The abundance of pink papershells and fragile papershells indicates that habitat in the project area attracts freshwater drum, allowing these species to disperse into and colonize the habitat. It is our recommendation that project site surveys be first conducted to determine what can be done to avoid or minimize impacts to local freshwater mussel populations. (South Dakota Dept. of Game, Fish and Parks, Nov. 3, 2004)

Prior to any future construction of sandbar habitat, we would also require pre and post construction surveys for freshwater mussels as well as other appropriate aquatic and terrestrial species that may be impacted by the construction. Because this is a large construction project in a river system, it is important to collect data on the fish and wildlife species that currently exist in the area. Baseline biological data will allow the Corps to determine how construction will impact fish and wildlife resources and develop mitigation measures if necessary.

The Corps will need to develop a monitoring plan and timeline that specifically addresses and documents the direct and indirect impacts. This will take considerable resources and time. Also recognize that the monitoring plan should be developed with input from the resource agencies prior to initiating the project in the field. Monitoring could include but not be limited to 1) herbicide application rates, times, and effectiveness; 2) vegetative composition, density and distribution; 3) invertebrate composition and biomass; 4) use and productivity of terns and plovers; 5) changes in sandbar size due to erosion or deposition; 6) human disturbance or related problems. (North Dakota Game and Fish Department, Feb. 3, 2005)

[For the MNRR] Collect and present, in coordination with the NPS, site-specific baseline data for fish and wildlife species and their habitats; including aquatic invertebrates, fishes, birds, mammals, herpetofauna, and vegetation. Here, baseline data refers to the fundamental, basic inventory information crucial for planning and management, including presence and/or abundance of species, and other dependent biotic data (such as plant cover). The objective is to develop baseline descriptions that will allow monitoring of expected changes in the river environment and predicted changes in populations of fish and wildlife species. This data should be collected to establish and understand the existing conditions before any kind of experimental manipulation begins under an adaptive monitoring program. Attached please find a listing for the minimal species needing baseline information. (NPS, 10/29/04)

A rigorous monitoring and adaptive management plan is key to the success of an ESH program. The service strongly recommends that an adaptive management program be implemented to best address and integrate those confounding factors. The EIS should describe the approach the Corps, in conjunction with other agencies/stakeholders, will use to collaborate, monitor, analyze, recommend, and implement measures to achieve our habitat goals, consistent with the riverine ecosystem. Such a program would integrate related conservation efforts in the study area. In addition, this would allow us to jointly identify and resolve resource concerns early in the process, or as soon as they are apparent. (USFWS, 12/3/04)

Suffice it to say that we have continued to have numerous concerns about the proposed project. Foremost among those is that the Corps is prematurely committing to an operational mode of habitat creation without first conducting and identifying the correct experimental design. The Department again strongly suggests that the DEA include a smaller scaled back alternative that has fewer islands, total acres and a specific time horizon. We believe the current number of islands, total acreage and time line is excessive. [ND Game and Fish Dept. June 14, 2005]

12 Necessity

It appears that the species of concern are doing quite well and thus the drastic and disruptive measures, at least, are not necessary at this time; particularly measures that require disturbance of the river bottom. Further, these more expensive methods are simply not a justified use of the public's tax dollars. (Montana-Dakota Utilities, Co. Feb. 9, 2005)

We would like to weigh in against more sandbars. PLEASE...DON'T HUMAN NEEDS COME BEFORE THE BIRDS? There a number of small towns along the Missouri that are without drinking water because of the low water. We feel that you must consider North Dakotans and our use of the river first. (Private Citizen)

Leave the Missouri river alone. By creating sandbar habitat for the least tern and piping plover, you are just harming native species that are left, doing more damage than if left as is. (Private Citizen)

I have many more concerns but I feel this is adequate enough for the COE to see the proposal lacks merit and the social and economic impacts are to severe to even be contemplated. (Private Citizen)

I am writing to voice my opposition to creating artificial habitat and artificial sandbars in the Missouri River. It seems odd that you would want to create an artificial habitat that needs to be "recreated" every few years. I would not like to see sandbars made off limits to the recreational public. I would not like to see an increase in the amount of sandbars in the river. (Private Citizen)

13 Scope

The scope envisioned for this programmatic document is too narrow. This programmatic EA is focused solely on the mechanical creation and maintenance of emergent sandbar habitat for interior least terns and piping plovers. The Corps has the responsibility to modify the flow regime from Gavins Point Dam to benefit endangered pallid sturgeon. The biological opinion issued by the FWS in 2000 declares that tern and plover habitat creation is a by-product of flows for pallid sturgeon. At our meeting in Omaha on August 12 [2004], the Corps stated this programmatic effort would be concerned with all methods of ESH creation and not just mechanical methods. As the 2000 BiOp determine, these restorations efforts for both birds and sturgeon are related and could well be mutually beneficial to all species needing recovery as well as being beneficial for the MNRR. Therefore, there are definite benefits to linking restoration work associated with pallid sturgeon with restoration work for terns and plovers. (NPS, 10/29/04)

A narrow focus on one aspect of implementation of the 2003 BiOp alone would likely overlook the potential for greater benefits to be seen when all aspects of the 2003 BiOp are studied together. In addition, this focus on one aspect, construction of habitat, has the potential to create impacts to the river system that might be avoided altogether by considering all other aspects. (NPS, 10/29/04)

The Corps indicates the proposed EA is driven by RPA IVB.3 of the 2003 Amended BiOp and will assess alternative methods of meeting the habitat goals identified in the RPA. The Corps further indicates that flow release alterations from the main stem dams will not be considered in the EA, but are being evaluated under a separate process. Given the dynamic nature of the Missouri River, we believe the EA must address ESH abundance, distribution, and sustainability in relation to river flows both over the years, and over the nesting season (i.e., May through August). In addition, the EA should address the relationship of artificial creation of ESH to flow management, including changes to the flow regime to facilitate construction and/or maintenance of ESH, and related ecosystem benefits (e.g., forage fish production, invertebrate production, etc.) that greatly influence the value of adjacent ESH to nesting terns and plovers. For example existing flow management such as power peaking at several dams (e.g., Garrison and Fort Randall) is known to affect ESH. We recommend that the Service, Corps and NPS discuss this issue further and strive to jointly develop a purpose and need statement, as well as sideboards for this EA. (USFWS, 12/3/04)

14 Site Selection and Avoidance Recommendations

We suggest that all high [recreation] use areas and boat ramps be avoided. (ND Parks and Recreation, 2/10/05)

In addition, we recommend that vegetation removal sites be at least 200 yards (upstream and downstream) from a public boat ramp and that no sites be constructed between the Burnt Boat ramp and the mouth of the Heart River. This portion of the Garrison Reach is heavily used by recreationalists during the open water period. It would seem irresponsible to purposely attract threatened and endangered species to sandbars in such a heavily used area. (North Dakota Game and Fish Department, February 3, 2005)

I suggest no habitat creations or manipulations from river mile 1310.0 to 1320.0 – within the immediate Bismarck-Mandan areas; and also within one-quarter mile of any public boat ramp along the Garrison reach. Creating habitat within these areas will only cause unnecessary conflict, as they are used extensively by thousands of people for recreational purposes. A prime example of this is the creation slated for RM 1319.9 near the Heskett Power Plant. This area is already a popular destination for recreation, and with the addition of a new ramp across from the plant, the number of users will only increase. (North Dakota, Office of the State Engineer, September 12, 2005)

15 Site-Specific Action Requests

I can't see why nobody has built "islands" in some of those swamps in the Springfield and Niobrara areas. They would provide some of the best bird habitat in the U.S. We strongly support construction of emergent sandbar habitat in the Kessler's Bend reach between Ponca State Park and Sioux City, IA in lieu of habitat construction in the upstream-unchannelized reaches. In-channel bars in this reach would not interfere with navigation, would add habitat diversity in the channel, and avoid serious impact to the more natural upstream river segments. Construction could occur on a trial basis to learn whether birds would use this habitat and if the habitat would persist through the nesting season given the deeper channel and greater flow energy in the reach. (Missouri River Natural Resources Committee, Nov. 16, 2004)
Maybe the plans for dredging and sand island creation in Springfield area can also create a small, safe boating channel? Remember the trouble the Lewis & Clark group had in September? (Private Citizen)

You can push up sand bars on Lake Oahe down by Winona Bay and the same time develop channels so irrigators can get water from the river channel also, on the SD line. Tesoro Mandan Refinery is concerned the increase in islands and sandbars could potentially impact our water intake structure on the Missouri River. We have experienced problems in the past with sandbars forming in front of the intake structure and are concerned the creation of additional sandbars would compound the problem. The created islands will erode during high flows and will be transported to the lower reaches of the river where the Tesoro Mandan Refinery's water intake is located. The proposed Corps plan would adversely impact the refinery's water intake. (Private Citizen)

I would suggest you consider maintaining the boat ramp access at Sibley Park by dredging the channel once again and at the same time establish habitat for the plover and tern on the sandbars isolated by the dredged channel. (Private Citizen)

Montana-Dakota utilities is concerned about the effect of the mechanical and dredging methods of creating or enlarging sandbars. We are also concerned about other methods of exposing more sand at the water line such as defoliation, that result in additional sand placed or exposed above the water line being easily eroded. While we are not opposed, in general, to these methods, tit is critical that any projects do not result in additional sand being deposited in front of the Heskett Station intake, which is down=stream of the majority of areas where the Corps intends to work and will be silted in more easily and frequently. (Montana-Dakota Utilities, Co. Feb. 9, 2005)

The State of ND should NOT issue the Corps any permits for this project unless it includes repairing waterways to municipal water access points and access to low water ramps. The fact that the Corps is not offering to help with these critical conditions as part of its proposal is insulting. (Private Citizen)

US Army Corps
of Engineers
Omaha District

Programmatic Environmental Impact Statement
for the Creation and Maintenance of
Emergent Sandbar Habitat in the Riverine Segments
of the Upper Missouri River

Appendix F

Real Estate Authorities, Policies, and Protocol for the Emergent Sandbar Habitat Program

October 2010

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Table of Contents

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1 INTRODUCTION

The U. S. Army Corps of Engineers (Corps) is proposing to implement a program for the mechanical maintenance and creation of emergent sandbar habitat as recommended by the U. S. Fish and Wildlife Service (Service) in the 2003 Amended Biological Opinion (BiOp). A Programmatic Environmental Impact Statement (PEIS) is being prepared to analyze the effects of this project. This project follows the recommendations of the Service and seeks to implement section IV.B.3 of the Reasonable and Prudent Alternative: Mechanically Created Habitat for the Interior Least Tern and Piping Plover. Appendix F is intended to be a discussion of real estate authorities, policies, and the Corps' intended protocol for addressing real estate needs related to implementation of the ESH program.

Activity along both river banks has the potential to affect the success of the sandbar for fledging young. Conflicts have occurred in the past between recreational users and nesting birds. Every summer, active bird colonies are posted with signs and twine indicating that access is restricted. As development increases along the banks, conflicts also increase. Land ownership along both banks of the Missouri River is primarily private with very few public lands. Private landowners have full rights (within county and state zoning regulations) to develop their property, including their shoreline, as they see fit. There is an increasing demand for riverfront developments and cabin areas, so this potential conflict is a concern when looking at long-term management needs for the birds.

In order to avoid potential conflict between recreational users and the birds, the Corps intends to take a pro-active approach and coordinating with landowners regarding staging and access areas, and pursuing the purchase of real estate rights from willing landowners when opportunities are identified.

2 PURPOSE OF REPORT

Presently, Real Estate authority for acquiring lands exists under three programs that are being used to implement the Missouri River Recovery Program (MRRP). All three programs are willing seller programs. These programs are in addition to the Continuing Authorities Programs and Section 514 Program where cost-sharing sponsors acquire lands needed for Missouri River restoration. Land acquisition has been approved and authority has been granted to acquire real estate under the Missouri River Bank Stabilization and Navigation Project Fish and Wildlife Mitigation Project, the Missouri National Recreational River (MNRR) and Section 33.

3 REAL ESTATE AUTHORITY

3.1 MISSOURI RIVER BANK STABILIZATION AND NAVIGATION, FISH AND WILDLIFE MITIGATION PROJECT

Authorized by the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), this project originally authorized acquisition and development of 48,100 acres of fish and wildlife habitat to mitigate losses of fish and wildlife resources resulting from construction and operation of the Bank Stabilization and Navigation Project, along the Missouri River between the bluffs from Sioux City, Iowa to the mouth of the Missouri River at St. Louis, Missouri. Congress later modified this project's authorization by Section 334(a) of WRDA 1999 and increased the lands and interests in lands to be acquired for this project by 118,650 acres.

Real Estate authority for the Missouri River Bank Stabilization and Navigation, Fish and Wildlife Mitigation Project was first obtained under Real Estate Design Memorandum (REDM) No. 1 approved May 20, 1991. The following estates are approved for acquisition under REDM No. 1:

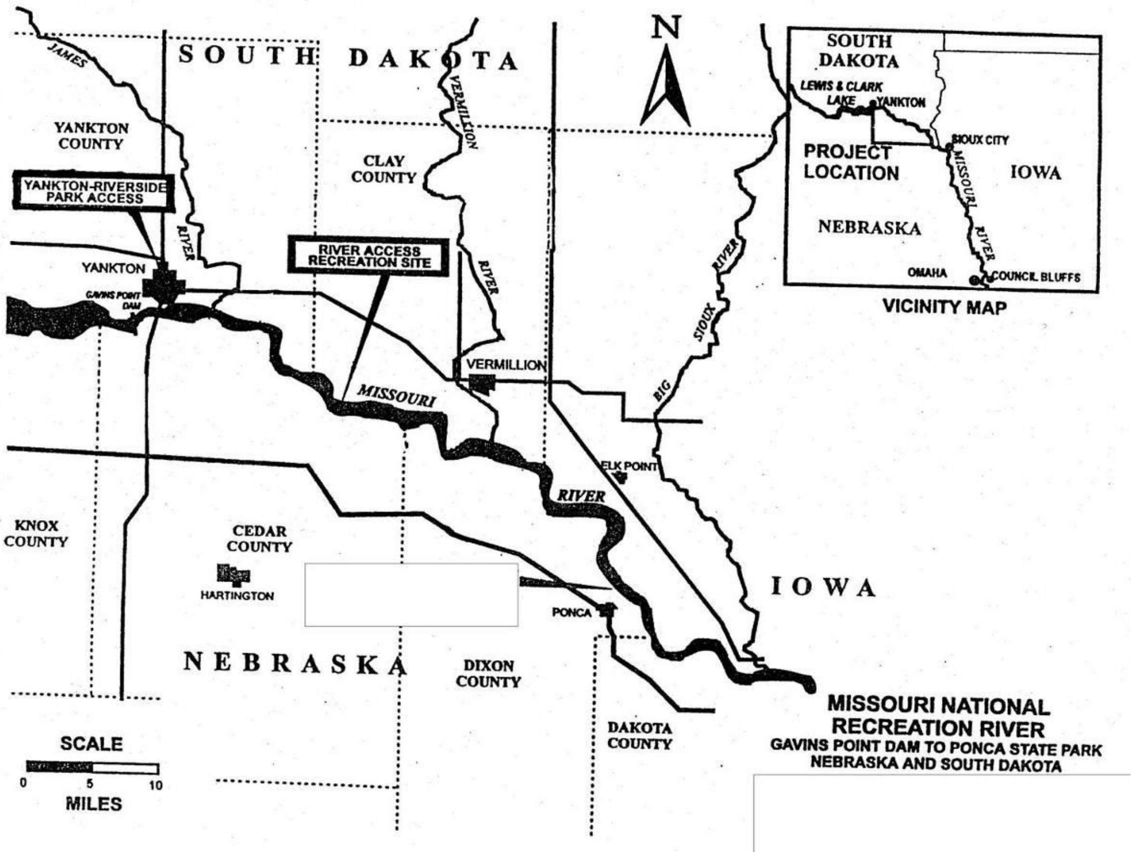
- Fee Simple Title
- Fish and Wildlife Mitigation Easement - this is a non-standard easement to be acquired from the States (No cost)
- Sloughing Easement
- Any standard estate listed in Exhibit 5-29 of EC 405-1-11
- Any standard or non-standard estate subsequently approved by Headquarters Real Estate for environmental/ecosystem projects

The preferred method is to acquire any property in fee simple title from private landowners. However, acquiring various easements or lesser interests from public or private landowners may be determined appropriate by the respective District Chiefs of Real Estate.

3.2 MISSOURI NATIONAL RECREATION RIVER (MNRR)

The MNRR was authorized by Section 707 of the National Parks and Recreation Act of 1978 (Public Law 95-625), which amended the Wild and Scenic Rivers Act of 1968 (Public Law 90-542), this legislation designates a 59-mile stretch of the Missouri River from Gavins Point Dam, South Dakota downstream to Ponca State Park, Nebraska as a National Recreational River. This legislation authorizes the Corps to construct recreational development, bank stabilization, and other recreational river features as necessary to support the values for which the river was designated.

Figure 1: 59-Mile Missouri National Recreational River



Pursuant to the authorizing legislation, a Cooperative Agreement between the Department of Interior and the Department of Army was developed and signed (February 1, 1980). In Section IV (E) of the Cooperative Agreement, the Secretary of the Army agreed that he would acquire in the name of the United States such lands and interests in lands required to carry out the purposes of the authorizing legislation.

Real Estate authority for the MNRR was obtained under a second Real Estate Design Memorandum (REDM) approved March 26, 2004. The following estates are approved for acquisition under the MNRR REDM:

- Channel Improvement Easement
- Sloughing Easement – non-standard estate
- Fee Simple Title
- Recreational River Easement – non-standard estate
- Recreational River Feature Easement – non-standard estate
- Easement Estate with States – non-standard estate

The main form of acquisition would be a Recreational River Easement and a channel improvement easement for bank stabilization.

3.3 SECTION 33

Section 33 of the 1988 Water Resources Development Act (Public Law 100-676) provides authority to purchase real estate interests and build or maintain bank stabilization structures as needed to alleviate bank erosion and related problems associated with reservoir releases along the Missouri River between Fort Peck, Montana and Gavins Point Dam, South Dakota and Nebraska.

Real Estate authority for Section 33 was obtained under a third Real Estate Design Memorandum (REDM) approved March 17, 1995. The following estates are approved for acquisition under the Section 33 REDM:

- Sloughing Easement
- Channel Improvement Easement
- Temporary Work Area Easement
- Road Easement

Acquisition of sloughing easements is preferred. Only actively eroding sites will be considered.

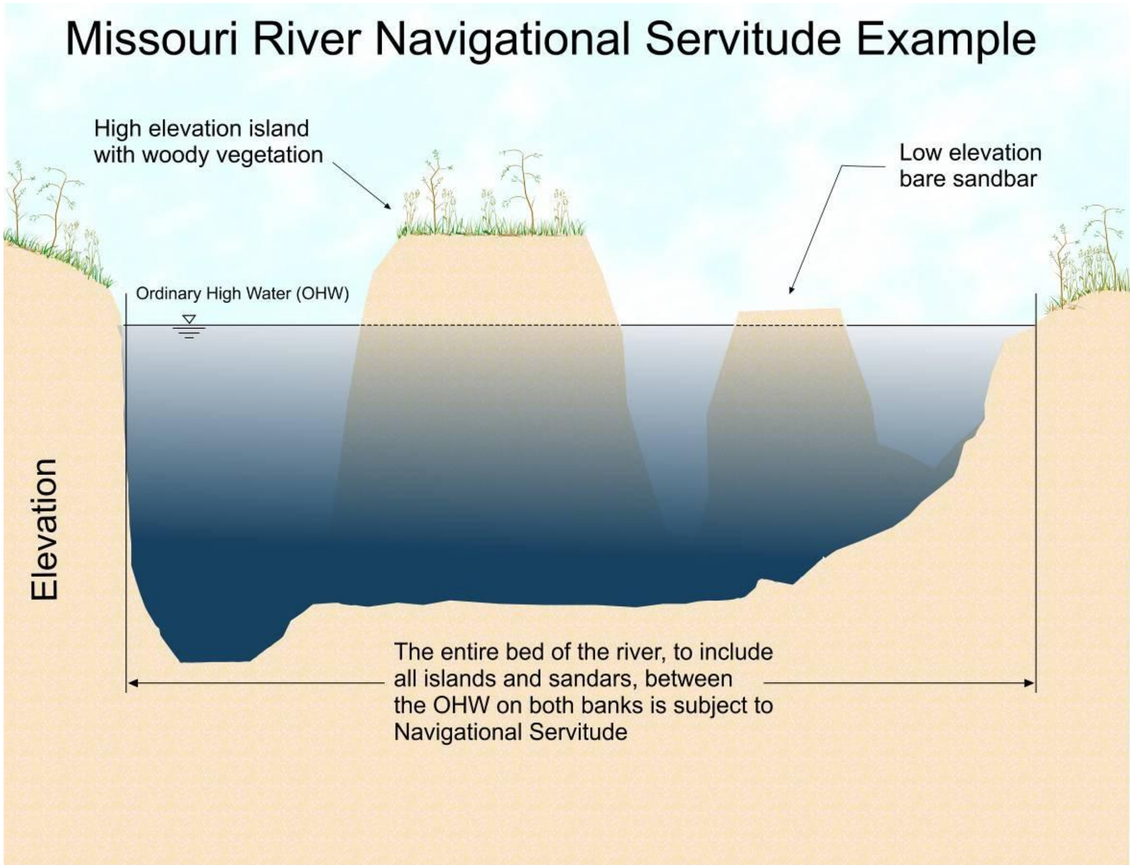
3.4 OPERATIONS

The Corps has real estate authority on Corps-owned land, in accordance with the Federal laws and regulations. The Corps has extremely limited authority outside of the Corps-acquired project land boundaries. The major reservoirs and tailwaters areas are not included within the ESH project boundary with the exception of Lewis and Clark Lake. Within Lewis and Clark Lake, ESH actions will be occurring and can occur without additional real estate requirements.

3.5 NAVIGATIONAL SERVITUDE

Navigational servitude applies to riverine lands below the ordinary high water mark. All of the ESH projects with real estate needs located below the ordinary high water line within the Missouri River will be evaluated for applicability of the use of navigational servitude.

The Assistant Secretary of the Army for Civil Works issued a memo dated December 4, 2004 indicating that navigational servitude be asserted in those cases where the ecosystem restoration measures are related to navigation, *e.g.*, the measures address the environmental impacts associated with navigation measures or the measures themselves have an impact on navigation. Omaha District Office of Council has issued a legal opinion on the applicability of navigational servitude to the ESH program and other Biological Opinion tasks.



3.6 Proposed Overall Missouri River Recovery Program (MRRP) Authority

Section 5018 (S5018) of the WRDA 2007-Missouri River and Tributaries, Mitigation, Recovery and Restoration, Iowa, Kansas, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming-Subsection (a) directs the Secretary of the Army, in consultation with the MRRIC, to conduct a study of the Missouri River and its tributaries to determine actions required to:

a) mitigate losses of aquatic and terrestrial habitat;
b) recover federally listed species under the Endangered Species Act (ESA); and
c) restore the ecosystem to prevent further declines among other native species.

With the passing of WRDA 2007, a supplement to the first Real Estate Design Memo (REDM) approved 22 March 1990 (Real Estate authority for the Missouri River Bank Stabilization and Navigation, Fish and Wildlife Mitigation Project) is currently being generated and will be submitted for approval as the overall MRRP REDM in accordance with Engineer Circular (EC) 405-1-11. The plan of the supplement to the existing

REDM is to request authorization to acquire real estate under all programs. Until the supplement to the REDM is completed, real estate for the ESH program will be acquired by relying on existing real estate authorities and vehicles as described in the existing REDM's for each existing program.

