

University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

U.S. National Park Service Publications and Papers

National Park Service

2007

Grassland Bird Monitoring at Agate Fossil Beds National Monument, Nebraska: 2001-2006 Status Report

David G. Peitz
National Park Service

Follow this and additional works at: <http://digitalcommons.unl.edu/natlpark>

Peitz, David G., "Grassland Bird Monitoring at Agate Fossil Beds National Monument, Nebraska: 2001-2006 Status Report" (2007).
U.S. National Park Service Publications and Papers. 169.
<http://digitalcommons.unl.edu/natlpark/169>

This Article is brought to you for free and open access by the National Park Service at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in U.S. National Park Service Publications and Papers by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.



Grassland Bird Monitoring at Agate Fossil Beds National Monument, Nebraska: 2001-2006 Status Report

Natural Resource Technical Report NPS/MWR/HTLN/NRTR—2007/023



ON THE COVER

Landscape at Agate Fossil Beds National Monument.

Photos from The Heartland Inventory and Monitoring Network and Prairie Cluster Prototype Monitoring Program files.

Grassland Bird Monitoring at Agate Fossil Beds National Monument, Nebraska: 2001-2006 Status Report

Natural Resource Report NPS/MWR/HTLN/NRTR—2007/023

David G. Peitz

National Park Service, The Heartland I&M Network and Prairie Cluster Prototype Monitoring Program
Wilson's Creek National Battlefield, 6424 West Farm Road 182, Republic, MO 65738



April 2007

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The Natural Resource Publication series addresses natural resource topics that are of interest and applicability to a broad readership in the National Park Service and to others in the management of natural resources, including the scientific community, the public, and the NPS conservation and environmental constituencies. Manuscripts are peer-reviewed to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and is designed and published in a professional manner.

The Natural Resource Technical Report series is used to disseminate the peer-reviewed results of scientific studies in the physical, biological, and social sciences for both the advancement of science and the achievement of the National Park Service's mission. The reports provide contributors with a forum for displaying comprehensive data that are often deleted from journals because of page limitations. Current examples of such reports include the results of research that addresses natural resource management issues; natural resource inventory and monitoring activities; resource assessment reports; scientific literature reviews; and peer reviewed proceedings of technical workshops, conferences, or symposia.

Views and conclusions in this report are those of the authors and do not necessarily reflect policies of the National Park Service. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Printed copies of reports in these series may be produced in a limited quantity and they are only available as long as the supply lasts. This report is also available from the Heartland I&M Network website (<http://www.nature.nps.gov/im/units/HTLN>) on the internet, or by sending a request to the address on the back cover.

Please cite this publication as:

Peitz, D.G. 2007. Grassland Bird Monitoring at Agate Fossil Beds National Monument, Nebraska: 2001-2006 Status Report. Natural Resource Technical Report NPS/MWR/HTLN/NRTR—2007/023. National Park Service, Fort Collins, Colorado.

Table of Contents

| | Page |
|------------------------------|------|
| Table of Contents..... | iii |
| Figures..... | iv |
| Tables..... | iv |
| Executive Summary..... | 1 |
| Introduction..... | 2 |
| Objectives | 2 |
| Methods..... | 3 |
| Site Selections..... | 3 |
| Grassland Bird Surveys..... | 4 |
| Grassland Bird Habitat | 5 |
| Data Analysis..... | 5 |
| Results..... | 7 |
| Grassland Bird Surveys..... | 7 |
| Grassland Bird Habitat | 22 |
| Discussion..... | 26 |
| Acknowledgements..... | 29 |
| Literature Cited..... | 29 |

Figures

| | Page |
|---|------|
| Figure 1. Bird plot locations on Agate Fossil Beds National Monument, Nebraska..... | 4 |
| Figure 2. Average (\pm std dev) species richness, diversity and species distribution evenness values for the breeding bird community in the riparian area at Agate Fossil Beds National Monument, Nebraska during the breeding seasons, years 2001 - 2006..... | 21 |
| Figure 3. Average (\pm std dev) species richness, diversity and species distribution evenness values for the breeding bird community in the prairie at Agate Fossil Beds National Monument, Nebraska during the breeding seasons, years 2001 - 2006..... | 21 |
| Figure 4. Average (\pm std dev) density of: A) Grasshopper Sparrow B) Western Meadowlark in the prairie and riparian areas at Agate Fossil Beds National Monument, Nebraska during the breeding seasons, years 2001 - 2006..... | 27 |

Tables

| | Page |
|---|------|
| Table 1. Species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys, years 2001-2006..... | 9 |
| Table 2. Number of individuals encountered per plot visit, for bird species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys..... | 11 |
| Table 3. Proportion of plots occupied by bird species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys..... | 14 |
| Table 4. Average density (\pm std. dev.) of bird species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys..... | 17 |
| Table 5. Average bird density (\pm std. dev.) for plots occupied by species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys..... | 19 |
| Table 6. Average (\pm std. dev.) coverage of habitat parameters on plots visited in the riparian area at Agate Fossil Beds National Monument, Nebraska during the breeding bird season, 2001-2006..... | 23 |
| Table 7. Average (\pm std. dev.) coverage of habitat parameters on plots visited in the prairie at Agate Fossil Beds National Monument, Nebraska during the breeding bird season, 2001-2006..... | 25 |

Executive Summary

Between 2001 and 2006, 54 plots (14 riparian, 40 prairie) were visited during annual surveys to characterize the breeding bird population at Agate Fossil Beds National Monument. Thirty-nine species occurred in riparian habitat, 43 in prairie habitat. Accounting for species overlap between habitats, 60 different species occurred on the monument. Only nine species breed on the monument annually, however: Common Yellowthroat, Mourning Dove, Marsh Wren, Common Snipe, and Mallard in the riparian zone; Grasshopper Sparrow and Lark Sparrow in the prairie; and Red-winged Blackbird and Western Meadowlark in both habitats. Seven grassland obligates were observed: Dickcissel, Grasshopper Sparrow, Horned Lark, Northern Harrier, Upland Sandpiper, Vesper Sparrow and Western Meadowlark. Partners in Flight, a consortium of bird conservation agencies and interested individuals, lists seven of the species observed as “species of continental importance”: Brown Thrasher, Dickcissel, Grasshopper Sparrow, Lark Bunting, Sharp-tailed Grouse, Swainson’s Hawk, and White-crowned Sparrow. Four of these species (Grasshopper Sparrow, Lark Bunting, Sharp-tailed Grouse, and Swainson’s Hawk), along with Upland Sandpiper, are species of conservation importance for the shortgrass prairie ecotype. The most commonly recorded species on the Monument across habitats was the Red-winged Blackbird. Management decisions aimed at influencing bird populations should center on those species identified as being of local or continental importance. Yet even species common at the site, such as the Red-winged Blackbird, face regional population declines.

Low species richness, diversity, and evenness values are defining features of shortgrass bird communities. Therefore, species richness, diversity, and distribution evenness values for the breeding bird community on the monument, which appear low when compared to other ecotypes, are quite normal. Average species richness on plots surveyed is less than 3.70 and 5.57 for the bird communities in prairie and riparian habitat, respectively.

Breeding bird habitat on Agate Fossil Beds National Monument is primarily shortgrass prairie and lowland riparian vegetation. Marshy wetland and stream habitats dominate the riparian corridor along the Niobrara River. Other habitats, such as willow shrubland and riparian woodland are also present, although rare. The vegetation is densest below 1-m in the riparian area but provides nesting cover up to 2-m in height. Vegetation in the riparian area consisted primarily of cool-season grasses, forbs, woody shrubs and vines, warm-season grasses, and moss and lichens with total foliar cover less than 50%. Dominating the upland prairie was shortgrass habitat with screening vegetation during the breeding season densest to 0.75-m in height. Little vegetation occurred above 1-m in height in the prairie. Cool-season grasses are most abundant in the prairie, followed by forbs, warm-season grasses, woody shrubs and vines, and moss and lichens. Total foliar coverage was less than 50% in the prairie as well.

Results from our first five years of bird monitoring on the monument provides a baseline on which to measure future changes in bird communities and their habitat. With knowledge of the nesting ecology of bird species and our habitat monitoring results, monument staff can make more informed natural resource management decisions that affect the breeding success of many bird species.

Introduction

Birds are an important component of park ecosystems, as their high body temperature, rapid metabolism, and high ecological position in most food webs make them good indicators of the effects of local and regional changes in ecosystems. It has been suggested that management activities aimed at preserving habitat for bird populations, such as for neotropical migrants, can have the added benefit of preserving entire ecosystems and their attendant ecosystem services (Karr 1991, Maurer 1993). Moreover, birds have a tremendous following among the public and many parks provide information on the status and trends of their birds through interpretive programs.

Once covering vast areas of the North American continent, native Great Plains grasslands are rapidly disappearing. During the last century, large portions of grassland landscapes were plowed for cropland or converted to livestock pasture (29% of shortgrass, 41% of mixed-grass, and 99% of tallgrass prairie; Knopf and Sampson 1997). Remaining grasslands have been altered through continued fragmentation and isolation, interruption of driving ecological processes such as periodic wildfire, and loss of significant faunal species, including bison (*Bos bison*), elk (*Cervus elaphus*), and wolves (*Canis lupus*).

While not affected to the extent of large native ungulates and mammalian predators, many grassland bird species have also demonstrated declining abundance as prairie habitat loss continues. Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 1966 and 1999 indicates that 70% of 29 grassland bird species show evidence of population declines (Sauer et al. 2000). Many prairie species such as the Grasshopper Sparrow (*Ammodramus savannarum*), Eastern Meadowlark (*Sturnella magna*), Horned Lark (*Eremophila alpestris*), Bobolink (*Dolichonyx oryzivorus*), Lark Bunting (*Calamospiza melanocrys*), and Dickcissel (*Spiza americana*) have declined at alarming rates. The destruction and fragmentation of prairie landscapes, as well as structural degradation (e.g. fire suppression, changes in grazing regimes, etc.) of remaining prairie habitats have contributed to these declines.

Trends in the composition and abundance of grassland bird populations have been proposed as a long-term indicator of prairie ecosystem integrity, which is defined as the capability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region (Karr and Dudley 1981). At Agate Fossil Beds National Monument, Nebraska, a native shortgrass prairie exists. Monitoring long-term trends in the community composition and abundance of breeding bird populations provides one measure for assessing the ecological integrity and sustainability of this prairie.

Objectives

There are two primary objectives for monitoring breeding birds at Agate Fossil Beds National Monument:

- Determine temporal changes in the species composition and abundance of birds that occur on the monument during the breeding season.

- Improve our understanding of breeding bird – habitat relationships and the effects of management actions such as prescribed fire on bird populations by correlating changes in bird community composition and abundance with changes in specific habitat variables (e.g. vegetation structure, ground cover).

This report summarizes survey results for the first five years of monitoring.

Methods

Site Selections

Permanent sampling locations were selected by overlaying a systematic grid of 400 x 400-m cells (originating from a random starting point) on a park map. Systematic sampling across the park will allow us to make park-wide inferences concerning the avian community. The orientation of the grid was rotated 45 degrees from North to prevent sampling sites from being influenced by man-made features (roads, fences, etc.) oriented along cardinal directions. The riparian corridor was identified as a separate stratum, with sampling extending 125 m on either side of the stream channel (Niobrara River). The riparian stratum makes up 15.6% of the total park area of 965 ha. Within the riparian stratum, plots were located at 250-m intervals along the extent of the stream. Any plots from the overall park grid that fell within the riparian stratum were discarded. Forty plots were established in prairie, with an additional 14 plots established in the riparian (Fig. 1). Sampling locations were not physically marked on the ground; rather UTM coordinates were maintained and located in the field with a GPS unit each time a plot was surveyed.

This systematic approach to selecting sampling sites allows flexibility to choose the appropriate reference frame for answering a variety of monitoring questions. When making park-wide inferences, results may be weighted by area for each stratum, then combined to give an overall park average and variance if desired. At the same time, more intensive sampling in the riparian corridor ensures an adequate sample to describe habitat relationships specific to this less common, but important stratum. The systematic grid also allows us to limit the reference frame appropriately when asking more specific monitoring questions (e.g. only those sampling points within particular habitat would be used to compare the avian response to that habitat type).

