Survey of Critical Biological Resources of Garfield County, Colorado

Volume II: Survey of Critical Wetlands and Riparian Areas in Garfield County

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Knowledge to Go Places

Survey of Critical Biological Resources of Garfield County, Colorado

Volume II: Survey of Critical Wetlands and Riparian Areas in Garfield County

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USER'S GUIDE

The Survey of Critical Biological Resources of Garfield County, conducted by the Colorado Natural Heritage Program, consists of two essentially distinct projects that are highly integrated with respect to methodology and fieldwork. This report reflects the separate nature of the projects by being organized in a two-volume set. Both projects utilized the same Natural Heritage methodology that is used throughout the globe, and both searched for and assessed the plants, animals, and plant communities on the Colorado Natural Heritage Program's list of rare and imperiled elements of biodiversity. Each volume prioritizes potential conservation areas based on the relative significance of the biodiversity they support and the urgency for protection of the site. All information explaining Natural Heritage methodology and ranks is repeated in each volume, so that each volume can stand-alone and be used independently of the other.

Volume I presents *all* potential conservation areas identified in Garfield County that support rare and imperiled plants, animals, and significant plant communities, including wetland and riparian areas. Volume II focuses exclusively on wetland and riparian areas. Volume II also presents "sites of local significance". These sites are among the most important wetlands in Garfield County, but they did not support animals, plants or plant communities that are unique from a global or statewide perspective, therefore these sites did not receive a Biodiversity Rank. Additionally, Volume II presents an assessment of the restoration potential and the wetland functions performed by each site that was surveyed. Functional assessments are intended to provide the user with a more complete picture of the value wetlands and riparian areas provide to Garfield County residents.

ACKNOWLEDGEMENTS

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Our staff in Fort Collins, including Susan Spackman, Jill Handwerk, Dave Anderson, Jodie Bell, Renée Rondeau, Barry Baker, Amy Lavender, Jeremy Siemers, Rob Schorr, and Mike Wunder all worked with us patiently.

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EXECUTIVE SUMMARY

Citizens of Garfield County are concerned about issues of open space, wildlife habitat, and conservation of their unique natural surroundings. They recognize the need to plan for the conservation of the plants, animals and plant communities that are native to Garfield County. They also recognize that with limited resources, it is important to prioritize their conservation efforts. The need for information on the locations of the most significant biological resources of the area is urgent. In 2000, the Colorado Natural Heritage Program (CNHP) in cooperation with Colorado Division of Wildlife's (CDOW) Wetlands Program proposed to the Colorado Department of Natural Resources (CDNR) through a grant from the Environmental Protection Agency (EPA), Region VIII to survey for critical wetlands and riparian areas within Garfield County. The survey summarized in this report was conducted concurrently with a Great Outdoors Colorado (GOCO) funded survey of critical biological resources of Garfield County. The goal of the project was to systematically identify the localities of rare, threatened, or endangered species dependent on wetland and riparian areas and the locations of significant natural wetland and riparian plant communities.

This project supports the CDNR's effort to strategically protect Colorado's wetland resource. The results of this survey support **six** statewide wetland efforts:

(1) the Colorado Wetlands Initiative Legacy Project, a wetlands protection partnership that includes the Colorado Division of Wildlife, the Colorado Office of The Nature Conservancy, Colorado State Parks, Partners for Wildlife, Ducks Unlimited, and GOCO;
(2) the Lower Colorado River Wetlands Focus Area Strategic Plan;
(3) the CNHP's Statewide Wetland Classification and Characterization Project;
(4) The Nature Conservancy's Priority Conservation Sites in the Colorado/Gunnison River Basins and Roan Plateau Priority Areas;
(5) the hydrogeomorphic (HGM) wetland functional assessment program; and
(6) the Wetland Bioassessment method or Index of Biological Integrity (IBI) project.

This project supports the IBI and HGM development process by identifying potential reference wetlands and the range of variation and potential subclasses within Garfield County, and by performing a qualitative wetland functional assessment to guide future quantitative efforts in assessing the range of variation within a subclass. The CNHP's wetland work provides input to the Wetlands Initiative Partners (e.g. The Nature Conservancy) and the Colorado Wetlands Partnership by identifying potential sites for protection and restoration. Finally, the results of this survey will be incorporated into the CNHP's Comprehensive Statewide Wetlands Classification.

Field surveys began in June 2000 and continued through September 2000. Wetlands and riparian areas occurring on private lands were given the highest priority for inventory. Such locations were identified by: (1) examining existing biological data for rare or imperiled plant and animal species, and significant plant communities (collectively called **elements**) from the Colorado Natural Heritage Program's database, (2) accumulating additional existing information on these elements and, (3) conducting extensive field surveys. Areas that were found to contain significant elements were delineated as "Potential Conservation Areas." These areas were prioritized by their biological urgency (the most rare or imperiled) and their ability to maintain viable populations of the elements (degree of threat). A functional assessment was conducted at most of the wetland and riparian areas visited using a modified version of the Montana Wetland Field Evaluation Form (Berglund 1996) and the hydrogeomorphic approach (HGM) (Brinson 1993). The restoration potential of each site was also noted.

Results of the survey confirm that Garfield County contains areas with high biological significance. There are several extremely rare plants and animals that depend on these areas for survival. The inventory documented new records for 19 biologically significant elements, including two plants, 14 plant communities, and two fish. In addition, many older records were updated. Garfield County contains a diverse array of wetlands that support a wide variety of plants, animals, and plant communities. At least 49 major wetland/riparian plant communities (G1-G5), six birds, five plants, five fish, and three amphibians from the CNHP list of rare and imperiled plants, animals, and plant communities are known to occur in, or are associated with, wetlands in Garfield County.

Thirty-nine wetland and riparian sites of biodiversity significance are profiled in this report as Potential Conservation Areas (PCAs). These sites represent the best examples of 49 types of wetland and riparian communities observed on the public and private lands visited. The CNHP believes these sites include those wetlands that most merit conservation efforts, while emphasizing that protecting only these sites will, in no way, adequately protect all the values associated with wetlands in Garfield County. Additionally, five areas of local significance have been identified based on the local importance of their functions within the county. Despite the best efforts during one field season, it is likely that some elements that are present were not documented during the survey due to either lack of access, phenology of species, or time constraints and future surveys may identify additional areas of biological significance that have not been identified in this report. The delineation of PCA boundaries in this report does not confer any regulatory protection on recommended areas. They are intended to be used to support wise planning and decision making for the conservation of these significant areas. Additional information may be requested from Colorado Natural Heritage Program, 254 General Services Building, Colorado State University, Fort Collins, CO 80523.

Protection and/or proper management of the PCAs would help to conserve the biological integrity of Garfield County and Colorado. Of these sites, several stand out as very significant such as East Fork Parachute Creek, which harbors the best known population of the endemic plant, hanging garden sullivantia and Rifle Stretch Colorado River, which contains the largest, continuous riparian habitat along the Colorado River in Garfield County.

Of the 39 PCAs, we identified six of **very high significance** (B2), 22 of **high significance** (B3), nine of **moderate significance** (B4), and two of **general significance** (B5). Overall, the concentration and quality of imperiled elements and habitats attest to the fact that conservation efforts in Garfield County will have both state and global significance.

The general location and distribution of weeds (non-native) and aggressive species were documented. For a separate, yet related project, the CNHP, in collaboration with the Bureau of Land Management's (BLM) Grand Junction District, also conducted an inventory for seeps and springs on BLM lands in western Garfield County. The results of this project indicate that Garfield County may have one of the highest concentrations of seeps and springs among counties in Colorado.

The results of the survey will be provided to the county in GIS format and will be available to the public on the CNHP website (http:\\www.cnhp.colostate.edu).

CONSERVATION STRATEGIES

Conservation strategies can be classified as three major types:

(1) Land protection can be accomplished through acquisition, conservation easements, land exchanges, long term leases, purchase of mineral or grazing rights, or government regulation;
(2) Management of the land can be influenced so that significant resources are protected; and
(3) Public education about the significant ecological values of the county will engender support for land use decisions that protect these values.

The first necessary step, identification of the significant elements of biodiversity in the county, and their locations, has been taken with this survey. The next step is to use this information to conserve these elements and sites. Specific protection and management needs are addressed under the descriptions of individual PCAs. However, some general recommendations for conservation of biological diversity in Garfield County are given here:

1. Develop and implement a plan for protecting the Proposed Conservation Areas profiled in this report, with most attention directed toward sites with biodiversity rank (B-rank) B1, B2 and B3. The sites in this report provide a basic framework for implementing a comprehensive conservation program. The B1, B2 and B3 sites, because they have global significance, should receive priority attention. Consider purchasing development rights or outright purchase from willing owners of land for significant sites that are in need of protection. Support local organizations, such as land trusts, in purchasing or acquiring conservation easements for protection of biological diversity or open space. Explore opportunities to form partnerships to access federal funding for conservation projects. Continue to promote cooperation among local entities to preserve the county's biodiversity.

2. Use this report in the review of proposed activities in or near Potential Conservation Areas to determine whether activities do or do not adversely affect elements of biodiversity. All of the areas presented contain natural heritage elements of state or global significance. Also, consider the potential natural heritage values of all other sites for which land use decisions are made, using this report as a guide for values to be considered. Insist on careful assessments of potential damages, including weed invasion and fragmentation.

Certain land use activities in or near a site may affect the element(s) present there. Wetland and riparian areas are particularly susceptible to impacts from off-site activities if the activities affect water quality or hydrologic regimes. In addition, cumulative impacts from many small changes can have effects as profound and far-reaching as one large change. As proposed land use changes within Garfield County are considered, they should be compared to the maps presented herein. If a proposed project has the potential to impact a site, planning personnel should contact persons, organizations, or agencies with the appropriate biological expertise for input in the planning process. The Colorado Natural Heritage Program, Colorado Natural Areas Program, and Colorado Division of Wildlife routinely conduct environmental reviews statewide and should be considered as valuable resources. To contact the CNHP's Environmental Review Coordinator call 970-491-7331.

3. Recognize the importance of all natural communities and lands at all elevations. Although much effort in the past has been directed at protecting the most scenic, high elevation areas, the lower elevations, such as the sagebrush and pinyon-juniper zones have received less attention. While the specific sites identified here contain the known locations of significant elements of natural diversity, protection of large areas in each vegetation type, especially where these are connected, will help to ensure that we do not lose species that have not yet been identified. Work to protect large blocks of land in each of the major vegetation types in the county, and avoid fragmenting large natural areas unnecessarily. Although large migrating animals like deer and elk are not tracked by the CNHP as rare species, they are a part of our natural diversity, and their needs for winter range and protected corridors to food and water should be taken into consideration. Fragmentation of the landscape also affects smaller animals and plants, opening more edge habitats and introducing exotic species. Encourage cluster developments that designate large common areas for preservation of natural communities, as an alternative to scattering residences over the landscape with a house on each 35-acre parcel. Work with developers early in the planning process to educate them about the benefits of retaining natural areas. Locate trails and roads to minimize impacts on native plants and animals. See Forman and Alexander (1998) for an excellent review of the literature on the ecological effects of roads. See the booklet published by the State Trails Program (Colorado Department of Natural Resources 1998) for suggestions regarding planning trails with minimum impacts to wildlife.

4. Develop and implement comprehensive programs to address loss of wetlands. In conjunction with the information contained in this report, information regarding the degree and trend of loss for all wetland types (e.g., salt meadows, emergent marshes, riparian forests, seeps/springs, etc.) should be sought and utilized to design and implement a comprehensive approach to the management and protection of Garfield County wetlands. Such an effort could provide a blueprint for wetland conservation in Garfield County. Encourage and support statewide wetland protection efforts such as CDOW's Wetlands Partnership. County governments are encouraged to support research efforts on wetlands. Countywide education of the importance of wetlands could be implemented through the county extension service or other local agencies. Cultivate communication and cooperation with landowners regarding protection of wetlands in Garfield County. Utilize the expertise and breadth of experience within the Lower Colorado River Wetland Focus Area Committee.

5. Increase efforts to protect biodiversity, promote cooperation and incentives among landowners, pertinent government agencies, and non-profit conservation organizations and increase public awareness of the benefits of protecting significant natural areas. Involve all stakeholders in land use planning. The long-term protection of natural diversity in Garfield County will be facilitated with the cooperation of many private landowners, government agencies, and non-government organizations. Efforts to provide stronger ties among federal, state, local, and private interests involved in the protection or management of natural lands will increase the chance of success. Expand public and staff awareness of Garfield County's natural heritage and its need for protection by providing community education, and forums where protection of our natural heritage is discussed.

6. Promote wise management of the biodiversity resources that exist within Garfield County, recognizing that delineation of potential conservation areas does not by itself guarantee protection of the plants, animals, and plant communities. Development of a site specific conservation plan is a necessary component of the long-term protection of a Potential Conservation Area. Because some of the most serious impacts to Garfield County' ecosystems are at a large scale (altered hydrology, residential encroachment, and non-native species invasion), considering each area in the context of its surroundings is critical. Several organizations and agencies are available for consultation in the development of conservation plans, including the Colorado Natural Heritage Program, the Colorado Division of Wildlife, the Natural Resources Conservation Service, and various academic institutions. With the rate of population growth in Colorado, rare and imperiled species will continue to decline if not given appropriate protection. Increasing the public's knowledge of the remaining significant areas will build support for the initiatives necessary to protect them, and allow proactive planning. Encourage good management by supporting incentives to landowners for improvements such as fencing riparian areas, weed control, or wildlife habitat restoration projects.

7. Stay informed and involved in public land management decisions. About two thirds of the county is publicly owned. Many of the sites identified here are on public land that may be protected from development, but not from incompatible uses. Even ownership is not always secure, since the federal agencies are becoming more and more involved in land exchanges. Both the White River National Forest and Bureau of Land Management are in the process of developing new or revised management plans, and are seeking public input. Encourage protection for the most biologically significant sites on public lands by special designation such as Areas of Critical Environmental Concern, Research Natural Areas, Wilderness, and Special Management Areas.

8. Continue inventories where necessary, including inventories for species that cannot be surveyed adequately in one field season and inventories on lands that the CNHP could not access in 2000. Not all targeted inventory areas can be field surveyed in one year due to either lack of access, phenology of species, or time constraints. Because some species are ephemeral or migratory, completing an inventory in one field season is often difficult. Despite the best efforts during one field season, it is likely that some elements that are present were not documented during the survey and other important sites have not been identified in this report.

9. Continue to take a proactive approach to weed control in the county. Give adequate support, in funding and staff, to the county Weed Management offices for weed control. Recognize that weeds affect both agriculture and native plant communities. Discourage the introduction and/or sale of non-native species that are known to significantly impact natural areas. These include, but are not limited to, tamarisk, Russian olive, purple loosestrife, wild chamomile, and non-native fish species. Natural area managers, public agencies, and private landowners should be encouraged to remove these species from their properties. Encourage the use of native species for revegetation and landscaping efforts. Ideally, seed should be locally harvested. This includes any seeding done on county road right-of ways. The Colorado Natural Areas Program has published a book entitled Native Plant Revegetation Guide for Colorado that describes appropriate species to be used for revegetation. This resource is available on the World Wide Web at http://elbert.state.co.us/cnap/Revegetation_Guide/Reveg_index.html.

INTRODUCTION

Wetlands are places where soils are inundated or saturated with water long enough and frequently enough to significantly affect the plants and animals that live and grow there. Until recently, most people viewed wetlands as a hindrance to productive land use. Consequently, many wetlands across North America were purposefully drained. Since 1986, wetlands are being lost at a rate of 58,500 acres/year (Dahl 2000). In Colorado an estimated 1 million acres of wetlands (50% of the total for the state) were lost prior to 1980 (Dahl 1990).

Although the rate of wetland loss in Garfield County is difficult to quantify, it is clear that many wetlands, especially along the Colorado River and other riparian areas, have been lost or profoundly altered from their pre-settlement state. Agriculture, grazing, development, construction of reservoirs, water diversions, and mining have had many impacts on wetlands throughout the study area. Fertile soils and available water for irrigation make floodplains productive areas for agriculture. Since the nineteenth century, hydrological diversions and the installation of groundwater wells have been developed for irrigation and drinking water supplies. Such activities have eliminated or altered some wetlands, and created other wetlands that are very different from those in existence prior to European settlement. The development of an extensive network of canals and irrigation agriculture has created irrigation-induced wetlands where none previously existed. It is clear that with the current rate of land use conversion and the lack of comprehensive wetland protection programs, wetlands will continue to be lost or dramatically altered.

Increasingly, local Colorado governments and federal agencies, particularly in rapidly growing parts of the state, are expressing a desire to better understand their natural heritage resources, including wetlands. The Colorado Natural Heritage Program approached this project with the intent of addressing this desire.

The wetland inventory of Garfield County, conducted by the CNHP, is a part of ongoing wetland inventories of Colorado counties by the CNHP. To date, similar inventories have been conducted in all or parts of over twelve counties. In addition to the county inventories, a riparian vegetation classification study was conducted in the Colorado River and White River Basins (Kittel et al. 1999). The riparian study randomly selected sites throughout the basin, a number of which were located in Garfield County. Currently, the CNHP is working on the Comprehensive Statewide Wetland Characterization and Classification Project. This project is compiling data from multiple sources, including the CNHP's Riparian Classification, to produce a comprehensive wetland classification for Colorado.

The primary objective of this project was to identify biologically significant wetlands within Garfield County, with an emphasis on private lands. The Survey of Critical Wetlands and Riparian Areas in Garfield County used the methodology that is used throughout Heritage Programs in the world. The primary focus was to identify the locations of the wetland plant and animal populations, and plant communities on the CNHP's list of rare and imperiled elements of biodiversity, assess their conservation value, and to systematically prioritize these for conservation action. Wetland functions and restoration potential for each site visited was also assessed.

The locations of biologically significant wetlands were identified by:

- Examining existing biological data for rare or imperiled plant and animal species, and significant plant communities (collectively called **elements)**;
- Accumulating additional existing information;
- Conducting extensive field surveys.

Locations in the county with natural heritage significance (those places where elements have been documented) are presented in this report as potential conservation areas (PCAs). The goal is to identify a land area that can provide the habitat and ecological needs upon which a particular element or suite of elements depends for their continued existence. The best available knowledge of each species' life history is used in conjunction with information about topographic, geomorphic, and hydrologic features, vegetative cover, as well as current and potential land uses to delineate PCA boundaries.

The PCA boundaries delineated in this report do not confer any regulatory protection of the site, nor do they automatically exclude all activity. It is hypothesized that some activities will prove degrading to the element(s) or the ecological processes on which they depend, while others will not. The boundaries represent the best professional estimate of the primary area supporting the long-term survival of the targeted species or plant communities and are presented for planning purposes. They delineate ecologically sensitive areas where land-use practices should be carefully planned and managed to ensure that they are compatible with protection of natural heritage resources and sensitive species. Please note that these boundaries are based primarily on our understanding of the ecological systems. A thorough analysis of the human context and potential stresses was not conducted. All land within the conservation planning boundary should be considered an integral part of a complex economic, social, and ecological landscape that requires wise land-use planning at all levels.

The CNHP uses the Heritage Ranking Methodology to prioritize conservation actions by identifying those areas that have the greatest chance of conservation success for the most imperiled elements. The sites are prioritized according to their **biodiversity significance rank**, or "B-rank," which ranges from B1 (outstanding significance) to B5 (general or statewide significance). These ranks are based on the conservation (imperilment or rarity) ranks for each element and the element occurrence ranks (quality rank) for that particular location. Therefore, the highest quality occurrences (those with the greatest likelihood of long-term survival) of the most imperiled elements are the highest priority (receive the highest B-rank). See the section on Natural Heritage Ranking System for more details. The B1-B3 sites are the highest priorities for conservation actions. The sum of all the sites in this report represents the area the CNHP recommends for protection in order to preserve the natural heritage of Garfield County's wetlands.

WETLAND DEFINITIONS, REGULATIONS, AND FUNCTIONAL ASSESSMENTS

Wetland Definitions

The federal regulatory definition of a jurisdictional wetland is found in the regulations used by the U.S. Army Corps of Engineers (Corps) for the implementation of a dredge and fill permit system required by Section 404 of the Clean Water Act Amendments (Mitsch & J.G. Gosselink 1993). According to the Corps, wetlands are "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." For Corps programs, a wetland boundary must be determined according to the mandatory technical criteria described in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987). In order for an area to be classified as a jurisdictional wetland (i.e., a wetland subject to federal regulations), it must have **all** three of the following criteria: (1) wetland plants; (2) wetland hydrology; and (3) hydric soils.

The U.S. Fish and Wildlife Service defines wetlands from an ecological point of view. In *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) the definition states that "wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water". Wetlands must have *one or more* of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (wetland plants); (2) the substrate is predominantly undrained hydric soil; and/or (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. This definition only requires that an area meet one of the three criteria (vegetation, soils, and hydrology) in order to be classified as a wetland.

The CNHP prefers the wetland definition used by the U.S. Fish and Wildlife Service, because it recognizes that some areas display many of the attributes of wetlands without exhibiting all three characteristics required to fulfill the Corps' criteria. Additionally, riparian areas, which often do not meet all three of the Corps criteria, should be included in a wetland conservation program. Riparian areas perform many of the same functions as do wetlands, including maintenance of water quality, storage of floodwaters, and enhancement of biodiversity, especially in the western United States (National Research Council 1995).

Wetland Regulation in Colorado

Wetlands in Colorado are currently regulated under the authority of the Clean Water Act. A permit issued by the Corps is required before placing fill in a wetland (e.g., building up a site before constructing a home), and before dredging, ditching, or channelizing a wetland. The Clean Water Act exempts certain filling activities, such as normal agricultural activities.

The 404(b)(1) guidelines, prepared by the Environmental Protection Agency in consultation with the Corps, are the federal environmental regulations for evaluating projects that will impact wetlands. Under these guidelines, the Corps is required to determine if alternatives exist for minimizing or eliminating impacts to wetlands. When unavoidable impacts occur, the Corps requires mitigation of the impacts. Mitigation may involve creation or restoration of similar wetlands in order to achieve an overall goal of no net loss of wetland area.