4 PEIS PROJECT AREA

As defined in the Amended Biological Opinion, the Missouri River is broken down into segments. Each of these segments or reaches has unique characteristics, ownership, and management considerations. Creation, maintenance, or manipulation of Emergent Sandbar Habitat (ESH) in any of the segments will involve rights of entries and coordination with various agencies. The reaches that are relevant for this appendix are detailed below:

- Fort Peck Dam to Lake Sakakawea Headwaters near Williston, ND, River Mile 1771.5 – 1568.
- Garrison Dam to Lake Oahe Headwaters, River Mile 1389.9-1304.
- Fort Randall Dam to Niobrara River, River Mile 880.0 – 845.0
- Niobrara River to Headwaters of Lewis & Clark, River Miles 845.0 – 828.0
- Gavins Point Dam to Ponca, Nebraska, River Mile 811.1 – 753
- Kenslers Bend Reach from Ponca State Park, Nebraska to the upstream end of the Bank Stabilization and Navigation Project, River 753 – 734.3

4.1 FORT PECK DAM TO LAKE SAKAKAWEA HEADWATERS NEAR WILLISTON, ND, RIVER MILE 1771.5 – 1568.0

4.1.1 Project Location and Description

The river stretch below Fort Peck to Lake Sakakawea is owned by private individuals on both sides of the river with one exception. The Fort Peck Indian Reservation is on the north bank of the river from river mile 1743.9, where the Porcupine River meets the Missouri at Nashua, to just west of Culbertson at river mile 1630.4, where the Big Muddy Creek meets the Missouri. (RM for Segment 2 is not consistent with the Master Manual 3.14.2, page 3-152: RM 1760 to RM 1547.1) The historic, pre-dam, middle Missouri River line is the southward reservation boundary. The Corps owns no land that abuts the reservation boundary. Within reservation boundaries, there are pockets of privately owned lands. If any ESH maintenance or creation activities take place within the boundaries of the Fort Peck Indian Reservation, rights of entries and permissions would need to be obtained from the tribe. If the work falls within the river miles of the Fort Peck Reservation, but south of the historic, middle Missouri River line, a right of entry would need to be obtained from the State of Montana. Courtesy notification and coordination with the tribe would occur as well.

From River mile 1630.4 eastward to the headwaters of Lake Sakakawea on the north bank is all private ownership. ¼ to ½ mile of the south side of the river around

Culbertson is covered by a bank stabilization easement. There is another bank stabilization easement in North Dakota near the town of Cartwright on the south bank. There are two weirs and weir easements on the south bank by the Buford Trenton Irrigation District Intake Structure.

Most existing sandbars on the Missouri River between Fort Peck and the headwaters of Lake Sakakawea occur from 10-12 miles above Wolf Point (River Mile 1707) to the North Dakota state line at river mile 1586.5. Any ESH projects in this reach will need an easement from State of Montana or from the Fort Peck Tribe if the work falls within the reservation boundaries.

According to Montana law, lands or islands arising from river bed can be enlarged by accretion and such accreted lands can attach to island. MONT. CODE ANN. § 70-1-202 (2009); Montana Dept. of State Lands v. Armstrong, 824 P.2d 255 (Mont. 1992).

According to Montana statutory law, accretions to islands formed in bed of Missouri River, which were discernible islands prior to attaching to adjoining lands, were owned by State of Montana. MONT. CODE ANN. § 70-1-202 (2009).

In Montana, the title of a riparian owner on a nontidal, navigable river extends to ordinary low-water mark. U.S. v. Eldredge, 33 F.Supp. 337 (194)).

4.2 GARRISON DAM TO LAKE OAHE HEADWATERS, RIVER MILE 1389.9-1304.0

4.2.1 Project Location and Description

The river stretch from Garrison Dam to Lake Oahe is owned by private individuals on both sides of the river.

Most existing sandbars on the Missouri River between Garrison Dam to the headwaters of Lake Oahe occur from river mile 1370 to 1325, and from river mile 1310 to 1304. ESH projects in this reach could need an easement from the State of North Dakota.

4.2.4 Summary of State Laws – North Dakota

N.D. CENT. CODE § 47-06-08 (2009) Islands and relicted lands in navigable streams belong to state.

Islands and accumulations of land formed in the beds of streams which are navigable belong to the state, if there is no title or prescription to the contrary. The control and management, including the power to execute surface and mineral leases, of islands, relictions, and accumulations of land owned by the state of North Dakota in navigable streams and waters and the beds thereof, must be governed by N.D. CENT. CODE § 61-33 ET. AL. (2010).

The state of North Dakota holds title to the bed of the Missouri River, which includes underlying oil and gas. J.P. Furlong Enters., Inc. v. Sun Exploration & Prod. Co., 423 N.W.2d 130 (N.D. 1988).

Owner of an island in a navigable stream is entitled to land added thereto by accretion to the same extent as owner of land on the shore of the mainland. Hogue v. Bourgois, 71 N.W.2d 47 (N.D. 1955).

N.D. CENT. CODE § 47-01-15 (2009) Banks and beds of streams - Boundary of ownership.
Except when the grant under which the land is held indicates a different intent, the owner of the upland, when it borders on a navigable lake or stream, takes to the edge of the lake or stream at low watermark. All navigable rivers shall remain and be deemed public highways. In all cases when the opposite banks of any stream not navigable belong to different persons, the stream and the bed thereof shall become common to both.

Nonnavigable Streams.
The owner of the banks along a nonnavigable stream owns the bed of the stream to its center or thread. Amoco Oil Co. v. State Hwy. Dep't, 262 N.W.2d 726 (N.D. 1978)

As riparian owner acquires title to additions to his riparian lands by accretion and reliction, he likewise loses title to such portions as are eroded and washed away by a navigable stream. N.D. CENT. CODE § 47-06-05 (2009).

4.3 FORT RANDALL DAM TO NIOBRARA RIVER, RIVER MILE 880.0 – 845.0

4.3.1 Project Location and Description
The sandbars occurring in the river reach from Fort Randall Dam to Lewis and Clark Lake are owned by the adjacent landowner in Nebraska on the southern bank and by the state of South Dakota on the northern bank. The Yankton Reservation is located on the northeastern shore of the Missouri River in Charles Mix County in southeastern South Dakota from river mile 878 to 851.5. The Corps owns no land that abuts the reservation boundary. Within reservation boundaries, there are pockets of privately owned lands. If any ESH maintenance or creation activities take place within the boundaries of the Yankton Reservation, rights of entries and permissions would need to be obtained from the tribe.

Over 300 permanent and seasonal cabins and trailers from Fort Randall to Lewis and Clark Lake compare with change in population (NPS, 1997 Final GMP/EIS, Missouri/Niobrara/Verdigre Creek, National Recreational Rivers)

Most existing sandbars on the Missouri River between Fort Randall Dam and Lewis and Clark Lake occur from river miles 878 to 840 except as defined above on the South Dakota side for the Yankton Sioux Tribe. Land owners would be notified individually either in person or by letter of any ESH projects proposed for this reach. Rights of Entry would be utilized to gain access to sandbars and a lease instrument would be needed to obtain land-based staging areas. Easements would be needed from landowners in South Dakota, Nebraska, and/or the Yankton Sioux Tribe to cross their land in order to gain access to a sandbar.

4.3.4 Summary of State Laws - South Dakota and Nebraska

South Dakota

S.D. CODIFIED LAWS § 5-2-4 (2004). State ownership of lake and river beds declared--Riparian owners protected
For the purposes of §§ 5-2-4 to 5-2-9, inclusive, the bed and channel of any lake or river in this state or bordering on this state to the middle of the main channel thereof, and all islands and sand bars lying therein shall be considered the property of the State of South Dakota unless this state or the United States has granted or conveyed an adverse legal or equitable interest therein. Nothing in said sections shall affect or impair the rights of riparian owners.

S.D. CODIFIED LAWS § 43-17-5 (2004). Accretions to bank of river or stream belong to owner of bank subject to existing right-of-way
Where from natural causes, land forms by imperceptible degrees upon the bank of a river or stream, navigable or not navigable, either by accumulation of material or by the recession of the stream, such land belongs to the owner of the bank, subject to any existing right-of-way over the bank.

S.D. CODIFIED LAWS § 43-17-1 (2004). Land below ordinary high-water mark of navigable lake or stream-- Law governing ownership
The ownership of land below ordinary high-water mark, and of land below the water of a navigable lake or stream, is regulated by the laws of the United States or by such laws of the state as the Legislature may enact.

Nebraska

Owner of land on shore, in absence of restrictions on his grant, owns to thread of stream, and his riparian rights extend to existing and subsequently formed islands. Krumwiede v. Rose, et al., 129 N.W.2d 491 (Neb. 1964).

Subject to easement of navigation, riparian owners are entitled to possession and ownership of soil under waters of stream as far as thread of stream.
Krumwiede v. Rose, et al., 129 N.W.2d 491 (Neb. 1964).

The state does not hold title to river beds in Nebraska. River beds in Nebraska are as effectually the subject of private ownership as other property, except that, in case of navigable streams, there is an easement for public navigation.
Thies, et al. v. Platte Valley Public Power & Irrigation District, 289 N.W. 386 (Neb. 1939).

Nebraska Revised Statutes.

NEB. REV. STAT. § 77-1306.01 (2009). Lands adjacent to rivers and streams; survey; report.

In all counties where land ownership may from time to time be altered to add new lands to the tax rolls due to the activity of any river, stream, or other body of water along or bordering state lines, whether by accretion or avulsion, it shall be the duty of the county surveyor prior to June 1, 1960, and at least once within each five-year period thereafter either to cause to be surveyed any lands believed to have been altered in such manner or to certify in writing that it is his or her opinion that no alteration of ownership of any land in the county from that shown by the then current tax rolls has occurred due to the action of any river, stream, or other body of water along or bordering state lines. A report of such survey or surveys, showing the extent of any probable alteration of ownership due to the action of a river, stream, or other body of water along or bordering state lines, or a certificate of no change as provided shall be filed with the county assessor within the periods hereinbefore stated. In any county where there is no regularly elected or appointed county surveyor the county board shall appoint a qualified surveyor to carry out the provisions of this section. In the event of a failure of county officials to act as directed by this section, within the periods stated, the Property Tax Administrator may appoint a qualified surveyor to act as provided by this section, and all costs incurred shall be paid by the county. In all counties where land ownership may from time to time be altered due to the activity of any river, stream, or other body of water not along or bordering state lines, whether by accretion or avulsion, it shall be the duty of the county surveyor to cause to be surveyed any lands believed to have been altered when directed by the county board of equalization or when requested by the Property Tax Administrator. If such a survey is ordered by the county board of equalization or requested by the Property Tax Administrator, the county surveyor shall perform the same duties as when a river, stream, or other body of water is along or borders state lines.

4.4 NIOBRARA RIVER TO HEADWATERS OF LEWIS & CLARK, RIVER MILES 845.0 – 828.0

4.4.1 Project Location and Description

4.4.4 Summary of State Laws – South Dakota and Nebraska

South Dakota

S.D. CODIFIED LAWS § 5-2-4 (2004). State ownership of lake and river beds declared--Riparian owners protected

For the purposes of §§ 5-2-4 to 5-2-9, inclusive, the bed and channel of any lake or river in this state or bordering on this state to the middle of the main channel thereof, and all islands and sand bars lying therein shall be considered the property of the State of South Dakota unless this state or the United States has granted or conveyed an adverse legal or equitable interest therein. Nothing in said sections shall affect or impair the rights of riparian owners.

S.D. CODIFIED LAWS § 43-17-5 (2004). Accretions to bank of river or stream belong to owner of bank subject to existing right-of-way
Where from natural causes, land forms by imperceptible degrees upon the bank of a river or stream, navigable or not navigable, either by accumulation of material or by the recession of the stream, such land belongs to the owner of the bank, subject to any existing right-of-way over the bank.

S.D. CODIFIED LAWS § 43-17-1 (2004). Land below ordinary high-water mark of navigable lake or stream-- Law governing ownership
The ownership of land below ordinary high-water mark, and of land below the water of a navigable lake or stream, is regulated by the laws of the United States or by such laws of the state as the Legislature may enact.

Nebraska

Owner of land on shore, in absence of restrictions on his grant, owns to thread of stream, and his riparian rights extend to existing and subsequently formed islands. Krumwiede v. Rose, et al., 129 N.W.2d 491 (Neb. 1964).

Subject to easement of navigation, riparian owners are entitled to possession and ownership of soil under waters of stream as far as thread of stream.
Krumwiede v. Rose, et al., 129 N.W.2d 491 (Neb. 1964).

The state does not hold title to river beds in Nebraska. River beds in Nebraska are as effectually the subject of private ownership as other property, except that, in case of navigable streams, there is an easement for public navigation.
Thies, et al. v. Platte Valley Public Power & Irrigation District, 289 N.W. 386 (Neb. 1939).

Nebraska Revised Statutes.
NEB. REV. STAT. § 77-1306.01 (2009). Lands adjacent to rivers and streams; survey; report.
In all counties where land ownership may from time to time be altered to add new lands to the tax rolls due to the activity of any river, stream, or other body of water along or bordering state lines, whether by accretion or avulsion, it shall be the duty of the county surveyor prior to June 1, 1960, and at least once within each five-year period thereafter either to cause to be surveyed any lands believed to have been altered in such manner or to certify in writing that it is his or her opinion that no alteration of ownership of any land in the county from that shown by the then current tax rolls has occurred due to the action of any river, stream, or other body of water along or bordering state lines. A report of such survey or surveys, showing the extent of any probable alteration of ownership due to the action of a river, stream, or other body of water along or bordering state lines, or a

certificate of no change as provided shall be filed with the county assessor within the periods hereinbefore stated. In any county where there is no regularly elected or appointed county surveyor the county board shall appoint a qualified surveyor to carry out the provisions of this section. In the event of a failure of county officials to act as directed by this section, within the periods stated, the Property Tax Administrator may appoint a qualified surveyor to act as provided by this section, and all costs incurred shall be paid by the county. In all counties where land ownership may from time to time be altered due to the activity of any river, stream, or other body of water not along or bordering state lines, whether by accretion or avulsion, it shall be the duty of the county surveyor to cause to be surveyed any lands believed to have been altered when directed by the county board of equalization or when requested by the Property Tax Administrator. If such a survey is ordered by the county board of equalization or requested by the Property Tax Administrator, the county surveyor shall perform the same duties as when a river, stream, or other body of water is along or borders state lines.

4.4.6 Existing Estates

Within the boundary of Lewis and Clark Lake, the Corps already owns the property on the Nebraska side and below elevation 1210 on the South Dakota side. Land above elevation 1210 on the South Dakota side is owned by the State of South Dakota after Title VI legislation was implemented. Additionally, the Corps has existing flowage easements upstream from the upper end of the lake.

4.5 GAVINS POINT DAM TO PONCA, NEBRASKA, RIVER MILE 811.1 – 753.0

4.5.1 Project Location and Description

The river stretch from Gavins Point Dam to Ponca, Nebraska is owned on the Nebraska side of the river by the adjacent landowner and by the state of South Dakota on the South Dakota side.

Cabin info: Main EIS notes that cabin development is extensive

Most existing sandbars on the Missouri River between Gavins Point Dam to Ponca, Nebraska occur from river miles 804 – 753. Landowners would be notified individually, either in person or by letter of any ESH projects proposed for this reach. Navigational Servitude would be utilized to construct the sandbars. Potentially, a lease instrument would be needed to acquire any land-based staging areas. Rights of Entry would be needed from landowners in the states of South Dakota and/or Nebraska to cross their land in order to gain access to a sandbar. Any state owned land within this reach will need easements from the South Dakota and/or Nebraska.

4.5.4 Summary of State Laws – South Dakota and Nebraska

South Dakota

S.D. CODIFIED LAWS § 5-2-4 (2004). State ownership of lake and river beds declared--Riparian owners protected
For the purposes of §§ 5-2-4 to 5-2-9, inclusive, the bed and channel of any lake or river in this state or bordering on this state to the middle of the main channel thereof, and all islands and sand bars lying therein shall be considered the property of the State of South Dakota unless this state or the United States has granted or conveyed an adverse legal or equitable interest therein. Nothing in said sections shall affect or impair the rights of riparian owners.

S.D. CODIFIED LAWS § 43-17-5 (2004). Accretions to bank of river or stream belong to owner of bank subject to existing right-of-way
Where from natural causes, land forms by imperceptible degrees upon the bank of a river or stream, navigable or not navigable, either by accumulation of material or by the recession of the stream, such land belongs to the owner of the bank, subject to any existing right-of-way over the bank.

S.D. CODIFIED LAWS § 43-17-1 (2004). Land below ordinary high-water mark of navigable lake or stream-- Law governing ownership
The ownership of land below ordinary high-water mark, and of land below the water of a navigable lake or stream, is regulated by the laws of the United States or by such laws of the state as the Legislature may enact.

Nebraska

Owner of land on shore, in absence of restrictions on his grant, owns to thread of stream, and his riparian rights extend to existing and subsequently formed islands. Krumwiede v. Rose, et al., 129 N.W.2d 491 (Neb. 1964).

Subject to easement of navigation, riparian owners are entitled to possession and ownership of soil under waters of stream as far as thread of stream.
Krumwiede v. Rose, et al., 129 N.W.2d 491 (Neb. 1964).

The state does not hold title to river beds in Nebraska. River beds in Nebraska are as effectually the subject of private ownership as other property, except that, in case of navigable streams, there is an easement for public navigation.
Thies, et al. v. Platte Valley Public Power & Irrigation District, 289 N.W. 386 (Neb. 1939).

Nebraska Revised Statutes.
NEB. REV. STAT. § 77-1306.01 (2009). Lands adjacent to rivers and streams; survey; report.
In all counties where land ownership may from time to time be altered to add new lands to the tax rolls due to the activity of any river, stream, or other body of water along or bordering state lines, whether by accretion or avulsion, it shall be the duty of the county

surveyor prior to June 1, 1960, and at least once within each five-year period thereafter either to cause to be surveyed any lands believed to have been altered in such manner or to certify in writing that it is his or her opinion that no alteration of ownership of any land in the county from that shown by the then current tax rolls has occurred due to the action of any river, stream, or other body of water along or bordering state lines. A report of such survey or surveys, showing the extent of any probable alteration of ownership due to the action of a river, stream, or other body of water along or bordering state lines, or a certificate of no change as provided shall be filed with the county assessor within the periods hereinbefore stated. In any county where there is no regularly elected or appointed county surveyor the county board shall appoint a qualified surveyor to carry out the provisions of this section. In the event of a failure of county officials to act as directed by this section, within the periods stated, the Property Tax Administrator may appoint a qualified surveyor to act as provided by this section, and all costs incurred shall be paid by the county. In all counties where land ownership may from time to time be altered due to the activity of any river, stream, or other body of water not along or bordering state lines, whether by accretion or avulsion, it shall be the duty of the county surveyor to cause to be surveyed any lands believed to have been altered when directed by the county board of equalization or when requested by the Property Tax Administrator. If such a survey is ordered by the county board of equalization or requested by the Property Tax Administrator, the county surveyor shall perform the same duties as when a river, stream, or other body of water is along or borders state lines.

4.5.6 Existing Estates

In this reach, the Section 33 sloughing authority applies, as well as the MNRR fee title purchasing authority and easement authorities, as well as standard estates.

4.6 KENSLER'S BEND REACH FROM PONCA STATE PARK, NEBRASKA TO THE UPSTREAM END OF THE BANK STABILIZATION AND NAVIGATION PROJECT, RIVER 753.0 – 734.3

4.6.1 Project Location and Description

The river stretch from Ponca State Park, Nebraska to Sioux City, Iowa is owned by the adjacent landowner on the Nebraska side and under the jurisdiction of the State of South Dakota on the South Dakota side. At the Big Sioux River confluence, the State of Iowa has jurisdiction on the Iowa side.

The Corps has no authority for land acquisition within the Kensler's Bend reach at this time.

The only existing sandbars on the Missouri River between Ponca, Nebraska and Sioux City, Iowa occurs at river mile 749.8. Landowners would be notified individually either in person or by letter of any proposed ESH projects in this reach. Navigational servitude would be utilized for construction of the sandbars and a lease instrument would be needed to acquire any land-based staging areas. Rights of entries would be needed from landowners in South Dakota and/or Nebraska to cross their land in order to gain access to a sandbar.

4.6.2 Summary of State Laws – South Dakota and Nebraska

South Dakota (same as previous section).

4.6.6 Existing Estates

No current authority. No standard estates. Corps can only use the estates where we have acquisition authority. Corps does not have acquisition authority at Kensler's Bend, however the Supplemental Real Estate Design Memorandum for Recovery will include this reach.

5 ACQUISITION SCHEDULE

The implementation of study documents will take place as each project is proposed. The time and cost to prepare Real Estate Letter Design Memorandums (RELDM) and Real Estate maps, as applicable, will vary depending on the size and nature of each proposed project. As required, each respective RELDM would provide a schedule of land acquisition milestones.

6 OTHER REAL ESTATE INFORMATION

6.1 RELOCATION

The Relocation Assistance Program mandated by Public Law 91-646 would be utilized in the event that any person would be displaced from their home, business, or farm. Relocation benefit costs are separate and in addition to the acquisition payments of real property. Relocation benefits would be reviewed during the study phase for each respective project that may be implemented. Project lands would be typically located within the river itself or on flood prone land that is unimproved. It is anticipated that if implemented projects affect improved lands, it would not involve a significant number of displacements. However, all of the projects that evolve from the Emergent Sandbar Habitat Program will be evaluated as to the provisions and requirements necessary for relocation assistance benefits. This will be performed during each project plan as necessary.

6.2 MINERAL RIGHTS

There are no active oil or gas fields although exploratory wells have been drilled. The main mineral-related activity in the project area is extraction of sand, gravel, clay and chalk in the bluffs along the river. Some floodplain areas contain sand/silt deposits. Hardrock mining or coal mining has not occurred in the project area, nor are there active oil or gas fields in the project area. Exploratory oil and gas wells have not been commercially successful and there is no renewed interest evident. No mineral activity study was conducted. If there are subsurface rights outstanding in third parties, the surface owners' rights may be acquired subject to outstanding sand, gravel, oil, gas and other mineral interests. These third party interests would be extinguished immediately by subsequent acquisition

6.3 Timber

Any "commercial timber" present is a component of the natural scenic values of the project corridor, as well as the habitat resources that are to be protected and enhanced. Timber may only be harvested if approved by a certified forester, the Corps and the NPS using an approved Forest Management Plan. Floodplain forests consist mainly of cottonwood and willow with various understory species present as well.

6.4 Utility Relocations

Sites that are occupied by utilities or other infrastructure are not likely to be selected for development under this program; however, each project submitted for implementation approval will undergo an evaluation of facility or utility relocation. Public Law 85-500, as amended, (33 USCA 633), provides for the protection of facilities owned by local governments during the development of Federal water resource projects. If such sites would be included, facilities will be relocated or otherwise protected. If applicable, a Preliminary Attorney's Opinion will be prepared in accordance with EC 405-1-11 and included in the Real Estate Design Memorandum, as applicable.

6.5 HTRW

There is no known contamination on-site or adjacent to the project area. No project areas have been identified as known or potential Hazardous, Toxic, Radioactive Waste (HTRW) sites.

7 REAL ESTATE ESTATES

The following are some of the approved estates for the Missouri National Recreational River Project. A complete listing of the approved estates will be included in the Supplement to the Real Estate Design Memorandum.

7.1 Channel Improvement Easement

A perpetual and assignable right and easement to construct, operate, and maintain channel improvement works on, over and across (the land described in Schedule A) (Tracts Nos. , and) for the purposes as authorized by the Act of Congress approved , including the right to clear, cut, fell, remove and dispose of any and all timber, trees, underbrush, buildings, improvements and/or other obstructions therefrom; to excavate, dredge, cut away, and remove any or all of said land and to place thereon dredge or spoil material; and for such other purposes as may be required in connection with said work of improvement; reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

7.2 Sloughing Easement

The perpetual right, power, privilege and easement permanently to overflow, flood, submerge, saturate, percolate, and erode Tract No. ___________, together with all right, title and interest in and to timber, structures and improvements situated on the land except fencing, and also excepting all bodies of water and all related structures to keep water on or off the land, and roads and appurtenant structures, if any, including the appurtenant right of normal use and maintenance of all improvements so excepted; and further together with the continuing right to clear and remove any trees, brush, debris, and natural obstruction which in the opinion of the representative of the United states in charge, may be detrimental to the project; provided that no structures for human habitation shall be constructed or maintained on the land, and provided further that no other structures shall be constructed or maintained on the land nor shall any excavation be made or landfill placed on the land, or any change be effected which will alter the natural contour of said land without first obtaining approval in writing from the representative of the United States in charge of the project; reserving, however to the landowner, its successors and assigns, all such rights and privileges as may be used and enjoyed without interfering with or abridging the rights and easement hereby acquired; except that no use shall be made of said land contrary to Federal and State laws with respect to pollution; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines.

7.3 Fee

The fee simple title to (the land described in Schedule A) or (Tract No. ____________) subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

7.4 Recreational River Easement

The perpetual right, power, privilege and easement in, upon, over and across the land described for the following purposes set forth below as authorized by Section 707 of the National Parks and Recreation Act of 1978 (Public Law 95-625, 16 USC 1271) as amended.

TERMS AND CONDITIONS: AS USED HEREIN, THE FOLLOWING DEFINITIONS SHALL APPLY

"THE LAND" means all the land covered by this easement, as described herein or in attachments hereto.

"RECREATIONAL RIVER" means the stretch of the Missouri River extending from the downstream boundary of the Gavins Point Dam Project near Yankton, South Dakota to Ponca State Park.