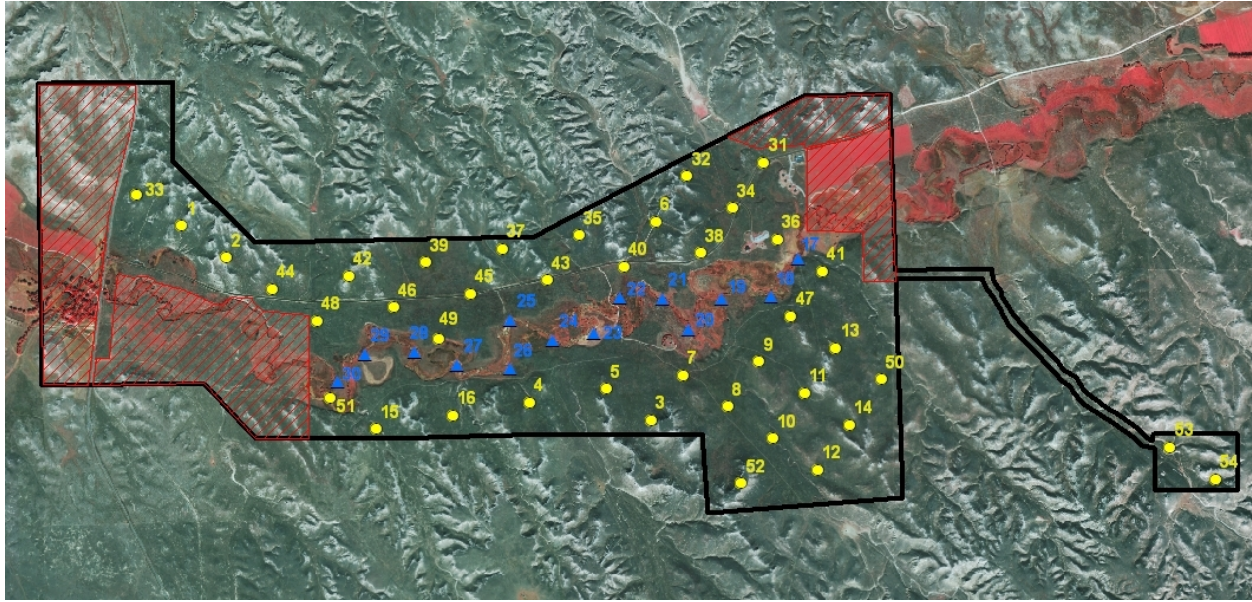


Figure 1. Bird plot locations on Agate Fossil Beds National Monument, Nebraska.

Grassland Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2003) and summarized below. Variable circular plot counts, a point count methodology that incorporates a measure of detectability into population estimates, were used to survey birds present (Fancy 1997). All birds seen or heard at plots during 5-min sampling periods were recorded along with their corresponding distance from the observer. Bird observations were separated into two time segments: those detected during the first three minutes of the count (to allow future comparisons with the national Breeding Bird Survey data), and any new birds detected during the final two minutes of the count. We counted all birds and recorded their distance from the observer. For most species, we recorded each individual bird as a separate observation. For species that usually occur in clusters or flocks, the units recorded were cluster or flock size, rather than the individual bird. After completing a count at a plot and filling out the data sheet, the observer navigated to the next plot using a GPS unit. Approximately thirteen or fourteen plots were sampled on a typical morning, when it was light enough to observe birds but not beyond four hours post sunrise. Fourteen riparian and 13 prairie plots were surveyed in 2001. Fourteen riparian and 40 prairie plots were surveyed in all other years. Sampling dates included May 7 – 11, 2001; June 3- 6, 2003; June 7 – 10, 2004; June 6 – 9, 2005 and June 6 – 9, 2006.

When we conduct a variable circular plot count, we are attempting to get an “instantaneous count” of all birds present. The observer records birds flushed from a plot when approached and counts start as soon as the observer reaches the plot center. Our method takes into account the fact that birds close to the observer have a higher probability of being detected (if they are not flushed) than birds far from the observer, and that different species have different detection functions (i.e., the probability of detecting a bird at different distances from the observer). An important assumption of the method is that a bird exactly at the center of the plot has a 100% probability of being detected, and that there is a high probability of detecting birds within the first 5-10 meters of the plot center. The most important birds to detect are those very close to the

observer (within the first 5-10 meters), and it is highly desirable that estimated distances, or those taken with a rangefinder, be within 1-2 meters of actual distances for any bird within 20 meters of the observer. We record all birds seen or heard along with distance from the observer when possible. For this report, all birds seen or heard during the full 5-min are included.

Grassland Bird Habitat

The collection of habitat data followed methods outlined in the bird monitoring protocol by Peitz et al. (2003) and summarized below. Habitat data collection started after the first variable circular plot count was completed. Observers visited plots for habitat measures in the same order they were surveyed for birds to avoid disturbing birds on a plot prior to a survey. Once the habitat crew arrived at a plot, they set up subplot one (plot center) and completed all habitat measures for this subplot and the 50-m radius plot, before locating and completing habitat measures on subplots two, three, and four. The azimuth to subplot two was determined randomly; subplots three and four were positioned 120 degrees on either side of two. Azimuths were determined the first time a plot was monitored, with azimuths maintained in subsequent years (see Peitz and Rowell 2003).

Habitat available to each bird species was characterized at a number of different scales. First, slope, slope variability, aspect, aspect variability, and topographic position of each 50-m radius plot were determined and recorded. These measurements only needed to be recorded during the first year of monitoring (see Peitz and Rowell 2003). Recorded each year were the amount of various vegetation types and the amount of road and water cover on each plot. Second, azimuth ($^{\circ}$) to and slope ($^{\circ}$) and aspect ($^{\circ}$) of each 5-m subplot were determined and recorded (see Peitz and Rowell 2003). These measures only needed recorded during the first year a plot was monitored as well. Each year a plot was visited, horizontal vegetation cover was estimated in 0.5-m intervals from 0.0 to 2.0 meters above ground surface using a cover board. The amount of vegetation impeding our ability to see the cover board was estimated at 5- and 15-m distances from the center of each subplot. Using a graduated measuring rod, vertical vegetation structures were measured in 1-m increments up to 7.5 m in height at four locations around the perimeter of each subplot. Locations were in the four cardinal directions. Vertical structure was recorded for deciduous and herbaceous vegetation. Third, within each subplot, ground and foliar cover were recorded in 1.78-m radius nested sample plots. Ground cover included deciduous and grass litter, bare soil, rock, woody debris (>2.50 cm DBH), and un-vegetated ground. Foliar cover was estimated for five plant guilds, including warm- and cool-season grasses, forbs, moss and lichens, and shrubs and vines, and for total foliar cover (<1.50 m tall).

Data Analysis

Prior to summary analyses, the residency status (permanent resident, summer resident, migrant) of each bird species recorded was determined (Stokes and Stokes 1996a, b). Identifying the residency of each species helps to exclude migrants from analyses of breeding birds within the park. Both residency status and territorial males, those males observed singing, help establish the breeding bird community. The frequency and abundance of bird species is reported in four ways: (1) For each species, the average number of individuals encountered per plot visit (including plots at which the species was absent) was calculated. (2) The proportion of plots occupied by each species was determined. (3) Restricting the area of inference to a 100-m radius around each plot center, we determined the average density (\pm std dev) for each species across

plots. (4) Local density was calculated using data from plots only where the species was encountered.

Distance software, which accounts for un-detected individuals, was used to estimate species density when there were enough observations (~60) to do so accurately (Buckland et al. 1993, Buckland et al. 2001). Densities of the Grasshopper Sparrow, Red-winged Blackbird (*Agelaius phoeniceus*) and Western Meadowlark (*Sturnella neglecta*) were determined with Distance.

Annual bird diversity, richness, and distribution evenness were calculated by plot with averages (\pm std dev) estimated for both the prairie and riparian habitat. Bird diversity values for each plot were calculated using the Shannon Diversity Index:

$$H' = -\sum(n_i/N)\ln(n_i/N)$$

where n_i/N is the proportion of the total number of individuals in a population consisting of the i^{th} species (Shannon 1949). Species richness is the total number of bird taxa recorded per plot. Species distribution evenness is calculated for each plot using Pielou (J):

$$J' = H' / H_{\text{max}}$$

where H' is the Shannon Diversity Index and H_{max} is the maximum possible diversity for a given number of species if all species are present in equal numbers ($\ln(\text{species richness})$). J' is a measure of how evenly individuals are distributed within a community when compared to the equal distribution and maximum diversity a community can have (Pielou 1969).

Location and permanent abiotic features of each plot and habitat subplot were reported (see Peitz and Rowell 2003). Annual averages (\pm std dev) for semi-permanent plot data, including road and water cover were calculated from plot estimates for both the prairie and riparian habitat. Using calculated plot averages or values, averages (\pm std dev) for horizontal vegetation cover between 0 – 0.5, 0.25-0.75, 0.5 – 1.0, 0.75-1.25, 1.0 – 1.5, 1.25-1.75, and 1.5 – 2.0 meters were calculated for 5- and 15-m distances for both the prairie and riparian habitat. Average (\pm std dev) vertical structure diversity values were estimated and reported as well. Vertical structure diversity values were determined for each plot using a modified Shannon Diversity Index:

$$H' = -\sum(n_i/N)\ln(n_i/N)$$

where n_i/N is the proportion of vegetation touching a measuring rod in the i^{th} meter increment to the total number of touches from vegetation along the rod.

Within each plot, ground cover, including deciduous and grass litter, bare soil, rock, woody debris (>2.50 cm DBH), and unvegetated ground were averaged across subplots, with habitat averages (\pm std dev) reported for both the prairie and riparian areas using these values. Foliar cover, by guild of warm- and cool-season grasses, forbs, mosses and lichens, shrubs and vines, and total foliar cover (<1.50 m tall) were averaged across subplots, with habitat averages (\pm std dev) reported for both the prairie and riparian areas using these values.

Results

Grassland Bird Surveys

Sixty bird species were recorded during surveys between 2001 and 2006 (Table 1). Fifteen of the 60 species recorded are classified as permanent residents, 38 as summer residents and the remaining seven as late migrants or species on the edge of their range (Stokes and Stokes 1996a,b). Seven species [Brown Thrasher (*Toxostoma rufum*), Dickcissel (*Spiza americana*), Grasshopper Sparrow, Lark Bunting, Sharp-tailed Grouse (*Tympanuchus phasianellus*), Swainson's Hawk (*Buteo swainsoni*), and White-crowned Sparrow (*Zonotrichia leucophrys*)] are considered "species of continental importance" (Rich et al. 2004). Seven species [Dickcissel, Grasshopper Sparrow, Horned Lark, Northern Harrier (*Circus cyaneus*), Upland Sandpiper (*Bartramia longicauda*), Vesper Sparrow (*Pooecetes gramineus*), and Western Meadowlark] are all grassland obligates (Northern Prairie Wildlife Research Center, 2006). Ten species [American Avocet (*Recurvirostra americana*), American Crow (*Corvus brachyrhynchos*), Belted Kingfisher (*Megaceryle alcyon*), Gray Partridge (*Perdix perdix*), Rock Dove (*Columba livia*), Sora (*Porzana carolina*), Spotted Towhee (*Pipilo maculatus*), Swainson's Hawk, Turkey Vulture (*Cathartes aura*), and White-crowned Sparrow] were only observed outside the five minute plot surveys.

Thirty-two species were encountered in the riparian area, seven of which were encountered in all sample years (Table 2). Of these seven species, the Red-winged Blackbird had the highest number of individuals per plot visit, followed by Western Meadowlark, Common Yellowthroat (*Geothlypis trichas*), Mourning Dove (*Zenaida macroura*), Marsh Wren (*Cistothorus palustris*), Common Snipe (*Gallinago gallinago*), and Mallard (*Anas platyrhynchos*), in that order. In the prairie, thirty-nine species were encountered, four of which were observed every year. The Western Meadowlark had the highest number of individuals per plot visit, followed by Grasshopper Sparrow, Red-winged Blackbird, and Lark Sparrow (*Chondestes grammacus*).

The Red-winged Blackbird was the most widely distributed species in the riparian area during the breeding season, occupying nearly 100% of all plots surveyed (Table 3). The Western Meadowlark was the second most widely distributed bird followed by Common Yellowthroat, Marsh Wren, Mourning Dove, Common Snipe and Mallard. Western Meadowlark was the most widely distributed bird in the prairie. Grasshopper Sparrow was the second most widely distributed bird, followed by Lark Sparrow and Red-winged Blackbird.

Average (\pm std dev) numbers of individuals per hectare across all plots during the breeding season are given by year in Table 4. Bird densities varied widely, ranging from less than one individual per 100 hectares for a number of species in the prairie, to a high of almost eight Red-winged Blackbirds per hectare in the riparian area. In the riparian area, the Red-winged Blackbird had the highest densities annually of any species, followed by Western Meadowlark, Common Yellowthroat and Marsh Wren, in that order. In the prairie, the Grasshopper Sparrow had the highest density annually, followed by Western Meadowlark and Lark Sparrow.