The U.S. Fish and Wildlife Service has conducted inventories of the extent and types of our nation's wetlands. The Cowardin et al. (1979) classification system provides the basic mapping units for the U.S. National Wetlands Inventory (NWI). The NWI drew maps for Garfield County, west of the 106th meridian, based on 1:58,000 scale color infrared aerial photography taken in September 1983. The NWI maps east of the 106th meridian were completed in the 1970s using black and white photos. Photo-interpretation and field reconnaissance was used to refine wetland boundaries according to the wetland classification system. The information is summarized on 1:24,000 and 1:100,000 maps.

The NWI maps provide important and accurate information regarding the location of wetlands. They can be used to gain an understanding of the general types of wetlands in the county and their distribution. The NWI maps cannot be used for federal regulatory programs that govern wetlands for two reasons. First, the U.S. Fish and Wildlife Service uses a definition for a wetland that differs slightly from Corps, the agency responsible for executing federal wetland regulations. Secondly, there is a limit to the resolution of the 1:24,000 scale maps. For example, at this scale, the width of a fine line on a map represents about 5 m (17 ft) on the ground (Mitsch & J.G. Gosselink 1993). For this reason, precise wetland boundaries must be determined on a project by project basis. Colorado's state government has developed no guidelines or regulations concerning the management, conservation, and protection of wetlands, but a few county and municipal governments have, including the City of Boulder, Boulder County, and San Miguel County.

Wetland Functions and Values

Wetlands perform many functions beyond simply providing habitat for plants and animals. It is commonly known that wetlands act as natural filters, helping to protect water quality, but it is less well known that wetlands perform other important functions. (Adamus et al. 1991) list the following functions performed by wetlands:

- Groundwater recharge--the replenishing of below ground aquifers.
- Groundwater discharge--the movement of ground water to the surface (e.g., springs).
- Floodflow alteration--the temporary storage of potential flood waters.
- Sediment stabilization--the protection of stream banks and lake shores from erosion.
- Sediment/toxicant retention--the removal of suspended soil particles from the water, along with toxic substances that may be adsorbed to these particles.

- Nutrient removal/transformation--the removal of excess nutrients from the water, in particular nitrogen and phosphorous. Phosphorous is often removed via sedimentation; transformation includes converting inorganic forms of nutrients to organic forms and/or the conversion of one inorganic form to another inorganic form (e.g., NO_3^- converted to N_2O or N_2 via denitrification).
- Production export--supply organic material (dead leaves, soluble organic carbon, etc.) to the base of the food chain.
- Aquatic diversity/abundance--wetlands support fisheries and aquatic invertebrates.
- Wildlife diversity/abundance--wetlands provide habitat for wildlife.

(Adamus & L.T. Stockwell 1983) include two items they call "values" which also provide benefits to society:

- Recreation--wetlands provide areas for fishing, birdwatching, etc.
- Uniqueness/heritage value--wetlands support rare and unique plants, animals, and plant communities.

"Values" are subject to societal perceptions, whereas "functions" are biological or physical processes which occur in wetlands, regardless of the value placed on them by society (National Research Council 1995). The actual value attached to any given function or value listed above depends on the needs and perceptions of society.

Wetland Functional Assessment

For this project, the CNHP utilized a qualitative, descriptive functional assessment based on the best professional judgment of the CNHP ecologists while incorporating some of the principles of the hydrogeomorphic (HGM) assessment method. Each wetland was classified according to both the Cowardin et al. (1979) and hydrogeomorphic (HGM) (Brinson 1993) classification systems and twelve categories (listed below) were used to assess each wetland. Using the HGM method, wetland functions are evaluated or compared only with respect to other wetlands in the same subclass, because different subclasses often perform very different functions. For example, a montane kettle pond may provide habitat for rare plant communities never found on a large river but provides little in the way of flood control, while wetlands along a major river perform important flood control functions but may not harbor rare plant species. Thus, the category, **Overall Functional Integrity**, was included in the functional assessment to provide the user of some indication of how a particular wetland is functioning in comparison to its natural capacity, as opposed to comparing it to different wetland types.

The functional assessment assigns to each of the functions a value rating of "low", "moderate", or "high". The following functions were evaluated for most of the sites profiled in this report:

- Overall Functional Integrity
- Flood attenuation and storage

- Sediment/shoreline stabilization
- Groundwater discharge/recharge
- Dynamic surface water storage
- Elemental Cycling
- Removal of Imported Nutrients, Toxicants, and Sediments
- Production export/food chain support
- Habitat diversity
- General wildlife habitat
- General fish habitat
- Uniqueness

Overall Functional Integrity
The overall functional integrity of each wetland is a rating indicating how a particular wetland is functioning in comparison to wetlands in its same hydrogeomorphic class and/or subclass (see discussion below). For example, mineral soil flats (salt meadows) do not typically function as high wildlife habitat but do have high capacity for storing surface/groundwater. Thus, a mineral soil flat that is given a low rating for General Wildlife Habitat, General Fish Habitat, and Production Export/Food Chain Support does not necessarily indicate that the wetland is not functioning to its capacity. These ratings may just reflect that mineral soil flats, because of their landscape position and soil chemistry, naturally perform less functions than a depressional wetland. However, this particular wetland may be functioning the 'best' that could be expected from a mineral soil flat. The Overall Functional Integrity rating would reflect this by giving this particular wetland a 'Functioning at Potential' rating, based on the best professional judgment of the CNHP ecologists. In summary, a mineral soil flat wetland having more low ratings than a depressional wetland does not necessarily mean that it is functioning improperly. However, if this particular mineral soil flat was given an Overall Functional Integrity rating of 'Functioning Below Normal', then it could be assumed that the wetland is not functioning to the capacity that it should (relative to other mineral soil flat wetlands).

Flood Attenuation and Storage
Many wetlands have a high capacity to store or delay floodwaters that occur from peak flow, gradually recharging the adjacent groundwater table. Indicators of flood storage include: debris along streambank and in vegetation, low gradient, formation of sand and gravel bars, high density of small and large depressions, and dense vegetation. This field assesses the capability of the wetland to detain moving water from in-channel flow or overbank flow for a short duration when the flow is outside of its channel.

Sediment/Shoreline Stabilization
Shoreline anchoring is the stabilization of soil at the water's edge by roots and other plant parts. The vegetation dissipates the energy caused by fluctuations of water and prevents streambank erosion. The presence of woody vegetation and sedges in the understory are the best indicator of good sediment/shoreline anchoring.

Groundwater Discharge/Recharge

Groundwater recharge occurs when the water level in a wetland is higher than the surrounding water table resulting in the movement (usually downward) of surface water (e.g., floodwater retention). Groundwater discharge results when the groundwater level of a wetland is lower than the surrounding water table, resulting in the movement (usually laterally or upward) of surface water (e.g., springs, seeps, etc.). Ground water movement can greatly influence some wetlands, whereas in others it may have minimal effect (Carter and Novitzki 1988).

Both groundwater discharge and recharge are difficult to estimate without intensive data collection. Wetland characteristics that may indicate groundwater recharge are: porous underlying strata, irregularly shaped wetland, dense vegetation, and presence of a constricted outlet. Indicators of groundwater discharge are the presence of seeps and springs and wet slopes with no obvious source.

Dynamic Surface Water Storage

Dynamic surface water storage refers to the potential of the wetland to capture water from precipitation and upland surface (sheetflow). Sheetflow is nonchannelized flow that usually occurs during and immediately following rainfall or a spring thaw. Wetlands can also receive surface inflow from seasonal or episodic pulses of flood waters from adjacent streams and rivers that may otherwise not be hydrologically connected with a particular wetland (Mitsch and Gosselink 1993). Spring thaw and/or rainfall can also create a time-lagged increase in groundwater flow. Wetlands providing dynamic surface water storage are capable of releasing these episodic pulses of water at a slow, stable rate thus alleviating short term flooding from such events. This function is applicable to wetlands that are not subject to flooding from in-channel or overbank flow (see Flood Storage and Attenuation). Indicators of potential surface water storage include flooding frequency, density of woody vegetation (particular those species with many small stems), coarse woody debris, surface roughness, and size of the wetland.

Elemental Cycling

The cycling of nutrients, or the abiotic and biotic processes that convert elements from one form to another, is a fundamental ecosystem process which maintains a balance between living biomass and detrital stocks (Brinson et al. 1985). Disrupting nutrient cycles could cause an imbalance between the two resulting in one factor liming the other. Thus, impacts to aboveground primary productivity or disturbances to the soil, which may cause a shift in nutrient cycling rates, could change soil fertility, alter plant species composition, and affect potential habitat functions. Indicators of wetlands with intact nutrient cycling need to be considered relative to wetlands within the same hydrogeomorphic class/subclass. Such indicators include high aboveground primary productivity and high quantities of detritus, within the range expected for that particular hydrogeomorphic class of wetlands.

Removal of Imported Nutrients, Toxicants, and Sediments

Nutrient retention/removal is the storing and/or transformation of nutrients within the sediment or vegetation. Inorganic nutrients can be transformed into an organic form and/or converted to another inorganic form via microbial respiration and redox reactions. For example, denitrification, which is a process that is mediated by microbial respiration, results in the transformation of nitrate (NO_3^-) to nitrous oxide (N_20) and/or molecular nitrogen (N_2). Nutrient retention/removal may help protect water quality by retaining or transforming nutrients before they are carried downstream or are transported to underlying aquifers. Particular attention is focused on processes involving nitrogen and phosphorus, as these nutrients are usually of greatest importance to wetland systems (Kadlec and Kadlec 1979). Nutrient storage may be for long-term (greater than 5 years) as in peatlands or depressional marshes or short-term (30 days to 5 years) as in riverine wetlands. Some indicators of nutrient retention include: high sediment trapping, organic matter accumulation, presence of free-floating, emergent, and submerged vegetation, and permanently or semi-permanently flooded areas.

Sediment and toxicant trapping is the process by which suspended solids and chemical contaminants are retained and deposited within the wetland. Deposition of sediments can ultimately lead to removal of toxicants through burial, chemical break down, or temporary assimilation into plant tissues (Boto and Patrick 1979). Most vegetated wetlands are excellent sediment traps, at least in the short term. Wetland characteristics indicating this function include: dense vegetation, deposits of mud or organic matter, gentle sloping gradient, and location next to beaver dams or human-made detention ponds/lakes.

Habitat diversity

Habitat diversity refers to the number of Cowardin wetland classes present at each site. Thus, a site with emergent, scrub/shrub, and forested wetland habitat would have high habitat diversity. The presence of open water in these areas also increases the habitat diversity at a site.

General Wildlife and Fish Habitat

Habitat includes those physical and chemical factors which affect the metabolism, attachment, and predator avoidance of the adult or larval forms of fish, and the food and cover needs of wildlife. Wetland characteristics indicating good fish habitat include: deep, open, non-acidic water, no barriers to migration, well-mixed (high oxygen content) water, and highly vegetated. Wetland characteristics indicating good wildlife habitat are: good edge ratio, islands, high plant diversity, and a sinuous and irregular basin.

Production Export/Food Chain Support

Production export refers to the flushing of relatively large amounts of organic material (both particulate and dissolved organic carbon and detritus) from the wetland to downstream ecosystems. Production export emphasizes the production of organic substances within the wetland and the utilization of these substances by fish, aquatic invertebrates, and microbes. Food chain support is the direct or indirect use of nutrients, carbon, and even plant species (which provide cover and food for many invertebrates) by organisms which inhabit or periodically use wetland ecosystems. Indicators of wetlands that provide downstream food chain support are: an outlet, seasonally flooded hydrological regime, overhanging vegetation, and dense and diverse vegetation composition and structure.

Uniqueness

This value expresses the general uniqueness of the wetland in terms of relative abundance of similar sites occurring in the same watershed, size, geomorphic position, peat accumulation, mature forested areas, and the replacement potential.

Hydrogeomorphic (HGM) Approach to Wetland Functional Assessment

In an effort to provide a more consistent and logical basis for regulatory decisions about wetlands, a new approach to assessing wetland functions--the *hydrogeomorphic* approach is being developed. In Colorado, the hydrogeomorphic, or HGM, approach to wetland function assessment is being developed by the Colorado Geological Survey, with help from the U.S. Army Corps of Engineers, other government agencies, academic institutions, the Colorado Natural Heritage Program, and representatives from private consulting firms (Colorado Geological Survey et al. 1998).

This approach is based on a classification of wetlands according to their hydrology (water source and direction of flow) and geomorphology (landscape position and shape of the wetland) called "hydrogeomorphic" classification (Brinson 1993). There are four hydrogeomorphic classes present in Colorado: riverine, slope, depression, and mineral soil flats (Table 1). Within a geographic region, HGM wetland classes are further subdivided into subclasses. A subclass includes all those wetlands that have essentially the same characteristics and perform the same functions.

One of the fundamental goals of HGM is to create a system whereby every wetland is evaluated according to the same standard. In the past, wetland functional assessments typically were on a site by site basis, with little ability to compare functions or assessments between sites. HGM allows for consistency, first through the use of a widely applicable classification, then through the use of *reference wetlands*. Reference wetlands are chosen to encompass the known variation of a subclass of wetlands. A subset of reference wetlands is a *reference standard*, wetlands that correspond to the highest level of functioning of the ecosystem across a suite of functions (Brinson and Rheinhardt 1996).

HGM assumes that the highest, sustainable functional capacity is achieved in wetland ecosystems and landscapes that have not been subject to long-term anthropogenic disturbance. Under these conditions, the structural components and physical, chemical, and biological processes in the wetland and surrounding landscape are assumed to be at a dynamic equilibrium which allows maximum ecological function (Smith et al. 1995). If a wetland is to be designated a reference standard for a given subclass of wetlands, it must meet these criteria. The need to locate reference wetlands is compatible with the CNHP's efforts to identify those wetlands with the highest biological significance, in that the least disturbed wetlands will often be those with the highest biological significance.

Table 1. Hydrogeomorphic wetland classes in Colorado (Cooper 1998 as cited in Colorado Geological Survey et al. 1998).

Class	Geomorphic setting	Water Source	Water Movement	Subclass	Examples
Riverine	In riparian areas along rivers and streams	Overbank flow from channel	One-directional and horizontal (downstream)	R1-steep gradient, low order streams R2-moderate gradient, low to middle order R3-middle elevation, moderate gradient along small/mid-order stream R4-low elevation canyons or plateaus R5-low elev. Floodplains	Herbaceous subalpine plant community. Streams near Trappers Lake East Elk Creek Colorado River - Glenwood Canyon Colorado River – Rifle stretch.
Slope	At the base of slopes, e.g., along the base of the foothills; also, places where porous bedrock overlying a non-porous bedrock intercepts the ground surface.	Groundwater	One-directional, horizontal (to the surface from groundwater)	S1-alpine and subalpine fens on non-calcareous substrates. S2-subalpine and montane fens on calcareous substrates S3-wet meadows at middle elev. S4-low elevation meadows	Willow carr at Fourmile Park; Flat Tops. None in Garfield County; High Creek Fen – Park County Springs along East Salt Creek Spring at Fisher Creek
Depressional	In depressions cause by glacial action (in the mountains) and oxbow ponds within floodplains. Lake, reservoir, and pond margins are also included.	Shallow ground water	Generally two-directional, vertical: flowing into and out of the wetland in the bottom and sides of the depression	D1-mid to high elevation basins with peat soils or lake fringe without peat D2-low elevation basins that are permanently or semi-permanently flooded D3-low elevation basin with seasonal flooding D4-low elevation basins that are temporarily flooded D5-low elevation basins that are intermittently flooded	White River Plateau; Flat Tops. Depressional wetlands on Colorado River floodplain. Mishak Lake in San Luis Valley Abandoned beaver ponds. Playa lakes.
Mineral Soil Flat	Topographically flat wetland	Precipitation and groundwater	Two directional	F1-low elevation with seasonal high water table	Antero Reservoir in South Park

PROJECT BACKGROUND

Location and Physical Characteristics of Study Area
Garfield County is located in northwestern Colorado, extending over one hundred miles from the Utah border eastward. It encompasses 2,948 square miles. It is bordered by Rio Blanco County on the north, Mesa and Pitkin counties on the south, and Routt and Eagle counties on the east (Figure 1). Garfield County lies primarily within two geologically distinct regions: the plateau country in the western two thirds, and the Rocky Mountains in the eastern third. The boundary between the two regions is defined by the western edge of the Grand Hogback, a large monocline that runs north to south through the county. The Rocky Mountain section in Garfield County is within the White River Plateau, one of three areas in the state that are capped by volcanic rock. (The other two are the West Elk Mountains and the San Juan Mountains.). The White River Plateau includes the Flat Tops, the Glenwood Canyon area and the Roaring Fork Valley. Major features within the western plateau area are the Roan Plateau and the Bookcliffs, along with a small part of the Grand Valley south of the Bookcliffs in the southwest corner of the county.

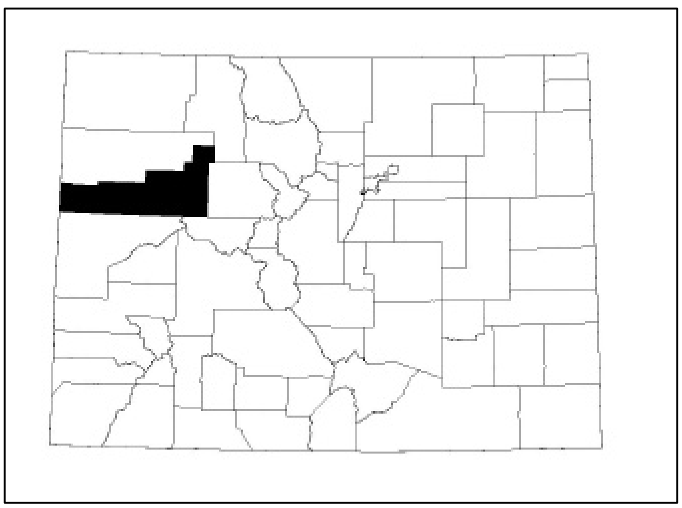


Figure 1. Location of Garfield County in Colorado

Bailey (1984) defines the ecoregions found in Garfield County as the Utah High Plateaus in the west, and the Rocky Mountains in the east (Figure 2). The small area south of the Bookcliffs falls within the Colorado Plateau ecoregion. The entire county is within the drainage of the Colorado River. While most of the area drains south directly into the Colorado River, a small area in the northern part of the county drains into the White River, which is a tributary of the Colorado. The Colorado River enters the county at the eastern end of Glenwood Canyon, about 12 miles east of Glenwood Springs, and flows southwest for about 62 miles before leaving the county between Parachute and DeBeque. Major tributaries in Garfield County are Parachute Creek, Roan Creek, Rifle Creek, Deep Creek, Elk Creek, Grizzly Creek, and the Roaring Fork River.

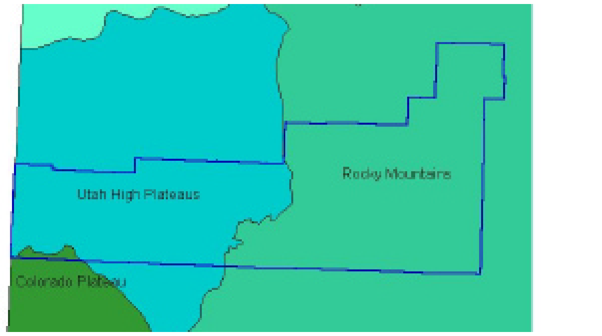


Figure 2. Ecoregions of Garfield County

Elevations in the county range from 4,960 ft., where the Colorado River crosses the Garfield-Mesa County line, to 12,241 ft. at Sheep Mountain in the Flat Tops. The Colorado River Valley averages between 5000 and 6000 feet, the Book Cliffs around 7000 feet, the Roan Plateau around 8,000 ft., and the Flat Tops between 10,000 and 12,000 ft.

Climate of the county varies greatly with elevation (Figure 3). The driest areas are in the southwest, the southeast, and in the central area around Rifle to New Castle, with between 10 and 15 inches annual precipitation. Mountainous areas such as the Flat Tops and Battlement Mesa may receive as much as 45 to 50 inches annually. Glenwood Springs records average annual high temperatures of 62.8 degrees F. and low temperature of 31.2 degrees F. Rifle is only slightly warmer, with average highs of 64.2 degrees and lows of 31.1 degrees (Western Regional Climate Center 2001).

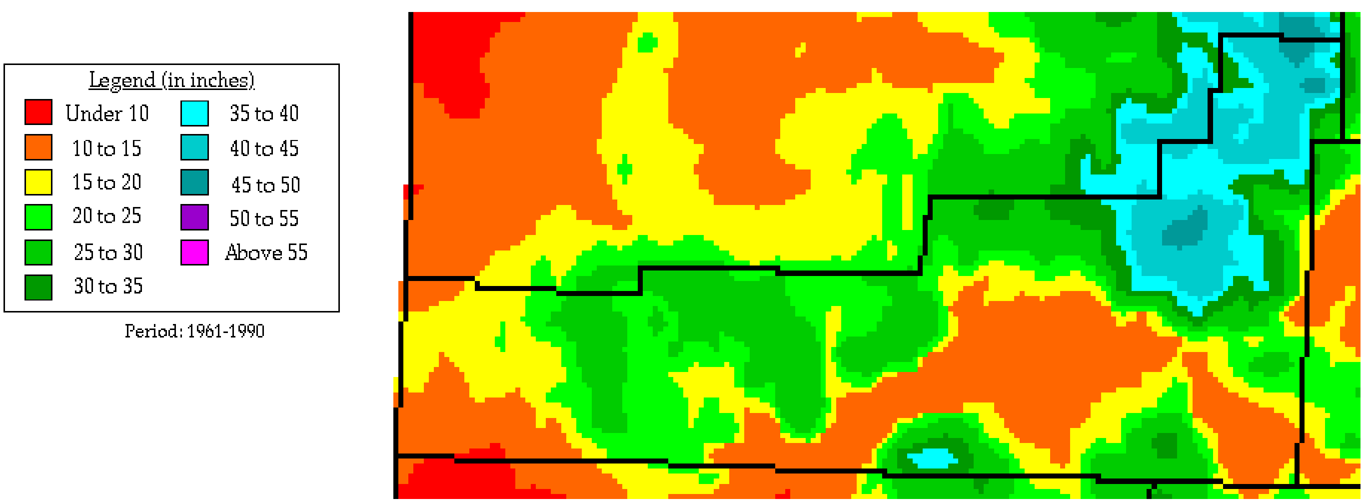


Figure 3. Precipitation in Garfield County. From Western Regional Climate Center (2001).