"LINE OF SIGHT" means a determination of areas of the land inadequately screened from view from the river including, but not limited to, consideration of topography and the existence of permanent vegetation and trees during the summer months when they are fully leafed out.

"TREES" means all trees of every species measuring four (4) inches or more in diameter at a point four and one-half (4 1/2) feet above the ground.

(1) The terms and conditions of this easement shall run with the land, and bind the Grantor and the United States of America, and assigns, in perpetuity.

(2) Except as provided for herein, this easement shall not affect any regular, on-going, legal use of the land exercised prior to the acquisition of this easement.

(3) This easement shall not be construed as granting the public any right to enter or use the land for any purpose.

(4) No new residences such as homes or cabins, or travel trailers, motor homes or mobile homes may be permanently placed on or affixed to the land.

(5) The Grantor reserves the right to perform all regular and ordinary maintenance to all existing structures, buildings, grounds and access roads; to replace, for any reason, any existing structure with another of the same size and in the same locations, and; to repair, or rebuild to no greater than the former size, any existing buildings or structures which are damaged by fire, storm or other casualty.

(6) Except for on-going uses and activities provided for in (1) above, the land shall not be used for any new or additional mining, quarrying, sand and gravel removal, industrial or commercial activity whatsoever, nor shall the Grantor make or permit any change in the character or topography of the land, unless previously approved in writing by the National Park Service.

(7) No accumulation or dumping of trash or unsightly materials shall be permitted on the land and no signs, billboards or advertisements shall be displayed or placed upon the land, except that one sign, not greater than 24 inches by 30 inches in size, advertising the sale of products raised thereon, services available on the premises, or sale or lease of the land, may be displayed on appropriate occasions in a location out of line of sight from the river.

(8) Commercial harvesting of timber on the land is prohibited under this easement. However, cutting, trimming, destroying or removal of trees, grasses, brush, or shrubbery shall be permitted on the land in accordance with good husbandry practices only if; necessary to the cultivation or harvesting of crops on lands in use for farming or for raising fruit or nut trees; necessary to maintain existing routes of ingress and egress to or from the land; necessary to maintain an existing yard area of a residence; necessary for the removal

of over-mature, diseased or injured trees; necessary for the protection and safety of existing dwellings and accessory buildings and of authorized persons using or occupying the land, or; necessary in development of an approved use hereunder. Additional activities of this type shall require the prior written approval of the representative of the United States in charge of the Project.

(9) The United States, its agents, employees and assigns, shall have the right, upon reasonable notice, to enter upon and cross the land for the purpose of managing the land described or to determine compliance with the terms of this easement. Reasonable verbal or written notice of intent to enter said lands shall be given by the United States to the Grantor and existing roads or other normally traveled routes shall be utilized wherever practicable except in instances of fire, police action, rescue action or other circumstances of an emergency or similar nature.

(10) The United States shall have the right to erect and maintain signs on the land, except in the immediate vicinity of or directly in front of a dwelling. Such signs shall be limited to those deemed appropriate for the management of the land described or to delineate private areas from public areas and shall not exceed 24 by 30 inches in size. Advance written notice of size, content and location of each sign shall be given to Grantor by the United States.

(11) The land shall not be used for public utility purposes other than as necessary in connection with a non-prohibited use of this land as provided for herein.

(12) The United States may take any legal action necessary to have removed from the land any unauthorized signs, personal property, or structures, or to require compliance with any of the terms of this easement. Written notice of intent to take such action or require such compliance shall be sent to the Grantor 10 days in advance by the United States. Removal of items or required compliance with the terms of this easement under such notice shall be at the expense of the United States, subject to the availability of funds regularly appropriated for such purposes.

(13) The United States shall be solely responsible for determining areas within "line of sight" on the land. Such determination shall be in writing and a copy furnished to the Grantor prior to the acquisition of this easement.

(14) The United States agrees to furnish written determinations within a reasonable period of time whenever the Grantor submits a written request for approval of some action proposed to be taken under the terms of this easement.

(15) Access to the river across this property shall be limited to that level and type of use which existed prior to the imposition of this easement or to the maximum usage allowed for a single family residential type ownership by the local, state or federal government agency having control over such usage, whichever is greater. No additional easements for ingress and egress to the river will be conveyed over the property.

(16) The Grantor agrees that any future transfer, sale, leasing or conveyance of any interest in the land or any agreement for use of the land, whether verbal or written, shall include a reference indicating that the transaction is subject to the terms of this easement.

(17) *(Subject to availability of funds, the United States shall construct, operate, and maintain bank stabilization structures on the land bordering the Missouri River described in Exhibit “A”.)

* The parenthetical clause may be deleted, where necessary, if bank stabilization construction is not conditioned upon United States to acquire both bank stabilization and recreational river easement.

7.5 RECREATIONAL RIVER FEATURE EASEMENT

The perpetual right, power, privilege and easement in, upon, over and across the land described for the following purposes set forth below as authorized by Section 707 of the National Parks and Recreation Act of 1978 (Public Law 95-625, 16 USC 1271) as amended.

TERMS AND CONDITIONS: AS USED HEREIN, THE FOLLOWING DEFINITIONS SHALL APPLY

"THE LAND" means all the land covered by this easement, as described herein or in attachments hereto.
"RECREATIONAL RIVER” means the stretch of the Missouri River extending from the downstream boundary of the Gavins Point Dam Project near Yankton, South Dakota to Ponca State Park.
"LINE OF SIGHT" means a determination of areas of the land inadequately screened from view from the river including, but not limited to, consideration of topography and the existence of permanent vegetation and trees during the summer months when they are fully leafed out.
"TREES" means all trees of every species measuring four (4) inches or more in diameter at a point four and one-half (4 1/2) feet above the ground.

(1) The terms and conditions of this easement shall run with the land, and bind the Grantor and the United States of America, and assigns, in perpetuity.

(2) Except as provided for herein, this easement shall not affect any regular, on-going, legal use of the land exercised prior to the acquisition of this easement.

(3) No new residences such as homes or cabins, or travel trailers, motor homes or mobile homes may be permanently placed on or affixed to the land.

(4) The Grantor, will not use, dump, or bury hazardous materials or toxic wastes determined by EPA to be detrimental to the environment on said lands, including all containerized materials, household pesticides, oil, paints, freon charged equipment, or

asbestos containing materials. All hazardous materials will be stored according to Environmental Protection Agency standards.

(5) Except for on-going uses and activities provided for in (1) above, the land shall not be used for any new or additional mining, quarrying, sand and gravel removal, industrial or commercial activity whatsoever, nor shall the Grantor make or permit any change in the character or topography of the land, unless previously approved in writing by the National Park Service.

(6) The land shall not be used for public utility purposes other than as necessary in connection with a non-prohibited use of this land as provided for herein.

(7) No accumulation or dumping of trash or unsightly materials shall be permitted on the land and no signs, billboards or advertisements shall be displayed or placed upon the land, except that one sign, not greater than 24 inches by 30 inches in size, advertising the sale of products raised thereon, services available on the premises, or sale or lease of the land, may be displayed on appropriate occasions in a location out of line of sight from the river.

(8) Commercial harvesting of timber on the land is prohibited under this easement. However, cutting, trimming, destroying or removal of trees, grasses, brush, or shrubbery shall be permitted on the land in accordance with good husbandry practices only if; necessary to the cultivation or harvesting of crops on lands in use for farming or for raising fruit or nut trees; necessary to maintain existing routes of ingress and egress to or from the land; necessary to maintain an existing yard area of a residence; necessary for the removal of over-mature, diseased or injured trees; necessary for the protection and safety of existing dwellings and accessory buildings and of authorized persons using or occupying the land, or; necessary in development of an approved use hereunder. Additional activities of this type shall require the prior written approval of the representative of the United States in charge of the Project.

(9) The Grantor reserves the right to perform all regular and ordinary maintenance to all existing structures, buildings, grounds and access roads; to replace, for any reason, any existing structure with another of the same size and in the same locations, and; to repair, or rebuild to no greater than the former size, any existing buildings or structures which are damaged by fire, storm or other casualty.

(10) The United States shall have the right of providing for scenic preservation of, and public recreation on, the land described in Exhibit “B”. The United States shall have the right to construct and maintain recreational and sanitation facilities on the land described in Exhibit “B”. As determined by the United States, the public shall be permitted to enter upon the area described in Exhibit “B” for the purpose of hiking, swimming, picnicking, tent camping and fishing only. Public access shall be from the Missouri River only.

(11) The United States, its agents, employees and assigns, shall have the right, upon reasonable notice, to enter upon and cross the land for the purpose of managing the land described or to determine compliance with the terms of this easement. Reasonable verbal

or written notice of intent to enter said lands shall be given by the United Stat
Grantor and existing roads or other normally traveled routes shall be utilized
practicable except in instances of fire, police action, rescue action or other cir
an emergency or similar nature.

(12) The United States shall have the right to erect and maintain signs on the
the immediate vicinity of or directly in front of a dwelling. Such signs shall b
those deemed appropriate for the management of the land described or to deli
areas from public areas and shall not exceed 24 by 30 inches in size. Advanc
notice of size, content and location of each sign shall be given to Grantor by t
States.

(13) The United States may take any legal action necessary to have removed from the land any unauthorized signs, personal property, or structures, or to require compliance with any of the terms of this easement. Written notice of intent to take such action or require such compliance shall be sent to the Grantor 10 days in advance by the United States. Removal of items or required compliance with the terms of this easement under such notice shall be at the expense of the United States, subject to the availability of funds regularly appropriated for such purposes.

(14) The United States shall be solely responsible for determining areas within "line of sight" on the land. Such determination shall be in writing and a copy furnished to the Grantor prior to the acquisition of this easement.

(15)*(Subject to availability of funds, the United States shall construct, operate, and maintain bank stabilization structures on the land bordering the Missouri River described in Exhibit “A”.)

* The parenthetical clause may be deleted, where necessary, if bank stabilization construction is not conditioned upon United States to acquire both bank stabilization and recreational river easement.

7.6 NON-STANDARD EASEMENTS ESTATE WITH STATES

The perpetual right, power, privilege, and easement in, upon, over and across (the lands described in Exhibit A) (Tracts   and   ) in connection with the construction and maintenance of bank stabilization work and recreational facilities for the Missouri National Recreational River Project as authorized by Section 707 of the National Parks and Recreation Act of 1978 (Public Law 95-625, 16 USC 1271), as amended, to protect, enhance, and preserve the river’s values, and appurtenant improvements and structures, together with the continuing right to post signs indicating the easement, and to use existing road systems within said lands and over other lands of the owner, for ingress and egress to and within said land for the purposes of exercising the rights herein granted; provided that without the prior written approval of the District Engineer, U.S. Army Engineer District, there shall be:

1. No defoliation to any extent whatsoever of any trees, brush or any other vegetation in its natural state by any cause, purpose, or means, or any trimming, felling and cutting thereon or removal therefrom of any trees, brush or vegetation in its natural state;

2. No removal, shifting, or altering in any manner of gravel deposits as they are now or may hereafter exist on said lands;

3. No exploration for, removal or mining of any oil, gas, coal or other minerals of any nature whatsoever;

4. No construction of new structures or improvements nor expansion of any existing structures or improvements on said lands.

The above estate is taken subject to existing easements for public roads and highways, public utilities, railroads, and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; provided further that any use of the land shall be subject to Federal and State laws with respect to pollution.

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US Army Corps
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Omaha District

Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Appendix G

Site Selection Criteria and Process
For the Emergent Sandbar Habitat Program

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October 2010

Emergent Sandbar Habitat

Site Selection Criteria and Process

I. Restoration Site Selection

The Emergent Sandbar Habitat (ESH) Program utilizes a multi-agency Product Delivery Team (PDT) approach when identifying and prioritizing ESH construction sites each year. Currently, project identification trips and meetings are conducted during the summer; approximately one and one half years prior to construction. There are currently two ESH PDTs: one represents Nebraska and southern South Dakota projects encompassing the reaches below Fort Randall and Gavins Point Dams and Lewis and Clark Lake; and the other represents northern South Dakota and North Dakota projects encompassing upper Lake Oahe and the river reach below Garrison Dam. A PDT representing Montana projects encompassing the segment below Fort Peck Dam would be anticipated to form as projects are proposed and would be coordinated there. The teams vary in their composition but generally include individuals from the U. S. Fish and Wildlife Service, the National Park Service (Missouri National Recreation River (MNRR) only), state wildlife agencies, state Water Commission (North Dakota), and other federal, state, and local agencies as appropriate. Corps members of the ESH PDT are from the Threatened and Endangered Species Section, the project Natural Resource Specialists, and representatives from Construction, Engineering, Real Estate, and the Planning, Programs and Project Management Divisions.

The ESH PDTs use a cadre of selection criteria to choose ESH construction locations. There are three general categories of selection criteria:

- avoidance of sensitive resource areas;
- capitalizing on areas of natural sand accumulation; and
- areas where terns and plovers have successfully nested in the past.

Sensitive resource areas have been solicited from agencies and municipalities as part of the NEPA process. Sensitive resource areas include such things as wetlands, eagle nests, municipal water intakes, etc. where construction should be avoided. Once the sensitive resources were identified, they were added into a GIS layer, along with a buffer. Site selection is focused on the area outside of the sensitive resource areas in the “available area” identified on the map (see Figure 1 below).

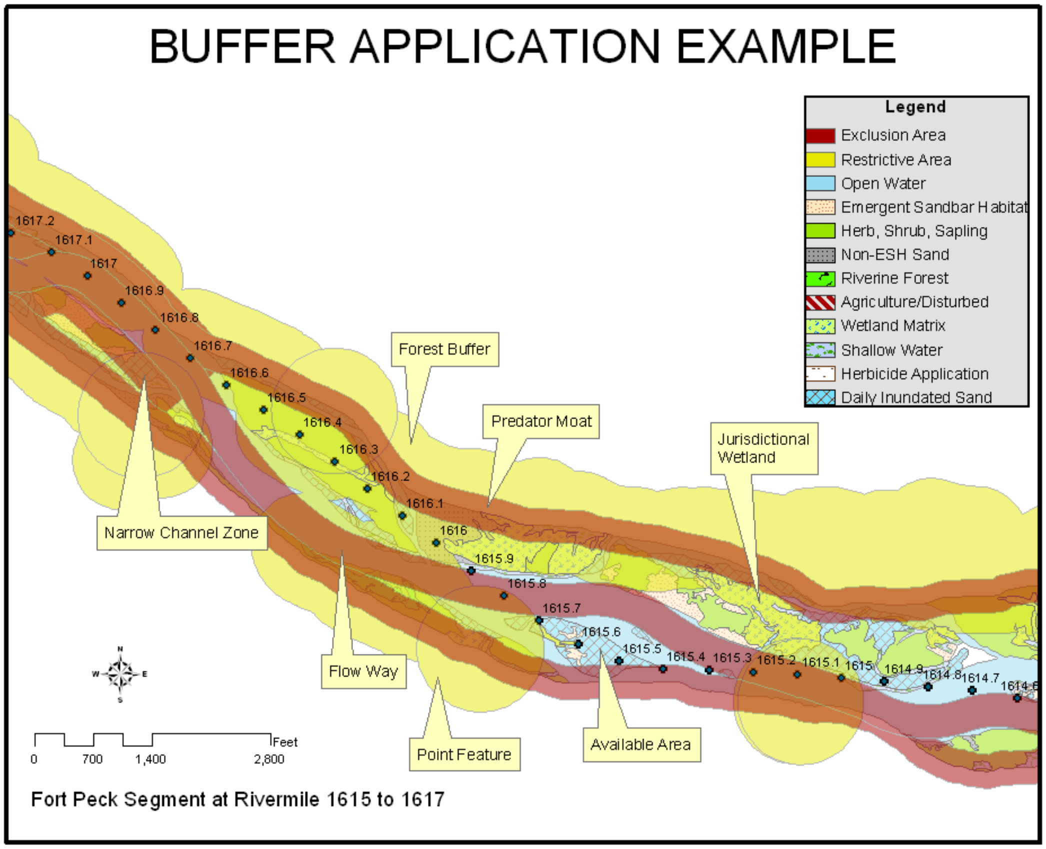

Figure 1: Buffer Application Example in the Fort Peck River Segment

The criteria used largely follow the results of technical work completed for the ESH PEIS which analyzed nest spacing with regard to certain resources that were believed to be tied to nest selection and an analysis of the characteristics of areas of high productivity over the period of record (1998-2006). In addition, expert opinion about resources that could be adversely impacted by ESH creation was sought and employed to establish buffers around certain sensitive resources. Some examples of sensitive resources are: bald eagle nests, boat ramps, mussel beds, populated areas, the thalweg, and established forest areas. The entire list of sensitive resources and avoidance buffers can be found in Appendix B (Section 2.6.4, Table 2-17).

The buffer areas assist in defining three possible zones:

(1) Available areas most suitable for, and protective of, nesting birds with minimal physical risk.

(2) Restrictive Areas - Locations where ESH could be created and replaced at relatively low physical risk, but would be within buffer limits of some sensitive resources, such as forests (increasing predation risk) or boat ramps, recreation areas or domiciles (increasing risk from recreational encroachment). Additional Federal and State coordination would be undertaken to address site-specific concerns.

(3) Exclusionary Areas - Locations where creation and replacement of ESH would generally be excluded. Intrusion into these locations, for example, within buffer limits of the thalweg, narrow river segments or intakes, could result in unsustainability of habitats, cause significant geomorphic alterations to the river corridor or risk physical and economic damages to major public and private infrastructure or land uses. High cost and high impact engineering solutions (e.g., hardened structures) may be necessary to overcome challenges. Therefore, these areas are generally excluded.

A new tool available to the ESH PDT is the Emergent Sandbar Habitat Evaluation and Ranking (ESHER) system, a GIS-based Decision Support System that has been created to help rank potential sites. The ESH PDT determines a site condition score and assigns weights to the different variables (sensitive resources). ESHER correlates this information along with the GIS layers of the sensitive resources to estimate which sites would be of highest priority. The PDT uses this information, along with team members' personal knowledge of the trends at the prioritized sites (e.g. channel stability/thalweg shifts, vegetation, previous bird usage), and selects which areas to focus on in the upcoming year.

The PDT will also consider where potential sites fall within the available, restrictive or exclusionary areas. As the program is progressively implemented through the AM process, the number of acres will be monitored (Appendix H). It is important to note that in some instances, construction activities may encroach into restrictive or exclusionary areas. The following tables demonstrate that acres from all alternatives, with the exception of Gavins Point Alternative 1, can be physically placed within the available area (Table 1). However, at certain levels, construction activities, including borrow areas, would require actions in the restrictive or exclusionary areas (Table 2).

Table 1: Summary of Available Area by # Acres of ESH (By Alternative, By Segment)

SEGMENT	# Acres in Available, Restrictive & Exclusion Areas By Segment	# Acres ESH Total (By Alternative, By Segment)						
		ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist
Ft Peck	Exclusion > 19,753	883	--	883	565	247	30	--
	Restrictive 3,825 - 19,753							
	Available 0 - 3,825							
Garrison	Exclusion > 9,678	4,295	2,148	2,066	1,327	588	500	--
	Restrictive 4,361 – 9,678							
	Available 0 – 4,361							
Ft Randall	Exclusion > 8,065	700	350	295	212	128	135	--
	Restrictive 2,784 – 8,064							
	Available 0 – 2,784							
L&C Lake	Exclusion > 13,969	1,360	680	566	354	142	80	25/yr
	Restrictive 4,711 – 13,969							
	Available 0 – 4,711							
Gavins Pt	Exclusion > 9,880	4,648	2,324	2,944	1,912	880	570	125/yr
	Restrictive 3,881 – 9,880							
	Available 0 - 3,881							
		11,886	5,502	6,754	4,370	1,985	1,315	150/yr

Table 2 Summary of Available Area by # Acres Required, Including Borrow (By Alternative, By Segment)

SEGMENT	# Acres in Available, Restrictive & Exclusion Areas By Segment	Area Impacted*: # Acres Required, Including Borrow Areas (By Alternative, By Segment)						
		ALT 1	Alt 2	Alt 3	Alt 3.5	Alt 4	Alt 5	Exist
Ft Peck	Exclusion > 19,753	2,623	--	2,623	1,681	737	89	--
	Restrictive 3,825 - 19,753							
	Available 0 - 3,825							
Garrison	Exclusion > 9,678	12,756	6,380	6,136	3,941	1,746	1,485	--
	Restrictive 4,361 – 9,678							
	Available 0 – 4,361							
Ft Randall	Exclusion > 8,065	2,079	1,040	876	630	380	401	--
	Restrictive 2,784 – 8,064							
	Available 0 – 2,784							
L&C Lake	Exclusion > 13,969	2,594	1,297	1,080	675	271	153	95
	Restrictive 4,711 – 13,969							
	Available 0 – 4,711							
Gavins Pt	Exclusion > 9,880	13,805	6,902	8,744	5,679	2,614	1,693	2,474
	Restrictive 3,881 – 9,880							
	Available 0 - 3,881							

For each acre of ESH constructed, an estimated 2.75 acres are impacted

Site selection would occur with the primary focus on avoiding impacts to sensitive resources. If sites would intrude into the restrictive area, first priority would be locations at which only borrow material would be utilized from that area. For example, if a construction activity would be within the buffer area recommended for a boat ramp, it is possible that the dredging of borrow material closer to the boat ramp could actually be beneficial to the community, State or managing agency. Another example could entail buffer areas around forest galleries. While placement of sandbars within these areas could increase predation risk to the birds, borrowing within a portion of these areas would likely be acceptable. Another example could be activities that require construction within a buffer zone of a cultural resource. This would require careful coordination with federal and state agencies to determine if the area overlapping within the buffer zone could or could not be utilized for borrow material.

Placement of a portion of a sandbar within the restrictive areas could also occur. These efforts would be carefully coordinated with federal and state agencies to determine if the area overlapping within the buffer zone would put the resource, the ESH project or river morphology at risk. An example would be working within the large buffer distances originally provided for some resources (often 18,000 or more feet, or more than 3.5 miles), where some slight overlap could be acceptable.

Dredging or placement from exclusionary areas would only be considered if it is found that such acre amounts are needed to support the bird populations. In these cases, the PDT would utilize all the tools available to choose the least impactful sites, and coordinate carefully with all federal and state agencies.

The ESH PDTs have annual meetings where the teams physically convene to view recent and current imagery to discuss locations in the river to construct ESH. During these annual meetings team members contribute information about the potential positive and negative aspects associated with construction at each location. In addition to the criteria developed for the PEIS, attendees discuss personal knowledge of the trends at the proposed sites including vegetation, channel stability and previous bird usage. A list of potential projects is identified and prioritized at these meetings. The agencies involved in these meetings typically comment on 404 permits and site specific National Environmental Policy Act (NEPA) documents that are prepared for each project. By involving them in the site selection process, they bring their agencies' concerns and contributed their agencies' expertise at the earliest possible time.

Once a prioritized list is compiled, the sites are entered into the electronic Project Work Request (PWR) system by the ESH Project Manager. Each office's prioritized projects are then combined and ranked by a team consisting of Corps team members from the Threatened and Endangered Species Section, the ESH Program Lead, the NEPA Lead for ESH, and the project Natural Resource Specialists as well as the U. S. Fish and Wildlife Service. Combined rank criteria is based upon current habitat availability in each reach and by the priorities established in the Biological Opinion. The BiOp reaches are currently prioritized by the Corps team in the following order:

1. Below Gavins Point Dam;
2. Lewis & Clark Lake
3. Below Garrison Dam;
4. Below Fort Randall Dam;
5. Below Fort Peck Dam.

These priorities may change in the future based on habitat and bird response monitoring. There are many other criteria that may factor into the combined rank process and these criteria may vary from year to year. An example of other criteria may be the reservoir habitat study and availability of habitat in Lake Oahe and Lake Sakakawea.

After the sites are prioritized, a portion of the yearly Missouri River Recovery Plan is then allocated to implementation of the ESH program. The annual funding amounts are developed by the MRRP managers with approval by the Executive Steering Committee. The available funding determines the number of sites that will be constructed in a given year.

II. Design

After the ESH sandbar construction sites have been selected, the design phase begins. The design team usually consists of the same people from the site selection team. An initial meeting is held to discuss each site. The design team reviews site specific discussions from the Annual ESH PDT and annual river trips. The Annual ESH PDT meetings focus on the gross scale site location. When the design phase begins, the focus shifts to specific design features. The engineer assigned to the ESH project will make a trip to the site and gather preliminary survey data in order to estimate the amount of material that will be needed. The project is preliminarily designed based upon survey data results and placement of material to capitalize on existing sand accumulation and conformance with the ESH design criteria specified in the Biological

Opinion. When the preliminary design is complete, a multi agency conference call is held to review and discuss any changes.