Average (\pm std dev) number of individuals per hectare calculated only for plots occupied during the breeding season are given by year in Table 5. Like densities across all plots, bird densities for plots occupied varied widely across species. Densities for plots occupied ranged from less

than one individual per three hectares for a number of species in both habitats, to a high of almost eight Red-winged Blackbirds per one hectare. In the riparian area, the Red-winged Blackbird had the highest densities annually on plots occupied by any species, followed by Western Meadowlark, Common Yellowthroat, and Marsh Wren, in that order. In the prairie, the Grasshopper Sparrow had the highest density annually on plots occupied, followed by Western Meadowlark and Lark Sparrow.

Species richness, diversity, and species distribution evenness values varied among sample years (Figs. 2 and 3). In the riparian area, average richness ranged from 3.43 species in 2001 to 5.57 species in 2005, diversity from 0.91 in 2001 to 1.46 in 2005 and species distribution evenness from 0.73 in 2001 to 0.89 in 2003. In the prairie, average richness ranged from 1.69 species in 2001 to 3.70 in 2006, diversity from 0.46 in 2001 to 1.14 in 2006 and species distribution evenness from 0.58 in 2001 to 0.93 in 2006. Species richness in the riparian area increased approximately 48% between 2001 and 2006. A much smaller increase (3.5%) in species richness was observed in the prairie, when 2001 was left out of the analysis. In 2001, only 13 prairie plots were visited versus 40 in other years.

Table 1. Species recorded at Agate Fossil Beds National Monument, Nebraska during bird surveys, years 2001-2006.

| Common name | Scientific name | AOU code ¹ | Status ² | Common name | Scientific name | AOU code | Status |
|--------------------------------|---------------------------------|-----------------------|---------------------|---|--------------------------------------|-------------|-----------|
| American Avocet ³ | <i>Recurvirostra americana</i> | AMAV | SR | Lark Bunting | <i>Calamospiza melanocorys</i> | LARB | SR |
| American Bittern | <i>Botaurus lentiginosus</i> | AMBI | SR | Lark Sparrow | <i>Chondestes grammacus</i> | LASP | SR |
| American Crow ³ | <i>Corvus brachyrhynchos</i> | AMCR | R | Mallard | <i>Anas platyrhynchos</i> | MALL | R |
| American Goldfinch | <i>Carduelis tristis</i> | AMGO | R | Marsh Wren | <i>Cistothorus palustris</i> | MAWR | SR |
| American Robin | <i>Turdus migratorius</i> | AMRO | SR | Mourning Dove | <i>Zenaida macroura</i> | MODO | R |
| Bank Swallow | <i>Riparia riparia</i> | BANS | SR | Northern Harrier | <i>Circus cyaneus</i> | NOHA | SR |
| Barn Swallow | <i>Hirundo rustica</i> | BARS | SR | Northern (Baltimore) Oriole | <i>Icterus galbula</i> | BAOR | M |
| Belted Kingfisher ³ | <i>Megaceryle alcyon</i> | BEKI | R | Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> | NRWS | SR |
| Blue Grosbeak | <i>Guiraca caerulea</i> | BLGR | SR | Orchard Oriole | <i>Icterus spurius</i> | OROR | SR |
| Blue Jay | <i>Cyanocitta cristata</i> | BLJA | R | Red-tailed Hawk | <i>Buteo jamaicensis</i> | RTHA | R |
| Blue-winged Teal | <i>Anas discors</i> | BWTE | SR | Red-winged Blackbird | <i>Agelaius phoeniceus</i> | RWBL | R |
| Brewer's Blackbird | <i>Euphagus cyanocephalus</i> | BRBL | M | Ring-necked Pheasant | <i>Phasianus colchicus</i> | RPHE | R |
| Brown-headed Cowbird | <i>Molothrus ater</i> | BHCO | SR | Rock Dove ³ | <i>Columba livia</i> | RODO | R |
| Brown Thrasher | <i>Toxostoma rufum</i> | BRTH | SR | Rock Wren | <i>Salpinctes obsoletus</i> | ROWR | SR |
| Chipping Sparrow | <i>Spizella passerina</i> | CHSP | SR | Say's Phoebe | <i>Sayornis saya</i> | SAPH | SR |
| Cinnamon Teal | <i>Anas cyanoptera</i> | CITE | M | Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | STGR | R |
| Clay-colored Sparrow | <i>Spizella pallida</i> | CCSP | SR | Sora ³ | <i>Porzana carolina</i> | SORA | SR |
| Cliff Swallow | <i>Petrochelidon pyrrhonota</i> | CLSW | SR | Spotted (Rufous-side) Towhee ³ | <i>Pipilo maculatus</i> | SPTO | SR |
| Common Grackle | <i>Quiscalus quiscula</i> | COGR | SR | Swainson's Hawk³ | <i>Buteo swainsoni</i> | SWHA | SR |
| Common Nighthawk | <i>Chordeiles minor</i> | CONI | SR | Tree Swallow | <i>Tachycineta bicolor</i> | TRES | M |
| Common Snipe | <i>Gallinago gallinago</i> | COSN | M | Turkey Vulture ³ | <i>Cathartes aura</i> | TUVU | SR |
| Common Yellowthroat | <i>Geothlypis trichas</i> | COYE | SR | Upland Sandpiper | <i>Bartramia longicauda</i> | UPSA | SR |
| Dickcissel | <i>Spiza americana</i> | DICK | SR | Vesper Sparrow | <i>Poocetes gramineus</i> | VESP | SR |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | EAKI | SR | Western Kingbird | <i>Tyrannus verticalis</i> | WEKI | SR |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | GRSP | SR | Western Meadowlark | <i>Sturnella neglecta</i> | WEME | R |
| Gray Catbird | <i>Dumetella carolinensis</i> | GRCA | SR | White-crowned Sparrow ³ | <i>Zonotrichia leucophrys</i> | WCSP | M |
| Gray Partridge ³ | <i>Perdix perdix</i> | GRPA | R | Wood Duck | <i>Aix sponsa</i> | WODU | M |
| Great Blue Heron | <i>Ardea herodias</i> | GBHE | SR | Yellow-headed Blackbird | <i>Xanthocephalus xanthocephalus</i> | YHBL | SR |
| Horned Lark | <i>Eremophila alpestris</i> | HOLA | R | Yellow Warbler | <i>Dendroica petechia</i> | YWAR | SR |
| House Wren | <i>Troglodytes aedon</i> | HOWR | SR | | | | |
| Killdeer | <i>Charadrius vociferous</i> | KILL | R | | | | |

Table 1. continued

¹ American Ornithologists' Union (AOU) code.

² Status: SR = summer resident; R = year round resident; M = late migrant or edge of range; from Stokes and Stokes (1996a, b).

³ Species recorded while traveling between point transects or at other times outside of 5-min survey periods.

Species names are valid and verified names taken from ITIS (Integrated Taxonomic Information System). <http://www.itis.usda.gov/>.

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 2. Number of individuals encountered per plot visit, for bird species at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys. Individual species results are listed by year (2001-2006) and habitat type (Riparian, Prairie). Average number of individuals per plot includes all individuals recorded on plots during a 5-min survey, including flyovers.

| Common name | Scientific name | 2001 | 2003 | 2004 | 2005 | 2006 |
|--------------------------------|---|-------------|-------------|-------------|-------------|-------------|
| Riparian | | | | | | |
| American Bittern | <i>Botaurus lentiginosus</i> | -- | -- | -- | 0.07 | -- |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | 0.07 | 0.14 | 0.07 |
| American Robin | <i>Turdus migratorius</i> | -- | -- | -- | 0.07 | -- |
| Bank Swallow | <i>Riparia riparia</i> | -- | 0.14 | 0.14 | 0.14 | 0.07 |
| Barn Swallow | <i>Hirundo rustica</i> | -- | 0.14 | -- | 0.21 | -- |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.07 |
| Blue Jay | <i>Cyanocitta cristata</i> | 0.07 | -- | -- | -- | -- |
| Blue-winged Teal | <i>Anas discors</i> | 0.14 | 0.07 | 0.07 | 0.21 | -- |
| Brown-headed Cowbird | <i>Molothrus ater</i> | 0.36 | 0.29 | -- | 0.07 | 0.14 |
| Brown Thrasher | <i>Toxostoma rufum</i> | -- | -- | -- | 0.07 | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.29 | -- | -- | -- | -- |
| Cinnamon Teal | <i>Anas cyanoptera</i> | -- | -- | -- | -- | 0.07 |
| Cliff Swallow | <i>Petrochelidon pyrrhonota</i> | -- | -- | -- | -- | 0.43 |
| Common Grackle | <i>Quiscalus quiscula</i> | -- | -- | 0.07 | -- | -- |
| Common Nighthawk | <i>Chordeiles minor</i> | -- | -- | -- | 0.50 | 0.14 |
| Common Snipe | <i>Gallinago gallinago</i> | 0.43 | 0.14 | 0.29 | 0.21 | 0.21 |
| Common Yellowthroat | <i>Geothlypis trichas</i> | 0.29 | 0.71 | 0.57 | 0.79 | 0.79 |
| Dickcissel | <i>Spiza americana</i> | -- | -- | -- | -- | 0.21 |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.29 | 0.07 | 0.14 | 0.07 |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | 0.07 | 0.21 | 0.07 | -- | 0.07 |
| Great Blue Heron | <i>Ardea herodias</i> | -- | 0.07 | 0.07 | -- | 0.14 |
| House Wren | <i>Troglodytes aedon</i> | -- | 0.07 | -- | -- | -- |
| Killdeer | <i>Charadrius vociferous</i> | 0.50 | 0.21 | 0.07 | -- | 0.07 |
| Lark Bunting | <i>Calamospiza melanocorys</i> | 0.36 | 0.07 | -- | -- | -- |
| Lark Sparrow | <i>Chondestes grammacus</i> | 0.07 | -- | -- | 0.07 | -- |
| Mallard | <i>Anas platyrhynchos</i> | 0.07 | 0.07 | 0.50 | 0.36 | 0.07 |
| Marsh Wren | <i>Cistothorus palustris</i> | 0.14 | 0.14 | 0.29 | 0.43 | 0.50 |
| Mourning Dove | <i>Zenaida macroura</i> | 0.14 | 0.14 | 0.07 | 0.93 | 0.36 |
| Northern (Baltimore) Oriole | <i>Icterus galbula</i> | -- | -- | -- | -- | 0.07 |
| Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> | 0.07 | -- | -- | -- | -- |
| Red-winged Blackbird | <i>Agelaius phoeniceus</i> | 5.43 | 3.36 | 5.00 | 4.43 | 4.43 |
| Ring-necked Pheasant | <i>Phasianus colchicus</i> | 0.07 | -- | 0.29 | 0.07 | 0.07 |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | -- | -- | -- | 0.36 | -- |
| Upland Sandpiper | <i>Bartramia longicauda</i> | -- | -- | -- | 0.07 | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | 0.07 | -- | 0.14 | -- |
| Western Meadowlark | <i>Sturnella neglecta</i> | 0.50 | 1.36 | 0.50 | 1.29 | 0.86 |
| Wood Duck | <i>Aix sponsa</i> | -- | 0.07 | -- | -- | 0.07 |
| Yellow-headed Blackbird | <i>Xanthocephalus xanthocephalus</i> | -- | 0.21 | -- | -- | -- |
| Yellow Warbler | <i>Dendroica petechia</i> | 0.07 | 0.14 | 0.43 | -- | 0.57 |