Major population centers in the county are located along the Colorado River and the Roaring Fork River (Figure 4): Glenwood Springs, New Castle, Silt, Rifle, Parachute, and Carbondale. As of the 1990 census, the population of the county was 29,974, centered mainly in the Glenwood Springs, Carbondale, and Rifle areas. Outside of the Colorado and Roaring Fork valleys, the county is very sparsely populated.

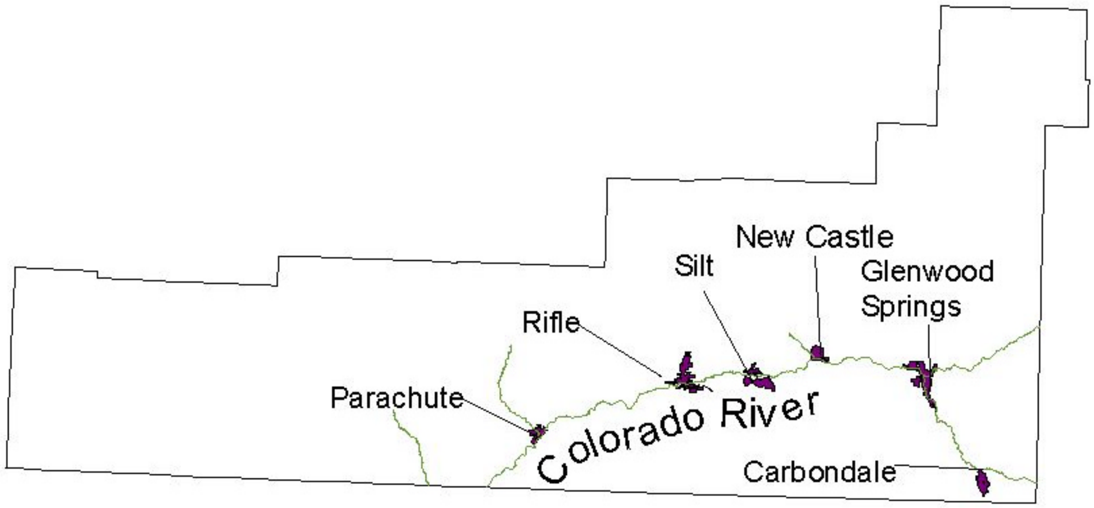


Figure 4. Municipalities and major rivers of Garfield County

Ownership is about equally divided between private, BLM and US Forest Service lands (Figure 5). Private lands are located primarily along the river corridors and on the Roan Plateau, where much of the land is either owned or leased by oil and gas companies. Although private lands often comprise only a narrow strip along streams and roads, they effectively block access to vast amounts of public lands. BLM land is found mainly in the western part of the county, and managed by the Grand Junction and Glenwood Springs Resource Areas. The White River National Forest occupies the northeastern part of the county, and includes the Flat Tops Wilderness. The state of Colorado holds land south of New Castle, in the Garfield State Wildlife Area (Figure 5).

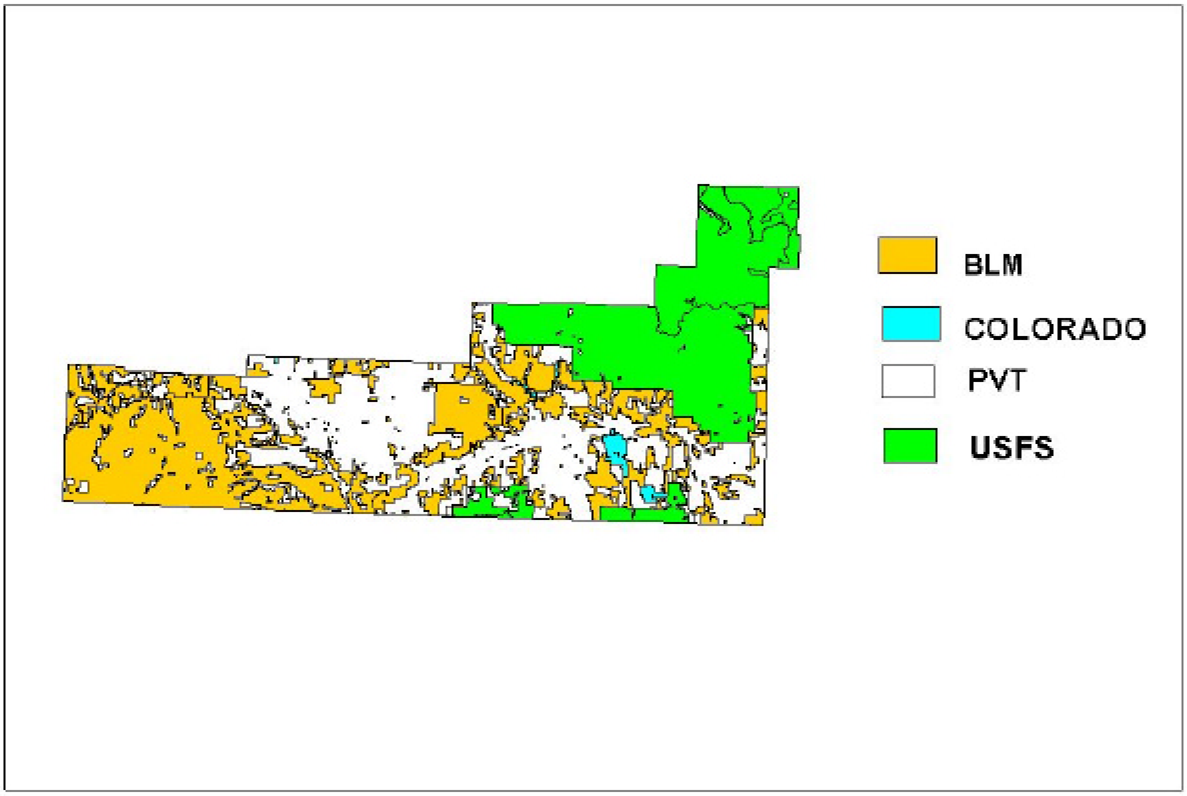


Figure 5. Land ownership of Garfield County

Geology and Hydrology

The geologic features of the county span the entire spectrum of ages, from quaternary alluvial deposits to Precambrian rocks exposed in Glenwood Canyon (Figure 6). The Plateau area in the western part of the county consists of relatively horizontal layers of sandstone that were deposited during the Cretaceous Period when the area was covered by a great inland sea, and during the Tertiary Period, when much of the area was under a large inland lake known as Lake Uinta. Beginning in the southwest, with the oldest layers, Cretaceous Mancos shale is exposed in the Grand Valley south of the Book Cliffs. This formation is more extensive in Mesa County. To the north, the Bookcliffs are composed of Mesaverde Formation sandstone and shale. Mesa tops in this area are capped by the Cretaceous Hunter Canyon Formation. Farther east, the Roan Plateau is composed of soft, erodable shales of the Tertiary Green River Formation, capped by the more resistant Uinta Formation. The Roan Cliffs, visible from Interstate 70 between Rifle and DeBeque, expose thousands of feet of pink and gray Green River Formation, with the Wasatch Formation at their base. The Green River Formation holds the richest oil-shale beds in the world, with over 1.8 trillion barrels (Chronic 1980). One layer of this formation, the Mahogany Ledge, is said to average 27 gallons of oil per ton. (Chronic 1980). Although it is not presently economical to mine the oil shale, there are numerous operating natural gas wells in the area. The Green River Formation is exposed again south of the Colorado River on Battlement Mesa. South and southeast of the Roan Plateau, above the Colorado River the soft sandstones and shales of the Tertiary Wasatch and Ohio Formations form a transitional zone between the alluvial deposits of the

Colorado River Valley and the Green River Formation. This formation represents the sediments on the floodplains around Lake Uinta.

The White River Plateau is a broad anticlinal dome, composed of a complex mix of folded and faulted Paleozoic layers (Cambrian, Ordovician, Silurian, Devonian, Mississippian, Permian and Pennsylvanian) that were uplifted during the Tertiary Period, and in some areas are capped by volcanic basalt flows. Deep canyons, carved through the rock during the Pleistocene, expose successively older layers, down to Precambrian granite in Glenwood Canyon and other tributary canyons. Interesting features include the karst area of limestone deposits that are home to several caves, and the deep red Maroon Formation exposed in the Roaring Fork Valley. The Grand Hogback, which forms the western boundary of the White River Plateau, is composed of Mesaverde sandstone that contains rich coal resources. The town of New Castle, located next to the Grand Hogback, is named for the coal mining area in Wales. To the west, the Town of Silt is named for the silty shale of the younger Wasatch formation. The Flat Tops are volcanic mountains formed by Cenozoic basalt flows. Numerous small lakes are evidence of glaciation in the Pleistocene. The Flat Tops Wilderness is the second largest wilderness area in the United States.

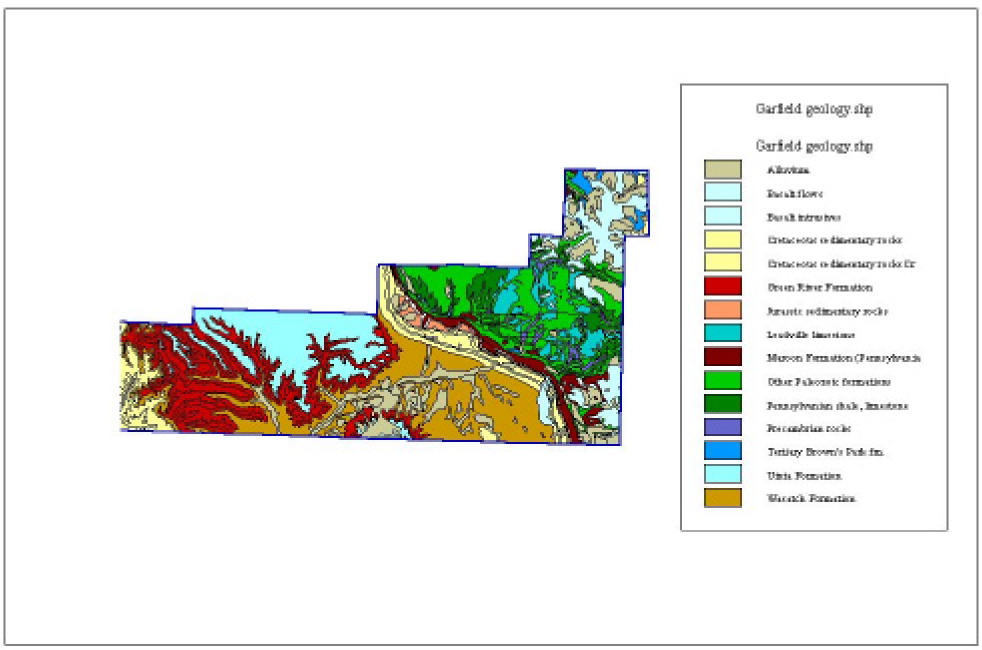


Figure 6. Geology of Garfield County (simplified)

Soils
Soils in the county are highly variable. Mountain soils are normally rocky and shallow, except in areas where groundwater discharge or slope wetlands occur. These areas often form organic soils (e.g., peat or muck) due to organic matter production, persistent soil saturation and thus anaerobic conditions, and cool year round temperatures. Along drainages, both in the mountains and on the valley floor, wetland plant communities occur on alluvium soils. There is minimal soil development around many of the seeps and springs in Garfield County, especially in the western half, as many of these wet areas are located on steep cliff faces or atop geologic bedrock. Soils along the Colorado River are highly variable ranging from very fine material to areas of sand and gravel. Some oxbows and backchannels have organic soil horizons but would not be classified as an organic soil. For more specific information, see "Soil Survey of Rifle Area, Colorado, Parts of Garfield and Mesa Counties" and "Soil Survey of Aspen-Gypsum Areas, Colorado, Parts of Eagle, Garfield, and Pitkin Counties" which are both published by the USDA Natural Resources Conservation Service (NRCS) or the Soil Survey Geographic Data Base (SSURGO) at the following web address: http://www.ftw.nrcs.usda.gov/ssur_data.html. This site has digitized versions of the aforementioned soil surveys.

Vegetation
Vegetation in Garfield County is closely related to geology, and even more to elevation. Ten broad vegetation types can be recognized. In order of elevation, they are: Salt desert shrublands; Shale barrens; Sagebrush shrublands; Pinyon-juniper woodlands; Mixed mountain shrublands; Mountain and foothill grasslands; Aspen forests; Douglas fir forests; Spruce fir forests; Alpine, including mountain meadows and tundra. Wetland and riparian vegetation varies with elevation, and is found in conjunction with all of the upland vegetation types above. In addition to the natural vegetation types, there is a small amount of agricultural land, both dryland and irrigated. This classification is simplified; in reality there is much overlap between the types described below, and mosaics consisting of patches of several different types often occur within a small area.

Agricultural land is concentrated along the major river valleys, The Colorado, Roaring Fork, and to a lesser extent, Parachute, Roan and Divide Creeks, where crops are irrigated. Dry land agriculture is practiced on mesa tops such as Hunter Mesa and Hubbard Mesa. Major crops are grass hay and alfalfa.

Salt desert shrublands are found primarily at low elevations (5,000 to 6,000 ft), in the Grand Valley south of the Bookcliffs, in the southwestern part of Garfield County. Soils here are derived from Mancos Shale, and support a mixed shrub and grass community dominated by members of the Goosefoot Family (Chenopodiaceae). Common shrubs are shadscale (*Atriplex confertifolia*), Gardner saltbush (*A. gardneri*), mat saltbush (*A. corrugata*), and greasewood (*Sarcobatus vermiculatus*). Common grasses in the community are needle and thread (*Stipa comata*), Indian rice grass (*Oryzopsis hymenoides*), and Salina wildrye (*Leymus salinus*) and inland saltgrass (*Distichlis spicata*). A frequent invasive exotic species is cheatgrass (*Bromus tectorum*). The harsh environment produced by the highly erodable Mancos shale limits the species that are able to survive in the this habitat, and has produced several rare plants, such as Grand buckwheat (*Eriogonum contortum).* Salt desert shrublands also occur in the Roan Creek drainage on Wasatch and Green River formations, although they tend to be in small patches that are not shown on the map. In addition to the species mentioned above, bluebunch wheatgrass (*Pseudoroegneria spicata*) is often associated with the shrubs here. The rare Uinta Basin hookless cactus (*Sclerocactus glaucus*) is found in this area, as well as in the pinyon-juniper woodlands in the foothills around Roan Creek. Plant communities within this type that are tracked by the CNHP include *Atriplex confertifolia/Leymus salinus, Atriplex confertifolia/Oryzopsis hymenoides, Atriplex confertifolia/Pseudoroegneria spicata*, and *Distichlis spicata* salt meadows. This vegetation type is more extensive in Mesa County and to the west in Utah.

Pinyon-juniper woodlands are the most extensive vegetation type in Garfield County, as well as much of southwestern Colorado. They are found primarily in the foothills areas between the valley bottoms and the mesa tops. The dominant species are pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). In cooler and more moist areas, the Utah juniper may be replaced by Rocky Mountain juniper (*Juniperus scopulorum*). The understory of pinyon-juniper woodlands varies widely depending on the age and structure of the tree canopy. Open woodlands might include species such as sagebrush (*Artemisia* spp.), oak (*Quercus gambelii*), serviceberry (*Amelanchier utahensis*), snowberry (*Symphoricarpus* spp.), and mountain mahogany (*Cercocarpus* spp.) mixed with grasses and forbs. Often there is considerable bare ground. Rare plants found in the pinyon-juniper communities of Garfield County include DeBeque milkvetch (*Astragalus debequaeus*), DeBeque phacelia (*Phacelia scopulina* var. *submutica*), Wetherill milkvetch (*Astragalus wetherillii*), and Naturita milkvetch (*Astragalus naturitensis*).

Shale barrens are an outstanding feature of Garfield County. They occur on the Roan Plateau, primarily on south facing slopes of the Green River shale. These areas are shown on vegetation maps as exposed rock, and although they appear from a distance to be devoid of vegetation, they support a very specific array of plants that are adapted to this habitat. These species are able to survive in the constantly moving scree, often by having elongated, flexible root systems. They are also able to survive the severe drought that results from the inability of the shale to hold moisture. Several rare and endemic plant species are found in this community, including the Parachute penstemon (*Penstemon debilis*), Piceance bladderpod (*Lesquerella parviflora*), Arapien stickleaf (*Nuttallia argillosa*), sun-loving meadowrue (*Thalictrum heliophilum*), and Utah fescue (*Argillochloa dasyclada*).

Sagebrush shrublands are widespread throughout Garfield County, both at elevations below and above pinyon-juniper woodlands. They are often found on mesa tops where sagebrush forms nearly pure stands. In addition to the areas where sagebrush is dominant, sagebrush is often an important constituent of pinyon-juniper woodlands and salt desert shrublands. Several species of sagebrush occur here, including Big sagebrush (*Artemisia tridentata* ssp. *tridentata*), the largest species, which is usually found in deep alluvial soils along bottomlands and on stream terraces, often associated with greasewood (*Sarcobatus vermiculatus*) fourwing saltbush (*Atriplex canescens*), and rabbitbrush (*Chrysothamnus nauseosus*). Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) are found at higher elevations in open upland areas, commonly mixed with other shrubs such as snowberry (*Symphoricarpos oreophilus*), Utah serviceberry (*Amelanchier utahensis*),and various grasses and forbs. Common understory species at lower elevations include Indian rice grass (*Oryzopsis hymenoides*) and needle and thread (*Stipa comata*). Common associated species at the upper elevations include Kentucky bluegrass (*Poa pratensis*), Idaho fescue (*Festuca idahoensis*) and Thurber fescue (*Festuca thurberi*). Rare plants that are associated with sagebrush include Harrington's penstemon (*Penstemon harringtonii*). Less common in Garfield County is black sagebrush (*Artemisia nova*), a low shrub usually found in drier pinyon-juniper communities.

Mountain shrublands are found throughout the county, at elevations between the pinyon-juniper and forested areas. Most mountain shrublands are dominated by Gambel oak, with associated shrubs that include mountain mahogany, serviceberry, chokecherry (*Prunus* sp.) and snowberry. Typical associated species in drier sites include mountain sagebrush (*Artemisia tridentata* ssp. *vaseyana*), arrowleaf balsamroot (*Balsamorhiza sagittata*), rabbitbrush (*Chrysothamnus* sp.), muttongrass (*Poa fendleriana*), junegrass (*Koeleria macrantha*), prickly pear cactus (*Opuntia polyacantha*), and longleaf phlox (*Phlox longifolia*). More mesic shrublands have understories with elk sedge (*Carex geyeri*), mountain lover (*Paxistima myrsinites*), and Oregon grape (*Mahonia repens*). Gambel oak and other associated shrubs often occur as understory or in patches in the pinyon-juniper zone below and the forested zones above. None of the rare plants of the county were found in this community.

Mountain and foothill grasslands are scattered throughout the county, but often occur in patches within other vegetation types that are too small to be mapped at this scale. Some of the most extensive grasslands occur south of the Colorado River between Rifle and Silt, at around 6,000 feet elevation. The deep rich soils that support the grasslands also make this an important agricultural area. Another large grass dominated area occurs on Coulter Mesa, north of Rifle. Native grass species that are sometimes dominant in Garfield County include (roughly from lower to higher elevations): inland saltgrass (*Distichlis spicata*), galleta (*Hilaria jamesii*), Basin wildrye (*Elymus cinereus*), Salina wildrye (*Leymus salinus*), bluebunch wheatgrass (*Pseudoroegneria spicata*), muttongrass (*Poa fendleriana*), Thurber fescue (*Festuca thurberi*), Idaho fescue (*Festuca idahoensis*), slender wheatgrass (*Elymus trachycaulus*) and tufted hairgrass (*Deschampsia cespitosa*). Forbs are often important components of these communities. Common forbs found in montane meadow sites include orange sneezeweed (*Dugaldia hoopsii*), Geranium (*Geranium* sp.), white peavine (*Lathyrus leucanthus*), American vetch (*Vicia americana*), edible valerian (*Valeriana edulis*). Wet subalpine meadows dominated by tufted hairgrass are often associated with marsh marigold (*Caltha leptosepala*), elephantella (*Pedicularis groenlandica*), and several species of sedges and rushes.

Aspen forests are found in the northwest corner of the county, on the Roan Plateau, the Flat Tops, and Battlement Mesa., mostly at elevations between 8,000 and 9,000 feet. The aspen groves often form a mosaic with patches of Douglas fir (*Pseudotsuga menziesii*), mixed shrubs, grassland and meadows, and at upper elevations, Engelmann spruce (*Picea engelmanii*). Understory species are extremely varied. Common species found in aspen communities are snowberry (*Symphoricarpos oreophilus*), serviceberry (*Amelanchier utahensis*), mountain lover (*Paxistima myrsinties*), white peavine (*Lathyrus leucanthus*), butterweed groundsel (*Senecio serra*), meadowrue (*Thalictrum fendleri*), blue wildrye (*Elymus glaucus*), and elk sedge (*Carex geyeri*). Generally considered to be a pioneer species, aspen thrives on disturbance. It is generally the dominant tree species where it occurs. It is a clonal species and sprouts new growth from suckers or shoots of old roots. It has been suggested that the root system of aspen clones are among the largest living organisms on earth, although the individual trees themselves are not long lived (75-80 years). In many cases aspen will eventually be replaced by a shade tolerant species such as Douglas Fir or Engelmann spruce. A rare plant associated with aspen is the large flower globemallow (*Iliamna grandiflora*).