Designs for the first constructed ESH sites were adapted from the narrative descriptions of ESH found within the BiOp. Subsequent designs have used a combination of knowledge gained from monitoring constructed sites and incidental evidence. Typical design criteria include bar height (elevation above the water), bar size (acreage), shape, and slope. These factors are also discussed at the annual PDT meetings and are typically adapted to the existing site condition for each specific site.

Designs may be tailored to the existing projections for water levels on the system. The Missouri River Mainstem System Annual Operating Plan (AOP) sets the system water management operations to meet the authorized purposes of the system and implement the current Master Manual on a yearly basis. The AOP is crafted by the Missouri River Basin Water Management Division. In addition, new designs or ideas for pilot projects may be recommended by the ESH Adaptive Management team.

III. Staging Area Selection

Staging areas are typically located on whichever adjacent shore has the highest ease of access to the river. They are either selected during a site visit, at the annual PDT meetings, by the design team or by the construction contractor. Suitability of a site is based on criteria from the Corps which includes avoidance of wetlands, mature tree stands, and prime farmland. Typically, the Corps Real Estate office works with local landowners to secure a lease for staging area; however under certain circumstances these duties are left to the construction contractor. In the Missouri National Recreation River (MNRR) reaches, a landowner liaison with Missouri River Futures also assists Corps Real Estate in working with the landowners.

Following construction, staging areas are monitored for presence of noxious weeds and non-native vegetation and to assure site is adequately returned to pre-construction conditions.

IV. Construction Methods

Specific methods and equipment employed for construction is left up to the contractor except in situations where site conditions or designs necessitate certain equipment or in the event that the Corps wishes to test an experimental method or equipment at a specific site. Construction methods that are employed are detailed in Appendix C.

Construction guidelines have been developed in order to limit impacts to the local hydrology. Initially, designs avoid areas of known high-flow and remain outside of the main channel or thalweg.   Based on hydrologic conveyance equations, the Corps places restrictions on the depth of dredge cuts made during construction (4 feet or the elevation of the thalweg, whichever is less). If kept within these criteria, calculations showed that conveyance would not be affected by construction activities. This means that no localized change in the hydrology is anticipated from the proposed projects.   In addition, a 75-foot "buffer" will be established around the footprint of the constructed sandbars. No material would be taken from this area. This is intended to retain a slope form the constructed sandbar's edge to the water line in order to provide additional wetted edge habitat for plovers to forage on as well as reducing erosion on the edges of sandbars.

Due to the dynamic nature of the river in this reach, it is sometimes necessary to field-adjust sandbar design based on hydrology changes that have occurred between planning and construction of a project. In order to allow for this, the Corps establishes a "Maximum Placement Area" zone for each project. Changes in the project footprint or layout would be within this boundary. This allows the Corps to respond to changing conditions during construction and avoid placing sediment in the path of a primary or secondary channel. This further limits impacts to local hydrology as well as minimizing material lost during construction and decreasing future erosion of the sandbar. All changes at any phase of design and construction are coordinated with the multi agency project identification and design teams through conference calls and shared design configuration files. Any changes must be coordinated with all agencies in order to assure no straying from regulatory permits, water quality certifications, or 404 permitting allowances.

IV. Compliance with Environmental Laws

Once multi agency changes are incorporated into the design drawings, many concurrent events begin. The responsible Corps project office requests a 404 regulatory permit. The Corps planning section begins the scoping process for the site specific NEPA that will be done. Prior to the completion of the ESH PEIS, site specific Environmental Assessments have been prepared for each construction project. After the PEIS is complete, there will still be a need for site specific NEPA coordination and clearance including cultural clearances, tribal coordination through the Programmatic Agreement process, noxious weed surveys, etc. at the construction site as well as the staging areas. Cultural clearances, tribal Programmatic Agreement compliance requirements, and steamboat wreckage surveys are coordinated through Corps Planning Branch, Environmental and Economics Section. Project offices conduct noxious weed surveys. Elutriate testing is conducted by Corps Hydro Branch, Water Quality Section on ESH projects that include a backwater area. Backwater soil is tested prior to being placed on sandbars.

Future actions will follow a streamlined NEPA approach that is tiered off the PEIS and focuses on potential site-specific issues.

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Draft Programmatic Environmental Impact Statement for the Mechanical Creation and Maintenance of Emergent Sandbar Habitat in the Riverine Segments of the Upper Missouri River

Appendix H

Adaptive Management

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Abbreviations and Acronyms

AAR	-	After Action Review
AM	-	Adaptive Management
AMWG	-	Adaptive Management Working Group
AOP	-	Annual Operating Plan
AWP	-	Annual Work Plan
CORE Team	-	COoperating for REcovery Team
CV	-	Coefficient of Variation
DMS	-	Tern and Plover Data Management System
ESA	-	Endangered Species Act of 1973
ESC	-	Executive Steering Committee
ESH	-	Emergent Sandbar Habitat
ESHER	-	Emergent Sandbar Habitat Evaluation and Ranking system
GIS	-	Geographic Information System
IPPAC	-	International Piping Plover Adult Census
ISP	-	Integrated Science Program
LiDAR	-	Light Detection And Ranging
Master Manual		Missouri River Mainstem Reservoir System Master Water Control Manual
MNRR	-	Missouri National Recreational River
MRMS	-	Missouri River Mainstem System

MRRIC	-	Missouri River Recovery Implementation Committee
MRRP	-	Missouri River Recovery Program
NEPA	-	National Environmental Policy Act
NPS	-	National Park Service
NRC	-	National Research Council
PDT	-	Project Delivery Team
PEIS	-	Programmatic Environmental Impact Statement
RWILTAC	-	Range Wide Interior Least Tern Adult Census
SPDT	-	Missouri River Recovery Program Senior Project Delivery Team
TAMR	-	Triennial AM Report
USACE	-	U.S. Army Corps of Engineers
USFWS	-	U. S. Fish and Wildlife Service
VPI	-	Virginia Polytechnic Institute
WRDA	-	Water Resources Development Act
WSRA	-	Wild and Scenic Rivers Act of 1968

Table of Contents

1.0 Introduction

1.1 Overview

The Emergent Sandbar Habitat (ESH) Programmatic Environmental Impact Statement (PEIS) Adaptive Management (AM) strategy is a sub-program level effort within the Missouri River Recovery Program (MRRP) aimed at improving the outcome of management actions implemented in response to the U.S. Fish and Wildlife Service (USFWS) *2003 Amended Biological Opinion to the U. S. Army Corps of Engineers operation of the Missouri River Mainstem Reservoir System, Bank Stabilization and Navigation Project, and Kansas River Projects* (USFWS 2003, hereafter, BiOp) under Section 7 of the Endangered Species Act of 1973 (ESA). Two avian species listed under the ESA, the endangered least tern (*Sternula antillarum*) and the threatened piping plover (*Charadrius melodus*) (hereafter, tern and plover, respectively), are of high management priority as specified in the BiOp. The primary management action of the ESH sub-program is to create and maintain tern and plover nesting and foraging habitat on the Missouri River.

In addition to the US Army Corps of Engineers (USACE) and the USFWS, the National Park Service (NPS) is involved in planning and implementation of the sub-program, as actions occur in the two segments of the Missouri National Recreational River (MNRR) designated under the Wild and Scenic Rivers Act of 1968 (WSRA). In the MNRR segments, the NPS retains permitting authority under Section 7a of the WSRA.

Managers within the ESH sub-program are confronted with making decisions in the face of uncertainty. The primary source of uncertainty is related to the effect management actions to restore habitat will have on species productivity and, ultimately, population size. This AM strategy was developed to serve four primary functions:

1. Identify the uncertainties involved with ongoing and potential management actions
2. Identify metrics that will help decision makers measure the success of the sub-program at meeting its stated objectives
3. Identify monitoring needed to measure progress toward these metrics
4. Identify the AM strategy by which management actions or objectives are adjusted over time to ensure success.

1.2 Uncertainties

The implementation of the ESH sub-program to mechanically restore sandbars in the Missouri River involves numerous uncertainties related to implementation and achievement of the stated objectives. The ESH AM strategy is intended to recognize and, to the extent possible, reduce these uncertainties to allow for better-informed decision-making. Major uncertainties are listed below.

1. **Biological response to habitat availability.** The primary uncertainty associated with the ESH sub-program is how availability of habitat affects biological responses of the species in terms of productivity and population growth. This involves the amount of habitat needed and the distribution of that habitat within designated segments in order to meet the objectives. To address this uncertainty, the PEIS in conjunction with this AM strategy is structured such that the level of construction effort and acreage target can be adjusted over time based on recorded and forecasted biological responses.

2. **Amount of annual habitat creation needed to reach acreage targets.** To achieve the objectives, a certain amount of habitat must be created on an annual basis. This involves estimating how existing acreage will change due to three primary factors: erosion, vegetation encroachment, and changes in habitat availability due to water levels. While there are initial assumptions for these processes, they may need to be refined over time.

3. **Biological response to various habitat types.** It is postulated that different habitat types (natural, constructed), habitats constructed using different methodologies (new construction, vegetation removal, overtopping of cleared bars), and habitats of different ages and sizes will elicit different responses in terms of bird use and productivity. This is believed to be reflective of the quality of the various habitat types. While initial assumptions have been made, improved understanding will result in more reliable predictions of biological response.

4. **Regional population dynamics.** More information is needed regarding the dispersal of juveniles within the MRMS and the extent to which birds enter or exit the MRMS. Currently, it is assumed that dispersal within the MRMS is density independent, and immigration from and emigration to other regions occur equally. More complex dynamics could result in greater or lesser population responses to constructed habitat. Additionally, events outside of the Missouri River basin, such as the recent oil spill in the Gulf of Mexico, may have unforeseen impacts on overwintering survival rates that could reduce populations on the Missouri River. The effect of such events is unknown at this time.

5. **Biological metrics.** Initial population and productivity targets established by Species Recovery Plans and the BiOp, respectively, may not accurately reflect population dynamics that will prevent jeopardy or lead to species recovery. These numbers may be revised based on recorded species trends or updated population models. For example, species numbers on the MRMS over the most productive period of record (1998-2005) were in the range of 463 to 1,764 for plovers and 630 and 904 for terns. These or similar

recorded variations in population numbers may help inform adaptation of targets for biological metrics.

6. **Predation at created sites.** There are numerous species known to predate terns and plovers on both natural and created bars, such as great horned owls and minks that have been documented on recently created bars. While it has been postulated that predators have keyed in on certain created sites, it is not known if this is due to sandbar design, location, high nest densities, or some other factor. It is also uncertain whether increases in predation at created sites over the lifetime of the bar are due to overall habitat declines on the MRMS or some other factor associated with the bar itself.

7. **Human disturbance impacts.** The amount and effects of human disturbance on the bird populations are not fully understood, although human activity is generally assumed to have a minimal impact on the populations in most places targeted for habitat restoration.

8. **Interspecific competition.** Observational evidence has indicated that when population density is too high on a single sandbar, the potential for agonism (behavior characterized by aggression, defense and/or avoidance) amongst the two species exists as they compete for limited nesting space. However, it is not understood whether the cause of this interaction is inter-nest spacing, food availability, or some other factor.

9. **Non-target impacts.** While the sub-program includes numerous design and site-selection considerations that are meant to alleviate non-target impacts of construction, the relationship between construction activities and potential impacts to water quality, fish species, mussel populations, recreation, bank erosion and deposition, and other factors is not fully understood.

10. **Long-term availability of sediment.** Although the ESH sub-program is not anticipated to affect trends in aggredation and degradation on the river, the long-term availability of sediment in the target segments to construct sandbars is uncertain due to ongoing trends in degradation and reduced sediment loads in the river.

11. **Budget.** While this strategy assumes that adequate budget will be available to implement recommendations, in any given year the budget afforded to this sub-program is uncertain.

1.3 Strategy Development

This AM Strategy was developed in accordance with numerous guiding documents relevant to the MRRP. The 2000 BiOp and its 2003 amendment call for establishing an AM process to evaluate species and habitat responses to management actions within the river and to continually provide knowledge for the decision-making process (USFWS 2000, 2003). In addition, the USACE recently released a Technical Memorandum describing implementation guidance for Section 2039 of the Water Resources Development Act (WRDA 2007) which calls for monitoring and AM of ecosystem restoration projects and provides some specific direction on what is to be addressed within AM plans. Finally, the National Research Council (NRC) calls for AM efforts in their 2002 report *The Missouri River Ecosystem: Exploring the Prospects for Recovery* (NRC 2002).

Strategy development was initiated by a multi-agency team consisting of representatives of the USACE, USFWS, NPS and experts in Structure Decision Making (SDM) and model development in 2008. Based on comments received on draft versions of the strategy and new USACE guidance issued in 2009 on AM, the strategy was then updated by the MRRP Adaptive Management Work Group (AMWG) and the ESH PEIS Project Delivery Team (PDT) in coordination with Cooperating Agencies on the PEIS (USFWS and NPS).

2.0 Objectives

The goal of the ESH sub-program is to provide sufficient habitat throughout the Missouri River Mainstem System (MRMS) to support self-sustaining populations of terns and plovers. "Self-sustaining" means that the population has a high probability of meeting population recovery targets as specified in the current Recovery Plan (USFWS 2000, 2003).

The current scope of the ESH sub-program involves supplementing existing habitat for terns and plovers through mechanical construction of sandbars (e.g., through dredging or bulldozing). While past experience has indicated that mechanically created habitat can be used for nesting by terns and plovers and that it can be highly productive, uncertainty remains over how much habitat is needed to support tern and plover populations on the MRMS. The alternatives of the PEIS identify potential amounts of habitat that could support the species based on the following:

1. Habitat estimates contained in the BiOp
2. Habitat amounts as measured during years bounding a period of positive biological response
3. Estimates of nesting habitat amounts used by the species over a period of positive biological response.

Additional uncertainties exist regarding the most effective and efficient methods of creating habitat, ways to maintain productivity after habitat is created, and biological responses to management actions. In order to implement the ESH sub-program in the face of these uncertainties, this AM strategy has been crafted to improve the success of management actions through the use of measurable objectives, targeted monitoring and research, and analysis of data in a manner that reduces uncertainty and leads to better informed decision making.

Clear articulation of goals and objectives is the foundation of AM, a process that iteratively compares management outcomes against these objectives and adjusts management actions or the objectives themselves based on learning over time. An effective AM strategy requires specific success metrics and a time horizon to guide and improve decision making that facilitates progress toward the goal. The AM process is iterative, and modifications to objectives, actions, and decisions may be made during the decision-making step based on information gained from implementation and monitoring (Williams et al. 2009).

The objectives presented below have been divided into three categories based on their focus: biological, construction and learning. The first three objectives directly address the ESH sub-program goal of providing sufficient habitat throughout the MRMS to support self-sustaining populations of terns and plovers. These three objectives are measured by metrics directly related to the BiOp (USFWS 2000, 2003). The fourth seeks to minimize potentially negative effects of ESH sub-program actions, socioeconomic impacts on stakeholders and adverse impacts to sensitive resources. The fifth objective addresses the need to proactively increase knowledge and reduce uncertainty in order to provide better information to decision makers. In addition to information on the appropriate spatial scale(s) for evaluation, each objective is presented with the following information for the evaluation of its status:

- Performance metric(s) – qualitative or quantitative metric used to assess whether an objective is being met
- Measurement – how data are collected for each metric or endpoint
- Target – the desired value of the metric(s) or endpoint(s).

It is recognized that there may need to be trade-offs between the objectives listed below and that all objectives may not be fully achieved during implementation.

2.1 Biological Objectives

These are the primary objectives aimed at the ecological outputs desired by the proposed suite of management actions.

2.1.1 Objective 1: Meet or exceed tern and plover productivity targets

Performance Metric: Annual and 3-year running average fledge ratios
Measurement: Count of chicks fledged divided by the number of breeding pairs. The number of breeding pairs is estimated to be the number of adults counted divided by 2
Target: Increasing tern and plover fledge ratios with ultimate targets of 0.94 and 1.22, respectively (3-year running average)

Fledge ratios are recommended in the BiOp as a measure of species productivity. Fledge ratios are also used as an indirect metric of ecosystem function under the assumption that, when nesting at similar densities, birds nesting on high-quality habitat will be more productive. Fledge ratios are calculated at three spatial scales: sandbar, river segment, and system. The primary utility of the sandbar-scale analysis is to assess effectiveness of restoration actions through comparison with local reference sites. This allows comparison of natural sites to created sites in order to assess relative habitat quality among habitat types. Fledge-ratio data will be used to evaluate species productivity annually (and within a 3-year assessment), which is thought to be reflective of the availability and quality of habitat on the MRMS.

2.1.2 Objective 2: Increase and subsequently stabilize tern and plover populations

Performance Metric: Adult population size
Measurement: Annual census
Target: Increasing and ultimately stable populations, currently set by Species Recovery Plans at a minimum of 1,139 piping plovers for 15 consecutive years and a minimum of 900 interior least terns for 10 consecutive years[1].

Performance Metric: Annual population growth rate, λ
Measurement: The growth rate for year t is the population size at year $t + 1$ divided by the population size at year t
Target: When the population size is below target, $\lambda > 1$ indicates a growing population, and therefore a population that is on track to reach the population size target.

This objective, while not specified in the BiOp, is included because directly connecting the relationship between productivity and acreage targets requires information on population size. An additional metric, population growth rate, is included in this objective in order to track progress towards the population size target, and is applicable when the population is below target. If faster progress towards the population size target is desired, a higher value of λ can be specified, while recognizing that population growth rates are expected to decrease over time as populations grow within a set quantity and quality of habitat. In addition, this objective ensures that outcomes predicted by the AM strategy can be related to the Species Recovery Plans. The population estimate is conducted at the system scale and will also be used to calibrate a numerical population model.

2.2 Construction Objectives

These are objectives related to the implementation of management actions in order to achieve the desired biological outputs.

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[1] Interpretation of species recovery plan goals for the Missouri River are based on information provided by USFWS in an email dated 12/15/2009.

2.2.1 Objective 3: Meet ESH acreage targets

Performance Metric: Area of ESH

Measurement: Aerial and satellite imagery

Target: Initial target of 1,315 acres with an upper limit of 4,370 acres

The PEIS alternatives outline a suite of potential ESH acreage targets as well as the spatial distribution of construction predicted to be necessary to reach the target. As habitat is created through mechanical means, overall sandbar acreage is also continually changing through natural processes such as erosion and vegetation growth, which may depend upon weather, flow, and other uncertain events. Due to the dynamic nature of these processes, adjustments of construction efforts over time may be required to meet acreage targets in the longer term. Constructed habitat is assumed to be of sufficient quality in order to sustain nesting birds; however, the AM strategy includes potential adjustments to address habitat quality at specific sites. The upper limit of acreage established in the AMIP preferred alternative is that of Alternative 3.5 (4,370 acres), however an initial target associated with Alternative 5 (1,315) will be used consistent with the acreage target AM strategy (see section 4.1.1). Biological metrics will be tracked over time as progress is made towards this target. If a higher or lower acreage is sufficient to meet the biological metrics, this acreage target would be adjusted accordingly. If the upper acreage limit (4,370 acres) is achieved and is determined not to be sufficient to meet the biological metrics, further analysis will be preformed as necessary to disclose the impacts of larger acreage alternatives and/or other potential management actions in order to meet the biological objectives.

2.2.2 Objective 4: Minimize negative impacts due to ESH construction activities

Performance Metric: Area affected by mechanical construction of ESH

Measurement: Cubic yards of sand moved

Target: Initial target of <960,712 cubic yards per year with an upper limit of < 6,750,509 cubic yards per year

The goal of habitat construction is to build sufficient ESH to support tern and plover populations as described in Objectives 1 and 2 while minimizing costs and potential negative impacts of construction on stakeholders and Outstandingly Remarkable Values of the Missouri National Recreational River. This minimization refers to the overall scale of the sub-program, as indicated by the various PEIS alternatives, as well as exploring opportunities to use construction techniques that minimize cost or impact, such as overtopping existing sandbars with new sand and vegetation removal. At the site-specific level, the ESH project delivery team (PDT) also incorporates avoidance measures and seeks to minimize impacts to non-target aspects of the human environment. Additionally, staying below the annual estimate of cubic yards placed associated with the initial acreage target (Alternative 5 – 960,712 cubic yards) and the upper limit of construction (Alternative 3.5 - 6,750,509 cubic yards) identified in Appendix C of the

PEIS will ensure that the impacts of implementation are adequately covered by the National Environmental Policy Act (NEPA) analysis in the PEIS.

2.3 Learning Objective

This objective seeks to proactively take steps to reduce uncertainties related to the proposed suite of management actions and biological outputs.

Objective 5: Reduce uncertainty to improve model projections

Performance Metric: Coefficient of Variation (CV) of projected or monitored performance metrics of Objectives 1-4
Target: Reduce CV over time.

One key function of AM is to "learn while doing". "Learning" in this context means improving knowledge of how the ecosystem responds to management (including doing nothing). "Knowledge" in this context is expressed as probability distributions for the parameters of the models used to make forecasts—less well-known parameters have wider distributions with a higher variance (Figure 1). Improved knowledge of the ecosystem, obtained through specific research or analysis of monitoring data, reduces the variance of these parameter distributions. More precise estimates of model parameters results in less variable projections of performance metrics of other objectives. Less variance in projected performance metrics reduces the risk of not meeting decision criteria for alternatives that are in fact adequate. In addition, reduced variance in projected performance reduces the risk of meeting decision criteria for overly optimistic alternatives. Having a specific objective that measures overall learning makes it possible to fairly evaluate alternatives that expend greater effort on research or monitoring (McDaniels and Gregory 2004).

A natural metric for measuring uncertainty is the variance (σ^2) of a distribution; minimizing the variance of expected performance is a classical technique widely used in decision making (e.g., investment portfolio optimization, Markowitz 1952). Because the variance is an absolute measure, it is difficult to compare across different distributions when the mean of the distribution is also changing. A relative measure of variance is the CV, the ratio of a distribution's standard deviation (σ, the square root of the variance) to its mean, such that CV = . The CV is typically expressed as a percentage, and lower values indicate greater certainty about the projected metric (Figure 2).

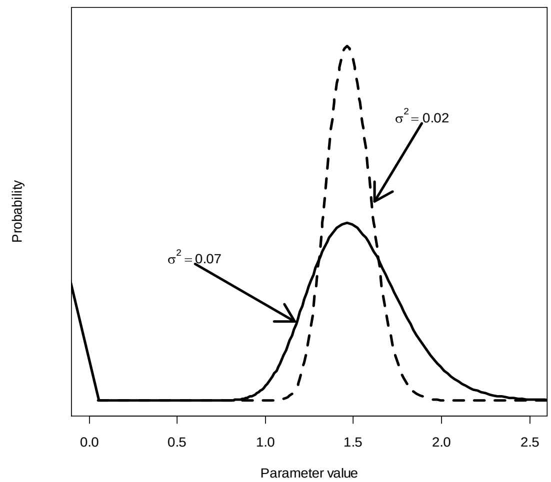

Figure 1. Two probability distributions that differ in their variances (σ^2) but not their means (μ).

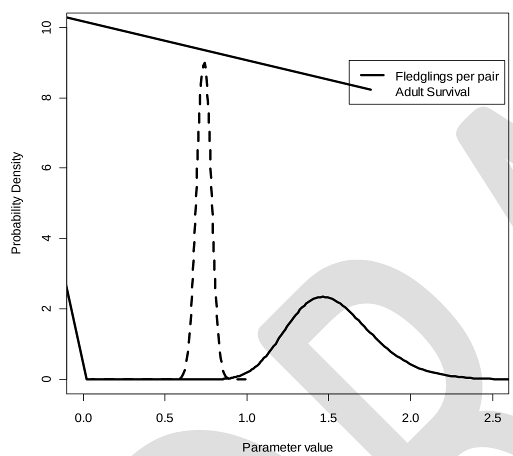

Figure 2. Probability distributions for two of the parameters used in making forecasts for piping plovers: adult survival and the expected fledglings per pair at low density. The variances of the two distributions are not comparable because the means are different, but the Coefficients of Variation are directly comparable. There is greater knowledge of adult survival with a CV of 6% compared to 47% for fledglings per pair.

3.0 Management Actions

The suite of potential management actions proposed under the ESH Creation and Replacement strategy detailed in the PEIS and intended to achieve the stated objectives are further described below along with costs, benefits and uncertainties.

3.1 Primary Management Actions

The primary methodologies that may be used to create and replace ESH are summarized in Table 1 and further described below.

Table 1. Potential ESH creation methods.