Table 2. continued

| Common name | Scientific name | 2001 | 2003 | 2004 | 2005 | 2006 |
|-------------------------------|--|-------------|-------------|-------------|-------------|-------------|
| Prairie | | | | | | |
| American Bittern | <i>Botaurus lentiginosus</i> | -- | -- | -- | 0.03 | -- |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | -- | -- | 0.03 |
| American Robin | <i>Turdus migratorius</i> | -- | -- | -- | 0.03 | -- |
| Bank Swallow | <i>Riparia riparia</i> | -- | 0.15 | 0.03 | -- | -- |
| Barn Swallow | <i>Hirundo rustica</i> | -- | -- | -- | 0.03 | -- |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.05 |
| Brewer's Blackbird | <i>Euphagus cyanocephalus</i> | -- | -- | -- | -- | 0.03 |
| Brown-headed Cowbird | <i>Molothrus ater</i> | -- | 0.15 | 0.15 | 0.18 | 0.13 |
| Brown Thrasher | <i>Toxostoma rufum</i> | -- | -- | -- | 0.03 | -- |
| Clay-colored Sparrow | <i>Spizella pallida</i> | -- | 0.05 | -- | -- | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.31 | -- | -- | -- | -- |
| Cliff Swallow | <i>Petrochelidon pyrrhonota</i> | -- | 0.03 | 0.03 | -- | 0.10 |
| Common Grackle | <i>Quiscalus quiscula</i> | 0.31 | -- | -- | -- | 0.03 |
| Common Nighthawk | <i>Chordeiles minor</i> | -- | 0.03 | 0.05 | 0.05 | 0.40 |
| Common Snipe | <i>Gallinago gallinago</i> | -- | 0.08 | 0.03 | 0.05 | 0.08 |
| Common Yellowthroat | <i>Geothlypis trichas</i> | -- | 0.03 | -- | 0.08 | 0.03 |
| Dickcissel | <i>Spiza americana</i> | -- | 0.03 | -- | -- | -- |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.03 | -- | -- | -- |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | 0.54 | 1.03 | 0.73 | 0.70 | 0.80 |
| Gray Catbird | <i>Dumetel carolinensis</i> | -- | -- | -- | 0.03 | -- |
| Horned Lark | <i>Eremophila alpestris</i> | -- | -- | -- | 0.03 | 0.10 |
| Killdeer | <i>Charadrius vociferous</i> | -- | 0.13 | 0.05 | 0.03 | 0.13 |
| Lark Bunting | <i>Calamospiza melanocorys</i> | -- | 0.40 | 1.00 | 0.03 | 0.15 |
| Lark Sparrow | <i>Chondestes grammacus</i> | 0.31 | 0.38 | 0.18 | 0.68 | 0.50 |
| Mallard | <i>Anas platyrhynchos</i> | -- | -- | 0.03 | -- | 0.08 |
| Marsh Wren | <i>Cistothorus palustris</i> | -- | -- | -- | -- | 0.03 |
| Mourning Dove | <i>Zenaidura macroura</i> | -- | 0.15 | 0.18 | 0.15 | 0.40 |
| Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> | -- | -- | -- | -- | 0.03 |
| Orchard Oriole | <i>Icterus spurius</i> | -- | -- | -- | -- | 0.03 |
| Red-tailed Hawk | <i>Buteo jamaicensis</i> | -- | 0.03 | -- | 0.03 | 0.03 |
| Red-winged Blackbird | <i>Agelaius phoeniceus</i> | 0.08 | 0.50 | 0.55 | 0.33 | 0.73 |
| Ring-necked Pheasant | <i>Phasianus colchicus</i> | -- | 0.15 | -- | 0.05 | 0.05 |
| Rock Wren | <i>Salpinctes obsoletus</i> | -- | 0.15 | 0.08 | 0.20 | 0.15 |
| Say's Phoebe | <i>Sayornis saya</i> | -- | 0.03 | -- | -- | -- |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | 0.08 | -- | 0.03 | -- | 0.03 |
| Tree Swallow | <i>Tachycineta bicolor</i> | -- | -- | -- | -- | 0.03 |
| Upland Sandpiper | <i>Bartramia longicauda</i> | 0.08 | -- | 0.05 | -- | 0.03 |
| Vesper Sparrow | <i>Poocetes gramineus</i> | 0.15 | -- | -- | -- | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | 0.15 | -- | 0.03 | 0.05 |
| Western Meadowlark | <i>Sturnella neglecta</i> | 1.15 | 2.35 | 1.58 | 2.45 | 2.00 |
| Wood Duck | <i>Aix sponsa</i> | -- | -- | -- | -- | 0.05 |

Table 2. continued

| Common name | Scientific name | 2001 | 2003 | 2004 | 2005 | 2006 |
|--------------------------------|--------------------------------------|------|-------------|------|------|------|
| Yellow-headed Blackbird | <i>Xanthocephalus xanthocephalus</i> | -- | 0.08 | -- | -- | -- |
| Yellow Warbler | <i>Dendroica petechia</i> | -- | 0.08 | 0.03 | 0.03 | 0.05 |

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 3. Proportion of plots occupied by bird species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys. Individual species results are listed by year (2001-2006) and habitat type (Riparian, Prairie). Proportion of plots occupied is determined using individuals recorded on plots during a 5-min survey, including flyovers.

| Common name | Scientific name | 2001 | 2003 | 2004 | 2005 | 2006 |
|--------------------------------|---|-------------|-------------|-------------|-------------|-------------|
| Riparian | | | | | | |
| American Bittern | <i>Botaurus lentiginosus</i> | -- | -- | -- | 0.07 | -- |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | 0.07 | 0.07 | 0.07 |
| American Robin | <i>Turdus migratorius</i> | -- | -- | -- | 0.07 | -- |
| Bank Swallow | <i>Riparia riparia</i> | -- | 0.07 | 0.14 | 0.14 | 0.07 |
| Barn Swallow | <i>Hirundo rustica</i> | -- | 0.07 | -- | 0.14 | -- |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.07 |
| Blue Jay | <i>Cyanocitta cristata</i> | 0.07 | -- | -- | -- | -- |
| Blue-winged Teal | <i>Anas discors</i> | 0.07 | 0.07 | 0.07 | 0.14 | -- |
| Brown-headed Cowbird | <i>Molothrus ater</i> | 0.07 | 0.07 | -- | 0.07 | 0.07 |
| Brown Thrasher | <i>Toxostoma rufum</i> | -- | -- | -- | 0.07 | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.21 | -- | -- | -- | -- |
| Cinnamon Teal | <i>Anas cyanoptera</i> | -- | -- | -- | -- | 0.07 |
| Cliff Swallow | <i>Petrochelidon pyrrhonota</i> | -- | -- | -- | -- | 0.07 |
| Common Grackle | <i>Quiscalus quiscula</i> | -- | -- | 0.07 | -- | -- |
| Common Nighthawk | <i>Chordeiles minor</i> | -- | -- | -- | 0.14 | 0.14 |
| Common Snipe | <i>Gallinago gallinago</i> | 0.29 | 0.14 | 0.21 | 0.21 | 0.21 |
| Common Yellowthroat | <i>Geothlypis trichas</i> | 0.21 | 0.43 | 0.43 | 0.64 | 0.64 |
| Dickcissel | <i>Spiza americana</i> | -- | -- | -- | -- | 0.14 |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.14 | 0.07 | 0.07 | 0.07 |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | 0.07 | 0.14 | 0.07 | -- | 0.07 |
| Great Blue Heron | <i>Ardea herodias</i> | -- | 0.07 | 0.07 | -- | 0.14 |
| House Wren | <i>Troglodytes aedon</i> | -- | 0.07 | -- | -- | -- |
| Killdeer | <i>Charadrius vociferous</i> | 0.29 | 0.21 | 0.07 | -- | 0.07 |
| Lark Bunting | <i>Calamospiza melanocorys</i> | 0.07 | 0.07 | -- | -- | -- |
| Lark Sparrow | <i>Chondestes grammacus</i> | 0.07 | -- | -- | 0.07 | -- |
| Mallard | <i>Anas platyrhynchos</i> | 0.07 | 0.07 | 0.14 | 0.36 | 0.07 |
| Marsh Wren | <i>Cistothorus palustris</i> | 0.14 | 0.14 | 0.29 | 0.29 | 0.36 |
| Mourning Dove | <i>Zenaida macroura</i> | 0.07 | 0.07 | 0.07 | 0.50 | 0.36 |
| Northern (Baltimore) Oriole | <i>Icterus galbula</i> | -- | -- | -- | -- | 0.07 |
| Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> | 0.07 | -- | -- | -- | -- |
| Red-winged Blackbird | <i>Agelaius phoeniceus</i> | 1.00 | 1.00 | 1.00 | 1.00 | 0.93 |
| Ring-necked Pheasant | <i>Phasianus colchicus</i> | 0.07 | -- | 0.29 | 0.07 | 0.07 |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | -- | -- | -- | 0.07 | -- |
| Upland Sandpiper | <i>Bartramia longicauda</i> | -- | -- | -- | 0.07 | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | 0.07 | -- | 0.14 | -- |
| Western Meadowlark | <i>Sturnella neglecta</i> | 0.50 | 0.64 | 0.43 | 0.93 | 0.64 |
| Wood Duck | <i>Aix sponsa</i> | -- | 0.07 | -- | -- | 0.07 |
| Yellow-headed Blackbird | <i>Xanthocephalus xanthocephalus</i> | -- | 0.07 | -- | -- | -- |
| Yellow Warbler | <i>Dendroica petechia</i> | 0.07 | 0.14 | 0.36 | -- | 0.36 |

Table 3. continued

| Common name | Scientific name | 2001 | 2003 | 2004 | 2005 | 2006 |
|-------------------------------|--|-------------|-------------|-------------|-------------|-------------|
| Prairie | | | | | | |
| American Bittern | <i>Botaurus lentiginosus</i> | -- | -- | -- | 0.03 | -- |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | -- | -- | 0.03 |
| American Robin | <i>Turdus migratorius</i> | -- | -- | -- | 0.03 | -- |
| Bank Swallow | <i>Riparia riparia</i> | -- | 0.08 | 0.03 | -- | -- |
| Barn Swallow | <i>Hirundo rustica</i> | -- | -- | -- | 0.03 | -- |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.03 |
| Brewer's Blackbird | <i>Euphagus cyanocephalus</i> | -- | -- | -- | -- | 0.03 |
| Brown-headed Cowbird | <i>Molothrus ater</i> | -- | 0.13 | 0.08 | 0.18 | 0.08 |
| Brown Thrasher | <i>Toxostoma rufum</i> | -- | -- | -- | 0.03 | -- |
| Clay-colored Sparrow | <i>Spizella pallida</i> | -- | 0.03 | -- | -- | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.15 | -- | -- | -- | -- |
| Cliff Swallow | <i>Petrochelidon pyrrhonota</i> | -- | 0.03 | 0.03 | -- | 0.05 |
| Common Grackle | <i>Quiscalus quiscula</i> | 0.08 | -- | -- | -- | 0.03 |
| Common Nighthawk | <i>Chordeiles minor</i> | -- | 0.03 | 0.05 | 0.05 | 0.23 |
| Common Snipe | <i>Gallinago gallinago</i> | -- | 0.08 | 0.03 | 0.05 | 0.08 |
| Common Yellowthroat | <i>Geothlypis trichas</i> | -- | 0.03 | -- | 0.08 | 0.03 |
| Dickcissel | <i>Spiza americana</i> | -- | 0.03 | -- | -- | -- |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.03 | -- | -- | -- |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | 0.31 | 0.70 | 0.60 | 0.50 | 0.53 |
| Gray Catbird | <i>Dumetella carolinensis</i> | -- | -- | -- | 0.03 | -- |
| Horned Lark | <i>Eremophila alpestris</i> | -- | -- | -- | 0.03 | 0.10 |
| Killdeer | <i>Charadrius vociferous</i> | -- | 0.10 | 0.05 | 0.03 | 0.08 |
| Lark Bunting | <i>Calamospiza melanocorys</i> | -- | 0.23 | 0.60 | 0.03 | 0.10 |
| Lark Sparrow | <i>Chondestes grammacus</i> | 0.23 | 0.20 | 0.15 | 0.38 | 0.30 |
| Mallard | <i>Anas platyrhynchos</i> | -- | -- | 0.03 | -- | 0.03 |
| Marsh Wren | <i>Cistothorus palustris</i> | -- | -- | -- | -- | 0.03 |
| Mourning Dove | <i>Zenaida macroura</i> | -- | 0.15 | 0.13 | 0.10 | 0.30 |
| Northern Rough-winged Swallow | <i>Stelgidopteryx serripennis</i> | -- | -- | -- | -- | 0.03 |
| Orchard Oriole | <i>Icterus spurius</i> | -- | -- | -- | -- | 0.03 |
| Red-tailed Hawk | <i>Buteo jamaicensis</i> | -- | 0.03 | -- | 0.03 | 0.03 |
| Red-winged Blackbird | <i>Agelaius phoeniceus</i> | 0.08 | 0.18 | 0.15 | 0.18 | 0.30 |
| Ring-necked Pheasant | <i>Phasianus colchicus</i> | -- | 0.15 | -- | 0.05 | 0.05 |
| Rock Wren | <i>Salpinctes obsoletus</i> | -- | 0.15 | 0.08 | 0.18 | 0.15 |
| Say's Phoebe | <i>Sayornis saya</i> | -- | 0.03 | -- | -- | -- |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | 0.08 | -- | 0.03 | -- | 0.03 |
| Tree Swallow | <i>Tachycineta bicolor</i> | -- | -- | -- | -- | 0.03 |
| Upland Sandpiper | <i>Bartramia longicauda</i> | 0.08 | -- | 0.05 | -- | 0.03 |
| Vesper Sparrow | <i>Poocetes gramineus</i> | 0.08 | -- | -- | -- | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | 0.05 | -- | 0.03 | 0.03 |
| Western Meadowlark | <i>Sturnella neglecta</i> | 0.62 | 0.98 | 0.85 | 0.95 | 0.93 |
| Wood Duck | <i>Aix sponsa</i> | -- | -- | -- | -- | 0.03 |