Douglas fir forests are concentrated in the western half of the county, but are also scattered throughout the White River Plateau, especially in the deeper canyons. They tend to occur at the same elevations as aspen, but on cooler sites. Common understory species occurring with Douglas fir include snowberry (*Symphoricarpos oreophilus*), mountain lover (*Paxistima myrsinites*), elk sedge (*Carex geyeri*), Oregon grape (*Mahonia repens*) and Gambel oak (*Quercus gambelii*). Occasionally ponderosa pine may be mixed with the fir, but in general, ponderosa pine is uncommon in the county. At middle elevations, forested areas often have a mixture of Douglas fir, Engelmann spruce, subalpine fir, aspen, and lodgepole pine.

Spruce/fir forests, dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) are located primarily in the White River National Forest north of Glenwood Springs, including the Flat Tops Wilderness. They are also found south of the Colorado River on Battlement Mesa and in the White River National Forest west of the Roaring Fork Valley in the Fourmile Creek area around the Sunlight Ski Area. Elevations are mostly between 9,000 and 11,000 feet. On the Flat Tops, spruce bark beetle epidemics in the 1940's left many standing dead trees, sometimes called "silver forests". At their upper limit, these trees form islands and dense patches of dwarfed trees called "krummholz". Common understory species include elk sedge (*Carex geyeri*), whortleberry (*Vaccinium* sp.), heartleaf arnica (*Arnica cordifolia*), parrots beak (*Pedicularis racemosa*), thimbleberry (*Rubus parviflorus*), and Jacob's ladder (*Polemonium pulcherrimum*). Two state rare plants, the northern twayblade (*Listera borealis*), an orchid which is known historically from a forest wetland, and the common moonwort (*Botrychium lunaria*) have been found within this vegetation type in Garfield County.

Alpine vegetation, including meadows and shrub-dominated tundra is found above treeline in the highest parts of the White River National Forest, mainly in the Flat Tops Wilderness. Elevations are usually above 11,500 feet. Animals tracked by the CNHP that occur in the alpine zone of Garfield County include the waterfowl Barrow's Goldeneye (*Bucephala islandica*), a butterfly, alpine theano (*Erebia theano*) and the boreal toad (*Bufo boreas*). Plant communities include tufted hairgrass (*Deschampsia cespitosa*) wet meadows, alpine meadows dominated by alpine avens (*Geum rossii*), alpine clover (*Trifolium* sp.) and false strawberry (*Sibbaldia procumbens*), and scrub tundra with dwarf blueberry (*Vaccinium* sp.). Surprisingly, no rare plants are known from this habitat in Garfield County.

Wetland and Riparian vegetation typically includes narrowleaf cottonwood (*Populus angustifolia*), aspen (*P. tremuloides*), Colorado blue spruce (*Picea pungens*), subalpine fir (*Abies lasiocarpa*), thinleaf alder (*Alnus incana*), and red-osier dogwood (*Cornus sericea*) along subalpine and montane streams while narrowleaf cottonwood, skunkbrush (*Rhus trilobata*), river birch (*Betula occidentalis*), thinleaf alder (*Alnus incana*), coyote willow (*Salix exigua*), and mountain willow (*S. monticola*) are common along riparian areas at lower elevations. Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*), narrowleaf cottonwood, skunkbrush (*Rhus trilobata*), silverberry *(Shepherdia argentea*), Russian olive (*Elaeagnus angustifolia*), and tamarisk (*Tamarix ramosissima*) are dominant along the Colorado River. Subalpine and montane herbaceous wetlands are typically dominated by various sedges and rushes (e.g., *Carex utriculata*, *C. simulata*, *C. lanuginosa*, *Eleocharis palustris*, and *Juncus balticus*). Herbaceous wetlands along the Colorado River's floodplain are dominated by cattail (*Typha latifolia*), bulrushes (*Scirpus acutus* and *S. pungens*), saltgrass (*Distichlis spicata*), and Baltic rush (*Juncus balticus*). Seep and spring wetlands are typically dominated by beaked sedge (*Carex utriculata*), monkshood (*Aconitum columbianum*), fowl mannagrass (*Glyceria striata*), Baltic rush, oil shale columbine (*Aquilegia barnebyi*), and occasionally the rare hanging garden sullivantia (*Sullivantia hapemanii var. purpusii*). Additional rare plants associated with wetland and riparian areas include canyon bog-orchid (*Limnorchis ensifolia*), yellow lady's slipper (*Cypripedium calceolus* subsp. *parviflorum*), and the lesser panicled sedge (*Carex diandra*).

Nonnative and Aggressive Plant Species

Exotic plant invasion is an increasingly serious problem in Colorado. Colorado now contains about 70 noxious weeds species that infest at least 1.5 – 2.0 million acres. Weeds tend to take advantage of any disturbance of the soil. Wind, water, animals, people and vehicles can disperse their seeds. In some cases, we have planted them intentionally. Once established, they often lack the native competitors, predators, and pathogens that would keep them under control in their native habitat. The current thinking in weed management is to aim for "early detection and early treatment....if you have one acre of spotted knapweed in a county, it makes more sense to devote resources to that and try to contain the spread before it gets too late" (Steve Anthony, personal communication). The following plants have been listed as noxious weeds by Garfield County and are found in wetland and riparian areas. The names in bold type are the weeds that we encountered most frequently during this survey.

Garfield County Noxious Weed List

Canada thistle	*Cirsium arvense*
Common burdock	*Arctium minus*
Hoary cress	*Cardaria draba*
Houndstongue	*Cynoglossum officinale*
Leafy spurge	*Euphorbia esula*
Musk thistle	*Carduus nutans*
Oxeye Daisy	*Chrysanthemum leucantheum*
Plumeless thistle	*Carduus acanthoides*
Purple loosestrife	*Lythrum salicaria*
Russian knapweed	*Acroptilon repens*
Russian olive	*Elaeagnus angustifolia*
Saltcedar	*Tamarix parviflora*
Saltcedar	*Tamarix ramosissima*
Scotch thistle	*Onopordum acanthium*

Other weed species that were observed during this survey that are not on the county list are listed below:

Annual wheatgrass	*Eremopyrum triticeum*
Bull thistle	*Cirsium vulgare*
Clasping pepperweed	*Lepidium perfoliatum*
Cocklebur	*Xanthium strumarium*
Common dandelion	*Taraxacum officinale*
Cranesbill	*Erodium cicutarium*
Halogeton	*Halogeton glomerata*
Jim Hill mustard	*Sisymbrium altissimum*
Kochia	*Kochia americana*
Russian thistle	*Salsola siberica*

Species that are commonly planted for pasture or for erosion control are frequent throughout the area. These species are especially evident along roads, trails, wetland, and riparian areas.
Non-native species planted for pasture or revegetation:

Crested wheat grass	*Agropyron spicatum*
Kentucky bluegrass	*Poa pratensis*
Siberian elm	*Ulmus pumilus*
Smooth brome	*Bromus inermis*
White sweet clover	*Melilotus alba*
Yellow sweet clover	*Melilotus officinalis*

In general, bull thistle, Canada thistle, houndstongue, tamarisk, Russian olive, white and yellow sweet clover, and Kentucky bluegrass were the most common weeds found in wetlands and riparian areas.

Selected species are described below:

Burdock is found throughout the area in moist disturbed sites.
Bull thistle is commonly found in pastures, roadsides, and disturbed sites. It was observed in many seeps and springs in western Garfield county and along riparian areas.
Canada thistle is widespread throughout the area. It invades almost anywhere, from the desert to the montane zone, where soils are disturbed and there is sufficient moisture. It is difficult to eradicate because it has underground stems, or rhizomes, which will continue to produce new shoots after the above ground parts of the plant are killed or removed. Digging and hand pulling are rarely effective. In addition, its seeds can remain dormant in the soil for many years. Prevention, by avoiding any unnecessary disturbance of the soil, is the best defense. *Although many people are under the impression that all thistles are bad, it is important to note that there are native thistles that are not aggressive and should not be destroyed.*
Dandelions are common in the mountains in disturbed and heavily grazed sites. Although not considered a serious problem by many people, they do replace native grasses and forbs.
Hoary cress (or white top) can be found in disturbed areas, often invading hayfields and roadsides.
Hound's tongue is widespread and abundant at higher elevations, particularly in the montane zone. It is thought to increase with poor grazing management (Anthony, personal communication).
Kentucky bluegrass is very abundant in moist areas, replacing native grasses. Although it provides feed, its shallow roots are not as effective in holding soil on stream banks as other native species are (FEIS 1996). It is particularly abundant in the montane zone.
Musk thistle and other invasive biennial thistles tend to be found in moist areas in the middle elevations. At its worst, it can form thickets that are impenetrable to livestock and wildlife.
Oxeye daisy was originally planted as an ornamental, but has become a major invader in Western Colorado, particularly in mountainous areas.
Purple loosestrife This tall purple-flowered plant invades wet areas and is potentially a serious threat to wetlands and riparian areas. It has not yet been seen in Garfield County, but it is present in neighboring counties, and vigilance is called for.
Russian knapweed is Colorado's third most common noxious weed (approximately 170,000 acres), located primarily on the West Slope where it causes tremendous damage to private and public lands. There are large infestations in Garfield County south of the Colorado River between New Castle and Rifle (Anthony 2001).
Russian olive is found in riparian areas along the Colorado River and most of its tributaries.
Salt Cedar (or tamarisk) occupies similar riparian habitats.
Siberian elm has been planted as a fast growing shade tree. It reseeds readily and has replaced native cottonwoods and willows in many riparian areas.

Some observations on the locations of weeds made during this survey follow:

At lower elevations in the southwest part of county, in the East and West Salt Creek drainages, salt cedar, and Canada thistle are common in the riparian areas. Greasewood flats often have an understory of cheatgrass and annual mustards such as purple mustard, alyssum and clasping pepperweed. Other weeds that are common in the area are: common dandelion, bur buttercup, and halogeton, a potentially very troublesome weed. Annual wheatgrass, Jim Hill mustard, sweet clover, and smooth brome are common along roads and pipelines.

In the south central part of the county, e.g. the Roan Creek and Mt. Logan foothills areas, weeds are similar to those in the southwest; we have noted tamarisk, cheatgrass, Canada thistle and annual mustards to be common here as well. Other species in this area include horehound, cranesbill, bindweed, and Russian thistle. Areas that have been disturbed by water developments such as stock ponds are especially prone to weed invasion. The bottomland of Logan Wash is particularly weedy with salt cedar, clasping pepperweed, cheatgrass, crested wheat grass, Russian thistle and burdock. Halogeton was observed along the pipeline that crosses the road.

In the Divide Creek and Hunter Mesa areas Canada thistle, cheatgrass, Russian thistle, Jim Hill mustard, houndstongue, horehound, and yellow sweet clover are common along roads and in disturbed areas. Some cultivated areas and roadsides have significant hoary cress, and there are pastures dominated by purple mustard and alyssum. Flatiron Mesa has houndstongue along the roads, powerlines, and riparian areas.

The Rifle area, particularly along the Rifle Creek trail through the city, has an abundance of weedy species, including the major tree species, salt cedar, Siberian elm and Russian olive, which have replaced the native cottonwoods and willows. The understory in this area contains smooth brome, cheatgrass, kochia, prickly lettuce, alfalfa, yellow sweet clover, Kentucky bluegrass, Russian thistle, and Jim Hill mustard.

New Castle's central open space, Mount Madearis, is quite weed-free above, but the trailhead parking area is weedy with cheatgrass, purple mustard, bindweed, and dandelion. Control of these weeds will help prevent invasion into the as yet uncontaminated open space. The drainage below has Siberian elm mixed with the native narrowleaf cottonwood.

At higher elevations in the county, such as the area around Douglas Pass, the most serious weed is houndstongue, which is abundant in moist areas, particularly in the aspen zone. This area also has Canada thistle, purple mustard, cheatgrass, and Russian thistle. Farther east, the Rifle Mountain Park area has Canada thistle, houndstongue, Kentucky bluegrass, common dandelion, and smooth brome (the most abundant grass along Rifle Creek). A bad infestation of common burdock occurs along the trail to the ice caves in the park. Moist areas on the Roan Plateau also have houndstongue, Canada thistle, Kentucky bluegrass, yellow sweet clover, and musk thistle. Climbing up the Box Canyon Road toward Triangle Park, both oxeye daisy and yellow toadflax can be seen along the road. These two high elevation weeds were also observed on the Buford-New Castle Road.

Seeps/Springs

Seeps and springs are discussed separately due to their importance, especially in western Garfield County, to regional landscape diversity. Garfield County has one of the highest concentrations of seeps and springs in Colorado (over 900) due to unique geologic substrates (Figure 7). Most of the seeps and springs within the western part of the county are supported by groundwater flow from two main aquifers (Martinson 1980). The upper aquifer is primarily located within the Uinta Formation (sandstone and marlstone) and increases in importance (in terms of groundwater discharge) eastward, while the lower aquifer is located in the Parachute Creek Member of the Green River formation (mainly dolomitic marlstone) and is the principal aquifer associated with seeps and springs in western Garfield County (Martinson 1980). The lower aquifer is highly saline mainly due to the dissolution of sodium rich minerals such as nahcolite ($NaHCO_3$) and halite ($NaCl$) (Weeks 1974). Thus, many seeps and springs associated with the lower aquifer have high conductivity and a high pH. The Mahogany Ledge separates the two aquifers both hydraulically and chemically except in recharge and discharge areas (Martinson 1980). Recharge to the aquifers occurs mainly through snow-melt since most summer rainfall is quickly lost to runoff or evapotranspired from moisture deficient soil (Weeks 1974). Many seeps and springs in the eastern half of the county discharge from the Leadville Limestone, which has been shown to be a major local aquifer (Teller 1983). This aquifer is recharged via precipitation, snowmelt, and stream-flow and has a general subsurface flow toward the south, west, and northwest away from the White River Uplift (Teller 1983). The water from these springs has a fairly high pH (~8.1) near the source due to a high calcium carbonate content. Excellent examples of these springs can be seen in Rifle Mountain Park.

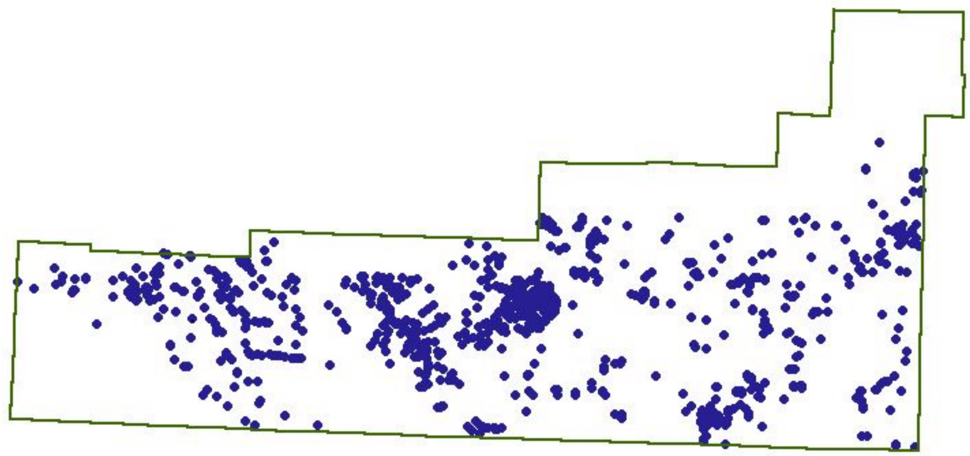


Figure 7. Location of Seeps and Springs (does not include those on White River National Forest lands) in Garfield County

Seeps and springs are small wetland ecosystems that are hydrologically supported by groundwater discharge (Hynes 1970). They are distinctive from other wetland and riparian habitats by the relatively constant water temperature and chemistry of the discharging groundwater (Sada 2000). This results from the groundwater being in contact with minerals for an extended period of time, which equilibrates solute concentrates. Thus, spring water tends to have constant concentrations of dissolved minerals while surface-fed streams vary according in response to rainfall and snowmelt (Mc Cabe 1998). Seeps differ from springs in that they often periodically dry and consequently support a lower diversity of wetland vegetation. Springs often have a more persistent source of water and thus support a greater diversity of wetland vegetation and often provide aquatic habitat (Sada 2000). However, springs supported by local aquifers may periodically dry, since local aquifers are comparatively small and shallow, and the amount of groundwater discharge associated with them varies in response to local precipitation levels. Springs supported by regional aquifers, or aquifers covering thousands of square kilometers, rarely dry, even during droughts, since the quantity of water within the aquifer is high and groundwater flow it typically slow (Sada 2000).

Seeps and springs often exhibit diverse flora composition and structural characteristics which provide potential cover for resting, nesting, and feeding for many different organisms, especially birds (Sada 2000). For example, submergent vegetation such as pondweed (*Potamogeton* sp.), duckweed (*Lemna* sp.), ditch-grass (*Ruppia* sp.), horned-pondweed (*Zannichellia* sp.), and watercress (*Rorippa* sp.) provide a food source for waterfowl, while watercress has been shown to be a critical resource for mollusks (Sada 1996). Watercress, duckweed, and hornwort (*Ceratophyllum demersum*) were the most common submergent plant species located in springs in western Garfield County. Sedges (*Carex utriculata*, *C. microptera*, *C. nebrascensis*, and *C. lanuginosa*), rushes (*Juncus balticus* and *J. saximontanus*), grasses (*Catabrosa aquatica, Agrostis gigantea*, and *Glyceria striata*), and other herbaceous species such as monkshood (*Aconitum columbianum*), alkali crowfoot (*Halerpestes cymbalaria* subsp. *saximontana*), and large-leaved avens (*Geum macrophyllum*), which are often found growing along the banks of springbrooks and in spring wetlands, help regulate water temperatures and provide areas for hiding and nesting, in addition to the habitat they provide for macroinvertebrates (Sada 1996). Some springs in the project area support an overstory of occasional trees (*Populus angustifolia*) and shrubs such as river birch (*Betula occidentalis*), thinleaf alder (*Alnus incana*), and various willow species (*Salix* spp.) which provide excellent habitat for birds and browse for large mammals. Unique water chemistry and/or edaphic conditions often provide habitat for rare plant species. In western Garfield County, species such as the hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*) and oil shale columbine (*Aquilegia barnebyi*) occur in seeps associated with the Green River Formation shale. The salinity of the groundwater, due to the dolomitic and calcareous nature of the oil shale, provides a unique environment for these species. Both of these species are endemic to western Colorado and eastern Utah and are only found associated with these unique seep/oil shale environments.

Spring environments (water temperature, water chemistry, etc.) are typically less variable than other aquatic habitats such as lakes, ponds, and streams. This results in low variability in macroinvertebrate populations at spring sources while downstream habitats typically show more variability in population dynamics (Sada 2000). In addition, the factors that lead to the evolution of endemic species or to the value of these isolated wetlands as refugia for relict species, can also result in low species richness due to the small size, isolation, and adverse conditions of these wetlands (Myers 1999). Martinson (1980) found that macroinvertebrate populations in the Piceance Basin, Colorado had greater density and biomass but fewer species (less diversity) at springs sources than in downstream habitats. Given similar geology and geographic proximity to the Piceance Basin, similar patterns in the structure of macroinvertebrate populations would be expected for the seeps and springs inventoried for this project. Thus, while no rare or endemic macroinvertebrate species were located in any of the seeps and springs inventoried for this project, it is likely that their populations are different than those found in other riparian/wetland habitats (streams, lakes, ponds, etc.) and represent an important aspect of biodiversity in Garfield County.

Many seeps and springs in Garfield County have been altered and/or modified from their natural condition due to anthropogenic disturbances such as livestock grazing and water diversions and impoundments to capture water for human or livestock use. These disturbances can result in an increase in non-native species, decrease in vegetation cover, inundation of springbrook habitat, replacement of species requiring flowing water with those more adapted to stagnate or slow moving water (lakes, ponds, etc.), and cause the extirpation of endemic spring species (Sada In press.). Sada and Nachlinger (1996) found higher levels of biodiversity in undisturbed springs while disturbed springs had a high percentage of non-native species present

Observations on Major Threats to Wetland Biodiversity

General threats to a particular species or site are identified in the Potential Conservation Areas profiles. The following table lists only those threats that were observed at or near the Potential Conservation Areas and were thought to potentially impact the elements of concern. Some general threats to biodiversity were not observed specifically at PCAs in Garfield County but rather have an effect on biodiversity on a larger landscape-level scale. These threats are discussed in the following text.

Table 2. Threats observed at the Potential Conservation Areas.

Potential Conservation Area	B –rank	Hydrologic Modification	Residential Development	Oil & Gas Development	Incompatible Grazing	Logging	Recreation	Roads	Non-native Species
East Fork Parachute Creek	B2				X				X
East Salt Creek	B2				X				
4A Ridge	B2				X			X	
Parachute Creek	B2				X				X
Rifle Stretch Colorado River	B2	X	X		X				X
Bear Creek at Glenwood Canyon	B3	X					X		
Beaver Creek at Battlement Mesa	B3	X	X		X				
Calf Canyon	B3				X				
Clear Creek	B3								
Conn Creek	B3			X					
Deep Creek	B3				X	X			
Deep Creek at Clark Ridge	B3					X	X		
East Douglas Creek	B3				X				X
East Elk Creek	B3						X	X	
East Rifle Creek	B3	X					X	X	X
Fourmile Creek at Sunlight	B3							X	X
Garfield Creek	B3	X	X						X
Grizzly Creek Canyon	B3				X		X	X	
Hanging Lake	B3						X		X
Headwaters of Patterson Creek	B3				X				
Meadow Creek at Deep Creek Point	B3	X							
North Fork Derby Creek	B3						X		
Northwater Creek	B3				X				
Sweetwater Lake	B3				X		X		X
The Meadows	B3					X	X		
Trapper Creek	B3				X				

Potential Conservation Area	**B –rank**	**Hydrologic Modification**	**Residential Development**	**Oil & Gas Development**	**Incompatible Grazing**	**Logging**	**Recreation**	**Roads**	**Non-native Species**
Wagonwheel Creek	B3						X		X
Brush Creek at Skinner Ridge	B4				X			X	
Douglas Pass	B4	X							X
Fisher Creek	B4				X				X
Main Elk Creek	B4				X			X	X
Middle Fork Derby Creek	B4						X		
Mitchell Creek	B4				X				
No Name Creek	B4	X					X		X
Ranch at the Roaring Fork	B4		X					X	X
Trappers Lake	B4						X		
Turret Creek	B4								X
West Elk Creek	B4		X					X	
Kaiser Steven Ditch	B5		X					X	X
Sutank	B5						X		X

Hydrological Modifications

River impoundment in the form of lakes and reservoirs and irrigation ditches or canals can affect aquatic dependent plants and animals (Chien 1985). Annual flooding is a natural ecological process that has been severely altered by the construction of dams, reservoirs, and other water diversions. These actions have altered the normal high peak flows that were once a part of the natural hydrological regime of many large tributaries of the Colorado River, and many of their smaller tributaries. These natural flows are necessary for continued viability of most riparian vegetation. For example, many plants can only reproduce with flooding events, e.g., cottonwood trees (Rood and. Mahoney 1993). As plant composition changes in response to alterations in the flooding regime, the composition of the aquatic and terrestrial fauna may also change.