Measure	Cost	Benefits	Considerations / Uncertainties
Mechanical Creation	$31,000/acre	Highly productive initially, heavily used by nesting birds.	Habitat quality can degrade quickly. High population densities can result in agonism amongst nesting birds, and high overall losses at a single site due to weather and predation.
Vegetation Removal	$750/acre	Inexpensive, relatively short construction timeframe, no material needed for placement.	Vegetation removal techniques alone have yet to successful replicate bare sand habitat. Projects completed to date have shown minimal usage for nesting and primarily low to moderate productivity.
Vegetation Removal with subsequent Overtopping	$20,000/acre	Less expensive than mechanical creation, reduced cubic yards needed for construction.	Initial removal of vegetation needed, subsequent rates of vegetation encroachment may be higher than at mechanically constructed sites, unknown biological responses.
Geotextile Tube Placement	$850,000/site	Can be used under high flow conditions, reduced cubic yards needed for construction.	Acreage gained by placement of geotextile tubes at a site is highly uncertain; can only be used during years where there are high flow conditions that are expected to be followed by a nesting season with substantially lower flows

Mechanical creation. This action is the primary method proposed for mechanical creation of habitat and is expected to directly increase the amount of ESH available in the MRMS. As previous mechanical creation projects have produced higher-than-average fledge ratios early in the life of the ESH, this action is also expected to increase productivity based on existing data collected from created ESH. Source material for placement typically comes from within the channel, however there are occasionally opportunities to restore floodplain features such as backwaters and side channels and use the material for sandbar creation. The primary benefit of these additions would be nursery habitat for fish, which provide forage opportunities for terns. Choice of construction method is typically left to the contractor and based on their own experience and capabilities. The cost per acre for mechanical creation is approximately $31,000 and is not expected to change significantly due to design or construction method.

Vegetation removal. *Pilot project.* Vegetation removal may be useful as a construction strategy for restoring existing bars. This action is intended to increase the amount of ESH available in a cost-effective manner. Thus far, an effective method of removing vegetation from sandbars has not been identified. However, investigations are currently underway to identify the relative success of different methods of vegetation removal. The cost per acre for vegetation removal is approximately $750.

Vegetation removal with subsequent overtopping. *Pilot project.* For this action, vegetated sandbars are cleared of vegetation and topped with additional sand, which is then shaped to create desirable habitat conditions. This method involves a combination of herbicides, mowers, bulldozers, and dredges, and is intended to increase the amount of ESH available. While this method is predicted to provide higher quality habitat than vegetation removal alone, it may not approximate natural or new created habitat. There are also uncertainties regarding the rate of vegetation encroachment following construction which may be higher than that occurring at new constructed sites. The cost per acre for this method is estimated at $20,000.

Geotextile Tube Placement. *Pilot project.* This methodology involves the placement of geotextile tubes placed in channel in order to cause deposition of sand under high flow conditions. The tubes for a specific site would likely be between 1000 and 1500 feet in length. They would be filled with approximately 4,000 – 6,000 cubic yards dredged material each taken from the adjacent river channel. Tubes would remain in place for approximately 2 to 6 months. As this method has not yet been tested, it is highly uncertain how many acres of sandbar may be formed through the placement of tubes at a site. Also, this method can only be used under specific circumstances when water is being evacuated from reservoirs causing higher flows than are anticipated during the following nesting season. This method is being employed opportunistically as a pilot project and will be monitored to determine the amount of habitat created and the benefit to terns and plovers. The cost per site is estimated at $850,000.

3.2 Potential Adjustments

The following potential management actions are intended to improve performance of sites following construction. Table 2 summarizes potential management actions under the ESH maintenance strategy.

Table 2. Potential ESH maintenance management actions.

Measure	Cost	Benefits	Considerations / Uncertainties
Vegetation Removal	$750 / acre	Increase productivity by improving habitat quality, increasing available nesting/foraging habitat, reducing predation by removing predator habitat.	Vegetation removal techniques have yet to successfully replicate bare sand habitat or consistently show positive biological response.
Re-shaping	$1,000 / acre	Increase productivity by improving habitat quality, increasing available nesting/foraging habitat.	Re-shaping is not necessary at all sites, only those that have degraded in a manner such that foraging or nesting habitat has become limited. Re-shaping also has the potential to improve access for humans and certain mammalian predators which may negatively impact nesting birds.
Site Removal	$5,000 / acre	Increase productivity by removing sites with low productivity.	If habitat is limited, even marginally productive habitat will contribute to productivity and, ultimately, population targets. Also, removing a site may force more birds onto fewer acres, reducing productivity elsewhere on the MRMS.
Predator Removal	$7,000 / site	Increase productivity and adult survivorship by reducing predation impacts.	It is uncertain whether, and how swiftly, removed predators will be replaced by other predators.
Nest Caging	$50 / nest	Increase plover productivity by reducing predation of plover eggs.	Placement of nest-cages may actual attract predators, may negatively impact adult plovers, and may have negative impacts on any terns nesting within the colony.

Vegetation removal. *Pilot project.* Removal of vegetation may provide additional nesting opportunities at previously constructed sites that have succumbed to vegetation encroachment. Additionally, removal of vegetation may reduce predation at these sites by removing hiding places for mammalian predator species. However, as previously mentioned, vegetation removal techniques have yet to successful reclaim bare sand habitat or consistently show positive biological response. The cost per acre for vegetation removal is approximately $750.

Re-shaping. This action would involve the use of small equipment to restore or alter contours at previously constructed sites. This may include altering steep banks that have developed in order to increase wetted perimeter and provide plovers access to shorelines, restoring inter-sandbar channels that have filled in with sand, and pushing sand up to increase the height of nesting platforms. While this action is anticipated to improve foraging and/or nesting habitat at degraded sites, it may not be necessary at all sites. It also has the potential to increase access to ESH sites for people and some mammalian predators, which may result in unintended declines in productivity. The anticipated cost is approximately $1,000 per acre.

Site removal. *Pilot project.* This action was recommended in the BiOp and would involve mechanical efforts to remove a nesting site that has shown severe declines in productivity or consistently high incidence of nest take. Measures would be taken to ensure that the site is not available for nesting by transforming an emergent sandbar into a bar that would be submerged during the nesting season, efforts to vegetate a site to the point where it could not be used, or some other methodology. However, there is considerable uncertainty associated with the benefits of this method and it would only be used as a method of last resort under extreme circumstances. For example, if habitat is limited, even marginally productive habitat will contribute to productivity and, ultimately, population targets. Also, removing a site may force the existing population onto fewer acres, reducing productivity elsewhere on the MRMS. For these reasons, site removal would only be tried if there seems to be adequate habitat on the MRMS that is unused and one or more bars have productivity that is well below the average of other bars or display consistently low productivity over three or more years. The anticipated cost is approximately $5,000 per acre.

Predator removal. This action involves the trapping and removal of avian and mammalian predators from constructed sites and has been described in a separate plan and environmental assessment. Expected benefits include increased productivity and higher adult survival resulting in increased populations. The anticipated cost is approximately $7000 per site over the course of a single nesting season.

Nest Caging. Currently the majority of plover nests are caged. This action is intended to reduce predation of plover eggs. However, the overall benefits of this action are uncertain. Cages may actual attract certain predators causing an increased impact to adult plovers and any terns nesting within the same colony. The cost is approximately $50 per nest.

3.3 Potential Future Management Actions

This AM strategy addresses a specific portion of the BiOp Reasonable and Prudent Alternative (RPA) which identifies the need to mechanically create habitat in order to supplement natural habitat on the MRMS. The BiOp also discusses other activities that may be undertaken to support terns and plovers. Elements of the BiOp's RPA related to the ESH program that are not encompassed in the mechanical creation program include the following:

- Reservoir Habitat Construction/Shoreline Management
- Gavins Point low summer releases
- Gavins Point fall flow test
- Fort Randall segment fall rise
- Gavins Point spring sandbar habitat conditioning
- Gavins Point Sediment Management.

Many of these elements may be addressed under future USACE studies or may be explored opportunistically as part of ongoing operations. For example, a new study for reservoir habitat is currently planned. Management actions implemented to restore reservoir habitat would affect overall productivity and populations on the MRMS and may reduce the number of acres that need to be created mechanically to support the species. Additionally, any habitat created or maintained through flows would reduce the amount of habitat needed to be constructed mechanically in order to reach the acreage target.

4.0 Implementation

Adaptive management occurs through a cycle of decisions, actions, responses, monitoring, analysis, learning and assessment, all of which inform future decisions. A conceptual model for the AM process, adapted from Hollings Learning Wheel and developed as part of the Corps' implementation of the current Campaign Plan, is shown in Figure 3. This figure depicts a cycle beginning with plan formulation, continuing with design and construction, and concluding with monitoring and assessment. At the assessment stage, the project in question is determined to either be successful and complete, in need of continuation, or in need of an adjustment which may or may not require additional planning, design, and construction. The dashed lines represent potential paths that do not complete the entire Plan – Design – Build – Monitor – Assess – Adjust loop.

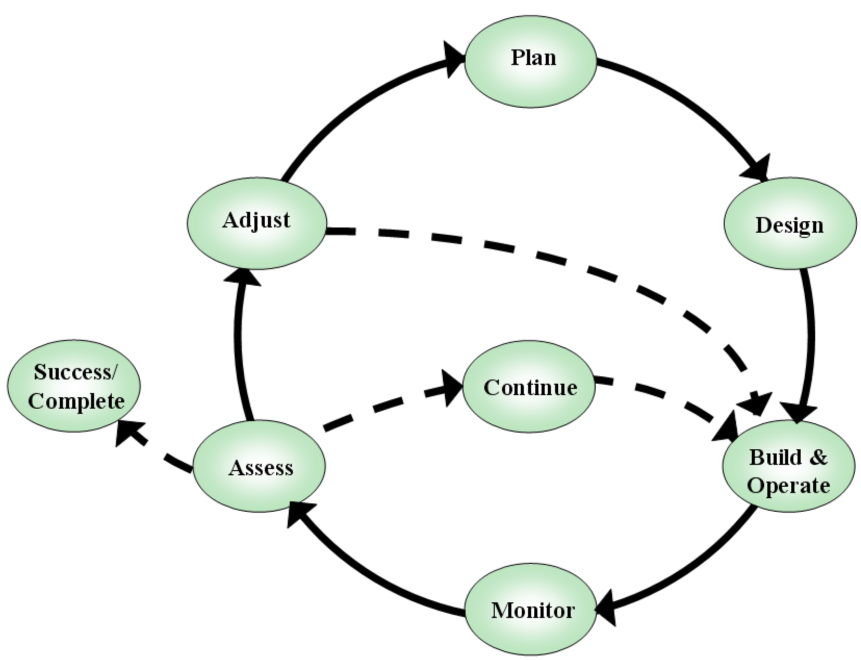

Figure 3. The Adaptive Management Learning Wheel.

The AM learning wheel as applied to the ESH sub-program is shown in Figure 4. In this context, the Plan/Formulate and Design steps were undertaken at the scale of the overall sub-program and not a specific project. These steps have been used to outline the sub-program which was analyzed in the PEIS. Construction of sandbars is the primary implementation strategy and comprises the management input to the MRMS. These sandbars supplement natural habitat available on the MRMS, including reservoir shorelines, to comprise tern and plover nesting habitat and plover forage habitat. Biological responses to this habitat occur as populations utilize the habitat for reproduction. Monitoring efforts collect data on habitat availability and biological responses. These data are then analyzed and compared against performance metrics to assess whether the sub-program is meeting its objectives. Additionally, predictive models are used to recommend which management strategy is most likely to meet objectives in the future. Monitoring data will also be used to validate the short-term predictions of the models and to refine parameter estimates within the model. This results in reductions of uncertainty and reduces the variability of predictions. Based on these analyses, an assessment is made regarding

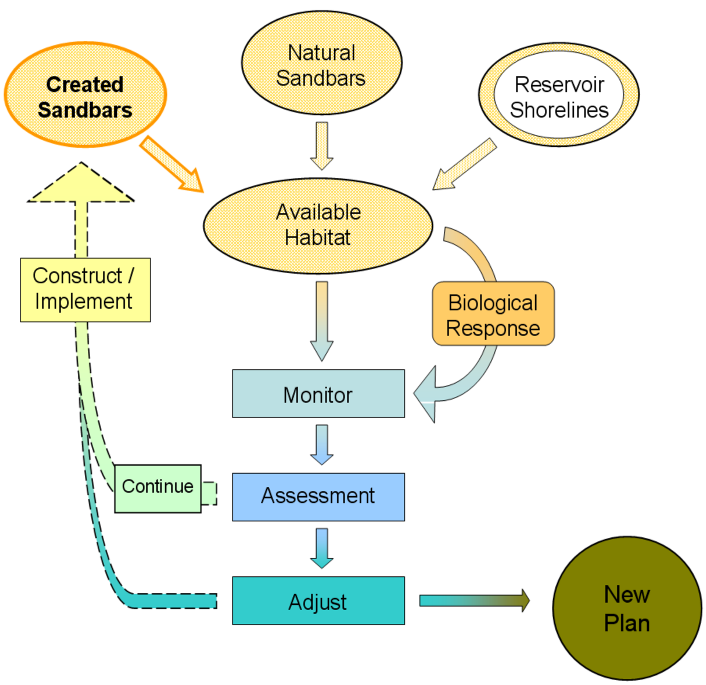

Figure 4. ESH AM Strategy implementation.

whether to continue the current implementation strategy or adjust the implementation strategy within the constraints of the current strategy. In the diagram, this "Adjust" box refers to the many types of adjustments covered within this AM strategy to include design and construction methods, acreage distribution, acreage targets, and measures to enhance productivity at individual sites (see Section 3.3). These adjustments would be used to alter the implementation of the sub-program within the constructs of this AM strategy. If analyses show that the range of management actions in the current sub-program is not sufficient to meet the stated objectives, a recommendation may be issued to develop a New Plan which may involve revisiting the objectives, metrics, proposed actions, and other related aspects of the ESH sub-program. This would constitute re-entering the Plan/Formulate phase for the sub-program. The cycle illustrated in Figure 4 repeats annually, with more in-depth analysis of objectives occur every third years.

4.1 AM Strategy

The ESH AM strategy will take information gained from construction efforts, biological responses, and monitoring of key metrics and analyze these data on an annual basis to help inform implementation and decision making. In the current ESH sub-program, which is described and analyzed in the PEIS, AM principles will be applied at numerous scales including individual sites (productivity enhancement at constructed sites, design and construction strategies), segments (distribution of acreage amongst segments), and at the scale of the entire sub-program (revision of biological metrics, and the selection of an acreage target) (Figure 5). These adaptations are within the scope of the PEIS and can be implemented without major revisions to the document. If the stated objectives cannot be met within the constructs of the current sub-program, a "New Plan" would be formulated which would constitute an in-depth look at the overall ESH sub-program and may involve the drafting of a new PEIS to address anticipated impacts prior to implementation.

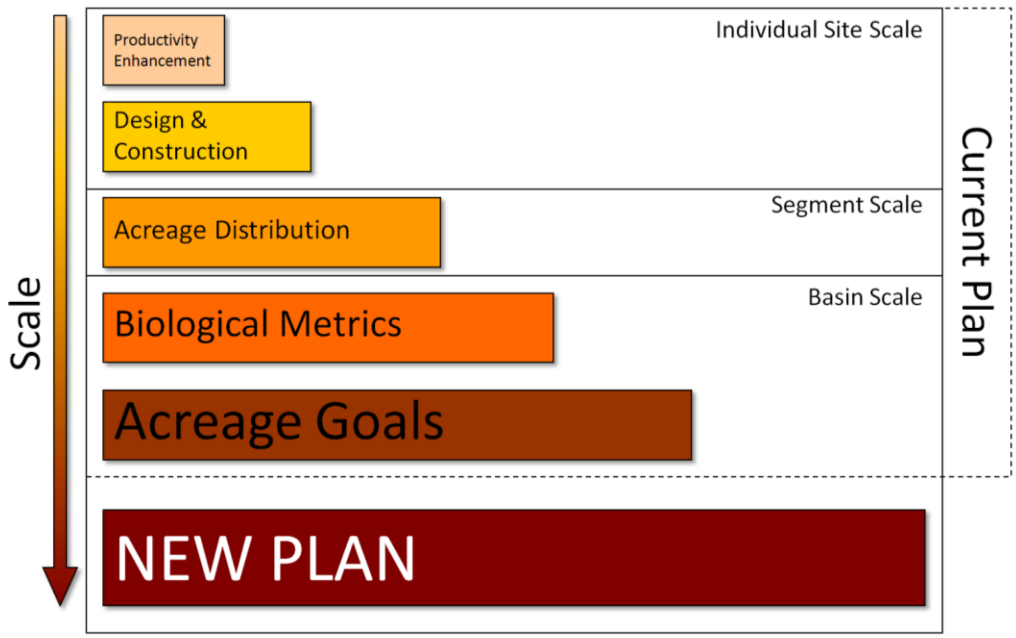

Figure 5. ESH AM strategies at numerous levels showing the relative scale at which adaptations may affect implementation.

4.1.1 Acreage Target

The primary uncertainty associated with this effort is the amount of habitat needed in order to support terns and plovers in the target segments. The PEIS alternatives formulated consist of acreage targets for each segment and are based on different rationales including habitat estimates contained in the BiOp, habitat amounts present during years bounding a period of positive biological response, and estimates of nesting habitat amounts used by the species over a period of positive biological response. While the acreage target was chosen based on the preferred alternative, uncertainty exists as to how this level of habitat will affect achievement of biological metrics related to Objectives 1 and 2.

Table 3 summarizes potential acreage targets as discussed in the PEIS. The associated costs of implementing each alternative are based on the use of mechanical construction and incorporate a 30% contingency cost. Figure 6 depicts progressive implementation of these acreage alternatives over time.

Table 3. Potential ESH acreage targets.

	Alt 1	Alt 2	Alt 3	Alt 3.5 (Upper Limit)	Alt 4	Alt 5	Existing Program
Target (acres)	11,886	5,502	6,754	4,370	1,985	1,315	883
Annual Work (acres)	4,802	1,786	2,140	1,054	347	164	150
Annual Cost (millions)	$193.5	$72.0	$86.2	$42.5	$14.0	$6.6	$6.0

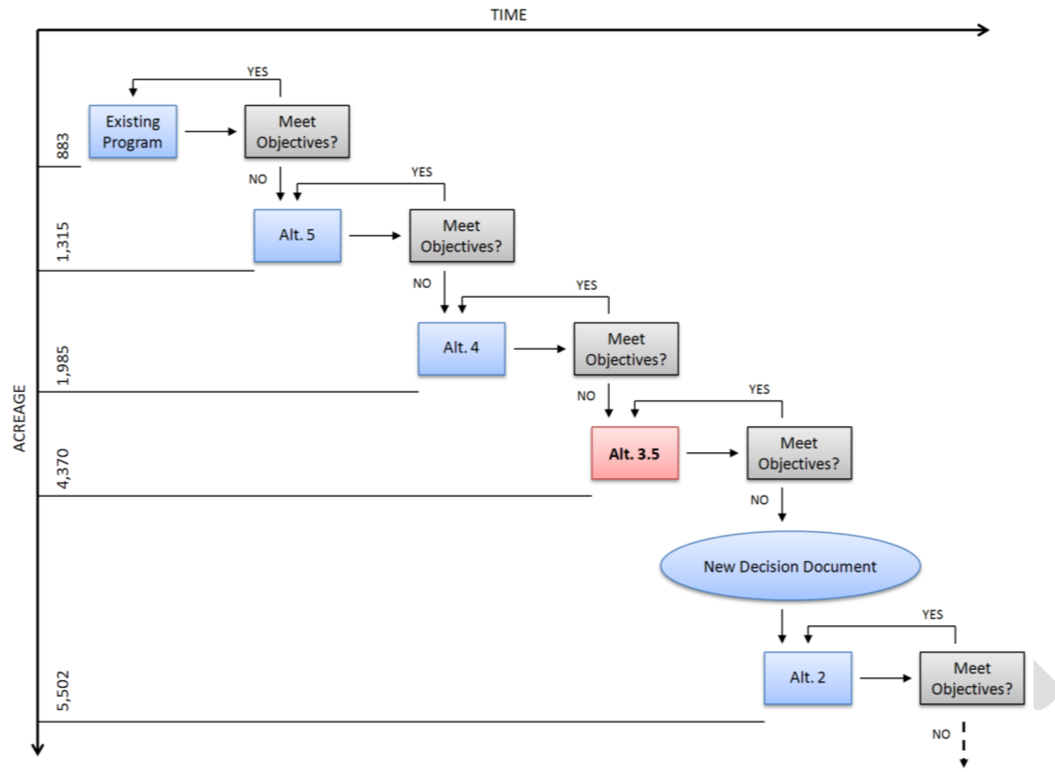

Figure 6. Progressive implementation of PEIS alternatives.

While alternative 3.5 has been as the upper acreage limit that would be targeted at this time, it is recognized that lesser acreage alternatives including the existing program and alternatives 5 and 4 will be reached while working toward full implementation of alternative 3.5. As such, the initial acreage target selected for implementation corresponds with alternative 5. This is the next higher acreage alternative after the existing program. Implementing the various alternatives in this manner will allow a check to see if a lesser acreage alternative is sufficient to meet the biological objectives while work is ongoing to meet the upper acreage limit of alternative 3.5. If the alternative 3.5 acreage is reached and biological objectives are still not being met, the preparation of an appropriate decision document (such as a revised Record of Decision, Supplemental EIS, Environmental Assessment, or other disclosure document) would be required to increase efforts (such as moving to the next higher acreage alternative – Alt 2). At this time, a new plan may also be developed if warranted (see the following section).

Using this strategy, movement to a lesser acreage target may occur when less acreage meets the biological objectives, or when predictive models consistently indicate that a lesser acreage would meet biological objectives over time. Conversely, a greater acreage target would be selected when the target is reached and biological objectives are not being met or when predictive models indicate that the acreage target is unlikely to meet biological objectives.

The time it takes to reach each alternative acreage goal will be largely dependent upon two factors; the amount of budget allocated to ESH creation and replacement as implementation progresses and the methods by which ESH is created. If more budget is allocated or less expensive methods are used, progress can be made more quickly towards checkpoints. The USACE and the FWS will work together to determine the appropriate check-in timeframes for compliance with the BiOp.

4.1.2 Acreage Distribution

While the PEIS Alternatives include acreages for each segment, these combinations may not represent the ideal distribution of ESH amongst the target segments. There may also be biological, political, or other factors that influence the amount of construction that is desirable or achievable in specific segments. In such situations, new acreage distributions will be devised based on input from the ESH PDT. These will be crafted as "scenarios" and subsequently analyzed using the predictive models. Changes with regard to this strategy may or may not affect the metrics for Objectives 3 and 4. If the new acreage target in any one segment is significantly greater than that of the upper acreage limit, a new decision document would be issued to disclose the impacts of the proposed change. Additionally, an analysis conducted for the preparation of the PEIS identified sensitive features, exclusion areas, restrictive areas and available areas after exclusions and restrictions were applied for each segment. If the acres disturbed due to ESH construction in any one segment is anticipated to exceed these available areas (Gavins Point Segment – 3,881 acres, Lewis and Clark Segment – 4,711 acres, Fort Randall Segment – 2,784 acres, Garrison Segment – 4,361 acres, Fort Peck Segment – 3,324 acres) additional measures may be taken within that segment to avoid impacts to these sensitive resources. These may include additional monitoring of effects to non-target resources, plans to avoid impacts in a specific segment by diverting work to another segment, targeted efforts to identify methods to reduce impacts due to construction, or other similar efforts.

4.1.3 Design and Construction

Currently, the program assumes that all constructed acres will be built at locations of natural deposition utilizing dredges and/or bulldozers. However, there are methodologies that require less placement of material to achieve a given acre of habitat. This would result in a lowered cost per acre and would facilitate achievement of Objective 4. Other potential methodologies, described in Section 3.1, have not yet proven successful but are being tested using pilot projects and may be incorporated into the program if deemed appropriate. For example, preliminary data from an ongoing study on vegetation removal methodologies has indicated that some combinations of methodologies may be successful at restoring bare sand conditions. Based on this data, a recommendation may be issued to implement them at a full site scale as a pilot project. If implemented, such a site would be used to determine bird usage and productivity. This data would be analyzed on an annual basis and an assessment would be made as to whether or not the methodology should be implemented in the future. If the methodology continues to show success, a recommendation would be issued to use it as a primary methodology to create and replace ESH.