Table 3. continued

| Common name | Scientific name | 2001 | 2003 | 2004 | 2005 | 2006 |
|--------------------------------|--------------------------------------|------|-------------|------|------|------|
| Yellow-headed Blackbird | <i>Xanthocephalus xanthocephalus</i> | -- | 0.03 | -- | -- | -- |
| Yellow Warbler | <i>Dendroica petechia</i> | -- | 0.03 | 0.03 | 0.03 | 0.05 |

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 4. Average density (\pm std. dev.) of bird species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys. Individual species results are listed by year (2001-2006) and habitat type (Riparian, Prairie). Most species densities are for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Species marked with an “*” have densities calculated using the program “DISTANCE”.

| Common name | Scientific name | Density (Individuals / ha) | | | | |
|----------------------------|--|----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| | | 2001 | 2003 | 2004 | 2005 | 2006 |
| Riparian | | | | | | |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | 0.023 (0.078) | NA | 0.023 (0.078) |
| Barn Swallow | <i>Hirundo rustica</i> | -- | NA | -- | 0.023 (0.078) | -- |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.023 (0.078) |
| Blue-winged Teal | <i>Anas discors</i> | 0.045 (0.167) | 0.023 (0.078) | 0.023 (0.078) | 0.023 (0.078) | -- |
| Brown Thrasher | <i>Toxostoma rufum</i> | -- | -- | -- | 0.023 (0.078) | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.091 (0.195) | -- | -- | -- | -- |
| Cinnamon Teal | <i>Anas cyanoptera</i> | -- | -- | -- | -- | 0.023 (0.078) |
| Common Grackle | <i>Quiscalus quiscula</i> | -- | -- | 0.023 (0.078) | -- | -- |
| Common Snipe | <i>Gallinago gallinago</i> | 0.114 (0.237) | 0.023 (0.078) | 0.023 (0.078) | NA | 0.023 (0.078) |
| Common Yellowthroat | <i>Geothlypis trichas</i> | 0.091 (0.195) | 0.205 (0.269) | 0.182 (0.241) | 0.250 (0.223) | 0.023 (0.202) |
| Dickcissel | <i>Spiza americana</i> | -- | -- | -- | -- | 0.068 (0.184) |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.091 (0.231) | 0.023 (0.078) | 0.045 (0.167) | NA |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | 0.024 (0.088) | 0.098 (0.200) | 0.024 (0.088) | -- | 0.024 (0.088) |
| House Wren | <i>Troglodytes aedon</i> | -- | 0.023 (0.078) | -- | -- | -- |
| Killdeer | <i>Charadrius vociferous</i> | 0.136 (0.299) | 0.023 (0.078) | 0.023 (0.078) | -- | NA |
| Lark Bunting | <i>Calamospiza melanocorys</i> | 0.045 (0.167) | NA | -- | -- | -- |
| Mallard | <i>Anas platyrhynchos</i> | NA | 0.023 (0.078) | 0.159 (0.511) | 0.023 (0.116) | NA |
| Marsh Wren | <i>Cistothorus palustris</i> | 0.045 (0.116) | 0.045 (0.116) | 0.091 (0.149) | 0.136 (0.271) | 0.136 (0.241) |
| Mourning Dove | <i>Zenaidura macroura</i> | 0.045 (0.167) | NA | NA | NA | NA |
| Red-winged Blackbird* | <i>Agelaius phoeniceus</i> | 4.349 (1.316) | 2.625 (0.788) | 7.452 (2.186) | 3.234 (0.857) | 3.218 (1.425) |
| Ring-necked Pheasant | <i>Phasianus colchicus</i> | 0.023 (0.078) | -- | 0.023 (0.078) | 0.023 (0.078) | 0.023 (0.078) |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | -- | -- | -- | 0.114 (0.432) | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | NA | -- | 0.023 (0.078) | -- |
| Western Meadowlark* | <i>Sturnella neglecta</i> | 0.147 (0.087) | 0.667 (0.511) | 0.191 (0.092) | 0.468 (0.260) | 0.110 (0.067) |
| Yellow Warbler | <i>Dendroica petechia</i> | 0.023 (0.078) | 0.045 (0.116) | 0.136 (0.206) | -- | 0.159 (0.300) |
| Prairie | | | | | | |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | -- | -- | 0.008 (0.049) |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.016 (0.100) |
| Brewer's Blackbird | <i>Euphagus cyanocephalus</i> | -- | -- | -- | -- | 0.008 (0.049) |

Table 4. continued

| Common name | Scientific name | Density (Individuals / ha) | | | | |
|-----------------------------|--|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| | | 2001 | 2003 | 2004 | 2005 | 2006 |
| Brown-headed Cowbird | <i>Molothrus ater</i> | -- | 0.024 (0.085) | 0.008 (0.049) | NA | 0.024 (0.151) |
| Clay-colored Sparrow | <i>Spizella pallida</i> | -- | 0.016 (0.100) | -- | -- | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.098 (0.272) | -- | -- | -- | -- |
| Common Grackle | <i>Quiscalus quiscula</i> | NA | -- | -- | -- | 0.008 (0.049) |
| Common Yellowthroat | <i>Geothlypis trichas</i> | -- | NA | -- | 0.008 (0.049) | 0.008 (0.049) |
| Dickcissel | <i>Spiza americana</i> | -- | 0.008 (0.049) | -- | -- | -- |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.008 (0.049) | -- | -- | -- |
| Grasshopper Sparrow* | <i>Ammodramus savannarum</i> | 1.046 (0.902) | 1.619 (0.332) | 1.382 (0.314) | 0.491 (0.130) | 0.943 (0.262) |
| Horned Lark | <i>Eremophila alpestris</i> | -- | -- | -- | NA | 0.008 (0.049) |
| Killdeer | <i>Charadrius vociferous</i> | -- | 0.016 (0.070) | 0.008 (0.049) | 0.008 (0.049) | NA |
| Lark Bunting | <i>Calamospiza melanocorys</i> | -- | 0.064 (0.194) | 0.143 (0.249) | NA | 0.024 (0.151) |
| Lark Sparrow | <i>Chondestes grammacus</i> | 0.024 (0.080) | 0.104 (0.243) | 0.032 (0.097) | 0.141 (0.297) | 0.079 (0.201) |
| Mourning Dove | <i>Zenaida macroura</i> | -- | 0.032 (0.097) | 0.016 (0.070) | 0.016 (0.100) | 0.024 (0.111) |
| Orchard Oriole | <i>Icterus spurius</i> | -- | -- | -- | -- | 0.008 (0.049) |
| Red-tailed Hawk | <i>Buteo jamaicensis</i> | -- | NA | -- | 0.008 (0.049) | NA |
| Red-winged Blackbird* | <i>Agelaius phoeniceus</i> | NA | 0.415 (0.395) | 0.311 (0.218) | 0.199 (0.253) | 0.169 (0.140) |
| Rock Wren | <i>Salpinctes obsoletus</i> | -- | 0.024 (0.085) | NA | 0.016 (0.070) | 0.016 (0.070) |
| Say's Phoebe | <i>Sayornis saya</i> | -- | 0.008 (0.049) | -- | -- | -- |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | 0.024 (0.080) | -- | 0.008 (0.049) | -- | NA |
| Tree Swallow | <i>Tachycineta bicolor</i> | -- | -- | -- | -- | 0.008 (0.049) |
| Upland Sandpiper | <i>Bartramia longicauda</i> | 0.024 (0.080) | -- | NA | -- | NA |
| Vesper Sparrow | <i>Poocetes gramineus</i> | 0.049 (0.172) | -- | -- | -- | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | 0.008 (0.049) | -- | 0.008 (0.049) | 0.016 (0.100) |
| Western Meadowlark* | <i>Sturnella neglecta</i> | 0.071 (0.028) | 0.681 (0.144) | 0.407 (0.119) | 0.419 (0.063) | 0.433 (0.102) |
| Wood Duck | <i>Aix sponsa</i> | -- | -- | -- | -- | 0.016 (0.100) |
| Yellow Warbler | <i>Dendroica petechia</i> | -- | 0.016 (0.100) | 0.008 (0.049) | 0.008 (0.049) | 0.008 (0.049) |

NA – Not able to calculate a density, individuals were recorded as flyovers or outside a distance of 100-m from plot center.

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 5. Average bird density (\pm std. dev.) for plots occupied by species recorded at Agate Fossil Beds National Monument, Nebraska during breeding bird surveys. Individual species results are listed by year (2001-2006) and habitat type (Riparian, Prairie). Most species densities are for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. Species marked with an “*” have densities calculated using the program “DISTANCE”. Species recorded from only one plot during a year, will not have standard deviation values.

| Common name | Scientific name | Density (Individuals / ha) | | | | |
|----------------------------|--|----------------------------|--------------------------------|------------------|------------------|--------------------------------|
| | | 2001 | 2003 | 2004 | 2005 | 2006 |
| Riparian | | | | | | |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | 0.318 | NA | 0.318 |
| Barn Swallow | <i>Hirundo rustica</i> | -- | NA | -- | 0.318 | -- |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.318 |
| Blue-winged Teal | <i>Anas discors</i> | 0.637 | 0.318 | 0.318 | 0.318 | -- |
| Brown Thrasher | <i>Toxostoma rufum</i> | -- | -- | -- | 0.318 | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.425 (0.184) | -- | -- | -- | -- |
| Cinnamon Teal | <i>Anas cyanoptera</i> | -- | -- | -- | -- | 0.318 |
| Common Grackle | <i>Quiscalus quiscula</i> | -- | -- | 0.318 | -- | -- |
| Common Snipe | <i>Gallinago gallinago</i> | 0.531 (0.184) | 0.318 | 0.318 | NA | 0.318 |
| Common Yellowthroat | <i>Geothlypis trichas</i> | 0.425 (0.184) | 0.478 (0.174) | 0.425 (0.165) | 0.389 (0.140) | 0.358 (0.113) |
| Dickcissel | <i>Spiza americana</i> | -- | -- | -- | -- | 0.478 (0.225) |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.637 | 0.318 | 0.637 | NA |
| Grasshopper Sparrow | <i>Ammodramus savannarum</i> | 0.318 | 0.425 (0.184) | 0.318 | -- | 0.318 |
| House Wren | <i>Troglodytes aedon</i> | -- | 0.318 | -- | -- | -- |
| Killdeer | <i>Charadrius vociferous</i> | 0.637 (0.319) | 0.318 | 0.318 | -- | NA |
| Lark Bunting | <i>Calamospiza melanocorys</i> | 0.637 | NA | -- | -- | -- |
| Mallard | <i>Anas platyrhynchos</i> | NA | 0.318 | 1.115 (1.126) | 0.318 | NA |
| Marsh Wren | <i>Cistothorus palustris</i> | 0.318 | 0.318 | 0.318 | 0.478 (0.319) | 0.478 (0.184) |
| Mourning Dove | <i>Zenaida macroura</i> | 0.318 | NA | NA | NA | NA |
| Red-winged Blackbird* | <i>Agelaius phoeniceus</i> | 4.349 (1.316) | 3.062 (0.853) | 7.452 (2.186) | 3.234 (0.857) | 3.469 (1.517) |
| Ring-necked Pheasant | <i>Phasianus colchicus</i> | 0.318 | -- | 0.318 | 0.318 | 0.318 |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | -- | -- | -- | 1.592 | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | NA | -- | 0.318 | -- |
| Western Meadowlark* | <i>Sturnella neglecta</i> | 0.342 (0.171) | 1.167 (0.851) | 0.445 (0.163) | 0.504 (0.277) | 0.219 (0.119) |
| Yellow Warbler | <i>Dendroica petechia</i> | 0.318 | 0.318 | 0.382 (0.142) | -- | 0.557 (0.305) |
| Prairie | | | | | | |
| American Goldfinch | <i>Carduelis tristis</i> | -- | -- | -- | -- | 0.318 |
| Blue Grosbeak | <i>Guiraca caerulea</i> | -- | -- | -- | -- | 0.637 |