In addition to river impoundment, rivers have also been altered by stream bank stabilization projects (i.e., channelization) (Rosgen 1996). Most streams and rivers are dynamic and inherently move across the land. Stabilizing or channelizing stream banks forces the river to stay in one place and often leads to changes in riparian ecology and more serious destruction downstream. It is also well known that different plant communities require different geomorphologic settings, e.g., point bars are required for some species of willows to regenerate, terraces are required for mature cottonwood/shrubland forests, and old oxbow reaches may eventually provide habitat for many wetland communities. By stabilizing a river, the creation of these geomorphic settings is often eliminated. Thus, the plant communities that require such fluvial processes are no longer able to regenerate or survive. In general, the cumulative effects from dams, reservoirs, and channelization on plant communities, has caused a gradual shift from diverse multi-aged riparian woodlands to mature single aged forest canopies.

Many wetlands, not associated with fluvial processes, have been altered by irrigation practices, water diversions, and well pumping. The increase of irrigated agriculture in Garfield County inadvertently created many new wetlands in areas where wetlands never existed. For example, seepage from hundreds of miles of unlined canals and earthen ditches and much of the water applied in irrigation contributes to groundwater and surface water runoff. As a result, many areas have developed wetland characteristics where none existed prior to irrigation. Conversely, many historical wetlands, such as seeps and springs, have been lost or altered due to water "development" projects, such as water diversions and impoundments, to create stock ponds. Thus, as the quality and extent of historical wetlands diminished, some of the habitat loss was offset by irrigation-induced wetlands. It is debatable whether the biodiversity significance of an integrated network of river bottom wetlands, sinuous marshy streams, and extensive intact seep and spring wetlands can be equated to the dispersed pattern of irrigation-induced wetlands across an agricultural landscape. In addition to providing valuable wildlife habitat, irrigation-induced wetlands may be acting to remove nitrate, pesticides, and sediments from agricultural tail waters before entering major rivers and local aquifers.

Development

Residential development is a localized but increasing threat in Garfield County, especially along the I-70 corridor and along the Roaring Fork River between Carbondale and Glenwood Springs. Development creates a number of stresses, including habitat loss and fragmentation, introduction of non-native species, fire suppression, and domestic animals (dogs and cats) (Oxley et al. 1974 and Coleman and Temple 1994). Habitat loss to development is considered irreversible and should therefore be channeled to areas with less biological significance. Since development tends to occur adjacent to watercourses, wetland and riparian habitats are highly susceptible to development.

Coal and Oil Shale Mining

Huge veins of coal deposits are located in the Grand Hogback from Chair Mountain on the Crystal River up through New Castle and all the way to Meeker (Gulliford 1983). The three major areas for coal mines are south of Glenwood Springs, along Coal Ridge at New Castle, and along the Crystal River.

Stresses from mining activities can include habitat loss and fragmentation, water pollution by acid mine drainage and excessive sedimentation of streams. Aquatic systems are the most threatened by these stresses, but wetland and riparian communities can be impacted as well. However, direct impacts from mining appeared to be localized and minimal in Garfield County.

At the present time, no oil shale mining is taking place. However, this is a potential threat in the future, if oil prices rise significantly and extraction processes improved enough to make it economically feasible. Much of the privately owned land is held by large oil companies, and would not be subject to the strict environmental review processes required on public lands. Although many people downplay the potential, the fact that the major oil companies are continuing to hold this land suggests that they consider there is potential for future mining. If oil shale mining were to take place, it would be extremely destructive to the natural landscape, requiring dumping of huge amounts of toxic waste, and filling entire drainages. In addition, it would probably require large amounts of water, which would have to be diverted from local streams.

Oil and Gas Development

Oil and gas development is a major threat to biodiversity in Garfield County, especially the rare plant occurrences. Access roads, well pads, and pipelines can directly disturb the plants, as well as act as conduits for weed invasion. They also fragment habitat, increase runoff and sedimentation of streams, and increase soil erosion. Gas wells are being drilled at a fairly rapid rate. Since 1984, Barrett Resources Corporation has completed 275 wells from Beaver Creek to Parachute (Rondeau et al. 1996). The Department of Energy has completed 267 wells on the Roan Plateau and is part owner with Barrett of another 21 wells (Rondeau et al. 1996). The economic feasibility of further development is probably directly correlated with the price of natural gas. Recently a decision to allow gas well spacing to 20 acres (the highest density in the world) on 9,000 acres of private land, much of it along the Colorado River was made by the Colorado Oil and Gas Commission. Garfield County opposed that decision, but was unable to avert it. A recent proposal by Barrett Resources to perform seismic exploration for oil and gas in the Rifle area may pose threats from the movement of heavy equipment on a grid over large areas.

Livestock Grazing

Domestic livestock grazing, another traditional industry of Garfield County since the late 1800s, has left a broad and often subtle impact on the landscape. Cattle were grazed on the hills from Rifle to Carbondale, on mesas, such as Battlement Mesa, on the Roan Plateau, and in the high mountains of the Flat Tops and Cline Tops (Gulliford 1983).

Today, many riparian areas in Garfield County are utilized for rangeland. Lush forests and meadows in the Flat Tops serve as summer pasture for sheep and cattle. In such rugged terrain, livestock tend to concentrate in the valley bottoms and meadows where the terrain is gentler and vegetation is more abundant. At lower elevations, livestock tend to congregate near wetland and riparian areas for shade, lush browse, and access to water. Long-term, improper livestock use of wetland and riparian areas could potentially erode stream banks, cause streams to downcut, lower the water table, alter channel morphology, impair plant regeneration, establish non-native species, shift community structure and composition, degrade water quality, and diminish general riparian and wetland functions (Windell et al. 1986). Depending on grazing practices and local environmental conditions, impacts can be minimal and largely reversible (slight shifts in species composition) to severe and irreversible (extensive gullying, introduction of non-native forage species).

Logging

Most logging operations require a large network of roads. The impacts from roads can result in threats to biodiversity (see "Roads" below for more detailed discussion). The Forest Service monitors logging closely, nonetheless, problems can still occur.

Recreation

Recreation, once very local and perhaps even unnoticeable, is increasing and becoming an increasing threat to natural ecosystems in Garfield County. Different types of recreation (i.e., motorized versus non-motorized activities) typically have different effects on ecosystem processes. ATV's can disrupt migration and breeding patterns, and fragment habitat for native resident species. This activity can also threaten rare plants found in non-forested areas. ATV's have also be identified as a vector for the invasion of non-native plant species.

Non-motorized recreation, mostly hikers but also some mountain biking and rock climbing, presents a different set of problems (Cole and Knight 1990; Knight and Cole 1991). Wildlife behavior can be significantly altered by repeat visits of hikers/bicyclists. Alpine areas, mountain lakes, and riparian zones are routes and destinations for many established trails. Thus, impacts to native vegetation (mainly trampling) in these areas could potentially be high.

Roads

There is a complex, dense network of roads in many parts of Garfield County due to livestock activities, past timber harvests, and mining operations. Expansion of the existing road network in some areas will detrimentally affect the natural heritage values of the region. Roads are associated with a wide variety of impacts to natural communities, including invasion by non-native plant species, increased depredation and parasitism of bird nests, increased impacts of pets, fragmentation of habitats, erosion, pollution, and road mortality (Noss et al. 1997).

Roads function as conduits, barriers, habitats, sources, and sinks for species and populations of species (Forman 1995). Road networks crossing landscapes can increase erosion and alter local hydrological regimes. Runoff from roads may impact local vegetation via contribution of heavy metals and sediments. Road networks interrupt horizontal ecological flows, alter landscape spatial pattern, and therefore inhibit important interior species (Forman and Alexander 1998).

Effects on wildlife can be attributed to road avoidance (a species avoids crossing a road) and occasionally roadkill. Traffic noise appears to be the most important variable in road avoidance, although visual disturbance, pollutants, and predators moving along a road are alternative hypotheses as to the cause of avoidance (Forman and Alexander 1998). Songbirds appear to be sensitive to remarkably low noise levels, even to noise levels similar to that of a library reading room (Reijnen et al. 1995).

Non-native Species

Although non-native species are mentioned repeatedly as stresses in the above discussions, because they may be introduced through so many activities they are included here as a general threat as well. Non-native plants or animals can have wide-ranging impacts. Non-native plants can increase dramatically under the right conditions and essentially dominate a previously natural area (e.g., scraped roadsides). This can generate secondary effects on animals (particularly invertebrates) that depend on native plant species for forage, cover, or propagation. Effects of non-native fishes include competition that can lead to local extinctions of native fishes and hybridization that corrupts the genetic stock of the native fishes.

Fragmentation and Edge Effects

Edges are simply the outer boundary of an ecosystem that abruptly grades into another type of habitat (i.e., edge of a conifer forest adjacent to a meadow) (Forman & Godron 1986). Edges are often created by naturally occurring processes such as floods, fires, and wind and will recover naturally over time. Edges can also be created by human activities such as roads, timber harvesting, agricultural practices, rangeland, etc. Human induced edges are often dominated by plant species that are adapted to disturbance. As the landscape is increasingly fragmented by large-scale, rapid anthropogenic conversion, these edges become increasingly abundant. The overall reduction of large landscapes jeopardizes the existence of specialist species, may increase non-native species, and limits the mobility of species that require large landscapes or a diversity of landscapes for their survival (i.e., large mammals or migratory waterbirds).

THE NATURAL HERITAGE NETWORK AND BIOLOGICAL DIVERSITY

Colorado is well known for its rich diversity of geography, wildlife, plants, and plant communities. However, like many other states, it is experiencing a loss of much of its flora and fauna. This decline in biodiversity is a global trend resulting from human population growth, land development, and subsequent habitat loss. Globally, the loss in species diversity has become so rapid and severe that (Wilson 1988) has compared the phenomenon to the great natural catastrophes at the end of the Paleozoic and Mesozoic eras.

The need to address this loss in biodiversity has been recognized for decades in the scientific community. However, many conservation efforts made in this country were not based upon preserving biodiversity; instead, they primarily focused on preserving game animals, striking scenery, and locally favorite open spaces. To address the absence of a methodical, scientifically based approach to preserving biodiversity, Robert Jenkins, in association with The Nature Conservancy, developed the Natural Heritage Methodology in 1978.

Recognizing that rare and imperiled species are more likely to become extinct than common ones, the Natural Heritage Methodology ranks species according to their rarity or degree of imperilment. The ranking system is scientifically based upon the number of known locations of the species as well as its biology and known threats. By ranking the relative rareness or imperilment of a species, the quality of its populations, and the importance of associated proposed Conservation Areas, the methodology can facilitate in prioritizing conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community began to realize that plant communities are equally important as individual species, this methodology has also been applied to ranking and preserving rare plant communities as well as the best examples of common communities.

The Natural Heritage Methodology is used by Natural Heritage Programs throughout North, Central, and South America, forming an international database network. Natural Heritage Network data centers are located in each of the 50 U.S. states, five provinces of Canada, and 13 countries in South and Central America and the Caribbean. This network enables scientists to monitor the status of species from a state, national, and global perspective. It also enables conservationists and natural resource managers to make informed objective decisions in prioritizing and focusing conservation efforts.

What is Biological Diversity?

Protecting biological diversity has become an important management issue for many natural resource professionals. Biological diversity at its most basic level includes the full range of species on Earth, from species such as bacteria, and protists, through multicellular kingdoms of plants, animals, and fungi. At finer levels of organization, biological diversity includes the genetic variation within species, both among geographically separated populations and among individuals within a single population. On a wider scale, diversity includes variations in the biological communities in which species live, the ecosystems in which communities exist, and the interactions among these levels. All levels are necessary for the continued survival of species and plant communities, and all are important for the well-being of humans. It stands to reason that biological diversity should be of concern to all people.

The biological diversity of an area can be described at four levels:

1. **Genetic Diversity** -- the genetic variation within a population and among populations of a plant or animal species. The genetic makeup of a species is variable between populations within its geographic range. Loss of a population results in a loss of genetic diversity for that species and a reduction of total biological diversity for the region. This unique genetic information cannot be reclaimed.

2. **Species Diversity** -- the total number and abundance of plant and animal species and subspecies in an area.

3. **Community Diversity** -- the variety of plant communities within an area that represent the range of species relationships and inter-dependence. These communities may be diagnostic or even endemic to an area. It is within communities that all life dwells.

4. **Landscape Diversity** -- the type, condition, pattern, and connectedness of plant communities. A landscape consisting of a mosaic of plant communities may contain one multifaceted ecosystem, such as a wetland ecosystem. A landscape also may contain several distinct ecosystems, such as a riparian corridor meandering through shortgrass prairie. Fragmentation of landscapes, loss of connections and migratory corridors, and loss of natural communities all result in a loss of biological diversity for a region. Humans and the results of their activities are integral parts of most landscapes.

The conservation of biological diversity must include all levels of diversity: genetic, species, community, and landscape. Each level is dependent on the other levels and inextricably linked. In addition, and all too often omitted, humans are also linked to all levels of this hierarchy. We at the Colorado Natural Heritage Program believe that a healthy natural environment and human environment go hand in hand, and that recognition of the most imperiled elements is an important step in comprehensive conservation planning.

Colorado Natural Heritage Program

The Colorado Natural Heritage Program is the state's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. After operating in Colorado for 14 years, the Program was relocated from the State Division of Parks and Outdoor Recreation to the University of Colorado Museum in 1992 and more recently to the College of Natural Resources at Colorado State University.

The multi-disciplinary team of scientists and information managers gathers comprehensive information on rare, threatened, and endangered species and significant plant communities of Colorado. Life history, status, and locational data are incorporated into a continually updated data system. Sources include published and unpublished literature, museum and herbaria labels, and field surveys conducted by knowledgeable naturalists, experts, agency personnel, and our own staff of botanists, ecologists, and zoologists. Information management staff carefully plot the data on 1:24,000 scale USGS maps and enter it into the Biological and Conservation Data System. The database can be accessed from a variety of angles, including taxonomic group, global and state rarity rank, federal and state legal status, source, observation date, county, quadrangle map, watershed, management area, township, range, and section, precision, and conservation unit.

The CNHP is part of an international network of conservation data centers that use the Biological and Conservation Data System developed by The Nature Conservancy. The CNHP has effective relationships with several state and federal agencies, including the Colorado Natural Areas Program, Colorado Department of Natural Resources and the Colorado Division of Wildlife, the U.S. Environmental Protection Agency, and the U.S. Forest Service. Numerous local governments and private entities also work closely with the CNHP. Use of the data by many different individuals and organizations, including Great Outdoors Colorado, encourages a proactive approach to development and conservation thereby reducing the potential for conflict. Information collected by the Natural Heritage Programs around the globe provides a means to protect species before the need for legal endangerment status arises.

Concentrating on site-specific data for each element of natural diversity allows the CNHP to evaluate the significance of each location to the conservation of Colorado's, and indeed the nation's, natural biological diversity. By using species imperilment ranks and quality ratings for each location, priorities can be established for the protection of the most sensitive or imperiled sites. A continually updated locational database and priority-setting system such as that maintained by the CNHP provides an effective, proactive land planning tool.

The Natural Heritage Ranking System

Information is gathered by the CNHP on the state's plants, animals, and plant communities. Each of these species and plant communities is considered an **element of**

natural diversity, or simply an **element**. Each element is assigned a rank that indicates its relative degree of imperilment on a five-point scale (e.g., 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences, i.e., the number of known distinct localities or populations. This factor is weighted more heavily because an element found in one place is more imperiled than something found in twenty-one places. Also of importance is the size of the geographic range, the number of individuals, trends in population and distribution, identifiable threats, and the number of already protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State or S-rank) and the element's imperilment over its entire range (its Global or G-rank). Taken together, these two ranks give an instant picture of the degree of imperilment of an element. The CNHP actively collects, maps, and electronically processes specific occurrence information for elements considered extremely imperiled to vulnerable (S1 - S3). Those with a ranking of S3S4 are "watchlisted" meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. A complete description of each of the Natural Heritage ranks is provided in Table 3.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 3, ranks followed by a "B", e.g., S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N", e.g., S4N, refer to nonbreeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Table 3. Definitions of Colorado Natural Heritage imperilment ranks.

Global imperilment ranks are based on the range-wide status of a species. State imperilment ranks are based on the status of a species in an individual state. State and Global ranks are denoted, respectively, with an "S" or a "G" followed by a character. **These ranks should not be interpreted as legal designations.**

G/S1	Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range.
G/S3	Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences).
G/S4	Apparently secure globally/state, though it might be quite rare in parts of its range, especially at the periphery.
G/S5	Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery.
GX	Presumed extinct.

G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but not verified for an extended period, usually.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not permanent residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used
SZ	Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.
SA	Accidental in the state.
SR	Reported to occur in the state, but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.
Notes: Where two numbers appear in a state or global rank (e.g., S2S3), the actual rank of the element falls between the two numbers.	

Legal Designations

Natural Heritage imperilment ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. Legal status is designated by either the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statute 33-2-105 Article 2. In addition, the U.S. Forest Service recognizes some species as "Sensitive," as does the Bureau of Land Management. Table 4 defines the special status assigned by these agencies and provides a key to the abbreviations used by the CNHP.

Please note that the U.S. Fish and Wildlife Service has issued a Notice of Review in the February 28, 1996 Federal Register for plants and animal species that are "candidates" for listing as endangered or threatened under the Endangered Species Act. The revised candidate list replaces an old system that listed many more species under three categories: Category 1 (C1), Category 2 (C2), and Category 3 (including 3A, 3B, 3C). Beginning with the February 28, 1996 notice, the Service will recognize as candidates for listing only species that would have been included in the former Category 1. This includes those species for which the Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act. Candidate species listed in the February 28, 1996 Federal Register are indicated with a "C". While obsolete legal status codes (Category 2 and 3) are no longer used, the CNHP will continue to maintain them in its Biological and Conservation Data system for reference.

Table 4. Federal and state agency special designations.

Federal Status:		
1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)		
	LE	Endangered; species formally listed as endangered.
	E(S/A)	Endangered due to similarity of appearance with listed species.
	LT	Threatened; taxa formally listed as threatened.
	P	Proposed endangered or threatened; species formally proposed for listing as endangered or threatened
	C	Candidate: species for which the Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.
2. U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as "S")		
	FS	Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by:
a. Significant current or predicted downward trends in population numbers or density.		
b. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.		
3. Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S")		
	BLM	Sensitive: those species found on public lands, designated by a State Director, that could easily become endangered or extinct in a state. The protection provided for sensitive species is the same as that provided for C (candidate) species.
State Status:		
1. Colorado Division of Wildlife		
	E	Endangered
	T	Threatened
	SC	Special Concern

Element Occurrence Ranking

Actual locations of elements, whether they be single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. In order to prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the estimated viability or probability of persistence (whenever sufficient information is available). This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO-Rank is based on three factors:

1. **Size** – a quantitative measure of the area and/or abundance of an occurrence such as area of occupancy, population abundance, population density, or population fluctuation.
2. **Condition** – an integrated measure of the quality of biotic and abiotic factors, structures, and processes within the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include reproduction and health, development/maturity for communities, ecological

processes, species composition and structure, and abiotic physical or chemical factors.

3. **Landscape Context** – an integrated measure of the quality of biotic and abiotic factors, and processes surrounding the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include landscape structure and extent, genetic connectivity, and condition of the surrounding landscape.

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then averaged to determine an appropriate EO-Rank for the occurrence. If there is insufficient information available to rank an element occurrence, an EO-Rank is not assigned. Possible EO-Ranks and their appropriate definitions are as follows:

A Excellent estimated viability.
B Good estimated viability.
C Fair estimated viability.
D Poor estimated viability.
E Verified extant, but viability has not been assessed.
H Historically known, but not verified for an extended period.

Potential Conservation Areas

In order to successfully protect populations or occurrences of rare or imperiled elements, it is necessary to recognize Proposed Conservation Areas. These PCAs focus on capturing the ecological processes that are necessary to support the continued existence of a particular element occurrence of natural heritage significance. Proposed Conservation Areas may include a single occurrence of a rare element or a suite of rare element occurrences or significant features.

Once the presence of rare or imperiled species or significant natural communities has been confirmed, the first step towards their protection is the delineation of a proposed conservation planning boundary. In general, the proposed conservation planning boundary is an estimate of the landscape that supports the rare elements as well as the ecological processes that allow them to persist. In developing such boundaries, the CNHP staff consider a number of factors that include, but are not limited to:

- extent of current and potential habitat for the elements present, considering the ecological processes necessary to maintain or improve existing conditions;
- species movement and migration corridors;
- maintenance of surface water quality within the site and the surrounding watershed;
- maintenance of the hydrologic integrity of the groundwater, e.g., by protecting recharge zones;

- land intended to buffer the site against future changes in the use of surrounding lands;
- exclusion or control of invasive non-native species;
- land necessary for management or monitoring activities.

As the label "conservation planning" indicates, the boundaries presented here are for planning purposes. They delineate ecologically sensitive areas where land-use practices should be carefully planned and managed to ensure that they are compatible with protection goals for natural heritage resources and sensitive species. All land within the conservation planning boundary should be considered an integral part of a complex economic, social, and ecological landscape that requires wise land-use planning at all levels.

Furthermore, it is often the case that all relevant ecological processes cannot be contained within a site of reasonable size. Taken to the extreme, the threat of ozone depletion could expand every site to include the whole globe. The boundaries illustrated in this report signify the immediate, and therefore most important, area in need of protection. Continued landscape level conservation efforts are needed. This will involve county-wide efforts as well as coordination and cooperation with private landowners, neighboring land planners, and state and federal agencies.