While site designs are generally determined in response to site-specific conditions, some characteristics (such as single large bars vs. complexes of smaller disconnected bars) will be experimented with and monitored in order to inform future designs. While these actions will be implemented at individual sites, success of new methodologies may lead to incorporation into the program as a primary construction or design method which may affect implementation at the segment or program scale. Incorporation of new methodologies is likely to affect progress toward Objective 4 in a positive way by reducing the amount of cubic yards needed to be placed in order to create an acre of ESH and may also reduce uncertainties under Objective 5. As vegetation removal with and without overtopping are both considered less impactful than the strategy assumed for the impacts analysis in the PEIS (mechanical creation), and potential impacts to vegetation are covered in the PEIS, no change to the Record of Decision would be needed for implementation. However, site-specific NEPA may be needed if any impacts are anticipated that have not been covered in the PEIS.

Results from monitoring efforts will be analyzed to identify whether or not there are differences in productivity, usage, or nest density at sites with different designs and using different construction methodologies. They will also be monitored for physical changes such as erosion and vegetation. Re-vegetation rates will also be monitored to assess if there are differences between the methods. Projects with overtopping will test the use of different thicknesses of material placement to determine if this results in different vegetation encroachment rates and/or habitat quality.

4.1.4 Productivity Enhancement

As constructed sites degrade over time, actions may be taken in order to enhance productivity at a previously created site. These actions may include re-shaping bars to increase forage or nesting habitat, removing vegetation to increase quality, nest caging to reduce predation and removing predators to increase survival. Conversely, if a sandbar shows signs of extremely low productivity (relative to other sites) and habitat does not appear to be limited, an action may be taken to remove the site so that it will not be available for nesting, and potential nesters would have to seek out higher quality habitat. Changes with regard to this strategy have the potential to positively affect the degree to which the program achieves Objective 1 (productivity) and, ultimately, Objective 2 (populations). Potential productivity enhancements are detailed in Section 3.2. Following is a description of the approach that will be taken to determine success of these adjustments.

Vegetation removal is currently being conducted experimentally first with test plots. Pre- and post-emergent herbicides, mowing, and root-ripping will be tested in different combinations.

Resulting site conditions and subsequent vegetation growth rates will be monitored to determine which methodology is most successful. Successful methodologies will be tested on entire bars and monitored. Hand pulling of vegetation will also be experimented with on constructed bars. This would be conducted in the fall after the nesting season and would be done in the first year following construction. Hand-pulling would be continued every year until the bar is eroded or ceases to be used for nesting.

In order to find the most effective methodology, different re-shaping strategies will be undertaken at different sites with the purpose of maximizing plover forage habitat around the base of the sandbars and nesting habitat quality in the interior.

Site-removal would only be tried if there seems to be adequate habitat on the MRMS that is unused and one or more bars have productivity that is well below the average of other bars.

For predator removal, different traps will be tried to identify the most effective and efficient methods of capturing and removing predators from sandbars.

In order to determine the success of nest-caging, an investigation would be conducted that would compare productivity and occurrences of predation at caged sites and uncaged reference sites. If the caged sites show statistically significant increases in productivity for terns and plovers, this practice would be continued. If no significant increase in productivity is observed, a recommendation would be issued to discontinue this practice.

4.1.5 Revision of Biological Metrics

The success metrics for Objectives 1 (meet or exceed tern and plover productivity targets) and 2 (increase and subsequently stabilize tern and plover populations) represent an initial estimation of biological metrics needed to sustain each species and move them toward recovery. These numbers may be revised over time based on refinements to population models, changes to recovery plans, or based on coordination with FWS. Changes relative to this strategy would affect the metrics for Objectives 1 and 2. Because the acreage target (Objective 3) is selected as the primary means to meet biological metrics under Objectives 1 and 2, any change to these metrics may also result in the selection of a new acreage target.

4.1.6 Development of a New Plan

If the alternatives considered in the PEIS are not able to meet the objectives, or other circumstances prevent the implementation of an alternative that would meet the objectives, a development of a new plan may be initiated. This new plan may revisit the objectives, performance metrics, proposed actions or other related aspects of the ESH sub-program. The resulting new plan would likely be coupled with a new PEIS to evaluate the associated impacts. While the new plan is being developed, the team would recommend an interim implementation strategy to help sustain the species.

4.2 Implementation Cycle

A full AM cycle will be implemented over two fiscal years as seen in Figure 7 (note that the first quarter of the USACE' fiscal year begins on October 1) with subsequent construction implemented in the third fiscal year. Information gained from construction actions, taking place over the first through the third quarter, will be documented in After Action Review (AAR) reports. This information, along with monitoring data collected during the tern and plover nesting season, will be analyzed and described in Annual Strategic Review Documents which will provide recommendations for the Annual Work Plan (AWP) for the Missouri River Recovery Program (MRRP) as well as design recommendations for new ESH construction projects. It is important to note that construction of new habitat is likely to occur in every fiscal year and the below graphic only depicts one full cycle of AM that will occur while other actions are ongoing.

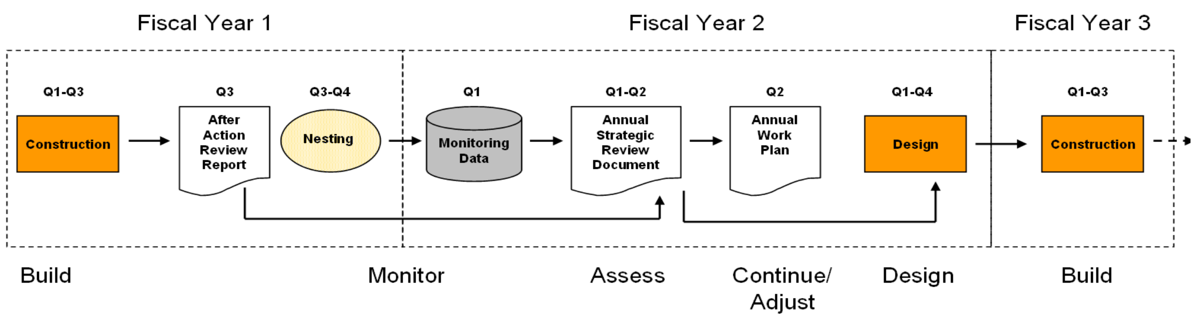

Figure 7. Annual Implementation of the ESH AM Strategy.

The majority of the decisions will be assessed on an annual basis as part of an Annual Strategic Review occurring in October-December (Q1). This will include decisions about productivity enhancements on previously created sites, design and construction of proposed projects, and the amount of habitat to be restored annually. Recommendations will be issued based on analysis of the existing data and projections based on the outputs of predictive models. An analysis of the various scenarios, which would be based on PEIS alternatives and any new distributions recommended by the ESH PDT or AM team, would be conducted as well. However, recommendations to move between acreage targets would be submitted every third year when enough data is available to analyze trends. Decisions to update or change biological metrics will be revisited every three years as well. If the data gathered allows refinement of species population models or increased understanding of population dynamics indicates that a different population or productivity target is needed to assess program success, a recommendation would be issued to update these metrics.

4.3 Responsible Parties

The ESH AM Strategy would be implemented primarily by the ESH PDT with assistance from the AMWG. On an annual basis, representatives of these teams would compile the necessary data, conduct analyses and assessments, and provide recommendations as part of an Annual Strategic Review. Following is a description of these two groups.

4.3.1 Emergent Sandbar Habitat Project Delivery Team (PDT)

The ESH Project Delivery Team (ESH PDT) is composed of an interagency group that designs projects, selects locations, and coordinates and conducts environmental compliance and permitting activities. Members include, but are not limited to, the following positions:

- ESH Sub-Program Manager, Omaha District
- ESH Planning Lead, Omaha District
- NEPA Specialist, Omaha District
- Hydrologic Engineer, Omaha District
- Construction Representative, Omaha District
- Real Estate Specialist, Omaha District
- Tern and Plover Biologists, Omaha District Field Offices
- Tern and Plover Biologist, USFWS
- Biologist, NPS
- Missouri National Recreation River Coordinator, NPS
- Landowner Coordinator, Natural Resource Conservation Service
- Biologists, State Resource Agencies

The ESH PDT also makes several annual implementation decisions, including selection of restoration sites. Potential locations are selected by the ESH PDT based upon previous bird usage, geomorphic trends, segment priority, minimization of conflict with sensitive resources, and other applicable factors identified in the Emergent Sandbar Habitat Evaluation and Ranking (ESHER) spatial decision support system. ESHER will be used to assist the PDT in the selection of restoration sites on an annual basis. The number of sites selected will be based on the amount of habitat needed in individual segments to meet habitat objectives. The ESH program manager, through input from the ESH PDT, works with the AMWG to develop the Annual Strategic Review Report which compiles the monitoring data collected, describes analyses and assessments and provides recommendations for development of the next year's Annual Work Plan for the MRRP.

4.3.2 Adaptive Management Working Group (AMWG)

The AMWG Assists Project Delivery Teams (PDT) in the development and implementation of AM strategies, AM plans and strategic reviews. Trains and develops USACE staff on analysis and assessment techniques to build in-house capability to perform strategic reviews.

Members of the AMWG:

- Omaha District AM Process Manager
- Kansas City District AM Process Manager

- ISP Applied Science Coordinator
- US Fish and Wildlife Service Missouri River AM Lead
- Northwestern Division Missouri River Water Management AM Lead
- AM Process Experts
- Model Development Experts

The AMWG will assist the PDT in forecasting the effects actions will have on achieving objectives, develop scenarios for implementation, develop and manage predictive and conceptual models, and assessments to track progress against objectives and targets, and use results of analyses of monitoring data to update predictive and conceptual models.

5.0 Monitoring and Investigations

Monitoring and investigations within the ESH program meet five purposes of AM: 1) they allow the evaluation of progress toward achieving objectives, 2) they help define resource status to identify appropriate management actions, 3) through comparisons of predictions against data, they increase understanding of resource dynamics, 4) they enhance development of resource models, and 5) they reduce uncertainties and allow improvements to predictive models.

5.1 Selected Performance Metrics and Targets

The BiOp suggests using fledge ratios as a measure of habitat quality which, along with total quantity of ESH, would determine ecological success in avoiding jeopardy to tern and plover populations. These two metrics alone, however, are not sufficient to determine whether a population is in jeopardy, recovering, or healthy and stable because they do not completely reflect how the birds respond to changes in habitat over time. Terns and plovers exhibit density dependence: a decrease in productivity and population growth rates as population size increases while using a fixed amount of resource. As a population grows in a set amount of habitat, increases in density will result in increased competition for nesting sites and other resources, reducing productivity to an equilibrium level and the overall population growth rate to a net increase of zero, on average, from year to year. Therefore, following an increase in the amount of habitat, fledge ratios will increase temporarily as the same population occupies a larger area. Over time, if increased productivity results in population growth, fledge ratios will again decrease toward equilibrium. The target fledge ratios provided in the BiOp are estimates of the level of productivity required to sustain a population, or the equilibrium fledge ratios, which the population cannot be expected to exceed over the long run.

If the quantity of habitat were to remain constant, decreasing fledge ratios may indicate consistent habitat quality and a growing population, or a decrease in habitat quality and a temporarily stable population that will eventually decline. These two scenarios have very different implications for management. Fledge ratios will also decline if the overall acreage of habitat decreases due to erosion, even if remaining habitat is of good quality. Thus a decrease in fledge ratios over time may either indicate a loss of habitat in quantity or quality or an increase in population density, and population sizes along with habitat acreage are needed to distinguish between these possibilities.

With this in mind, performance metrics were selected for each objective (Table 4).

Table 4. ESH performance metrics.

Objective	Performance Metric	Interim Metric	Target	Ultimate Success Criteria
Objective 1: Meet or exceed tern and plover productivity targets	Fledge Ratios (Fledged Chicks divided by half of the adult population)	Increasing Annual Fledge Ratios	Terns: 0.94 Plovers: 1.22	Sustained fledge ratios at or above targets
Objective 2: Increase and subsequently stabilize tern and plover populations	Adult Population Size	Increasing or Stable Adult Populations	Terns: 900 Plovers: 1,139 Population growth rates > 1	Populations sustained above targets for 10 years (terns) and 15 years (plovers)
Objective 3: Meet ESH acreage targets	Acres of ESH	Increasing ESH Acreage	1,315 acres with an upper limit of 4,370 acres	Construction of sufficient habitat to meet Objectives 1 and 2
Objective 4: Minimize construction of ESH to reduce negative impacts	Cubic Yards Placed Annually	Minimize Cubic Yards Placed	960,712 cubic yards with an upper limit of 6,750,509 cubic yards	Cubic Yards Placed Annually is less than 6,750,509
Objective 5: Improve predictive models by reducing uncertainty	Coefficient of Variation (CV)	Coefficient of Variation Decreases	None	CV is reduced over time

5.2 Monitoring

To facilitate decision making within the ESH program, information is needed regarding acres of ESH, fledge ratios, and population numbers (Table 5). Currently, two separate monitoring programs exist to collect data on some of the selected metrics: the *Least Tern and Piping Plover*

Monitoring Program and the *Emergent Sandbar Habitat Evaluation Program*. These efforts are designed to gather information about the bird species as well as understand the dynamics of created sandbar habitat to make sure the biological requirements of the species are being met. Additional data are gathered as part of the ESH construction program. The U.S. Army Corps of Engineers, Omaha District assumes the responsibility for all monitoring associated with implementation of the AM strategy; however, some tasks may be conducted by other parties utilizing funding provided by the USACE.

Table 5. ESH monitoring needs for performance metrics.

Metric	Data Gathered	Methodology	Relevant Program	Collection Time	Associated Annual Cost
Adult Population Size	Number of adult terns and plovers	Annual Census	Least Tern and Piping Plover Monitoring Program	June	$1,050,000
Fledge Ratios	Nest location and success	Annual Surveys		May - August	
Acres of ESH	Satellite Imagery	Remote sensing /Automated Habitat Classification	ESH Evaluation Program	Late July	$250,000
Cubic Yards Placed Annually	Sandbar Elevations	Pre and Post-Construction Surveys	Construction Program	Through-out the year	Encompassed in construction costs

5.3 Investigations

In addition to information collected through monitoring efforts, other data are needed in order to improve predictive models and/or reduce uncertainties regarding implementation. Potential investigations are detailed in Table 6 and further elaborated upon in Section 5.4.

Table 6. Investigations needed to improve the predictive model and/or reduce uncertainties.

Variable	**Data Gathered**	**Methodology**	**Relevant Program**	**Collection Time**	**Estimated Cost**
Dispersal	Survival and return rate	Banding adults/juveniles	ESH Evaluation Program	May – August	$500,000
Erosion and Deposition	Elevation data	Pedestrian surveys – OR – Remote sensing	ESH Evaluation Program	October – December	$50,000 - $300,000 per site, per year
Geo-morphology	Long-term trends in erosion and deposition at the segment level	Rangeline hydrographic suveys	Operations and Maintenance Program	Throughout the year	$300,000 per year conducted
Habitat availability at different flows	Satellite imagery – OR – Elevation data	Remote sensing	ESH Evaluation Program	Throughout the year	$250,000 - $500,000
Habitat Quality	Habitat characteristics	On-site measurement	ESH Evaluation Program	May-August	$300,000
Sediment	Trends in aggradation, degradation; long-term availability of sediment	Development of a sediment budget	None	Throughout the year	$50,000 - $1,000,000
Vegetation	Vegetation growth rates and land cover classifications	Use of test-plots to test vegetation removal methods and assess efficacy	ESH Evaluation Program	May-August	$50,000 per year
Water Quality	Water and sediment samples	Elutriate testing	Water Quality Monitoring Program	Throughout the year	$25,000 per segment, per year

5.4 Priorities

Monitoring and Investigations are detailed and prioritized below as to which data are most important to support management decisions:

Priority 1: Adult Population Size and Fledge Ratios

These data are collected simultaneously and are crucial for assessing the success of the program and making informed management decisions. This monitoring effort includes data collection of adult numbers and locations, nest attributes, and egg-to-fledgling information. The *Least Tern and Piping Plover Monitoring Handbook* (USACE 2008b) provides the protocols for conducting productivity surveys and the adult census and serves as a guide and training tool for the USACE Tern and Plover monitoring program. The data collected using these protocols have direct applicability to ESH AM program Objectives 1-2 and are complementary to the AWP for the ESH program.

Least tern and piping plover surveys for returning adults commence in May in reservoirs and river segments. Bird numbers are recorded via weekly visits, and nests are located during return visits to each location. Eggs are floated in water to estimate age and then monitored until they hatch. Monitoring is continued at each location until either the chicks have successfully fledged or the nest has been destroyed or abandoned. In addition to these surveys (adult, nest, and chick) the adult census occurs during the last two weeks in June and is focused on the population numbers for long-term trend data; this census provides adult numbers for the fledge-ratio calculations. The surveys end in mid-August to mid-September, depending on the year and duration of nesting.

Three survey types exist for acquiring tern and plover productivity data: adult, nest, and chick surveys. The target of adult surveys is to locate and count adult piping plovers and least terns. Maps from previous years are used to locate nest sites and provide researchers with points of reference for locating birds. Nest surveys, conducted during the adult survey, determine whether nests are present after physically locating the birds. Chick surveys are used to locate and count chicks, determine species, and estimate ages. In addition, chick surveys include tracking methods for pre-flight and fledged chicks (USACE 2008b).

The adult census is conducted during the breeding season as a compliance measure of the 2003 Amended BiOp. It consists of the total number of adults observed, the number of nests found, and the number of broods observed. Adult census counts provide a measure of how close a population is to the recovery goal, and provide information about productivity (expressed as fledge ratios) and to chart the trajectory of population trends through time. In addition to the adult census, two separate but complementary efforts are used to obtain adult bird counts for the broader range of each species: the Range Wide Interior Least Tern Adult Census (RWILTAC) and the International Piping Plover Adult Census (IPPAC). The RWILTAC is completed in conjunction with the USACE census for the Biological Opinion and the IPPAC is conducted every five years (USACE 2008b). These efforts will be conducted by individuals at the USACE Project Offices including Fort Peck, Lake Sakakawea, Lake Oahe, Fort Randall and the Threatened and Endangered Species Section at Gavins Point.

Priority 2: ESH acreage

The amount of habitat on the MRMS forms the second-highest priority piece of information to make informed management decisions. This information is needed to assess the success of efforts to increase the amount of ESH on the MRMS, as well as whether or not the USACE is creating enough ESH to meet stated targets under Objective 3. These data will be collected through remote sensing. The BiOp recommends measuring acreages in late July. Efforts should be made to collect a complete satellite imagery set of each segment at a single point during the nesting season, with late July being the ideal target. The second-highest priority for data collection should be given to early to mid August when the majority of chicks are fledging. If neither is available, priority should be given to imagery sets collected prior to late July, closer to late July being preferable. The USACE will acquire this data from a satellite imagery provider. In the event that satellite imagery from an entire segment cannot be collected at a single time or under similar flow conditions, separate imagery sets may need to be flow-corrected in order to accurately measure the amount of ESH present at a given period of time. The process of correcting for flow is further described in the analysis section.

Priority 3: Cubic Yards Placed Annually

These data are needed to assess progress toward Objective 4. As part of construction contracts, pre- and post-construction elevation surveys will be conducted to assess the amount of material placed.

Priority 4: Vegetation Modification

Determining a method of removing vegetation and preventing re-growth from existing and created sandbars that successfully re-creates bare sand habitat is a high priority for the ESH program. If found, such a method would permit the construction of ESH more quickly and for less money; allowing acreage targets to be achieved on a shorter timeframe. It would also permit maintenance of newly created sandbars and enhance the lifespan of bars. The cost for the ongoing vegetation modification study is approximately $50,000 per year and is expected to take 3-5 years to complete.

Priority 5: Habitat Availability at Different Flows

In the short term, refining the amount of change in habitat availability due to alterations in water levels will be necessary to accurately predict the amount of ESH that will be available for nesting birds in successive years. These data will also allow for refinement of predicted ESH loss rates due to erosion and vegetation encroachment on created and natural sandbars. This will facilitate planning of annual work in order to reach acreage targets and would require acquisition of additional satellite imagery sets gathered at different times of the year to assess changes. Priority should be given to those times when water is at the minimum and maximum levels anticipated during the nesting season as defined in the *Missouri River Mainstem Reservoir Master Water Control Manual* (Master Manual). The USACE would acquire these data from a satellite imagery provider. As an alternative, elevation data could be acquired during low flow conditions to resolve this uncertainty. Depending on the methodology selected, this investigation is anticipated to cost between $250,000 and $500,000.

Priority 6: Habitat Quality

Anticipated quality of different habitat types, primarily in terms of forage availability, will aid in predicting biological productivity anticipated at different habitat types and age classes within the predictive model. A framework developed by Sherfy et al. (2007) establishes procedures for selecting river reaches within segments, reservoir shoreline segments, and nest sites for monitoring habitat and food sources, while incorporating flexibility to adapt monitoring for particular areas and situations. Sampling of plots or transects includes collecting data on terrestrial (substrate, vegetation, terrain) and aquatic MRMSs (water depth, temperature, velocity, turbidity) as well as terrestrial invertebrates by size class and biomass, and species richness of small fish. The intensity of monitoring required to detect differences in characteristics between natural and constructed habitat has been determined, and before-after-control-impact studies, when possible, would improve the power of the monitoring efforts. Ideally, monitoring would take place during nesting season to most accurately characterize habitat available to and selected by terns and plovers, but the intensity of productivity monitoring may require habitat monitoring to take place later in the season. The monitoring plan was field-tested in 2006. This effort would likely be performed by an independent contractor. The anticipated cost for this investigation is $300,000.

Priority 7: Dispersal

Data on dispersal is necessary to supplement population census data in order to determine the extent to which changes in population size are due to emigration and immigration to and from the Missouri River from other regions. Protocol for this effort has been developed by representatives from Virginia Polytechnic Institute (VPI) using funding provided by the USACE. Efforts would likely be performed by an independent contractor in the future.

Priority 8: Water Quality

An investigation has already been undertaken to determine baseline water quality conditions and potential impacts by collection and analysis of elutriate samples from water and sediment in Segments 8, 9, and 10 (Fort Randall, Lewis and Clark Lake, and Gavins Point). This investigation could be expanded to cover the Garrison and Fort Peck Segments and could be updated every 3-5 years as conditions change and program implementation continues. The cost is approximately $25,000 per segment per year and involves the collection of water and sediment samples from sites that are representative of conditions in the target segments.

Priority 9: Geomorphology

This investigation would involve the collection of rangeline survey data from historic rangelines to determine long-term trends in river geomorphology including bankline erosion and deposition. The proposed rangelines have been monitored every 5 to 10 years since the 1950's and would be used to detect long-term trends in geomorphology on the target segments. The estimated cost for this effort is $300,000 per survey. This effort has been previously conducted under the Operations and Maintenance program.

Priority 10: Erosion and Deposition

This investigation would involve pre and post-construction, site-specific surveys of ESH projects to detect any changes in erosion or deposition. Surveys would be conducted upstream and downstream of sites and would involve collection of elevation data from both the constructed sandbars themselves and the surrounding area (bank-to-bank). Surveys would be conducted for 3 to 5 years before and after a project is completed for a total of 6 to 10 years per site. The cost is anticipated to be between $50,000 and $300,000 per site, per year depending on the extent of the survey area and the methodology selected to collect the data.

Priority 11: Sediment

Based on comments received on the PEIS as well as the recommendations from a recent National Academy of Sciences report on sediment in the Missouri River, a scope is currently being developed for a Missouri River sediment budget. Such a study would look at the inputs of sediment sources and outputs from the Missouri River basin and help determine long-term forecasts for sediment variables including degradation, aggradation, and sediment load. The cost of this effort will depend on the scope that is developed and may vary between $50,000 and $1,000,0000.

Priority 12: Additional Investigations

Additional investigations may facilitate greater understanding of tern and plover biological response, habitat dynamics, and effects to non-target resources. Research needs will be identified in Annual Strategic Review Documents and will be funded as a lower priority after information needed to address success metrics and information needed to improve the predictive model. Potential investigations that have been discussed include the effects of predator removal on predation and the effect of nest caging on tern and plover survival and productivity. Scopes for these investigations have not yet been developed.

5.5 Data Storage and Reporting

A large amount of physical and biological data will continue to be generated to assess the success of the program and improve predictive models. Data Management is a fundamental function of the ISP. The ISP has a Data Management system that houses biological data on tern and plover productivity and habitat characteristics, as well as baseline physical information including nesting sites and nest locations. Data of other types (aerial photography, LiDAR) are housed at the GIS Service Center within the Omaha District Office. Hydrological and physical site characteristics are stored with the Sedimentation and Channel Stabilization Section of the Omaha District Office. Plans are underway to provide an integrated database that links these various sources of information. Data collected from monitoring efforts and investigations will be stored and reported in the following formats:

5.5.1 Tern and Plover Data Management System

The Tern and Plover Data Management System (DMS) stores data on adult population numbers and fledge ratios along with nest success, predation, and other related data. This information is provided in a web-based format throughout the year. Official data are checked, finalized and subsequently posted in late October. This information will be accessed through the web site and downloaded for analysis in the predictive model.