Table 5. continued

| Common name | Scientific name | Density (Individuals / ha) | | | | |
|-----------------------------|--|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| | | 2001 | 2003 | 2004 | 2005 | 2006 |
| Brewer's Blackbird | <i>Euphagus cyanocephalus</i> | -- | -- | -- | -- | 0.318 |
| Brown-headed Cowbird | <i>Molothrus ater</i> | -- | 0.318 | 0.318 | NA | 0.955 |
| Clay-colored Sparrow | <i>Spizella pallida</i> | -- | 0.637 | -- | -- | -- |
| Chipping Sparrow | <i>Spizella passerina</i> | 0.637 (0.450) | -- | -- | -- | -- |
| Common Grackle | <i>Quiscalus quiscula</i> | -- | -- | -- | -- | 0.318 |
| Common Yellowthroat | <i>Geothlypis trichas</i> | -- | NA | -- | 0.318 | 0.318 |
| Dickcissel | <i>Spiza americana</i> | -- | 0.318 | -- | -- | -- |
| Eastern Kingbird | <i>Tyrannus tyrannus</i> | -- | 0.318 | -- | -- | -- |
| Grasshopper Sparrow* | <i>Ammodramus savannarum</i> | 3.400 (2.549) | 2.398 (0.415) | 2.304 (0.429) | 1.092 (0.216) | 1.790 (0.403) |
| Horned Lark | <i>Eremophila alpestris</i> | -- | -- | -- | NA | 0.318 |
| Killdeer | <i>Charadrius vociferous</i> | -- | 0.318 | 0.318 | 0.318 | NA |
| Lark Bunting | <i>Calamospiza melanocorys</i> | -- | 0.509 (0.285) | 0.441 (0.245) | NA | 0.955 |
| Lark Sparrow | <i>Chondestes grammacus</i> | 0.318 | 0.591 (0.220) | 0.318 | 0.550 (0.321) | 0.455 (0.251) |
| Mourning Dove | <i>Zenaida macroura</i> | -- | 0.318 | 0.318 | 0.637 | 0.478 (0.225) |
| Orchard Oriole | <i>Icterus spurius</i> | -- | -- | -- | -- | 0.318 |
| Red-tailed Hawk | <i>Buteo jamaicensis</i> | -- | NA | -- | 0.318 | NA |
| Red-winged Blackbird* | <i>Agelaius phoeniceus</i> | NA | 3.317 (2.938) | 2.487 (1.457) | 1.327 (1.616) | 0.843 (0.647) |
| Rock Wren | <i>Salpinctes obsoletus</i> | -- | 0.318 | NA | 0.318 | 0.318 |
| Say's Phoebe | <i>Sayornis saya</i> | -- | 0.318 | -- | -- | -- |
| Sharp-tailed Grouse | <i>Tympanuchus phasianellus</i> | 0.318 | -- | 0.318 | -- | NA |
| Tree Swallow | <i>Tachycineta bicolor</i> | -- | -- | -- | -- | 0.318 |
| Upland Sandpiper | <i>Bartramia longicauda</i> | 0.318 | -- | NA | -- | NA |
| Vesper Sparrow | <i>Poocetes gramineus</i> | 0.637 | -- | -- | -- | -- |
| Western Kingbird | <i>Tyrannus verticalis</i> | -- | 0.318 | -- | 0.318 | 0.637 |
| Western Meadowlark* | <i>Sturnella neglecta</i> | 0.153 (0.040) | 0.732 (0.138) | 0.494 (0.140) | 0.441 (0.064) | 0.469 (0.109) |
| Wood Duck | <i>Aix sponsa</i> | -- | -- | -- | -- | 0.637 |
| Yellow Warbler | <i>Dendroica petechia</i> | -- | 0.637 | 0.318 | 0.318 | 0.318 |

NA – Not able to calculate a density, individuals were recorded as flyovers or outside a distance of 100-m from plot center.

Bolded species names are those species considered of continental importance (Rich et al. 2004).

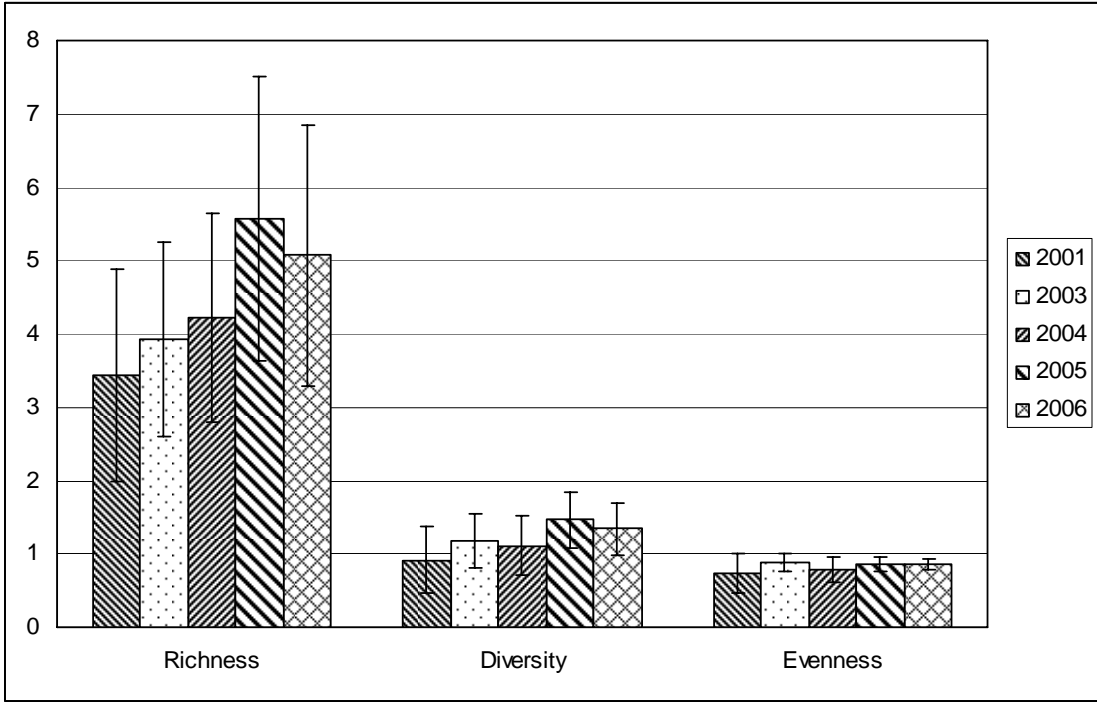


Figure 2. Average (\pm std dev) species richness, diversity, and species distribution evenness values for the breeding bird community in the riparian area at Agate Fossil Beds National Monument, Nebraska during the breeding seasons, years 2001 - 2006.

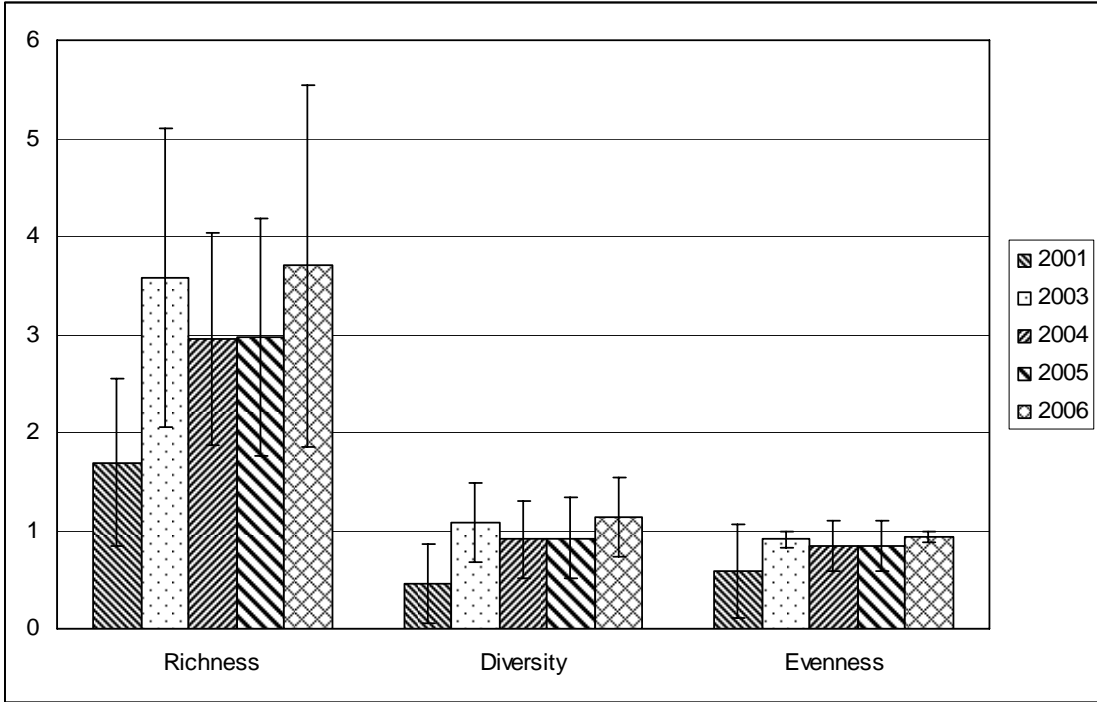


Figure 3. Average (\pm std dev) species richness, diversity, and species distribution evenness values for the breeding bird community in the prairie at Agate Fossil Beds National Monument, Nebraska during the breeding seasons, years 2001 - 2006.

Grassland Bird Habitat

Dominating the riparian habitat in all years were marshy wetlands, followed by stream habitat (Table 6). Recorded in lesser amounts were upland prairie, willow shrubland, western wheatgrass, and riparian woodland habitats, in that order. Pasture roads covered a trace amount of the riparian area in 2006. Vegetation during the breeding season was densest below one meter from the ground surface when read from both 5- and 15-m distances. Some vegetation reached two meters in height, however. Vertical structure diversity estimates were similar among years and appear to be quite low.

Ground cover in the riparian area was primarily grass litter and bare soil along with smaller amounts of deciduous litter, woody debris, and rocks, resulting in plots being mostly unvegetated. The plant community was dominated by cool-season grasses, followed by forbs, woody shrubs and vines, warm-season grasses, and moss and lichens. Total vegetation cover averaged from 8.00% (2001) to 46.21% (2005) across riparian plots.

Dominating the prairie habitat in all years was upland prairie habitat (Table 7). Recorded in far lesser amounts were wetland, western wheatgrass, stream, and riparian woodland habitats, in that order. Both paved and pasture roads covered a trace amount of the prairie. Vegetation during the breeding season was densest below 0.75-m from the ground surface, when read from both 5- and 15-m distances. Very little vegetation occurred above one meter in height. Vertical structure diversity estimates were similar between years and appear to be quite low.

Ground cover in the prairie was primarily bare soil and grass litter (Table 7). Other ground cover included rocks, deciduous litter, and a small amount of woody debris, resulting in plots being mostly unvegetated. The soil surface was between 80.98% (2003) and 93.04% (2001) unvegetated. The plant community was dominated by cool-season grasses, followed by forbs, warm-season grasses, woody shrubs and vines, and moss and lichens. Total vegetation cover averaged from 5.91% (2001) to 44.18% (2005) across prairie plots.