Ranking of Potential Conservation Areas

One of the strongest ways that the CNHP uses element and element occurrence ranks is to assess the overall biodiversity significance of a site, which may include one or many element occurrences. Based on these ranks, each site is assigned a **biodiversity** (or B-) **rank**:

B1	Outstanding Significance (Irreplaceable): only site known for an element, or an excellent (A-ranked) occurrence of a G1 species, or a concentration of excellent or good (A- or B-ranked) occurrences of G1 or G2 elements (4 or more).
B2	Very High Significance (Almost irreplaceable): good or fair (B- or C-ranked) occurrence of a G1 species, or excellent or good (A- or B-ranked) occurrence of a G2 species, or a concentration of excellent or good occurrences (A- or B-ranked) of G3 species (4 or more), or concentration of fair (C-ranked) G2 elements (4 or more).
B3	High Significance: excellent (A-ranked) example of a community type, excellent or good (A- or B-ranked) occurrence of a G3 species, or a fair occurrence of a G2 species, or up to 5 of the best occurrences of a G4 or G5 community in an ecoregion.

B4 Moderate Significance: good (B-ranked) example of a community type, excellent or good (A- or B-ranked) occurrence of state-imperiled (S1 or S2) species, or a large concentration of excellent or good (A- or B-ranked) occurrences of state rare (S3) species (4 or more).

B5 General or Local Biodiversity Significance: good or marginal occurrence of a community type, S1, or S2 species.

Protection and Management Urgency Ranks

Protection urgency ranks (P-ranks) refer to the time frame in which conservation protection must occur. In most cases, this rank refers to the need for a major change of protective status (e.g., agency special area designations or ownership). The urgency for protection rating reflects the need to take legal, political, or other administrative measures to alleviate threats that are related to land ownership or designation. The following codes are used to indicate the rating which best describes the urgency to **protect** the area:

P1 Very high urgency. Protection actions needed immediately. It is estimated that stresses may reduce the viability of the elements in the PCA within 1 year.

P2 High urgency. Protection actions may be needed within 5 years. It is estimated that stresses may reduce the viability of the elements in the PCA within this approximate timeframe.

P3 Moderate urgency. Protection actions may be needed, but probably not within the next 5 years. It is estimated that stresses may reduce the viability of the elements in the PCA if protection action is not taken.

P4 Low urgency. No protection actions are needed in the foreseeable future.

P5 Land protection is complete and no protection actions are needed.

A protection action involves increasing the current level of legal protection accorded one or more tracts at a potential conservation area. It may also include activities such as educational or public relations campaigns or collaborative planning efforts with public or private entities to minimize adverse impacts to element occurrences at a site. It does not include management actions, i.e., any action requiring stewardship intervention. Threats that may require a protection action are as follows:

1) Anthropogenic forces that threaten the existence of one or more element occurrences at a site; e.g., development that would destroy, degrade or seriously compromise the long-term viability of an element occurrence and timber, range, recreational, or hydrologic management that is incompatible with an element occurrence's existence;
2) The inability to undertake a management action in the absence of a protection action; e.g., obtaining a management agreement;
3) In extraordinary circumstances a prospective change in ownership management that will make future protection actions more difficult.

Management urgency ranks (M-ranks) indicate the time frame in which a change in management of the element or site must occur. Using best scientific estimates, this rank refers to the need for management in contrast to protection (e.g., increased fire frequency, decreased herbivory, weed control, etc.). The urgency for management rating focuses on land use management or land stewardship action required to maintain element occurrences at the potential conservation area.

A management action may include biological management (prescribed burning, removal of exotics, mowing, etc.) or people and site management (building barriers, rerouting trails, patrolling for collectors, hunters, or trespassers, etc.). Management action does not include legal, political, or administrative measures taken to protect a potential conservation area. The following codes are used to indicate the action needed to be taken at the area:

- **M1** Very high urgency. Management actions may be required within one year or the element occurrences could be lost or irretrievably degraded.
- **M2** High urgency. New management actions may be needed within 5 years to prevent the loss of the element occurrences within the PCA.
- **M3** Moderate urgency. New management actions may be needed within 5 years to maintain the current quality of the element occurrences in the PCA.
- **M4** Low urgency. Current management seems to favor the persistence of the elements in the PCA, but management actions may be needed in the future to maintain the current quality of the element occurrences.
- **M5** No management needs are known or anticipated in the PCA.

METHODS

Focusing on private lands, site selection was based on the objective of visiting every wetland type at various geomorphic positions and elevations within Garfield County. The highest quality occurrences of each wetland type were targeted during the field season. Wetland types were defined using plant associations. The CNHP classifies wetland and riparian plant associations or communities, not wetland types. Plant communities reflect the broad nature of wetlands in the study area (i.e., willow carr, sedge meadow, cottonwood riparian forest, etc.), while also mirroring the local nature of wetlands in the watershed. Most other classifications applied to wetlands in Colorado, and across the nation, discriminate wetlands based primarily on the physiognomy (physical structure) of the vegetation. Broad structural classes, however, do not recognize the relative rarity of the plant species or communities contained in Garfield County.

Collect Available Information

The CNHP databases were updated with information regarding the known locations of species and significant plant communities within Garfield County. A variety of information sources were searched for this information. The Colorado State University museums and herbarium were searched, as were plant and animal collections at the University of Colorado, Mesa State College, Rocky Mountain Herbarium, and local private collections. The Colorado Division of Wildlife provided extensive data on the fishes of Garfield County as well as information regarding the status of the boreal toad. Both general and specific literature sources were incorporated into the CNHP databases as either locational information or as biological data pertaining to a species in general. Such information covers basic species and community biology including range, habitat, phenology (timing), food sources, and substrates. This information was entered into the CNHP's Biological Conservation Database (BCD).

Identify rare or imperiled species and significant plant communities with potential to occur in Garfield County

The list of plant communities thought to occur in Garfield County was derived from the ongoing Colorado Statewide Wetland Classification and Characterization (CSWCC) project, which is based on the U.S. National Vegetation Classification (USNVC) (Anderson et al. 1998), the accepted national standard for vegetation. The CSWCC utilizes and integrates previously collected data e.g., the CNHP Riparian Classification, the CNHP Wetland Inventories, and Colorado State University. The CSWCC incorporates all these data on riparian and other wetlands collected during the past 10 years as well as data from other researchers to avoid any duplication of effort.

The information collected in the previous step was used to refine the potential element list and to refine our search areas. In general, species and plant communities that have been recorded from Garfield County, or from adjacent counties, are included in this list. Species or plant communities which prefer habitats that are not included in this study area were removed from the list.

A list of elements includes those elements currently monitored by the CNHP that were thought to potentially occur in Garfield County and were therefore targeted in the CNHP field inventories.

The amount of effort given to the inventory for each of these elements was prioritized according to the element's rank. Globally rare (G1 - G3) elements were given highest priority, state rare (S-S3) elements were secondary.

Identify Targeted Inventory Areas

Survey sites or Targeted Inventory Areas (TIAs) were chosen based on their likelihood of harboring rare or imperiled species or significant plant communities. Known locations were targeted, and additional potential areas were chosen using a variety of information sources, such as aerial photography. Precisely known element locations were always included so that they could be verified and updated. Many locations were not precisely known due to ambiguities in the original data, i.e., "headwaters of Cataract Creek." In such cases, survey sites for that element were chosen in likely areas in the general vicinity. Areas with potentially high natural values were chosen using aerial photographs, geology maps, vegetation surveys, personal recommendations from knowledgeable local residents, and numerous roadside surveys by our field scientists. Aerial photography is perhaps the most useful tool in this step of the process.

General habitat types can be discerned from the aerial photographs, and those chosen for survey sites were those that appeared to be in the most natural condition. In general, this means those sites that are the largest, least fragmented, and relatively free of visible disturbances such as roads, trails, fences, quarries, etc.

The above information was used to delineate over 100 survey areas that were believed to have relatively high probability of harboring natural heritage resources. These areas vary in size from less than 10 to several thousand acres.

Roadside surveys were useful in further resolving the natural condition of these areas. The condition of grasslands is especially difficult to discern from aerial photographs, and a quick survey from the road can reveal such features as weed infestation or overgrazing.

Because of the overwhelming number of potential sites and limited resources, surveys for all elements were prioritized by the degree of imperilment. For example, all species with Natural Heritage ranks of G1-G3 were the primary target of our inventory efforts. Although species with lower Natural Heritage ranks were not the main focus of inventory efforts, many of these species occupy similar habitats as the targeted species, and were searched for and documented as they were encountered.

Landowner Contacts

Attaining permission to conduct surveys on private property was essential to this project. Once survey sites were chosen, land ownership of these areas was determined using records at the Garfield County assessor's office. Landowners were then either contacted by phone or mail or in person. If landowners could not be contacted, or if permission to access the property was denied, this was recorded and the site was not visited. **Under no circumstances were properties surveyed without landowner permission.**

Conduct Field Surveys

Survey sites, where access could be attained, were visited at the appropriate time as dictated by the phenology of the individual elements. It is essential that surveys take place during a time when the targeted elements are detectable. For instance, breeding birds cannot be surveyed outside of the breeding season and plants are often not identifiable without flowers or fruit which are only present during certain times of the season.

The methods used in the surveys necessarily vary according to the elements that were being targeted. In most cases, the appropriate habitats were visually searched in a systematic fashion that would attempt to cover the area as thoroughly as possible in the given time. Some types of organisms require special techniques in order to capture and document their presence. These are summarized below:

Amphibians: visual or with aquatic nets
Mammals: Sherman live traps
Birds: visual or by song/call, evidence of breeding sought
Insects: aerial net, pit fall traps, moth lighting
Wetland plant communities: visual, collect qualitative or quantitative composition, soil, hydrological, and function data
Fishes: electroshocking, seining, barbless fly fishing, observation

When necessary and permitted, voucher specimens were collected and deposited in local university museums and herbaria.

When a rare species or significant natural community was discovered its precise location and known extent was recorded on 1:24,000 scale topographic maps. Other data recorded at each occurrence included numbers observed, breeding status, habitat description, disturbance features, observable threats, and potential protection and management needs. The overall significance of each occurrence, relative to others of the same element, was estimated by rating the quality (size, vigor, etc.) of the population or community, the condition or naturalness of the habitat, the long-term viability of the population or community, and the defensibility (ease or difficulty of protecting) of the occurrence. These factors are combined into an element occurrence rank, which is useful in refining conservation priorities. See the previous section on Natural Heritage Network for more about element occurrence ranking.

Field surveys also included a wetland functional evaluation. Some of the sites profiled in this report were not visited by the author of this report but rather by previous CNHP ecologists. For these sites, only a qualitative, descriptive paragraph of the potential functions of that site (based on ecological information collected by the previous CNHP scientist) is given. For those sites visited by the author, a wetland functional evaluation, using the Montana based-evaluation method, is detailed in the site profile. Site visits and assessments were conducted on the following two levels:

(1) **Roadside or adjacent land assessments.** Many of the sites could be viewed at a distance from a public road or from adjacent public land. While on the ground the field scientist can see, even from a distance, many features not apparent on maps and aerial photos. The road assessments determined the extent of human and livestock impacts on the TIA, which included ditching, adventive plant species, indicator plant species of intensive livestock use, stream bank destabilization, major hydrologic alterations, excessive cover of non-native plant species, or new construction. Sites with one or more of these characteristics were generally excluded as potential conservation areas and no extensive data were gathered at these areas.

(2) **On-site assessments**. On-site assessment was the preferred method, as it is the only assessment technique that can yield high-confidence statements concerning the known or potential presence of rare and imperiled elements or excellent examples of common communities. On-site assessments are also the most resource intensive because of the effort required to contact landowners. In several cases where on-site assessments were desired, they could not be conducted because either field personnel were denied access to the property by the landowner, or the CNHP was unable to contact the landowner during the time frame of this study.

The following information was collected for the sites in this report:

General Field Information
- list of all plant associations in the wetland complex, including the amount of wetland area covered by that community. In almost all cases, plant associations were immediately placed within the CNHP's Statewide Wetland Classification. However, on rare occasions a plant association was encountered which could not be easily classified based on the stands that had been previously sampled.
- vegetation data for each major plant association in the wetland were collected using visual ocular estimates of species cover in a representative portion of the plant association.
- sketch of the site layout, with distribution of community types indicated (this was generally done on the 7.5' USGS topographic map, but occasionally for clarity a separate map was drawn on the site survey form)
- elevation (from 7.5 min. USGS topographic maps)
- current and historic land use (e.g., grazing, logging, recreational use) when apparent
- notes on geology and geomorphology
- reference photos of the site
- indicators of disturbance such as logging, grazing, flooding, etc.

Natural Heritage Information
- list of elements present or expected at the site
- element occurrence (EO) ranks or information that will lead to EO Rank
- proposed conservation area boundaries

General Wetland Information

- proposed HGM Class and Subclass
- Cowardin System and Subsystem
- water source
- hydroperiod
- general soils description (these are based on either a detailed description of a soil profile in the field (i.e., horizons, texture, color, cobble size, percent mottling) or from information from the county soil surveys.

Qualitative Functional Assessment

- hydrological functions (i.e., groundwater recharge/discharge, flood storage, shoreline anchoring)
- biogeochemical functions (i.e., elemental cycling, sediment trapping, and toxicant retention/removal)
- biological functions (i.e., foodchain support, production export, fish and wildlife habitat, habitat diversity)

Restoration Potential

- cause of disturbances, if any (i.e., alteration of hydrology, peat removal, fill material, presence of non-native species, etc.)
- feasibility of rectifying the disturbance (re-establishing natural hydrological regime, remove fill material, plant native species, etc.)
- discussion of possible methods for restoration.

Delineate Potential Conservation Area Boundaries

Finally, since the objective for this inventory is to prioritize specific areas for conservation efforts, potential conservation area boundaries were delineated. Such a boundary is an estimation of the minimum area needed to assure persistence of the element. Primarily, in order to insure the preservation of an element, the ecological processes that support that occurrence must be preserved. The preliminary potential conservation area boundary is meant to include features on the surrounding landscape that provide these functions. Data collected in the field are essential to delineating such a boundary, but other sources of information such as aerial photography are also used. These boundaries are considered preliminary and additional information about the site or the element may call for alterations of the boundaries.

RESULTS

CNHP ecologists identified 104 wetland/riparian Targeted Inventory Areas (TIAs) that merited on-site investigation (Figures 8). Out of these TIAs, 57 (55%) sites are encompassed within Potential Conservation Areas and 4 (4%) sites are presented as Sites of Local Significance (Figure 8). An effort was made to select sites that potentially had natural hydrology, native species composition, and vegetation structure intact. However, on-site inspection revealed that many of the wetland TIAs (20%) were heavily impacted by roads, buildings, non-native species, agriculture, and/or grazing and were dropped from the inventory (Figure 8). Due to time limitations, 14% of the TIAs were not visited, most of these were located on U.S. Forest Service and Bureau of Land Management land (Figure 8). CNHP ecologists were denied access and/or unable to contact landowners for 7 (7%) TIAs.

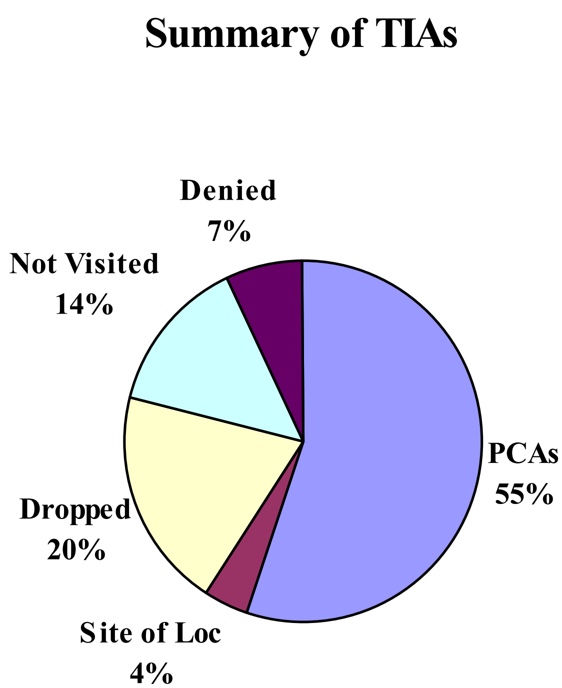


Figure 8. Summary of TIAs.

Significant Elements Associated with Wetlands and Riparian Areas

The following table presents CNHP elements of biological significance known to occur in or associated with wetlands and riparian areas in Garfield County. Occurrences of all elements are archived in the CNHP's Biological Conservation Data System.

Table 5. List of known elements of concern for Garfield County by taxonomic group. Elements with the highest global significance (G1-G3) are in bold type. Detailed descriptions of all of the elements listed below can be found in the Natural History section.

Element	Common Name	Global Rank	State Rank	Federal and State Status
Plants				
Carex diandra	Lesser panicled sedge	G5	S1	
Cypripedium calceolus ssp. *parviflorum*	Yellow lady's-slipper	G5	S2	BLM
Iliamna grandiflora	**Large-flower globe-mallow**	**G3?Q**	**S1**	
Limnorchis ensifolia	**Canyon bog-orchid**	**G4G5T3?**	**S3**	
Sullivantia hapemanii* var. *purpusii	**Hanging garden sullivantia**	**G3T3**	**S3**	
Plant Communities				
Abies lasiocarpa-Picea engelmannii/Alnus incana	Montane riparian forests	G5	S5	
Abies lasiocarpa-Picea engelmannii/Ribes spp.	Coniferous wetland forests	G5	S3	
Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	Montane riparian forests	G5	S5	
Abies lasiocarpa-Picea engelmannii/ Salix drummondiana	Montane riparian forests	G5	S4	
Abies lasiocarpa/ Rubus parviflorus	Subalpine forests	G5	S2	
Acer negundo-Populus angustifolia/Cornus sericea	**Narrowleaf cottonwood riparian forests**	**G2**	**S2**	
Acer negundo/ Cornus sericea	**Montane riparian deciduous forest**	**G3?**	**S2**	
Acer negundo/ Prunus virginiana	**Montane riparian deciduous forest**	**G3**	**S2**	
Alnus incana-Cornus sericea	Thinleaf alder-red osier dogwood riparian shrubland	G3G4	S3	
Betula occidentalis/ mesic forb	**Foothills riparian shrubland**	**G3**	**S2**	
Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	Alpine wetlands	G4	S4	
Carex aquatilis	Montane wet meadows	G5	S4	
Carex aquatilis-Carex utriculata	Montane wet meadows	G4	S4	
Carex nebrascensis	Wet meadows	G4	S3	
Carex utriculata	Beaked sedge montane wet meadows	G5	S4	
Catabrosa aquatica-Mimulus spp.	Spring wetland	GU	S3	
Cornus sericea	Foothills riparian shrubland	G4	S3	
Deschampsia cespitosa	Mesic alpine meadow	G4?	S4	
Distichlis spicata	Salt meadows	G5	S3	
Juncus balticus var. montanus	Western Slope wet meadows	G5	S5	

Element	Common Name	Global Rank	State Rank	Federal and State Status
Picea engelmannii/ Cornus sericea	Montane riparian forests	GU	SU	
Picea pungens/ Alnus incana	**Montane riparian woodland**	**G3**	**S3**	
Picea pungens/ Betula occidentalis	**Montane riparian woodland**	**G2**	**S2**	
Picea pungens/ Cornus sericea	Montane riparian forest	G4	S2	
Populus angustifolia/ Alnus incana	**Montane riparian forest**	**G3?**	**S3**	
Populus angustifolia/ Betula occidentalis	**Montane riparian forest**	**G3?**	**S2**	
Populus angustifolia/ Cornus sericea	Cottonwood riparian forest	G4	S3	
Populus angustifolia/Crataegus rivularis	**Narrowleaf cottonwood riparian forest**	**G2?**	**S2?**	
Populus angustifolia/ Rhus trilobata	**Narrowleaf cottonwood/skunkbrush**	**G3**	**S3**	
Populus balsamifera	Montane riparian woodland	GU	SU	
Populus deltoides ssp. wislizenii/Rhus trilobata	**Rio Grande cottonwood riparian forests**	**G2**	**S2**	
Populus tremuloides/ Acer glabrum	**Montane riparian forests**	**G2**	**S1S2**	
Populus tremuloides/ Alnus incana	**Montane riparian forests**	**G3**	**S3**	
Populus tremuloides/ Pteridium aquilinum	Aspen wetland forests	G4	S3S4	
Pseudotsuga menziesii/Acer glabrum	Lower montane riparian forests	G4	S1	
Pseudotsuga menziesii/Cornus sericea	Lower montane riparian forests	G4	S2	
Salix boothii/Carex utriculata	Willow carr	G4	S3	
***Salix boothii/*mesic graminoid**	**Riparian willow carr**	**G3**	**S3**	
***Salix boothii/*mesic forb**	**Booth's willow/mesic forb**	**G3**	**S3**	
*Salix brachycarpa/*mesic forb	Alpine willow scrub	G4	S4	
Salix drummondiana/ Carex utriculata	Montane willow carr	GU	S3	
Salix drummondiana/ mesic forb	Drummond's willow/mesic forb	G4	S4	
Salix monticola/ Carex utriculata	**Montane riparian willow carr**	**G3**	**S3**	
***Salix monticola/*mesic forb**	**Montane riparian willow carr**	**G3**	**S3**	
Salix planifolia/ Caltha leptosepala	Subalpine riparian willow carr	G4	S4	
Salix planifolia/ Carex aquatilis	Subalpine riparian willow carr	G5	S4	
Salix wolfii/Carex aquatilis	Subalpine riparian willow carr	G4	S3	
***Salix wolfii/*mesic forb**	**Subalpine riparian willow carr**	**G3**	**S3**	
Amphibians				
Bufo boreas	**Boreal toad (Southern Rocky Mountain population)**	**G4T1Q**	**S1**	**FS, State - E**
Rana pipiens	Northern leopard frog	G5	S3	FS/BLM, SC

Element	Common Name	Global Rank	State Rank	Federal and State Status
Spea intermontana	Great Basin spadefoot	G5	S3	
Birds				
Accipiter gentilis	Northern Goshawk	G5	S3B, SZN	FS/BLM
Bucephala islandica	Barrow's Goldeneye	G5	S2B,SZN	
Cypseloides niger	Black Swift	G4	S3B	
Grus canadensis tabida	Greater Sandhill Crane	G5T4	S2B,S4N	
Haliaeetus leucocephalus	Bald Eagle	G4T?Q	S1B,S3N	LT
Plegadis chihi	White-Faced Ibis	G5	S2B,SZN	
Fish				
Catostomus latipinnis	Flannelmouth sucker	G3G4	S3	BLM
Gila robusta	**Roundtail chub**	**G2G3**	**S2**	
Oncorhynchus clarki pleuriticus	**Colorado River cutthroat trout**	**G4T3**	**S3**	
Prosopium williamsoni	Mountain whitefish	G5	S3	
Xyrauchen texanus	**Razorback sucker**	**G1**	**S1**	**LE/E**
Invertebrates				
Erebia theano	Theano Alpine	G4	S3	
Mammals				
Thomomys bottae pervagus	Valley pocket gopher	G5T3	S3	

Sites of Biodiversity Significance

The 39 most important wetland sites in Garfield County are profiled in this section as Potential Conservation Areas (PCAs) with biodiversity ranks (Figure 9). These PCAs include the wetlands with the highest biodiversity significance, as well as the best examples of wetland types present in the study area. Four sites of local significance are also profiled. These sites were chosen based on the local importance of their functions within Garfield County. Sites of Local Significance did not receive B-ranks.