5.5.2 Acreage Accounting Utility

A database will be developed to store habitat classifications and compile ESH acreage measurements. The creation of this utility will require dedicated funding for completion. Although somewhat reliant on the timing of imagery acquisition, habitat classifications will be available in approximately February of the following year.

5.5.3 After Action Review Reports

AAR meetings are held following construction projects to create reports that summarize the aspects of a project that were successful and the lessons learned that can be applied to future projects. The AAR report will include a brief description of each project implemented during the previous year along with cost, methodology, construction time, cubic yards of material placed, and ESH acres created. Additional information will include the feasibility of sandbar area targets and timeframes for construction, appropriateness and degree of success of particular construction techniques, the information and guidelines that should be supplied to contractors, limitations imposed by presence of native species and mechanisms for reducing impact, and actions required for restoring staging areas to pre-construction conditions. These reports will feed into the AM report, providing important construction feedback and lessons learned to the design team. AAR sessions will be held following completion of sandbar construction projects (typically late spring) and reports will be completed in early summer.

5.5.4 Investigation Reports

Reports will be provided for each investigation undertaken on an annual basis that compiles the data collected during the previous field season. Timing of these reports will vary based on the field season for the specific effort. Data on dispersal and habitat quality would be reported in this manner.

6.0 Analysis and Assessment

Monitoring effort will collect data to compare towards the selected performance metrics and targets (such as population, fledge ratio and ESH availability) and comparison with recent or historical trends from previous years monitoring data. However, some monitoring data will require additional analysis to inform decision makers. Population-level responses to increases in habitat availability or quality will occur over time, so predictive models will be used to assess the probability of achieving the success metrics in the future. Analysis methods are detailed in the following sections.

6.1 Comparison against targets and trend analysis

For some of the selected performance metrics - including population numbers, fledge ratios, area of ESH, and cubic yards moved – annual data collected from monitoring efforts will simply be compared to the targets to determine if they have been met or not. For area of ESH, attempts will be made to gather data at one time during the nesting season. However, if the data are gathered at different times, acreages may need to be corrected for flow using curves found in Section 6.1.3 in order to ensure data are consistent and comparable.

Some performance metrics, including population growth rate, require a trend analysis in order to measure success. For these metrics, data will be used from previous years in order to determine changes over time and determine progress towards targets. For population growth rate, the following equation will be used:

Annual growth rate, λ = population size at year $t + 1$ divided by the population size at year t

When the population size is below target, $\lambda > 1$ indicates a growing population, and therefore a population that is on track to reach the population size target.

This data would be used to assess the need to adjust acreage targets based on the following matrix:

Figure 8. Example decision matrix for population, population growth rate, fledge ratio, and acreage of ESH.

		Acreage < target	Acreage ≈ target
GROWING POPULATION **Fledge ratio > target** **Growth rate > 1**	**Population ≥ target**	**Unexpected** Much less density dependence than expected *Actions:* Consider reducing acreage target	**Overbuilding** Less density dependence than expected *Actions:* Maintain habitat, consider reducing acreage target
	Population < target	**Desired Population Growth** Increasing acreage is supporting a growing population on its way to meeting targets *Actions:* Continue with current habitat creation plan	**Desired Population Growth** Population size is limited by factors other than habitat or may require additional time to reach target *Actions:* Maintain habitat and monitor population size
STABLE POPULATION **Fledge ratio = target** **Growth rate = 1**	**Population ≥ target**	**Overbuilding** Less density dependence than expected *Actions:* Maintain habitat, consider reducing acreage target	**Desired Population Stability** Acreage is sufficient to support a stable population *Actions:* Continue to replace habitat as needed to maintain acreage
	Population < target	**Underbuilding** Population is stable but not growing *Actions:* Continue habitat creation, consider increasing pace	**Underbuilding** More density dependence than expected *Actions:* Increase acreage target or improve habitat quality
DECLINING POPULATION **Fledge ratio < target** **Growth rate < 1**	**Population ≥ target**	**Reversal** Habitat was sufficient but quantity and/or quality is declining *Actions:* Reconstruct habitat, improve maintenance	**Reversal** Habitat was sufficient but quality is declining *Actions:* Improve habitat quality or increase acreage target
	Population < target	**Underbuilding** Habitat quality and or quantity is not sufficient to support species *Actions:* Increase pace of habitat creation	**Unexpected** Much more density dependence than expected *Actions:* Increase acreage target, and/or improve habitat quality

Additionally, trends in fledge ratio will be analyzed to determine if they are increasing over time. Increased fledge ratios in the target segments would indicate progress towards Objective 1 and an increase in either the quantity or quality of habitat. While this analysis will be conducted and reported on an annual basis, recommendations to increase or decrease acreage targets would be issued after three-years of data have been collected.

6.2 Model Predictions

Predictive models have been developed to represent system variables and the dynamics that affect these variables over time. These models will be used to inform the decision-making process. The ESH models are conceptual and numerical, and provide a means of predicting the consequences of actions as they relate to ESH objectives. Coupled with monitoring results, models are the central tools for making refined predictions of outcomes from the actions taken. The models will use inputs from monitoring data and the AM Team to refine model assumptions over time. They are used to predict biological responses to management actions over time in order to help decision makers select an implementation strategy with the potential to meet the success metrics identified for the stated objectives.

The models necessary for the ESH plan are being developed through a process involving various state and federal agency scientists who are knowledgeable about the Missouri River ecosystem, the ESH program, and the species of interest. The primary models are focused on the environmental and biological variables within the system and the ways in which these variables change over time. The three environmental and biological variables are: 1) volume of system storage (*S*; million acre feet), 2) area of ESH (*A*; acres), and 3) bird population size (*N*). Each environmental variable will be stratified by segment and reservoir, and as needed into the finer-scale categories described below. Other models will be constructed as needed to support or refine these system state models.

6.2.1 Model Variables

Following are descriptions of the primary variables included in the predictive models for the ESH sub-program.

6.2.1.1 System Storage

System storage is a primary driver of water management on the MRMS. Runoff from the Great Plains coupled with spring rains and mountain runoff from snowmelt provide flow into the reservoirs and river segments directly and through tributary inflow. These inflows, along with the associated sediment, are stored within reservoirs. Releases from the reservoirs are heavily regulated, with the MRMS being operated to serve the congressionally authorized purposes of flood control, navigation, hydropower, water supply, water quality, fish and wildlife management, irrigation, and recreation. Based on the amount of storage in the MRMS, releases are made to meet the congressionally authorized purposes. For example, in an extremely high-water runoff year when reservoir levels are in their exclusive flood control zone, storage is evacuated. The technical criteria for MRMS releases are included in the Master Manual.

The MRMS storage model currently uses historical data on the flows within each segment and elevation in each reservoir to drive the other environmental variables. This limits the evaluation of the effects of changes in flow, but does provide an estimate of inter-annual variability driven by variation in inflow (upstream runoff) and downstream flow requirements (navigation and flood control). The USACE also prepares an Annual Operating Plan (AOP) with input from tribal groups, states, and the public to reflect operations under runoff scenarios in light of annual conditions. The selected AM scenario could suggest changes to operations within the flexibility of the Master Manual that potentially maximize tern and plover nesting success; however, such suggestions would need to be balanced with other MRMS purposes during the development of the AOP.

"Unbalancing" of the storage within the upper three reservoirs (which contain 85% of the water storage for the entire MRMS) currently occurs, when applicable, for lake fisheries management. This incidentally affects available habitat on these reservoirs in certain years because birds nest on reservoir shorelines. This reservoir habitat is not included in the acreage target, but does affect tern and plover population growth.

6.2.1.2 Acreage of Sandbar Habitat

This environmental variable is directly related to the objective of enhancing area of ESH. Habitat area influences population processes and is directly modifiable through a USACE action. The definition of ESH acreage includes all bare or sparsely vegetated within-channel sandbars available to terns and plovers, and encompasses new ESH (non-vegetated sandbars) as well as old ESH (sandbars that have aged and been subject to vegetation encroachment and erosion).

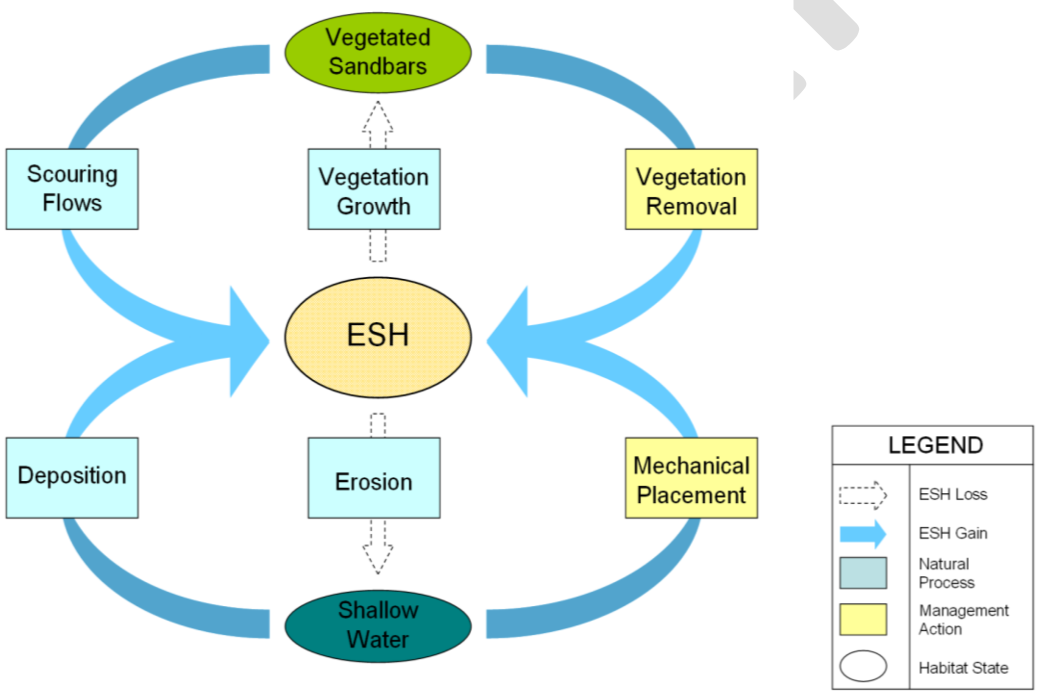

Figure 9. Major processes resulting in the gain or loss of ESH.

River ESH acreage naturally changes because of high flows that scour and deposit sediment into a new mosaic of stream and land formations in the segments below the dams. These flows provide fresh depositions of sand that are exposed in various quantities and elevations above the water. Since these natural processes work below the river's surface and the highest annual flows are typically during the nesting season of terns and plovers, habitat created in this manner is not available to nesting birds on a reliable basis. To supplement natural habitat, management actions attempt to re-create these natural processes above the water's surface through mechanical removal of vegetation and placement of sand to provide additional ESH. It should be noted that Figure 8 is a generalization of the processes affecting change in ESH acreage. For example, flows that scour vegetation typically also result in a loss of ESH because of erosion. Additionally, loss to erosion may result in shallow water or open water habitat. The latter is not typically targeted for ESH restoration as it requires a much larger amount of sand placement when compared to shallow water. It should also be noted that efforts to remove vegetation thus far have mostly resulted in marginal quality ESH with limited use by nesting birds. Recent efforts by the USACE include exploring a combination of vegetation removal and mechanical placement in order to successfully transition from vegetated sandbars to ESH. These are being undertaken on a small scale as part of a vegetation modification study and at a larger scale as pilot projects.

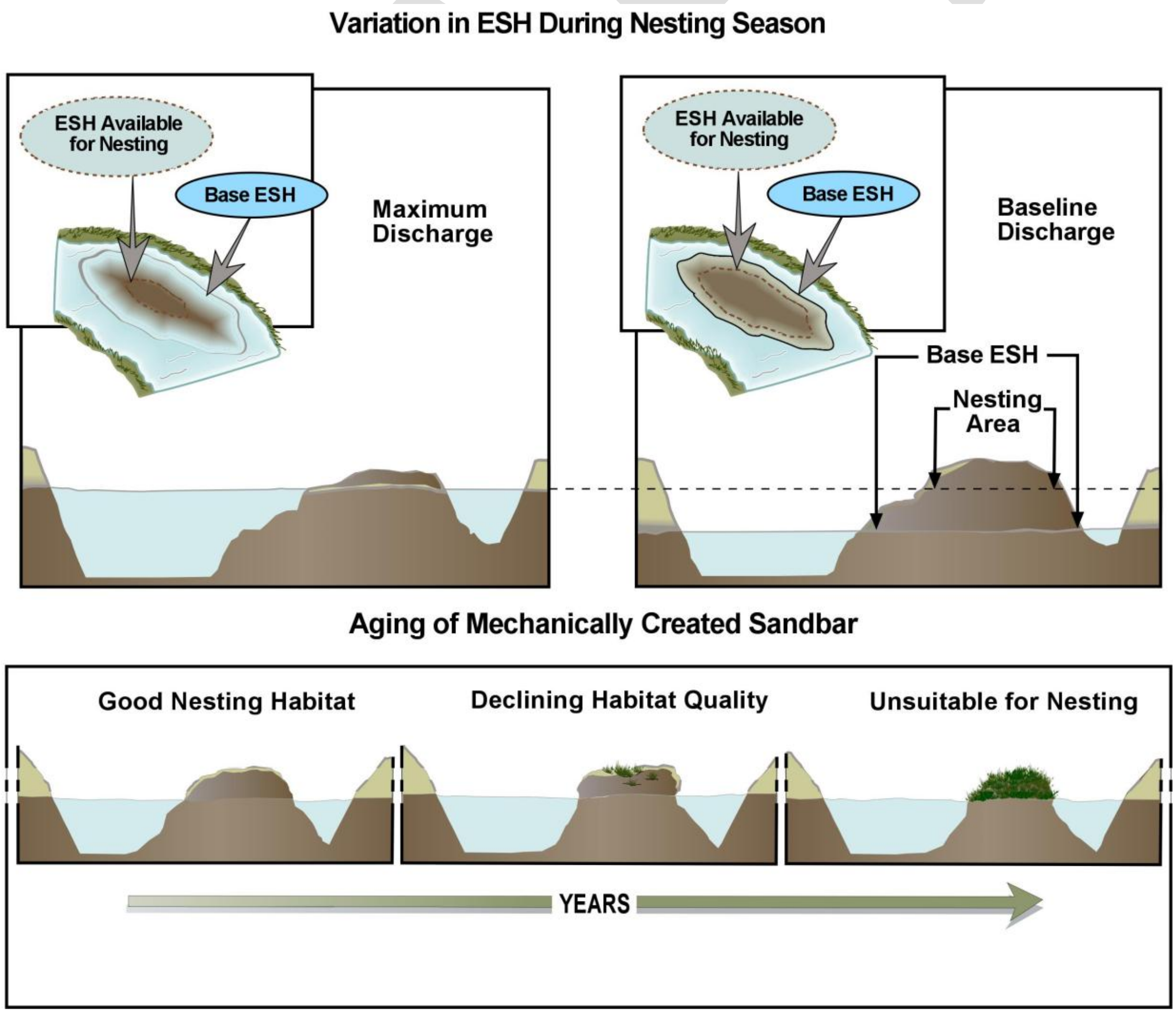

Figure 10. Sandbar cross-sections showing effects of water level on nesting area availability, and progression of a sandbar from suitable to unsuitable nesting habitat through erosion and vegetation growth.

Releases from reservoirs also affect the area of ESH in the river segments below each dam, although the direction of the effect depends strongly on the temporal scale involved. At short time scales (days),an increase in discharge rates leads to reduced habitat area (Figure 9) because low elevation ESH is inundated. At longer time scales (year to year), low discharge rates reduce ESH area because erosion increases. Erosion rates may also increase during high discharge rates (much higher than Full Navigation) if sediment supply is inadequate.

Assumptions about ESH loss rates due to erosion and vegetation (Table 7) were garnered from the analysis in the PEIS. The loss rates from Appendix C (Construction Assumptions) are dependent upon both the segment and the amount of habitat within that segment. The assumption that the percentage loss of total ESH due to erosion will be greater when there is a larger quantity of ESH within a given segment is based on observations over the period of 1998-2005. Since only a subset of each segment has the necessary physical characteristics (such as adequate channel width) to support sustained bars, higher rates of overall erosion are predicted after these areas are already filled with ESH and sand is placed in other areas with less than ideal physical characteristics. While the deposition of sand is possible in these areas, higher erosion rates will occur, leading to an overall higher rate of erosion for the segment. For the reservoir segment, Lewis and Clark Lake, a constant loss rate is assumed because of high anticipated rates of vegetation encroachment and subsidence. This assumption is also derived from observed loss rates between 1998 and 2005. Table 8 will likely be refined as additional data are collected through monitoring.

Table 7. Anticipated annual percentage loss rates of ESH as a function of total ESH acreage within segments.

Segment Acre Range	Gavins Point	Lewis and Clark Lake	Fort Randall	Garrison	Fort Peck
> 2324	40%	50%	40%	40%	40%
2148 - 2324	30%	50%	40%	40%	40%
1913 - 2148	30%	50%	40%	30%	40%
1328 - 1912	25%	50%	40%	30%	40%
880 - 1327	25%	50%	40%	25%	40%
589 - 880	15%	50%	40%	25%	40%
571 - 588	15%	50%	40%	15%	40%
566 - 570	10%	50%	40%	15%	40%
501 - 565	10%	50%	40%	15%	25%
350 - 500	10%	50%	40%	10%	25%
248 - 350	10%	50%	30%	10%	25%
212 - 247	10%	50%	30%	10%	15%
136 - 212	10%	50%	25%	10%	15%

129 - 135	10%	50%	25%	10%	15%
81- 128	10%	50%	15%	10%	15%
31 - 80	10%	50%	10%	10%	15%
1 - 30	10%	50%	10%	10%	10%

To refine these loss rates, as well as look at overall trends in acreage, successive years of habitat delineations derived from satellite imagery will be compared. Due to frequent fluctuations in water levels on the MRMS, two sets of imagery may be taken when water levels are dissimilar. To accurately compare two data sets, the influence of flow (water levels) on the amount of exposed habitat visible must be removed. To accomplish this, acreage amounts will be flow-corrected and set to a common water-level for the basis of comparison. The curves below (Figure 9) were developed based on Appendix B of the PEIS and Appendix 7H of the Master Manual. Curves are not needed for the Lewis and Clark Lake segment because water levels are fairly consistent across multiple years. No curve has been developed for the Fort Peck segment. The curves will be used as a starting point to correct for dissimilar flows and will be updated over time. Targeted efforts to collect imagery sets at different times in the same year will allow acreage differences to be analyzed on a timescale where erosion can be considered negligible.

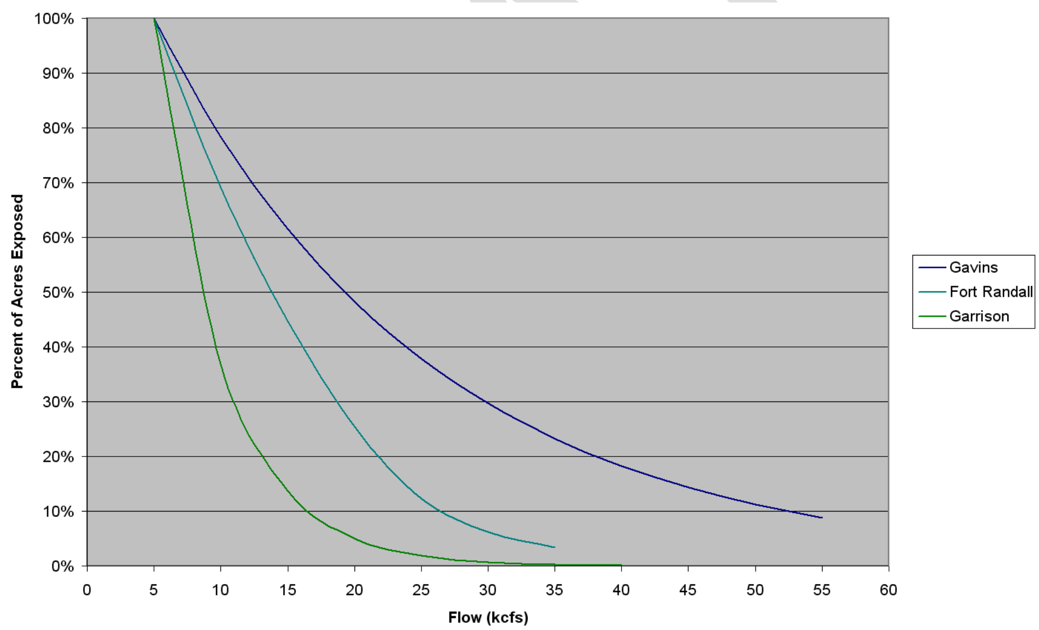

Figure 9. Initial curves used to correct ESH acreage measurements taken at one flow (in thousand cubic feet per second – kcfs) to the acreage available at a different flow.

By manipulating the volume and timing of releases, there is some flexibility within the Master Manual to minimize the "take" of interior least terns and piping plovers both within and below the MRMS during the nesting season. Temporarily increased releases early in the nesting season that encourage birds to nest at higher elevations can allow for higher flows later in the season without inundating nests. The USACE retains a certain level of flexibility within the bounds of reservoir regulation priorities to make short-term adjustments in releases. More extensive alterations of existing regulations for conservation or restoration purposes may be possible through established review (e.g., public consultation and environmental impact assessment) as well as oversight and authorization procedures.

Additional flow affects on ESH availability occur due to hydropower flows. Hydropower generation from Fort Randall and Garrison dams requires these facilities to "power peak" – cycling releases on a daily basis to match variation in power demand on the grid. On a daily basis, water levels can vary as much as five feet in portions of these segments, drastically affecting the acreage of sandbars that are exposed.

The models use existing data to develop relationships between actions and responses to address remaining critical uncertainties (e.g., one assumption is that vegetation modification activities lead to an increased useable amount of ESH, but it is not clear whether resulting habitat is used). Monitoring the response of the state variables (e.g., acres) to actions (e.g., construction) over time will provide information to test the model assumptions and further refine the model. Hence, the model can be used in the process for decision making (more fully described in the decision-making section). The models will be revised during the iterative phase of the project to improve their predictive capabilities. Data from the monitoring program will be used to refine the models.

6.2.1.3 Reservoir Shoreline Habitat

No acreage targets currently exist for habitat on the shorelines of the reservoirs. In the past, these shoreline habitats have been particularly important for plovers and have produced significant numbers of plover fledglings under low water conditions. The habitat is ring-shaped and increases and decreases in area with the amount of runoff entering the reservoir. An analogous inter-annual change in available ESH occurs depending on river flow. Figure 10 illustrates an increase in shoreline habitat as reservoir storage is reduced. Over time, if shoreline habitat remains above water, vegetation growth reduces the amount of bare shoreline suitable for nesting. In the models, reservoir shoreline contributes to overall usable nesting habitat on the MRMS and is used to determine expected population size.

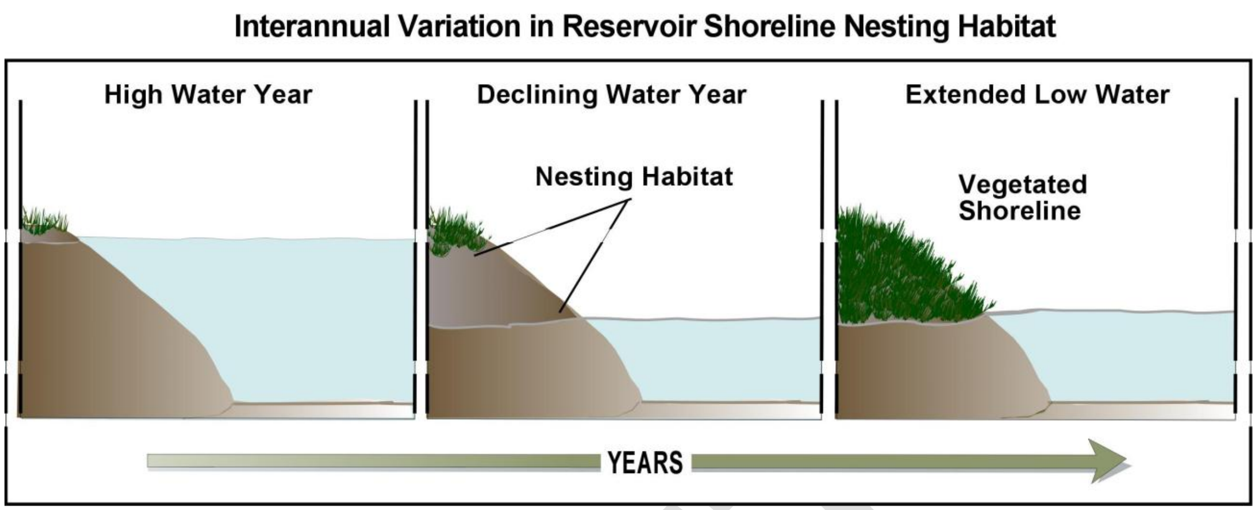

Figure 10. Increase in reservoir shoreline nesting habitat after declines in water levels, and the subsequent decrease in nesting habitat as a result of vegetation encroachment when storage remains low.