Table 6. Average (\pm std. dev.) coverage of habitat parameters on plots visited in the riparian area at Agate Fossil Beds National Monument, Nebraska during the breeding bird season, 2001-2006. Habitat parameters reported are at the scale they were collected; 50-m plot, 5-m subplot and 1.78-m sample plot. Within each scale, percentages of coverage may not sum to 100%, as values are averages over mid-point values of cover classes (i.e. class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

| Habitat Parameter | 2001 | 2003 | 2004 | 2005 | 2006 |
|---------------------------------------|------------------|------------------|------------------|------------------|------------------|
| 50 meter plot | | | | | |
| Pasture road coverage (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 (0.80) |
| Riparian Woodland coverage (%) | 0.00 | 0.00 | 0.00 | 0.04 (0.13) | 0.00 |
| Stream coverage (%) | 37.86 (18.39) | 36.07 (11.12) | 23.43 (19.16) | 13.18 (8.93) | 21.43 (10.55) |
| Upland prairie coverage (%) | 0.00 | 8.93 (22.70) | 8.75 (24.11) | 10.00 (22.60) | 13.89 (20.86) |
| Western wheatgrass coverage (%) | 0.00 | 0.00 | 5.75 (16.82) | 0.00 | 0.00 |
| Wetland coverage (%) | 40.57 (17.68) | 58.04 (25.91) | 68.21 (33.86) | 76.07 (25.36) | 66.61 (30.58) |
| Willow shrubland coverage (%) | 0.00 | 3.75 (10.50) | 0.04 (0.13) | 0.00 | 2.68 (10.02) |
| 5 meter subplot | | | | | |
| Horizontal vegetation profile at 5-m | | | | | |
| 0.0 – 0.5 m (%) | 15.64 (28.69) | 70.99 (19.46) | 55.55 (20.96) | 91.66 (8.54) | 74.97 (11.99) |
| 0.25 – 0.75 m (%) | -- | 16.22 (12.48) | 42.25 (28.51) | 50.48 (23.67) | 32.02 (23.35) |
| 0.5 – 1.0 m (%) | 0.00 | 6.74 (12.03) | 35.17 (41.85) | 12.64 (25.64) | 21.64 (30.68) |
| 0.75 – 1.25 m (%) | -- | 0.25 (0.80) | 28.12 (45.55) | 9.64 (27.19) | 24.86 (40.86) |
| 1.0 – 1.5 m (%) | 0.00 | 0.00 | 16.07 (34.91) | 6.07 (22.72) | 16.79 (33.30) |
| 1.25 – 1.75 m (%) | -- | 0.00 | 8.21 (22.75) | 2.68 (10.02) | 2.18 (5.43) |
| 1.5 – 2.0 m (%) | 0.00 | 0.00 | 1.29 (4.03) | 0.21 (0.80) | 0.04 (0.13) |
| Horizontal vegetation profile at 15-m | | | | | |
| 0.0 – 0.5 m (%) | 34.80 (18.27) | 85.61 (9.51) | 73.67 (18.90) | 95.38 (4.39) | 92.57 (6.47) |
| 0.25 – 0.75 m (%) | -- | 38.44 (15.24) | 57.44 (25.45) | 66.74 (21.41) | 44.74 (21.27) |
| 0.5 – 1.0 m (%) | 15.00 (35.18) | 11.73 (17.08) | 44.99 (35.54) | 16.56 (26.56) | 34.48 (39.43) |
| 0.75 – 1.25 m (%) | -- | 7.61 (25.90) | 28.93 (45.18) | 7.89 (21.44) | 22.96 (31.89) |
| 1.0 – 1.5 m (%) | 0.00 | 4.46 (16.70) | 16.07 (34.91) | 7.00 (26.05) | 13.32 (25.98) |
| 1.25 – 1.75 m (%) | -- | 0.00 | 14.11 (33.02) | 4.46 (16.70) | 2.75 (10.00) |
| 1.5 – 2.0 m (%) | 0.00 | 0.00 | 1.29 (4.03) | 1.07 (4.01) | 0.00 |

Table 6. continued

| Habitat Parameter | 2001 | 2003 | 2004 | 2005 | 2006 |
|-----------------------------------|------------------|------------------|------------------|------------------|------------------|
| 5 meter subplot | | | | | |
| Vertical structure diversity | 1.18 (0.16) | 1.35 (0.13) | 1.39 (0.16) | 0.99 (0.23) | 1.49 (0.19) |
| 1.78 meter sample plot | | | | | |
| Deciduous litter coverage (%) | 5.64 (6.70) | 0.19 (0.37) | 0.60 (1.37) | 0.04 (0.11) | 0.10 (0.21) |
| Grass litter coverage (%) | 34.33 (18.44) | 29.50 (12.92) | 32.16 (12.75) | 35.90 (15.06) | 43.86 (20.44) |
| Bare soil (%) | 5.64 (6.70) | 21.52 (12.44) | 29.42 (17.90) | 24.30 (12.31) | 38.83 (16.69) |
| Rock coverage (%) | 0.11 (0.23) | 0.05 (0.07) | 0.02 (0.04) | 0.07 (0.27) | 0.10 (0.26) |
| Woody debris coverage (%) | 0.00 | 0.74 (2.50) | 0.28 (1.01) | 0.01 (0.03) | 0.00 |
| Unvegetated coverage (%) | 81.44 (11.39) | 70.01 (13.71) | 68.05 (13.54) | 51.11 (13.08) | 75.54 (12.07) |
| Warm-season grass coverage (%) | 0.01 (0.05) | 0.11 (0.28) | 0.01 (0.05) | 0.12 (0.40) | 0.06 (0.21) |
| Cool-season grass coverage (%) | 6.24 (4.61) | 18.58 (7.32) | 17.81 (8.91) | 32.24 (15.63) | 20.88 (7.91) |
| Forb coverage (%) | 4.59 (3.38) | 16.15 (7.50) | 16.19 (8.79) | 18.69 (11.74) | 17.51 (8.56) |
| Moss and lichen coverage (%) | 0.00 | 0.36 (1.01) | 0.01 (0.05) | 0.00 | 0.18 (0.44) |
| Woody shrub and vine coverage (%) | 0.39 (1.02) | 0.40 (1.03) | 1.27 (2.71) | 0.06 (0.21) | 0.35 (1.02) |
| Total foliar coverage (%) | 8.00 (4.67) | 27.96 (8.44) | 32.02 (7.15) | 46.21 (14.29) | 39.87 (7.17) |

Table 7. Average (\pm std. dev.) coverage of habitat parameters on plots visited in the prairie at Agate Fossil Beds National Monument, Nebraska during the breeding bird season, 2001-2006. Habitat parameters reported are at the scale they were collected; 50-m plot, 5-m subplot and 1.78-m sample plot. Within each scale, percentages of coverage may not sum to 100%, as values are averages over mid-point values of cover classes (i.e. class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

| Habitat Parameter | 2001 | 2003 | 2004 | 2005 | 2006 |
|---------------------------------------|------------------|------------------|------------------|------------------|------------------|
| 50 meter plot | | | | | |
| Pasture road coverage (%) | 1.15 (4.16) | 0.45 (2.41) | 0.38 (2.37) | 0.39 (2.37) | 1.86 (6.67) |
| Paved road coverage (%) | 0.00 | 1.84 (6.68) | 0.45 (1.08) | 1.54 (6.33) | 1.28 (4.01) |
| Riparian woodland (%) | 0.00 | 0.00 | 0.00 | 0.38 (2.37) | 0.01 (0.08) |
| Stream coverage (%) | 0.00 | 0.08 (0.47) | 0.08 (0.47) | 0.38 (2.37) | 0.09 (0.48) |
| Upland prairie coverage (%) | 97.50 (0.00) | 94.19 (16.25) | 84.90 (31.13) | 91.45 (21.97) | 90.75 (20.96) |
| Western wheatgrass coverage (%) | 0.00 | 0.00 | 5.63 (18.03) | 2.13 (13.44) | 0.08 (0.47) |
| Wetland coverage (%) | 0.00 | 2.44 (15.42) | 1.56 (9.88) | 1.64 (9.88) | 1.09 (5.94) |
| 5 meter subplot | | | | | |
| Horizontal vegetation profile at 5-m | | | | | |
| 0.0 – 0.5 m (%) | 19.04 (19.04) | 49.39 (18.18) | 24.06 (15.52) | 74.15 (10.99) | 46.65 (15.01) |
| 0.25 – 0.75 m (%) | -- | 4.56 (5.72) | 4.81 (8.96) | 16.97 (12.55) | 4.55 (7.69) |
| 0.5 – 1.0 m (%) | 0.00 | 0.55 (2.36) | 4.81 (16.25) | 2.06 (4.48) | 1.01 (5.94) |
| 0.75 – 1.25 m (%) | -- | 0.00 | 1.56 (9.88) | 0.00 | 0.01 (0.08) |
| 1.0 – 1.5 m (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.25 – 1.75 m (%) | -- | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.5 – 2.0 m (%) | 0.00 | 0.00 | 0.08 (0.47) | 0.00 | 0.00 |
| Horizontal vegetation profile at 15-m | | | | | |
| 0.0 – 0.5 m (%) | 37.10 (16.62) | 69.47 (18.93) | 50.84 (19.79) | 89.65 (8.10) | 69.22 (20.79) |
| 0.25 – 0.75 m (%) | -- | 17.56 (15.40) | 11.71 (15.32) | 37.62 (17.10) | 14.88 (15.14) |
| 0.5 – 1.0 m (%) | 0.04 (0.14) | 4.54 (11.25) | 3.99 (16.45) | 4.14 (5.40) | 3.00 (15.51) |
| 0.75 – 1.25 m (%) | 0.00 | 0.00 | 0.00 | 0.01 (0.08) | 0.94 (5.93) |
| 1.0 – 1.5 m (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.25 – 1.75 m (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.5 – 2.0 m (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Table 7. continued

| Habitat Parameter | 2001 | 2003 | 2004 | 2005 | 2006 |
|-----------------------------------|------------------|------------------|------------------|------------------|------------------|
| 5 meter subplot | | | | | |
| Vertical structure diversity | 1.29 (0.10) | 1.34 (0.07) | 1.31 (0.11) | 1.36 (0.07) | 1.35 (0.09) |
| 1.78 meter sample plot | | | | | |
| Deciduous litter coverage (%) | 0.52 (1.38) | 0.10 (0.60) | 0.03 (0.13) | 0.57 (2.47) | 0.12 (0.14) |
| Grass litter coverage (%) | 30.55 (9.94) | 24.54 (12.07) | 18.55 (9.59) | 36.29 (14.73) | 17.10 (10.55) |
| Bare soil (%) | 35.38 (16.18) | 39.92 (13.92) | 56.50 (11.47) | 54.69 (12.89) | 69.38 (10.23) |
| Rock coverage (%) | 2.23 (2.91) | 2.58 (4.42) | 1.81 (3.67) | 2.60 (5.76) | 3.20 (4.79) |
| Woody debris coverage (%) | 0.00 | 0.01 (0.03) | 0.40 (2.50) | 0.03 (0.06) | 0.00 |
| Unvegetated coverage (%) | 93.04 (5.48) | 80.98 (8.41) | 82.89 (9.59) | 81.72 (8.40) | 86.44 (4.39) |
| Warm-season grass coverage (%) | 0.46 (0.24) | 0.62 (0.73) | 0.43 (0.71) | 1.04 (1.56) | 1.17 (1.78) |
| Cool-season grass coverage (%) | 4.79 (2.77) | 17.72 (8.57) | 11.96 (7.94) | 33.39 (15.86) | 22.97 (7.18) |
| Forb coverage (%) | 4.32 (3.21) | 9.18 (6.42) | 3.73 (5.07) | 5.40 (5.28) | 7.36 (4.99) |
| Moss and lichen coverage (%) | 0.00 | 1.30 (1.82) | 0.34 (0.99) | 0.05 (0.10) | 1.35 (2.61) |
| Woody shrub and vine coverage (%) | 0.01 (0.03) | 0.23 (0.85) | 0.23 (0.85) | 0.95 (2.80) | 1.59 (2.84) |
| Total foliar coverage (%) | 5.91 (3.34) | 23.57 (8.07) | 18.10 (9.69) | 44.18 (13.78) | 33.69 (6.20) |

Discussion

Two unique and very different habitat types, shortgrass prairie and lowland riparian areas, dominate the monument. Five species breed annually and exclusively in the riparian area demonstrating the importance of this habitat to the monuments bird community. Only two species annually breed in the prairie habitat. Similar to our findings, others have observed low numbers of bird species breeding in shortgrass prairie habitat (Knopf 1996, Wiens 1974). More breeding species in the riparian area may be the result of eastern birds moving into the riparian area. Knopf (1986) reported numerous eastern birds expanding their range westward along riparian corridors, as agricultural practices have changed drainage patterns of rivers and streams, allowing woody vegetation to establish.

Of the 60 bird species recorded during breeding bird surveys, 16 species require grassland habitat during some portion of their breeding cycle (Northern Prairie Wildlife Research Center 2006). Seven of the sixteen species are grassland obligates, requiring relatively treeless grasslands for most or all parts of their breeding cycles, including nesting and foraging. Of the seven grassland obligates reported, only two were observed consistently enough to graph population trends (Fig. 4). Observations of the remaining grassland obligates occurred in two or fewer years, or between plots or as flyovers. Density of breeding grassland obligates across

habitats ranged from 1.361 individuals / ha in 2001 to 3.073 individuals / ha in 2003, which is relatively high when compared to other areas of shortgrass prairie (Sparks et al. 2005).