The PCAs are organized in ascending order or according to their B-Rank (e.g. B1 to B5). Sites of Local Significance are profiled after the PCAs.

Each Potential Conservation Area (PCA) is described in a standard site profile report that reflects data fields in the CNHP's Biological and Conservation Data (BCD) System. The contents of the profile report are outlined and explained below:

Site Profile Explanation

Biodiversity Rank: B#
The overall significance of the site in terms of rarity of the Natural Heritage resources and the quality (condition, abundance, etc.) of the occurrences. Please see *The Natural Heritage Ranking System* section for more details.

Protection and Management Ranks:
A summary of major land ownership and management issues that may affect the long-term viability of the site and the element(s).

Location: General location and legal description using a U.S.G.S. 7.5-minute Quadrangle name and Township Range Section(s).

Size: Expressed in acres.

Elevation: Expressed in feet.

General Description: A brief narrative picture of the topography, hydrology, vegetation, and current use of the proposed conservation site. Common names are used along with the scientific names. The approximate acreage included within the proposed conservation area boundary for the site is reported.

Biodiversity Rank Justification: A synopsis of the rare species and significant plant communities that occur within the proposed conservation area. A table within the area profile lists each element occurrence found in the site, global and state ranks of these elements, the occurrence ranks and federal and state agency special designations. See Table 1 for explanations of ranks and Table 2 for legal designations.

Boundary Justification: Justification for the location of the proposed conservation area boundary delineated in this report, which includes all known occurrences of natural heritage resources and, in some cases, adjacent lands required for their protection.

Protection Management Comments: Discussion of major land ownership and management issues that may affect the long-term viability of the site and the element(s).

Soils Description: Soil profile descriptions were generally conducted at each site. When these profile descriptions were found to match the mapped soil type found in the county soil surveys, then reference is only given to that particular soil series and no profile description is provided. However, if a profile description did not match the mapped soil type, then profile descriptions are presented. Classification of these soils was conducted, when possible, using *Keys to Soil Taxonomy*.

Restoration Potential: A brief summary describing the feasibility of restoring ecosystem processes at each site.

Wetland Functional Assessment: A summary of the functions and the proposed HGM classification, Cowardin system, and the plant community derived from the CSWCC (the CNHP's Statewide Wetland Classification) for the wetlands occurring within each Potential Conservation Area and Site of Local Significance. (Note: Some of the sites profiled in this report were not visited by the author but rather by previous CNHP ecologists. For these sites, only a qualitative descriptive paragraph of the potential functions of that site (based on ecological information collected by the previous CNHP scientist) is given. For those sites visited by the author, a wetland functional evaluation, using the Montana based-evaluation method, is detailed in the site profile.)

Table 6 displays all 39 PCAs and four Sites of Local Significance in the Garfield County study area. All of these sites merit protection, but available resources should be directed first toward the higher B-ranked sites (e.g., B2 & B3 sites). These sites alone do not represent a complete wetland conservation program; they represent only the rare and imperiled elements. In addition, as was discussed above, inventory efforts were focused on private lands and due to time limitations, a comprehensive inventory of public lands (i.e., U.S. Forest Service and BLM) was not conducted.

Table 6. Potential Conservation Areas identified in Garfield County, arranged by biodiversity rank (B-rank).

Potential Conservation Area
B2
East Fork Parachute Creek
East Salt Creek Headwaters
4A Ridge
No Name Creek
Parachute Creek
Rifle Stretch Colorado River
B3
Bear Creek at Glenwood Canyon
Beaver Creek at Battlement Mesa
Calf Canyon
Clear Creek
Conn Creek
Deep Creek
Deep Creek at Clark Ridge
East Douglas Creek
East Elk Creek
East Rifle Creek
Fourmile Creek at Sunlight
Garfield Creek
Grizzly Creek Canyon
Hanging Lake
Headwaters of Patterson Creek
Meadow Creek at Deep Creek Point
North Fork Derby Creek
Northwater Creek
Sweetwater Lake
The Meadows
Trapper Creek
Wagonwheel Creek
B4
Brush Creek at Skinner Ridge
Douglas Pass
Main Elk Creek
Middle Fork Derby Creek
Mitchell Creek
Ranch at the Roaring Fork
Trappers Lake
Turret Creek
West Elk Creek
B5
Kaiser Stevens Ditch
Sutank
Sites of Local Significance
Coulter Creek
Dry Rifle Creek
Fisher Creek
Spring Valley
West Rifle Creek

Figure 9. Map of PCAs and Sites of Local Significance in the Garfield County study area.

East Fork Parachute Creek Potential Conservation Area

Biodiversity Rank: B2 Very High Significance. The site supports an excellent occurrence of a critically imperiled plant community.

Protection Urgency Rank: P2 High Urgency. Although the potential for oil shale development is unknown, the threats are high especially on private lands.

Management Urgency Rank: M2 High Urgency. Competition from non-native trout populations threaten the native cutthroat.

Location: East Fork Parachute Creek is located approximately five miles northwest of Rifle and ten miles southeast of Rio Blanco.

Legal Description: U.S.G.S. 7.5 minute quadrangles: Anvil Points, Forked Gulch; T5S R94W Sections 23, 26, 27, 33, and 34; T5S R95W Section 35; T6S R95W Sections 1, 2, 3, 4, and 5

Size: 7,326 acres.

Elevation: 6,700 – 9,000 ft.

General Description: East Fork Parachute Creek is a small but biologically significant tributary to the Colorado River. The headwaters for this creek begin at approximately 9,000 feet in elevation with gently rolling hills of aspen forests (*Populus tremuloides*), mountain sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and snowberry (*Symphoricarpos rotundifolius*) shrublands, and grasslands. East Fork Parachute Creek originates near the eastern rim of the Roan Plateau and forms a deep canyon before plunging 200 feet into a narrow, scenic box canyon.

Numerous creeks drain into East Fork Parachute Creek: JQS, Golden Castle, First and Second Anvil Creeks, First, Second, and Third Water Gulches, Camp, Grassy and Bull Gulches, Sheep Hollow Trail, etc. All of these tributaries begin with small springs and seeps, which flow more or less year round. Each tributary, except for Golden Castle and First and Second Anvil, have a dramatic cliff/waterfall near its confluence with East Fork Parachute Creek, providing picturesque hanging garden habitat, where the rare hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*) occurs.

The riparian plant communities of East Fork Parachute Creek are one of the most diverse in Garfield County. Near the headwaters of First Anvil Creek on a north-facing hillside, aspen (*Populus tremuloides*) and Rocky Mountain maple (*Acer glabrum*) dominate a large, forested slope wetland. Willow dominated communities, primarily mountain willow (*Salix monticola)* and Drummond's willow (*S. drummondiana)*, create several miles of habitat for common birds such as Yellow Warbler (*Dendroica petechia*), Cordilleran Flycatcher (*Empidonax occidentalis*), Song Sparrow (*Melospiza melodia*), House Wren (*Troglodytes aedon*), and Lincoln Sparrow (*Melospiza lincolnii*).

Approximately a mile above the 200 foot waterfall, the canyon narrows and the riparian vegetation is forested with spruce-fir (*Picea-Abies* ssp.) and narrowleaf cottonwoods (*Populus angustifolia*). Below the falls, the riparian vegetation changes drastically to a low-elevation community of box elder (*Acer negundo)*, narrowleaf cottonwood, and red osier dogwood (*Cornus sericea*).

Due to the westerly orientation of the creek, the north and south-facing slopes are dramatically different. The south-facing slopes are sparsely vegetated on the steep sections right above the creek and more densely vegetated on the more gentle slopes above, which are dominated by mountain sagebrush and snowberry. North-facing slopes consist of spruce-fir forests on the steep, mesic slopes adjacent to the stream and at higher elevations aspen forests occur on more gentle terrain.

The creek itself is primarily a pool/drop stream system on shale bedrock. Although the volume of this stream is relatively small, especially towards the end of the summer, it has an amazingly dense population of trout, primarily brook trout (*Salvelinus fontinalis*).

The Roan Plateau and surrounding areas were within the summer camps and hunting grounds for Ute and prehistoric Native Americans, dating back to more than 5000 B. C. (Tickner et al. 1996). They probably hunted bison, deer, elk, and other game and fished East Fork Parachute Creek. Grinding stones, arrowhead points, and bison bones have all been found within this site.

Native peoples were followed by ranchers. In the late 1800's ranchers from Rifle and Parachute began to use this area for summer grazing grounds (Rifle Reading Club 1973). They built many cabins near the numerous springs, which may still be seen today. The Bull Gulch cabin was built in the early 1900's and was first restored by BLM in 1940 (M. Kinser pers. comm.). Livestock grazing is still the primary use of this land, although hunting is extremely popular in this area.

Table 7. Natural Heritage element occurrences at the East Fork Parachute Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Nuttallia argillosa	Arapien stickleaf	G3	S2				A
Argillochloa dasyclada	Utah fescue	G3	S3				A
Sullivantia hapemanii var *purpusii*	Hanging garden sullivantia	G3T3	S3			FS	A
Plant Communities							
Acer negundo-Populus angustifolia/Cornus sericea	**Boxelder riparian forest**	**G2**	**S2**				**A**
Populus tremuloides/Acer glabrum	Montane riparian forests	G2	S1S2				B
Populus angustifolia/Cornus sericea	Cottonwood riparian forest	G3	S2?				B
Salix drummondiana/mesic forb	Drummond's willow/mesic forb	G3	S3				C
Salix monticola/mesic forb	Mountain willow/mesic forb	G3	SU				B
Picea pungens/Cornus sericea	Montane riparian forest	G4	S2				B
Populus tremuloides-Pteridium aquilinum	Aspen wetland forest	G4	S3S4				C
Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	Alpine wetland	G4	S4				A
Abies lasiocarpa-Picea engelmannii/Salix drummondiana	Spruce-fir/Drummond's willow	GU	SU				B
Fish							
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T2T3	S2			FS	C
Birds							
Catharus fuscenscens	Veery	G3	S3S4B SZN				B
Aegolius funereus	Boreal owl	G5	S2			FS	B
Mammals							
Sorex c.f. preblei	Preble's shrew	G5	S1?				A

*EO Rank is "Element Occurrence" Rank

Biodiversity Comments: The East Fork Parachute Creek PCA hosts a very high concentration of Natural Heritage elements. Included in the 16 elements are nine significant natural communities, one globally vulnerable fish, two species of birds, three globally vulnerable plants, and one state imperiled mammal.

This site harbors the best-known population (A-Ranked) of the globally vulnerable (G3T3/S3) hanging garden sullivantia (*Sullivantia hapemannii* var. *purpusii*), with over 25 high quality sub populations within the site. This site also contains an excellent (A-ranked occurrence) of the globally vulnerable (G3S3) Utah fescue (*Argillochloa dasyclada*) and a fair (C-ranked) occurrence of the state rare (G4T3/S3) Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*). This population was given a B+ rating for genetic purity by the Colorado Division of Wildlife in 1983. The globally imperiled (G4T2T3/S2) Colorado River cutthroat trout are a sensitive species that are native to the Colorado River basin, and have recently been in decline. Remnant populations still remain in Colorado, Wyoming, and Utah. Important plant communities included in this site are an excellent (A-ranked) occurrence of the globally imperiled (G2/S2) boxelder riparian forest (*Acer negundo – Populus angustifolia*/*Cornus sericea*), good (B-ranked) occurrences of the state imperiled (G4/S2) blue spruce/red-osier dogwood montane riparian forest (*Picea pungens*/*Cornus sericea*), fair (C-ranked) occurrence of the globally vulnerable (G3/S3) Drummond's willow/mesic forb (*Salix drummondiana*/mesic forb). The globally imperiled (G2/S2) aspen/Rocky Mountain maple (*Populus tremuloides/Acer glabrum*) forest occurs on a hillslope where groundwater seepage has created moist soil conditions. There are less than 10 locations of this aspen forest association in the central and south-central mountain regions of Colorado.

Boundary Justification: The site boundaries encompass East Fork Parachute Creek and all of its tributaries from the headwaters to approximately 1 mile beyond the Bureau of Land Management boundary. These boundaries will ensure continued natural surface flow and maintain a natural hydroperiod through East Fork Parachute Creek, which will maintain a dynamic distribution of riparian plant communities along the drainage and support fish populations. The complete distribution of the trout population within the East Fork Parachute Creek drainage has not been scientifically determined, thus the site boundaries may not be adequate for the viability of the trout population.

Protection Rank Comments: The BLM portion of this site was transferred from the Department of Energy to the BLM in 1997. The BLM's amended Resource Management Plan for oil and gas leasing and development calls for no surface occupancy stipulations for riparian areas. UNOCAL Oil Company owns the lower stretch of this site. UNOCAL should be contacted and made aware of the biological significance of the site.

Management Rank Comments: The primary threat to this site is degradation of the native trout population from competition with the non-native brook trout. Sealing et al. (1996) believe the native trout population may be gone from the site in few years. The last trout study, in 1983, of East Fork Parachute Creek (Sealing 1996) gave the population a B + genetic purity rating. Gathering and analyzing basic population data would establish distribution patterns of cutthroat trout over the East Fork, East Middle Fork and Middle Fork of Parachute Creek. An extensive program of electro-shocking would assist in determining species composition and genetic composition of the cutthroat trout populations present at these streams. It would also aid in the identification of non-native fish and in determining the location of fish barriers to prevent migration of non-native fishes into the trout habitat. Streamside grazing by livestock could change the hydrology of East Parachute Creek by increasing sedimentation and reducing streamside shrub cover, stream shade, and ultimately increasing water temperatures. Restricting grazing along East Parachute Creek would benefit the cutthroat trout population. Cutthroat trout are susceptible to overharvest if angling is unrestricted, so Colorado has instituted restrictive angling regulations. Strict enforcement of these regulations will help to ensure survival of this population of cutthroats.

Soils Description: The soils along East Fork Parachute Creek are mapped as Torriorthents. These soils formed on colluvial slopes below the steep cliff faces along this drainage. The soils are mostly well drained and vary from loamy to clayey with variable amounts of gravel, cobbles, and stones (Soil Conservation Service 1985). The aspen/Rocky Mountain maple wetland/riparian forest occurs on the Northwater series. The Northwater is a loamy-skeletal, mixed Pachic Cryoboroll and consists of deep, well-drained soils (Soil Conservation Service 1985).

Restoration Potential: The current land use patterns allow for overuse of this site by livestock. The primary concerns from such activity are uncontrolled non-native species invasions and increased erosion and downcutting of the stream banks. Grazing practices should be minimized or a reasonable method of grazing implemented in order to improve the health of the riparian vegetation and hence the riparian ecosystem.

Due to the natural barrier to migrating fish (a 200-foot waterfall) on East Fork Parachute Creek and an existing trout population, this site is an excellent location to restore the Colorado River cutthroat trout. There are several ways to control the exotic fish population. All possibilities such as poisoning and electroshocking should be researched and a plan to restore a healthy native trout population should be seriously considered.

The portion of this site in which the aspen/Rocky Mountain maple site occurs is a large, pristine area with little impacts from current land use. However, there is a dirt road that cuts through the area and thus, restoration activities should focus on restoring this area to native vegetation. Further research should determine whether the road and/or fill used in the creation of the road (if any) is affecting subsurface hydrology. If hydrology has been impacted, measures should be taken to reestablish natural subsurface hydrologic flow (i.e. remove the fill/compacted material to the native soil surface).

Wetland Functional Assessment for the East Fork Parachute Creek PCA: This site contains a long but narrow riparian area with fairly high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The diversity of habitats, including numerous locations of a permanent water source in an otherwise arid landscape, provide excellent habitat for avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris for fish habitat.

Since the aspen/Rocky mountain maple forested wetland occurs on a hillside and not along a stream, the capacity of this site to perform flood attenuation and storage and sediment/shoreline stabilization is minimal. Given the large size of the area, the presence of periodically saturated soils, and a thick litter layer within the forest, there are many potential pathways for nutrient transformations. Thus, important, local biogeochemical functions are likely occurring at this site. Many bird species were observed in the area and deer, elk, and bear are also suspected of using the area.

Figure 10. East Fork Parachute Creek PCA.

East Salt Creek Headwaters Potential Conservation Area

Biodiversity Rank: B2 Very High Significance. The site supports an excellent occurrence of a globally imperiled plant plus a unique population of balsam poplar, a species more typical of boreal regions to the north.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Approximately 30 miles north of Loma, CO, east of Hwy. 139.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Henderson Ridge, Calf Canyon, Middle Dry Fork and Garvey Canyon. T5S R100W S30 and 31; T5S R101W S36; T6S R101W S3-5, 8-11, 14-16, 20-28, and 33-36.

Size: 9,561 acres

Elevation: 6,200 to 8,500 ft.

General Description: The East Salt Creek Headwaters PCA occupies the ridge separating the East Salt Creek drainage to the west and the Roan Creek drainage to the east, along with the riparian zone of Corral Canyon, a tributary of East Salt Creek. The uplands consist of sparsely vegetated shale slopes of the Green River Formation. There are scattered Douglas fir (*Pseudotsuga menziesii*), with snowberry (*Symphoricarpos rotundifolius*), spearleaf buckwheat (*Eriogonum lonchophyllum*) and penstemons (*Penstemon* sp.) Corral Canyon is a fairly steep, remote canyon with vertical, shale cliff faces exposed near the rim. Narrowleaf cottonwood (*Populus angustifolia*) and skunkbrush (*Rhus trilobata*) dominate the major drainage in Corral Canyon. Adjacent slopes are dominated by Gambel's oak (*Quercus gambelii*), Utah serviceberry (*Amelanchier utahensis*), and juniper (*Juniperus osteosperma*).

There are numerous seeps and springs scattered throughout the area due to the outcropping of the Green River shale formation. Approximately 2 miles upstream from where Corral Canyon opens into the East Salt Creek drainage, there is a fairly long, steep, step/pool complex on the east-facing slope. At the headwaters of this springbrook, is a stand of balsam poplar (*Populus balsamifera*). This species is common at more northern latitudes but is at the southern edge of its distribution in Colorado. The stand occurs at an old spring source, which no longer discharges at this location. The spring currently discharges approximately 50 feet west of the old source and is dominated by beaked sedge (*Carex utriculata*), alkali crowfoot (*Halerpestes cymbalaria* subsp. *saximontana*), and brookgrass (*Catabrosa aquatica*). The springbrook flows downhill along a steep drainage and is periodically interrupted by small flat areas where wetland vegetation has established around small pools. Beaked sedge, mare's tail (*Hippuris vulgaris*), hardstem bulrush (*Scirpus acutus*), cattail (*Typha latifolia*), American speedwell (*Veronica americana*), and wild mint (*Mentha arvense*) are abundant in these small marshes. Sandbar willow (*Salix exigua)*, skunkbrush, and narrowleaf cottonwood are dominant along portions of the springbrook.

Table 8. Natural Heritage element occurrences at the East Salt Creek Headwaters PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Lesquerella parviflora	**Piceance bladderpod**	**G2G3**	**S2**	**BLM**			**A**
Plant Communities							
Populus angustifolia/Rhus trilobata	Montane riparian forest	G3	S3				C
Populus balsamifera	Montane riparian woodland	GU	S2?				B
Juncus balticus var. *montanus*	Wet meadow	G5	S5				B

*EO Rank is "Element Occurrence" Rank

Biodiversity comments: This site contains an excellent (A ranked), and one of the largest known occurrences of the Piceance bladderpod, with an estimated 21,000 individual plants. The Piceance Bladderpod is a globally imperiled (G2S2) Colorado endemic known only from Garfield and Rio Blanco counties, and one location in Mesa County. It is restricted to shale barrens of the Green River Formation. The site also supports a fair occurrence of the globally vulnerable narrowleaf cottonwood/skunkbrush montane riparian forest and a good occurrence of balsam poplar montane riparian woodland community. Balsam poplar has a limited distribution in Colorado and is somewhat restricted to the north-central regions of the state (Harrington 1954). Colorado may be the southern limit of the range of balsam poplar (USDA PLANTS). The balsam poplar plant association is a minor type in Colorado and rarely forms stands larger than a few hundred yards long.

Boundary Justification: The boundary encompasses the locations of Piceance bladderpod, and takes in the suitable habitat from the ridge top to the bottom of the Green River Formation on southwest slopes. It also includes the riparian zone of Corral Canyon, and the adjacent uplands, which overlap with the Piceance bladderpod habitat. The narrow riparian area, surrounding slopes, and all of the upstream drainages and springs are essential to ensure that hydrological sources and the ability of the creek's fluvial processes to continue flooding, scouring, and sediment deposition are protected. These processes are necessary for the viability of the riparian elements and maintenance of ecological functions such as a dynamic distribution of aquatic and terrestrial habitat and nutrient cycling.