6.2.1.4 Population Size

The population model used for this analysis is an age-structured model with a discrete annual time step. The model tracks the number of birds using each segment and reservoir. The model includes environmental variation in all process rates (annual variation), as well as environmental effects of variation in discharge rates. Discharge primarily influences the area available for nesting, and consequently the growth and survival of chicks to fledging (Figure 11). The model incorporates variability (demographic stochasticity) in productivity (birth rates) and survival of all age classes.

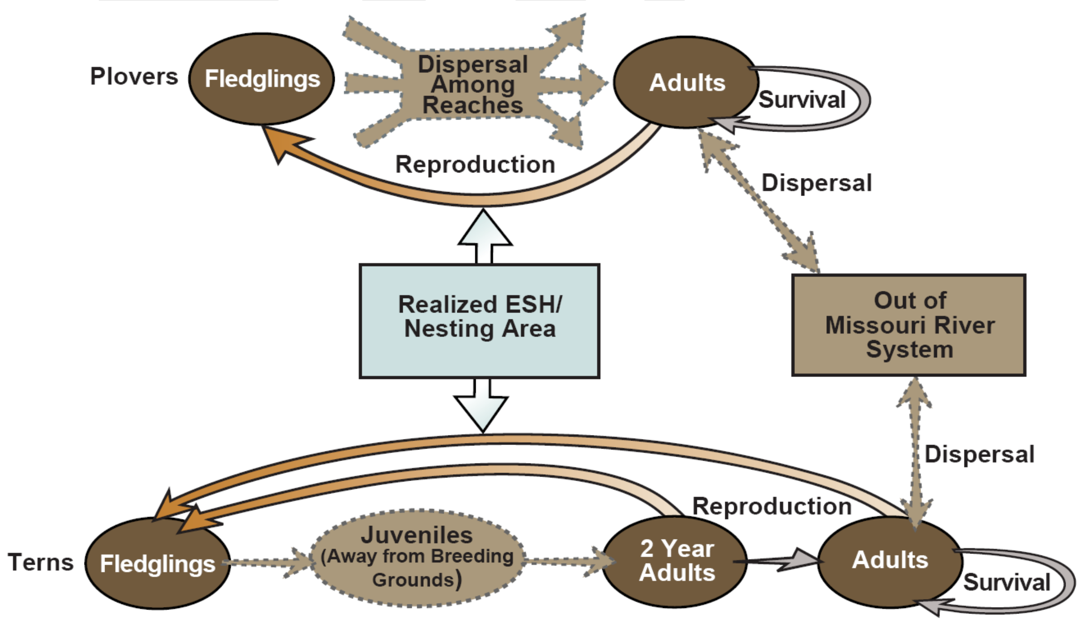

Figure 11. Conceptual model for tern and plover populations. Dashed lines indicate processes of higher uncertainty.

The model predicts the outcomes of management actions on Objective 1; fledge ratio, and Objective 2, population size. The fledge ratio is defined as the number of plover or tern chicks fledged divided by the number of adult breeding plovers or terns within the MRMS. Observation errors are included in the calculation of forecasted fledge ratio.

6.2.2 Assessments using model outputs

A comparison of model predictions with new monitoring data will be conducted as part of the Annual Strategic Review. Monitoring data describe tern and plover population sizes and fledgling ratios, as well as area of ESH. The relationships among variables in the model can be assessed, and if appropriate, modified based on this comparison. This is another example of how the model can be modified over time as new knowledge of the system becomes available, with the intention of increasing the accuracy of model predictions, which will lead to the ultimate goal of improving decision making through the AM process.

When attempting to predict the result of management actions in a dynamic system, models must account for potential changes in environmental conditions, population dynamics, and other factors. This natural variation is not reducible through research efforts but is inherent in the processes themselves. To accommodate this variability, the models developed for this effort are stochastic – each time the model is run with the same input parameters it forecasts a unique trajectory of environmental conditions, births, and deaths. The model is simulated multiple times (replications) to forecast outcomes of a proposed management action. Consequently, forecasts using stochastic models will not result in one single predicted value for each performance metric, but rather a probability distribution of possible values for each metric. For example, using 5,000 replicates of the model to simulate possible fledgling ratios of terns, the probability distribution may approximate a normal distribution, with an average ratio of 1.44 and a range of 0.13 to 3.47. Extreme values fall within the tails (i.e., away from the center of the distribution) and are less likely to occur than those in the center of the distribution, near the average of 1.44 in this hypothetical example (Figure 13).

In addition to natural variation, each of the input parameters in the model is unknown to some extent. Some parameters are estimated from existing data, but even these have some amount of error. Thus, the final probability distribution for each metric includes two sources of variation – natural variation and uncertainty in inputs.

The output of models will result in a probability measurement indicating the likelihood that management actions will meet the success metrics. In the simulation example below (Figure 13), 80% of the forecasted fledge ratios exceed the success metric of 0.94, suggesting this set of actions is likely to meet the objective. In the second example, more than 95% of the forecasted fledge ratios exceed the success metric of 0.94 (Figure 14), indicating that the scenario is very likely to meet the objective. Conversely, if the distribution is shifted to the left, less than 50% of the forecasted fledge ratios exceed the success metric (Figure 15) and the objective is less likely to be achieved.

To facilitate communication of this information to decision makers, probabilities of exceeding a success metric will be assigned a color coded category which indicates this likelihood (Figure 13). If the decision criteria is less likely to be met than not met (>50%), it is coded red. If the decision criteria are more likely to be met than not met, it is coded amber. If the decision criteria have a 95% chance of being met, it is coded green. The 95% cutoff for green corresponds to a 90% confidence limit on the expected value of the objective.

< 50%	50 - 95%	> 95%
Red	Amber	Green

Figure 12. Color coding describing the likelihood that a management action will result in meeting success criteria (as a function of distribution percentage of all runs that meet or exceed targets).

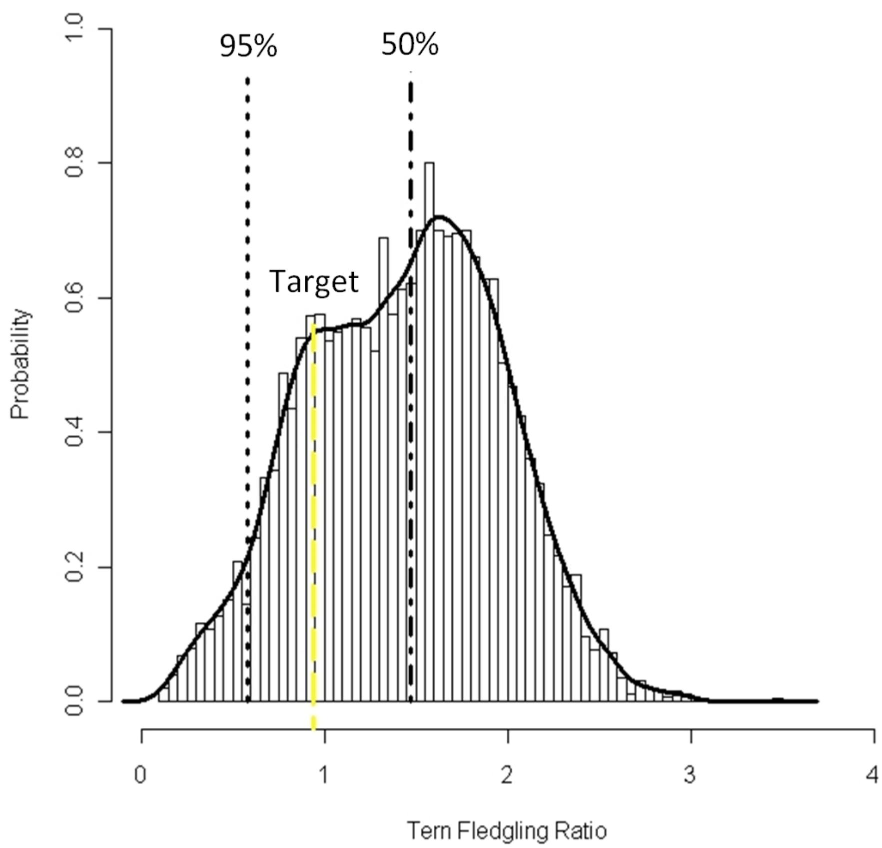

Figure 13. Example probability distribution of fledgling ratios for terns based on hypothetical model results. In this example, 80% of fledge ratios exceed the target (yellow line), suggesting a

moderate level of probability that the target level of 0.94 will be reached. For reference, 50% (black dotted-dashed line) and 95% (black dotted line) are shown.

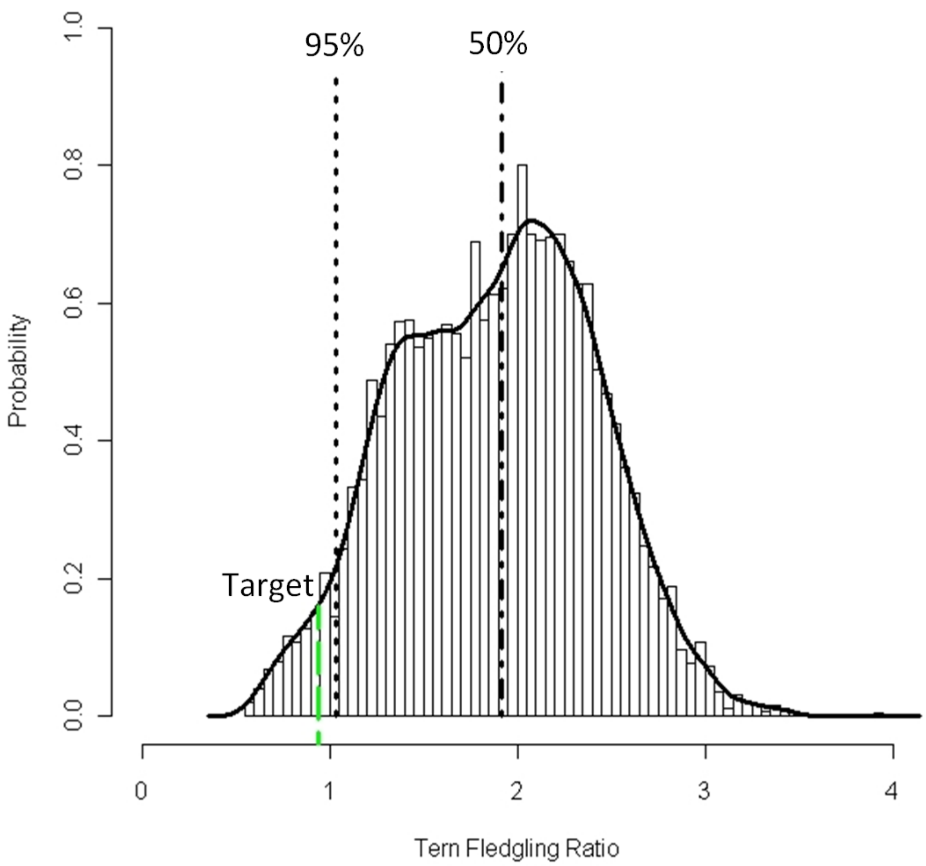

Figure 14. Example probability distribution of fledgling ratios for terns based on hypothetical model results. More than 95% (black dotted line) of fledge ratio predictions exceed the target (green dashed lines), suggesting a high level of probability that the target level of 0.94 will be reached.

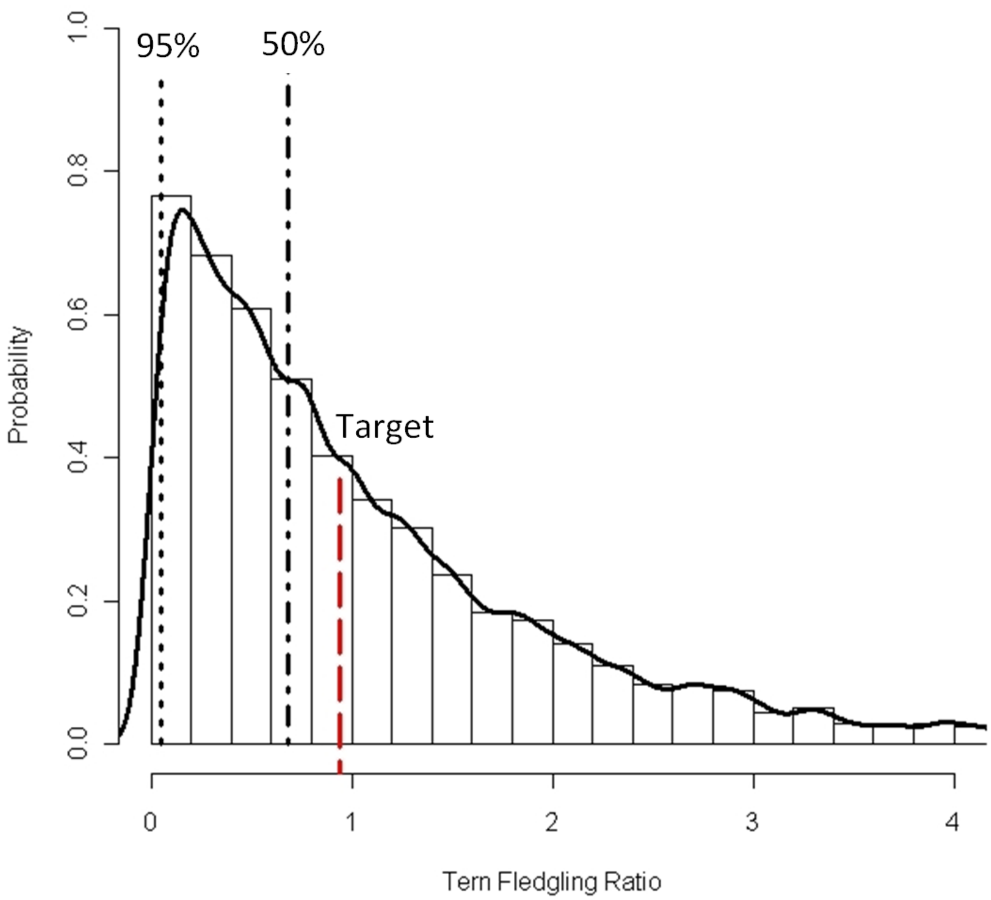

Figure 15. Example probability distribution of fledgling ratios for terns based on hypothetical model results. Less than 50% (black dotted-dashed line) of predicted fledge ratios meet or exceed the target (red dashed line), suggesting a low level of probability that the target level of 0.94 will be reached.

These probability distributions will also be used to determine the coefficient of variation (CV) for each variable to determine progress towards Objective 5. The CV for each variable will be calculated as $CV = \sigma/\mu$ where σ is the standard deviation (the square root of the variance) and μ is the mean. All CVs will then be added together and averaged to determine an overall CV for the year. After two years, the CV trend will be tracked with a reduced CV representing progress towards meeting Objective 5. This would reflect a reduction in uncertainty regarding model parameters. If the CV remains the same, this would indicate that uncertainty has remained the same over time. An increased CV would indicate that increased uncertainty has been introduced to the model.

6.3 Frequency of Assessments

Information gained from monitoring efforts directed at improving model forecasts will be included on an annual basis to continually update model assumptions as part of an Annual Strategic Review. Models will be run annually to assess the likelihood that acreage targets will be met and the likelihood that management actions will result in meeting biological metrics.

Every third year, models will be run to assess the scope of the program. Scenarios will be developed based on input from the ESH PDT and the AMWG and will be run to assess whether or not a new alternative should be selected to best meet the stated objectives. At this time, the Annual Strategic Review will also take a critical look at objectives, metrics, targets, and management actions, to see if adjustments to the AM Strategy are needed. If a recommendation is made to update the ESH AM Strategy and major changes are warranted, this document may be updated to reflect these changes. Otherwise, general updates would be made and coordinated through the external and internal teams described above under Strategy Development.

6.4 Documentation

Annual and triennial reports containing the results of the analyses, the assessment, and recommendations will be produced through the ESH PDT with assistance from the AMWG. As mentioned above, reporting will occur annually. Reports will be shared with management and others in draft form as early as possible to share information and capture policy and other input. Reports will be final by December of the existing calendar year. (i.e.,the 2009 report will be complete December 2009).

7.0 Decision-making

7.1 Decision-makers

To accomplish the goals of the MRRP, decisions must be made at various times and at various levels. The MRRP has developed a suite of teams that are designed to implement actions, investigate uncertainties, summarize progress, make recommendations for next steps, and make decisions. These teams include managers, stakeholders, scientists, and engineers. The teams are as follows:

7.1.1 Integrated Science Program Management Team (ISP MT)

This team coordinates monitoring and research activities associated with the MRRP and provides technical analysis of recovery activities. The purpose of the ISP is to: 1) provide support to the MRRP in meeting its goals and purposes by applying an integrative system perspective to the planning and implementation of the program, 2) conduct scientific and technical evaluations and analysis to improve the MRRP's success, and 3) communicate and coordinate the results of these evaluations. This USACE team coordinates monitoring and investigations associated with the MRRP and provides technical analysis of recovery activities. The ISP is also responsible for issuing recommendations to the SPDT and the ESC as to the level of funding needed for monitoring and research and the priorities for the various efforts. Thus, decisions about which monitoring and research efforts are conducted on an annual basis, and the justifications for these efforts, are the responsibilities of the ISP. Members include the following:

- Omaha District Integrated Science and Planning Program Manager
- Kansas City District Integrated Science and Planning Program Manager
- Integrated Science Project Manager
- Environmental Resources Specialist, Omaha District
- Environmental Resources Specialist, Kansas City District
- Aquatic Science Coordinator, Omaha District Threatened and Endangered Species Section

7.1.2 Missouri River Recovery Program Senior Project Delivery Team (SPDT)

This USACE team includes upper-level managers from the Omaha and Kansas City Districts and Missouri River Water Management District staff who coordinate with the Program Manager to ensure coordination across the different sub-programs of the overall recovery effort, including development of the AWP (Budget). The SPDT also provides the ESC with recommendations on budget priorities among the various MRRP elements. Members include the following:

- Missouri River Recovery Program Manager
- MRRP Funds Implementation Manager
- Omaha District MRRP Implementation PM
- Kansas City District MRRP Implementation PM
- Omaha District Integrated Science and Planning Program Manager
- Kansas City District Integrated Science and Planning Program Manager
- Missouri River Ecosystem Restoration Plan PM, Omaha District
- Missouri River Ecosystem Restoration Plan PM, Kansas City District
- Adaptive Management Process Manager, Omaha District
- Adaptive Management Process Manager, Kansas City District

7.1.3 Cooperating for Recovery Team (CORE Team)

The CORE Team is the primary interagency group that makes recommendations related to ESA compliance and recovery activities within the MRRP, although decisions are made at multiple levels. This team includes USACE, USFWS, and Missouri River Water Management staff who meet regularly to discuss implementation of the BiOp by the MRRP. Members include the following:

- Missouri River Recovery Program Manager
- MRRP Funds Implementation Manager
- Integrated Science and Planning Program Managers
- Adaptive Management Process Managers
- North Dakota Field Office Supervisor, USFWS

- Tern and Plover Biologist, USFWS
- MRRIC PM
- USFWS AM Lead

The CORE Team will operate by consensus, recognizing that the USACE has the ultimate responsibility of implementing the MRRP to meet the requirements of the BiOp. If consensus cannot be reached and discussions have led to an impasse, the decision will be elevated to leadership within the USACE and USFWS for resolution.

7.1.4 Executive Steering Committee (ESC)

The ESC's main responsibility is to make program-level decisions for the MRRP, including budgetary priorities, based on input from the Senior PDT, CORE team, and stakeholder groups such as MRRIC. This is the primary decision-making entity with regard to budget allocation to various MRRP elements, including AM efforts, monitoring and research, and ESH construction. ESC members include the following:

Deputy District Engineer, Kansas City District
Deputy District Engineer, Omaha District
Planning Branch Chief, Kansas City District
Planning Branch Chief, Omaha District
Chief, Planning, Environmental Resources, and Fish Policy and Support Division, USACE Northwestern Division
Missouri River Basin Water Management Division Chief
Civil Works Branch Acting Chief, Omaha District
Civil Works Branch Chief, Kansas City District
Office of Council, Kansas City
Missouri River Recovery Communications Program Manager

7.1.5 Missouri River Recovery Implementation Committee (MRRIC)

Section 5018 of the WRDA of 2007 authorized the Secretary of the Army to establish the MRRIC. The MRRIC was established on July 1, 2008, and includes representatives from basin tribes, states, and non-governmental stakeholders. The MRRIC is tasked with providing recommendations to the SA with regard to the Missouri River recovery and mitigation programs, including changes to the implementation strategy from the use of AM and the coordination of the development of consistent policies, strategies, plans, programs, projects, activities, and priorities for the program.

7.2 Decision-making Process

On an annual basis, representatives of the ESH PDT and the AMWG will compile and report information gained from monitoring and investigations, describe analyses and assessments conducted and make recommendations as part of an Annual Strategic Review. This report will include recommendations related to all or some of the following decisions:

1. **Level of construction effort:** Continue with current, increase level of effort, or decrease level of effort. If a change to the level of effort is proposed, a cost estimate will be included along with a list of potential implications if the change is not adopted (e.g., the model predicts populations will decline).
2. **Pilot projects:** Recommendations for new construction pilot projects associated costs and expected benefits. Include performance metrics, monitoring needs and timeframe for monitoring.
3. **Productivity Enhancements:** Recommended actions to be taken at existing created sites in order to improve or maintain productivity. Include methods, cost estimate, anticipated benefits and any additional monitoring necessary.
4. **Incorporation of new methodologies:** If previous pilot projects indicate that new methodologies will be successful, the team will recommend how these methodologies should be incorporated into the program and estimate changes in cost and expected benefits.
5. **Changes to biological metrics:** If improvements to population models suggest that new biological metrics are necessary to adequately address Objectives 1 and 2, a recommendation may be issued to alter the success metrics with regard to these objectives.
6. **New Plan:** In the event that actions are not able to adequately meet the stated objectives, the team may recommend initiating a program review to revisit the objectives, metrics, proposed actions, and other related elements of the program.

This information will be captured in an Annual Strategic Review Report which will be submitted to the CORE team, SPDT, MRRIC and ESC in January of each year.

Decisions to be made on an annual basis will be identified in this document. A key decision will be the level of funding allocated to the budget. The report will identify whether the current level of funding will allow the program to meet Objective 3 and whether a greater or lesser level of funding would be needed in order to implement the program. The report will include the consequences of failure to implement the recommended changes in terms of impacts to the other Objectives. The level of funding allocated will be decided by the ESC.

Another key decision will be the incorporation of new construction methodologies based on the results of pilot projects. The document will include results of monitoring efforts and anticipated outputs of incorporating the new methodology in terms of the stated objectives. In addition, the impacts on program cost will be identified. The ESH PDT will decide whether or not to include the new methodologies and the extent to which they will be included in annual implementation. The report will also identify any new pilot projects that could be implemented to test other methodologies and the cost associated with the new pilot projects. Any change to monitoring efforts needed in order to implement the AM strategy will also be identified and prioritized with cost estimates for each effort. The ESH PDT will make the decision on whether to implement the pilot project and, if one is selected for implementation, select an appropriate site if applicable. Any changes to design or implementation proposed as a result of the AAR will be included as well.

Every three years, additional analyses will be conducted in order to assess whether the scope of the program should be altered by selecting a different preferred alternative. Scenarios will be developed for each alternative from the PEIS, along with any additional scenarios identified by the ESH PDT. The analyses will be summarized in a table indicating the likelihood that each scenario will meet the stated objectives and including the updated costs associated with implementation. The report will describe the scenarios, recommend a scenario for implementation, identify the annual costs associated, and identify any additional requirements of implementation (e.g., needs for supplemental NEPA documentation). The decision to change from the existing program to the implementation of a new scenario will be made by the ESC in coordination with the SPDT and CORE team.

7.3 Reporting on the Decision

A summary of the decisions made from the previous year will be included in the following year's Annual Strategic Review Report. In addition, decisions made the by the ESH PDT will be captured in meeting minutes, AARs, VE Studies and any other applicable documents. Decisions made by the ESC and SPDT will be captured in the AWP.

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