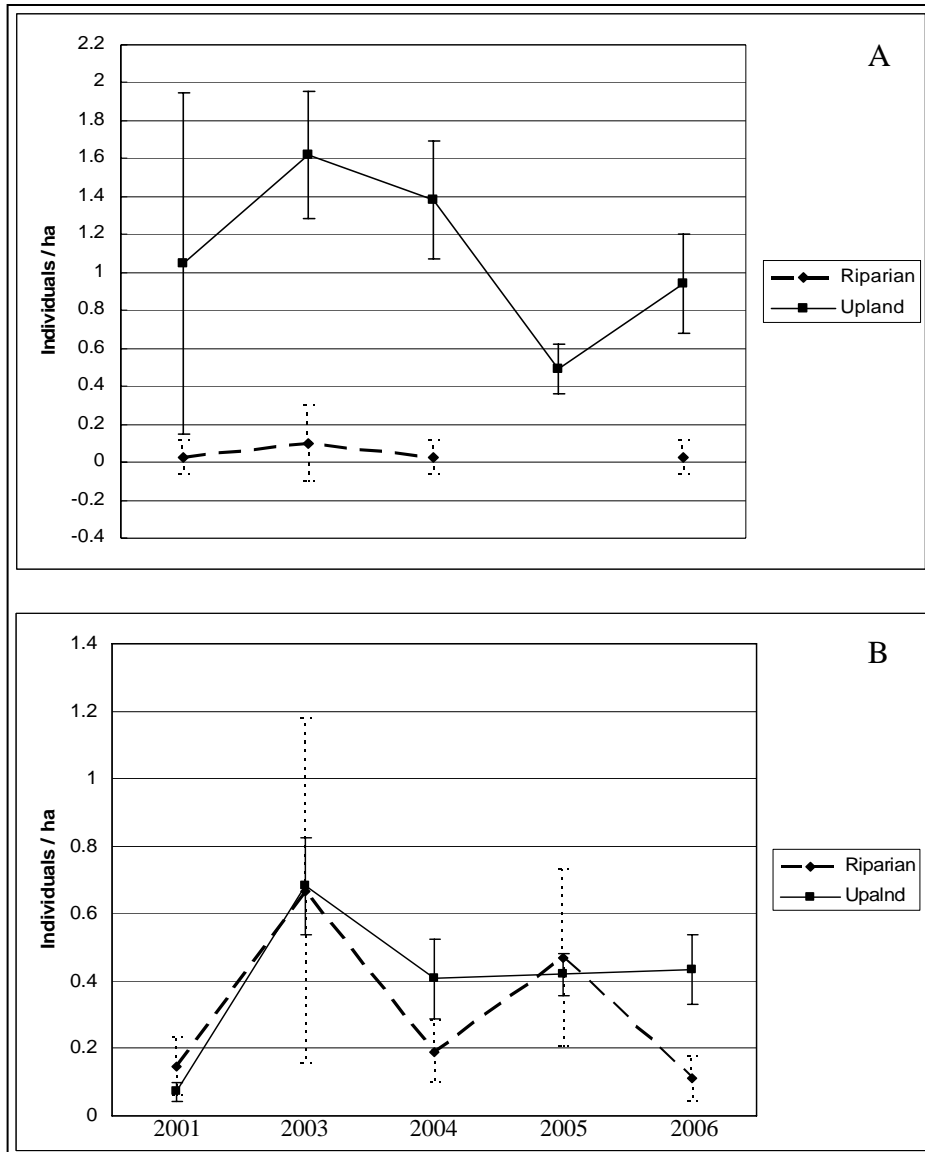


Figure 4. Average (\pm std dev) density of: A) Grasshopper Sparrow, and B) Western Meadowlark in the prairie and riparian areas at Agate Fossil Beds National Monument, Nebraska during the breeding seasons, years 2001 - 2006.

Signifying the importance of the monument toward bird conservation is our observation of seven species of continental importance (Rich et al. 2004). Four of these species, along with Upland Sandpiper, have been identified as species of conservation importance for the shortgrass prairie ecotype (Beidleman 2000). Grasshopper Sparrow, the second most widely distributed species that breeds on the monument, and Lark Bunting, another species of conservation importance, have suffered precipitous declines in numbers on a continental scale (Sauer et al 2000).

The Red-winged Blackbird, the most common species across habitats, has shown precipitous declines in other areas of North America (Sauer et al. 2000). Blackwell and Dolbeer (2001) found the species to have declined by over 53% in Ohio, due in part to changing agriculture practices. Therefore, the importance of the monument to conservation of even its most common species cannot be underestimated. Management decisions aimed at influencing bird populations should center on those species identified as being of local or continental importance. Species common to the monument, however, such as the Red-winged Blackbird, need consideration in a broader context when making management decisions. The monument may provide some of the best habitat remaining for this continentally declining species.

Low species richness, diversity, and evenness values are common for shortgrass bird communities (Knopf 1996, Wiens 1974). Therefore, species richness, diversity, and distribution evenness values for the breeding bird community, which appear low when compared to other ecotypes, is quite normal. Distribution evenness values also suggest that in most years and in both habitats, only a few species contributed significantly to diversity measures. A defining aspect of both habitats on the monument are bird communities dominated by a relatively few common species. Though hard to discern now, the real value of richness, diversity and evenness values will be realized when we examine changes in the bird community through time, 20, 30 or more years, and these changes can be linked to management activity rather than innate variability of the shortgrass prairie ecotype.

Part of our monitoring efforts included documenting breeding habitat. The riparian corridor along the Niobrara River, dominated by marshy wetland and stream habitats, is ideal nesting habitat for common species like the Red-winged Blackbird, Common Yellowthroat, Marsh Wren, Common Snipe, and Mallard, as well as many less common species. Other habitats, such as willow shrubland and riparian woodland, provide nesting habitat as well. The vegetation, though densest below 1-m, provides good screening cover up to 2-m in height. Total vegetation cover of 46.21% or less across riparian plots indicates that management actions aimed at improving available nesting vegetation would likely succeed.

Shortgrass prairies support a depauperate breeding bird community (Beidleman 2000). Therefore, our observation of only four species breeding in this habitat annually is not of concern. Low vegetation during the breeding season (densest below 0.75-m) provides little screening cover for nesting individuals of most species. Densities and distribution of grassland obligates, such as the Grasshopper Sparrow and Western Meadowlark, however, illustrate the importance of this habitat. The importance of relatively pristine areas such as the monument to bird conservation is increasing. Well documented is the rapid loss to development and the conversion of large tracts of shortgrass prairie to evenly grazed pasture, which pose major threats to the bird communities living within this region (Beidleman, 2000).

Results from our first five years of bird monitoring at Agate Fossil Beds National Monument provide a baseline for measuring future changes in bird communities and their habitat. For example, if increases in the drawdown of water in the Niobrara River were to occur, then increases in the amounts of willow shrubland and riparian woodland are expected. Increases in eastern bird species nesting in these habitats would be expected (Knopf, 1986). With knowledge of the nesting ecology of bird species and our habitat monitoring results, monument staff can

make more informed natural resource management decisions that affect breeding success of birds. Thus, Agate Fossil Beds National Monument can make an important contribution to the conservation of birds across the shortgrass eco-region.

Acknowledgements

We would like to thank the staff of Agate Fossil Beds National Monument, Nebraska for allowing us access to the prairie, riparian area, and other resource during our site visits and for welcoming us. We would especially like to thank Lil Morava for assisting us with housing arrangements.

Literature Cited

- Beidleman, C. A. 2000. Partners in Flight land bird conservation plan: Colorado. Partners in Flight, Estes Park, Colorado. 320pp.
- Blackwell, B. F. and R. A. Dolbeer. 2001. Decline of the red-winged blackbird population in Ohio correlated to changes in agriculture (1965-1996). *Journal of Wildlife Management* 65:661-667.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. Chapman and Hall, New York. 446 pp.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press. 432 pp.
- Fancy, S. G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. *Pacific Science* 51:107-114.
- ITIS (Integrated Taxonomic Information System). <http://www.itis.usda.gov/>.
- Karr, J. R. and D. R. Dudley. 1981. Ecological perspective on water quality goals. *Environmental Management* 5:55-68.
- Karr, J. R. 1991. Biological integrity: a long-neglected aspect of water resource management. *Ecological Applications* 1:66-84.
- Knopf, F. L. 1986. Changing landscapes and the cosmopolitanism of the eastern Colorado avifauna. *Wildlife Society Bulletin* 14:132-142.
- Knopf, F. L. 1996. Prairie legacies--birds. Pages 135-148 *in* *Prairie Conservation* (F. B. Samson and F. L. Knopf, editors). Island Press, Washington, D.C.

- Knopf, F. L. and F. B. Samson. 1997. Conservation of grassland vertebrates. Pages 273-289 in F. L. Knopf and F. B. Samson, eds. Ecology and Conservation of Great Plains Vertebrates. Springer-Verlag, New York, New York.
- Maurer, B. A. 1993. Biological diversity, ecological integrity, and neotropical migrants: New perspectives for wildlife managers. Pages 24-31 in D.M. Finch and P.W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229.
- Northern Prairie Wildlife Research Center. 2006. Managing habitat for grassland birds: A guide for Wisconsin. <http://www.npwrc.usgs.gov/resource/birds/wiscbird/overview.htm>
- Peitz, D. G., S. G. Fancy, L. P. Thomas, G. A. Rowell, and M. D. Debacker. 2003. Bird monitoring protocol for Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas. Prairie Cluster Prototype Long-term Ecological Monitoring Program, National Park Service, Department of the Interior.
- Peitz, D. G. and G. A. Rowell. 2003. Grassland Bird Monitoring at Agate Fossil Beds National Monument, Nebraska and Tallgrass Prairie National Preserve, Kansas: Status Report 2001 – 2003. Prairie Cluster Prototype Long-term Ecological Monitoring Program, National Park Service, Department of the Interior.
- Pielou, E. C. 1969. An introduction to mathematical ecology. John Wiley and Sons, New York, New York. 286pp.
- Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, New York. 84pp.
- Sauer, J. R., J. E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. The North American breeding bird survey, results and analysis 1966 – 1999. Version 98.1, USGS Patuxent Wildlife Research Center, Laurel, Maryland. Available at <http://www.mbr-pwrc.usgs.gov/bbs/bbs.html>
- Shannon, C. E. 1949. The mathematical theory of communication. University of Illinois Press, Urbana, Illinois. 177 pp.
- Sparks, R. A., D. J. Hanni and M. McLachlan. 2005. Section-based monitoring of breeding birds within the shortgrass prairie bird conservation region (BCR 18). Rocky Mountain Bird Observatory, Brighton Colorado. 173 pp.
- Stokes, D. W. and L. Q. Stokes. 1996a. Stokes Field Guide to Birds: Eastern Region. Little, Brown and Company, New York, New York. 471 pp.

Stokes, D. W. and L. Q. Stokes. 1996b. Stokes Field Guide to Birds: Western Region. Little, Brown and Company, New York, New York. 519 pp.

Wiens, J. A. 1974. Climatic instability and the "ecological saturation" of bird communities in North American grasslands. *Condor* 76:385-400.

The NPS has organized its parks with significant natural resources into 32 networks linked by geography and shared natural resource characteristics. HTLN is composed of 15 National Park Service (NPS) units in eight Midwestern states. These parks contain a wide variety of natural and cultural resources including sites focused on commemorating civil war battlefields, Native American heritage, westward expansion, and our U.S. Presidents. The Network is charged with creating inventories of its species and natural features as well as monitoring trends and issues in order to make sound management decisions. Critical inventories help park managers understand the natural resources in their care while monitoring programs help them understand meaningful change in natural systems and to respond accordingly. The Heartland Network helps to link natural and cultural resources by protecting the habitat of our history.

The I&M program bridges the gap between science and management with a third of its efforts aimed at making information accessible. Each network of parks, such as Heartland, has its own multi-disciplinary team of scientists, support personnel, and seasonal field technicians whose system of online databases and reports make information and research results available to all. Greater efficiency is achieved through shared staff and funding as these core groups of professionals augment work done by individual park staff. Through this type of integration and partnership, network parks are able to accomplish more than a single park could on its own.

The mission of the Heartland Network is to collaboratively develop and conduct scientifically credible inventories and long-term monitoring of park "vital signs" and to distribute this information for use by park staff, partners, and the public, thus enhancing understanding which leads to sound decision making in the preservation of natural resources and cultural history held in trust by the National Park Service.

www.nature.nps.gov/im/units/htln/



The U.S. Department of the Interior (DOI) is the nation's principal conservation agency, charged with the mission "*to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.*" More specifically, Interior protects America's treasures for future generations, provides access to our nation's natural and cultural heritage, offers recreation opportunities, honors its trust responsibilities to American Indians and Alaska Natives and its responsibilities to island communities, conducts scientific research, provides wise stewardship of energy and mineral resources, fosters sound use of land and water resources, and conserves and protects fish and wildlife. The work that we do affects the lives of millions of people; from the family taking a vacation in one of our national parks to the children studying in one of our Indian schools.

**National Park Service
U.S. Department of the Interior**



Natural Resource Program Center

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nps.gov

EXPERIENCE YOUR AMERICA™