Protection Rank Comments:. The PCA contains both private and BLM land managed by the Grand Junction Resource Area. There is no special protective status. However, any new oil or gas development would require an Environmental Assessment, at which time the presence of the Piceance bladderpod would be addressed, and efforts made to avoid direct disturbance to the plants. There is no protection for the plants that may occur on private land within the PCA.

Management Rank Comments: No management needs for the rare plants that grow on the dry shale slopes are known. Steepness and lack of forage tend to discourage cattle from using these areas. However, improper grazing may degrade the riparian vegetation. Heavy grazing is occurring near the springs. Dense vegetation has precluded heavy livestock activity in portions of the step/pool complex, however in areas where there is little shrub or tree cover, excessive erosion is occurring from heavy hoof action disrupting the soil surface on steep slopes. Beneficial management actions would include fencing out the spring from cattle. If gas wells are developed in the canyon bottom, consideration should be given to directional drilling to minimize direct impacts to riparian vegetation.

Soils Description: Soils along the creek bottoms are mapped Torriorthents. These soils formed on colluvial slopes below the steep cliff faces along this drainage. The soils are mostly well drained and vary from loamy to clayey with variable amounts of gravel, cobbles, and stones (Soil Conservation Service 1985). Soils along the step/pool complex, where balsam poplar was found, have more organic matter within the soil profile due to semi-permanent saturation. This is especially evident around and in the small pools.

Restoration Potential: Dense vegetation has precluded heavy livestock activity in portions of the step/pool complex, however in areas where there is little shrub or tree cover, excessive erosion is occurring from heavy hoof action disrupting the soil surface on steep slopes. Beneficial management actions would include fencing this area to allow plant growth to recover in those areas where erosion is occurring.

Wetland Functional Assessment for the East Salt Creek Headwaters PCA:
Proposed HGM Class: Riverine   Subclass: R3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus angustifolia/Rhus trilobata*

Table 9. Wetland functional assessment for the riverine wetland at the East Salt Creek Headwaters site (within Corral Canyon). Functions in **BOLD** are those functioning below normal.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland appears to be functioning slightly below normal potential as current grazing activity is affecting the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The riparian areas are fairly narrow and incised which limits the ability of flood waters to spread out.
Sediment/Shoreline Stabilization	Moderate	Although, there is a high density of trees and shrubs, there is little herbaceous understory present, especially along the stream bank, limiting bank stabilization.
Groundwater Discharge/ Recharge	High	This stream appears to be a losing stream, indicating that upstream groundwater discharge from seeps and springs and surface water drainage recharge local aquifers.
Dynamic Surface Water Storage	N/A	This wetland floods via overbank flow.
Biogeochemical Functions		
Elemental Cycling	Moderate	The presence of aerated water (the stream) and small areas of saturated soil provide a gradient for various nutrient transformations. However, the lack of a herbaceous understory (due to excessive grazing) may be disrupting nutrient cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of sediment from eroding streambanks is likely moderate given the incised nature of the stream. However, removal of excess nutrients (e.g. from upstream livestock activity) is likely occurring in the stream sediments.
Biological Functions		
Habitat Diversity	Moderate	Basically a scrub-shrub and forested wetland exist in this area.
General Wildlife Habitat	Moderate	This area provides browse for ungulates and cover, nesting habitat, and food for birds.
General Fish/Aquatic Habitat	Moderate	Not sure if any fish populations exists in the creek within Corral Canyon. Since this is a losing stream may be unlikely. Probability is higher for actual East Salt Creek reach.
Production Export/Food Chain Support	Moderate	A permanent water source and allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. The lack of diversity of structural vegetation classes (e.g. herbaceous layer is minimal) limits the variety of habitats for invertebrate populations.
Uniqueness	Moderate	The wetland supports a globally vulnerable plant community.

Wetland Functional Assessment for the East Salt Creek Headwaters PCA:
Proposed HGM Class: Slope Subclass: S3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus balsamifera* and spring wetland.

Table 10. Wetland functional assessment for the slope wetland at the East Salt Creek Headwaters site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	The wetland is functioning at its potential.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	High	There is an extensive springbrook associated with this wetland which is heavily vegetated and periodically interrupted by small depression.
Groundwater Discharge/ Recharge	High	Discharge is occurring at the spring sources.
Dynamic Surface Water Storage	High	Groundwater water storage is high due to the buildup of organic soil horizons (which have formed from permanent groundwater discharge) and the numerous small depressions along the step/pool complex. These soils restrict water movement through these areas and provides storage of discharging groundwater.
Biogeochemical Functions		
Elemental Cycling	High	Saturated soils and a large carbon source maintain vital nutrient cycling processes.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	There is little potential for these areas to remove sediments/ nutrients/toxicants as there are no upstream sources of these excess inputs as the spring source occurs at the base of a large cliff. However, local inputs from cattle could be retained in the small depressional areas.
Biological Functions		
Habitat Diversity	High	Emergent wetlands, scrub-shrub, forested, and open water wetlands occur in the area.
General Wildlife Habitat	High	These areas provide a permanent source of water in an otherwise arid landscape, thus many species use these areas for water and forage. Many birds, small mammals, signs of bear and elk, and numerous butterfly species were observed near the spring.
General Fish/Aquatic Habitat	Low	Although the spring has an extensive spring-brook, it did not appear able to support fish populations, possibly due to the very steep nature of the step/pool complex.
Production Export/Food Chain Support	High	Permanent discharge of groundwater and subsequent organic matter accumulation produces dissolved organic carbon sources, and likely very little in the way of particulate organic carbon, that eventually make their way into East Salt Creek. Moist soil and permanent flowing water help support insect populations.
Uniqueness	Moderate	The wetland supports a rare plant community in Colorado.

Figure 11. East Salt Creek Headwaters PCA.

4A Ridge Potential Conservation Area

Biodiversity Rank: B2 Very High Significance. The site supports an excellent occurrence of a globally imperiled plant.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Approximately thirty miles north of Grand Junction, Colorado. Seven miles south of the Rio Blanco county line and 27 miles east of the Utah border.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Henderson Ridge, Desert Gulch, Brushy Point, Razorback Ridge, Calf Canyon. T4S R100W S32; T5S R99W S19,20,28-34; T5S R100W S3-5, 9-15, 24-27, 34-36; T6S R99W S18, 19; T6S R100W S1-17, 21-24

Size: 16,907 acres

Elevation: 6,400 to 8,700 feet

General Description: The 4A Ridge PCA occupies the top and steep shale slopes of 4A Ridge, Horse Ridge, Henderson Ridge, Brush Mountain, and Bear Point, along with the riparian area of the Left Fork of Carr Creek. The site contains a mosaic of several habitats that form a repeating pattern throughout the Roan Plateau. South facing slopes with barren scree of the Green River formation support several rare plants that are endemic to this habitat. North facing slopes, while geologically similar, retain more moisture and support heavier vegetation. The riparian complex includes the stream in the valley bottoms and tributary drainages that often begin at springs. The steep south facing slopes are essentially barren, but in some places support a sparse cover of mountain shrubs, grasses and forbs, and scattered Douglas fir (*Pseudotsuga menziesii*) and Engelmann spruce (*Picea engelmannii*). Associated plant species in this habitat include Gambel's oak (*Quercus gambelii*), rock spirea (*Holodiscus dumosus*), mat penstemon (*Penstemon caespitosus*), pincushion (*Chaenactis douglasii*), Utah serviceberry (*Amelanchier utahensis*), snowberry (*Symphoricarpos rotundifolius*), Indian rice grass (*Oryzopsis hymenoides*) and Colorado bedstraw (*Galium coloradense*). Utah fescue (*Argillochloa dasyclada*) was found on the less steep areas (17% slopes), while the sun-loving meadowrue (*Thalictrum heliophilum*) and Piceance bladderpod (*Lesquerella parviflora*) were located on the very steep (44%) slopes.

Brush Mountain is a northwest-southeast trending ridge between Carr Creek on the southwest and Brush Creek on the northeast. A dirt road runs along the top of the ridge through a sagebrush-snowberry shrubland which is grazed by cattle and has several stock ponds. The habitat for three rare plants is found along the upper part of the cliffs on the southeast side of the ridge, on steep barren shale slopes of the Green River formation. This part of the mountain is too steep for cattle, and is undisturbed except for natural erosion. The sparse vegetation on the shale slopes includes scattered Douglas fir, Cainville thistle (C*irsium calcareum*), mat penstemon, Colorado bedstraw, rock spirea, Oregon grape (*Mahonia repens*), and snowberry.

Several springs emerge at the top of unnamed side-drainages. These springs, many of which have been developed for livestock use, eventually drain into Bear Gulch and Left Fork Carr Creek. The hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*) occupies crevices of several of these calcareous seeps. Oil shale columbine (*Aquilegia barnebyi)* was associated with the sullivantia at some of these seeps. Below Bear Point, a tributary of Carr Creek enters a narrow canyon, with seeping vertical walls and ledges of thin layered shale that support a luxurious growth of the globally vulnerable hanging garden sullivantia (*Sullivantia hapemannii* var. *purpusii*). The moist canyon bottom has a diverse assemblage of plants, including chiming bells (*Mertensia ciliata*), Colorado columbine (*Aquilegia coerulea*), sweet cicely (*Osmorhiza depauperata*), butterweed groundsel (*Senecio serra*), whitestem gooseberry (*Ribes inerme*), baneberry (*Actaea rubra*), little ricegrass (*Oryzopsis micrantha*), smallwing sedge (*Carex microptera*), willow herb (*Epilobium hornemannii*), and stinging nettles (*Urtica gracilis*), along with a rich assortment of liverworts and mosses. The cool, north-facing hillside above the stream is forested with Douglas fir and subalpine fir, while the south facing slope is sparsely vegetated shale of the Green River formation. Piceance bladderpod (*Lesquerella parviflora*) and sun-loving meadowrue (*Thalictrum heliophilum*) are found on the steep, dry, south-facing slopes. These hillsides have scattered Douglas fir, and a plant species composition that is typical of the shale slopes in the area, including rock spirea, Colorado bedstraw, and Indian rice grass.

The site contains the narrow riparian area of Left Fork Carr Creek, which flows within a wide valley. The riparian area is dense with narrowleaf cottonwood (*Populus angustifolia*), Douglas fir, skunkbrush (*Rhus trilobata*), chokecherry (*Prunus virginiana*), and hawthorn (*Crataegus rivularis*). Understory species include Oregon grape (*Mahonia repens*) and sweet cicely (*Osmorhiza depauperata*). Hydrological processes are mostly intact but development of springs has likely increased erosion, altered plant species composition, and altered flow along the springbrooks.

Table 11. Natural Heritage element occurrences at the 4A Ridge PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Lesquerella parviflora	**Piceance bladderpod**	**G2G3**	**S2S3**			**BLM**	**A**
Lesquerella parviflora	Piceance bladderpod	G2G3	S2S3			BLM	B
Lesquerella parviflora	Piceance bladderpod	G2G3	S2S3			BLM	B
Lesquerella parviflora	Piceance bladderpod	G2G3	S2S3			BLM	B
Lesquerella parviflora	Piceance bladderpod	G2G3	S2S3			BLM	C
Nuttallia argillosa	Arapien stickleaf	G3	S3			BLM	B
Thalictrum heliophilum	Sun loving meadowrue	G3	S3				A
Thalictrum heliophilum	Sun loving meadowrue	G3	S3				A
Thalictrum heliophilum	Sun loving meadowrue	G3	S3				B
Thalictrum heliophilum	Sun loving meadowrue	G3	S3				B
Thalictrum heliophilum	Sun loving meadowrue	G3	S3				B
Argillochloa dasyclada	Utah fescue	G3	S3				C
Argillochloa dasyclada	Utah fescue	G3	S3				E
Sullivantia hapemannii ssp. purpusii	Hanging garden sullivantia	G3T3	S3				E
Sullivantia hapemanii var. *purpusii*	Hanging garden sullivantia	G3T3	S3				E
Sullivantia hapemanii var. *purpusii*	Hanging garden sullivantia	G3T3	S3				E
Plant Communities							
Populus angustifolia/Rhus trilobata	Narrowleaf cottonwood/skunk brush riparian forest	G3	S3				A

*EO Rank is "Element Occurrence" Rank

Biodiversity comments: This PCA supports seventeen occurrences of five rare plant species, including one excellent (A ranked) and three good (B ranked) occurrences of Piceance bladderpod, a globally imperiled (G2S2) plant. Three other plants that are endemic to the Green River shale, Arapien stickleaf, sun loving meadowrue and Utah fescue, are found on the steep shale slopes in the site. Hanging garden sullivantia occupies at least four seeps that feed the headwaters of Carr Creek.

The Piceance bladderpod occurrences consisted of over 4,000 estimated individuals. Piceance Bladderpod is a Colorado endemic known only from Garfield and Rio Blanco counties, and one location in Mesa County. It is restricted to shale barrens of the Green River Formation. Arapien stickleaf is known from two distinct and widely separated regions: central Utah and west-central Colorado. Its range is only about 30 square miles in Colorado (NatureServe 2000), where it may be locally common. The 21 documented occurrences in Colorado all are found on Green River shale on the Roan Plateau in Garfield County. The sun-loving meadowrue grows on sparsely vegetated, steep shale talus slopes of the Green River Formation. It is restricted to Colorado, in Garfield, Mesa and Rio Blanco counties, with 36 known occurrences and approximately 130,000 individuals. Utah fescue is restricted to Colorado and Utah. Of the 85 occurrences known in Colorado, 37 are in Garfield County, 57 in Rio Blanco County, and one in Mesa County. Hanging garden sullivantia grows on moist cliff faces (hanging gardens). The species is endemic to Colorado, in Garfield, Gunnison, Montrose, Pitkin, and Rio Blanco counties, where there are 45 documented occurrences and approximately 40,000 individuals (NatureServe 2000). This site also harbors one of the best occurrences (A-ranked) of the globally vulnerable narrowleaf cottonwood/skunkbrush riparian forest that was observed in Garfield County. There are relatively few disturbances to this occurrence and although narrow in width, it is almost 2 continuous miles in length.

Boundary Justification: The boundary is drawn to include the area that supports the long-term survival of the rare plants that occur on the steep shale slopes of 4A Ridge and Henderson Ridge. Apparently unoccupied but similar habitat between the occurrences is included to allow for movement or expansion of the populations over time as landslides open up new sites, and existing sites become more heavily vegetated. The site boundaries also include the Left Fork of Carr Creek. The area important to maintain this high quality riparian area encompasses the springs and small side drainages on the adjacent slopes, and overlaps the habitat of the rare shale endemic plants. This upland area, encompassing a major part of the hydrological input to the creek, is critical to the natural hydrological processes, such as periodic flooding and subsequent dynamic changes in plant community distribution, which are vital to the viability of this riparian system.

Protection Rank Comments: This PCA is located on both BLM and private lands. No threats to the rare plants were noted during the survey. However, future activities such as oil shale or natural gas extraction could impact the plants. Development on BLM lands would require an Environmental Analysis (EA), at which time presence of BLM sensitive species including Piceance bladderpod and Arapien stickleaf would be addressed. Development is restricted by no surface occupancy (NSO) stipulations on steep slopes of over 40%, which would apply to many of the rare plant sites. Modifications to locations of proposed developments can often be made to protect rare plant locations. The private land has no such protection. BLM's long range plans include a public access road in Corral Canyon (USDI 1987), although this does not appear to be imminent. An Environmental Assessment would be required, and should take into account the locations of the riparian plant community and the hanging garden sullivantia.

Management Rank Comments: The rare plant locations in this PCA are probably too steep for cattle, and therefore not subject to grazing impacts. Few exotic species are adapted to the rare plant habitat, and none were observed. No current management needs are known.

There is a road that traverses its way up Left Fork Carr Creek on the adjacent hillside. No impacts from this road were observed in the riparian area. Potential erosion and spread of non-native species should be monitored along this road corridor. Developed springs have greatly altered the composition and structure of wetland vegetation near these areas. The density and frequency at which cattle use the springs has caused excessive erosion to these areas. Restoration of these springs should be considered.

An undocumented report (Lambeth, pers. comm.) of Colorado River cutthroat trout in pools in the upper reaches of Left Fork Carr Creek should be investigated, and if high purity trout are found, measures to protect the cutthroat from contamination by downstream brook trout should be considered.

Soils Description: The hanging garden occurs on a rock outcrop (shale) while the moist bottomland areas are mapped as the Tosca series. Tosca soils are loamy-skeletal, mixed, frigid, Typic Calciborolls (Soil Conservation Service 1985).

Restoration Potential: Removing stock ponds and other manipulations to the springs would reestablish historical flow from the springs and thus would restore natural hydrologic processes.

Wetland Functional Assessment for the PCA: Manipulation of springs and excessive grazing near these areas has altered hydrological flow, increased erosion and disrupt nutrient cycles by disrupting the soil surface via hoof action, which might increase erosion and the rate of certain nutrient transformations in the soil. The riparian area provides important habitat for numerous birds, mammals, and insects. Production export/food chain support is likely not functioning to capacity in the seep areas, but is likely functioning well in the riparian areas.

Figure 12. 4A Ridge PCA.

No Name Creek Potential Conservation Area

Biodiversity Rank: B2 Very High significance. This site supports a good occurrence of a state rare plant community.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: The site is located approximately 1 mile northeast of Glenwood Springs, CO, within the White River National Forest.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Glenwood Springs and Carbonate. T4S R88W Sections 29, 31, and 32; T4S R89W Sections 33-36; T5S R88W Sections 5-8, 17-20, and 29-32; T5S R89W Sections 1-3, 11, and 12; T6S R89W Section 2.

Size: 7,851 acres

Elevation: 6,000 to 10,700 feet.

General Description: This is a very large site that encompasses the entire watershed for No Name Creek, which is used by the City of Glenwood Springs for their city water supply. The lower reach of the creek is dominated by a dense and diverse overstory of trees and shrubs including narrowleaf cottonwood (*Populus angustifolia*), Douglas fir (*Pseudotsuga menziesii*), river birch (*Betula occidentalis*), red-osier dogwood (*Cornus sericea*), black twinberry (*Lonicera involucrata*), Rocky Mountain maple (*Acer glabrum*), and thimbleberry (*Rubus parviflorum*). Upland slopes along the lower reach are very steep and mainly covered with scattered Douglas fir. A globally imperiled community consisting of aspen (*Populus tremuloides*) and sticky-laurel (*Ceanothus velutinus*) is found near the top of the ridge on the east facing slopes. Non-native species such as orchard grass (*Dactylis glomerata*) and Kentucky bluegrass (*Poa pratensis*) are fairly abundant in this area. Upstream, above the narrow limestone canyon (approx. 6 miles), the vegetation changes to a riparian system more typical of subalpine environments. These subalpine areas have gentler upland slopes dominated by Engelmann spruce (*Picea engelmannii*) and aspen (*Populus tremuloides*). The riparian areas are dominated by Drummond's willow (*Salix drummondiana*), planeleaf willow (*S. planifolia*), and a variety of herbaceous species. About 3 miles upstream from the mouth of No Name Creek, an aqueduct dumps water, from nearby Grizzly Creek to the east, into No Name Creek to supplement Glenwood Springs' city water supply.

Table 12. Natural Heritage element occurrences at the No Name Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Populus tremuloides/Ceanothus velutinus	**Aspen forests**	**G2G3**	**S2S3**				**B**
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood riparian forest	G4	S3				B
Salix drummondiana/ Mesic forb	Drummond's willow deciduous alluvial shrubland	G4	S4				B
Salix drummondiana/ Mesic forb	Drummond's willow deciduous alluvial shrubland	G4	S4				B
Plants							
Sullivantia hapemanii var. *purpusii*	Hanging garden sullivantia	G3T3	S3			FS	D

*EO = Element Occurrence

Biodiversity Comments: This site supports one good (B-ranked) occurrence of the globally imperiled (G2G3/S2S3) aspen/sticky-laurel forest, one good occurrence of the state rare (G4/S3) narrowleaf cottonwood/red-osier dogwood (*Populus angustifolia*/*Cornus sericea*) riparian forest and two good (B-ranked) occurrences of the common (G4/S4) Drummond's willow/mesic forb (*Salix drummondiana*/mesic forb) deciduous alluvial shrubland. There is also a poor (D-ranked) occurrence of the hanging garden sullivantia.

Boundary Justification: The boundary encompasses the entire No Name Creek watershed and thus, ensures continued hydrological flow and allows natural fluvial processes to dynamically maintain the riparian plant communities found at this site.

Protection Rank Comments: The site is managed by the White River National Forest. The site is currently managed for the City of Glenwood Springs' water supply.

Management Rank Comments: There is heavy recreation along the lower reach of the creek, where hiking and horseback riding are prevalent. Non-native species are abundant in this area due to these activities. Upstream, recreational use such as hunting and camping occurs.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Control and eradication of non-native species within the lower reach and minimizing encroachment of recreational trails into adjacent riparian habitat would benefit the site.

Wetland Functional Assessment for the PCA: This site contains a long and extensive riparian area with a high cover of woody vegetation plus numerous subalpine meadows and ponds, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The diversity of habitats, including scrub-shrub, forested, and emergent wetlands, provide excellent habitat for avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris and thus excellent fish habitat.

Figure 13. No Name Creek PCA.

Parachute Creek Potential Conservation Area

Biodiversity Rank: B2 Very High Significance. This PCA contains an excellent occurrence of a globally imperiled plant community.

Protection Urgency Rank: P2 High Urgency. This PCA is nearly all private land and the area is currently threatened by oil shale and gas development, haying operations and intense grazing along Parachute Creek.

Management Urgency Rank: M2 High Urgency. Current grazing intensity is degrading some community and plant element occurrences.

Location: This PCA is located 3 miles northwest of Parachute, Colorado.

Legal description: U.S.G.S. 7.5 minute quadrangles: Grand Valley, Red Pinnacle, Forked Gulch, Circle Dot Gulch, McCarthy Gulch and Cutoff Gulch. T5S R95W, S15-22, 25-31; T5S R96W, S10-15, 21-27, 35, 36; T6S R95W, S18, 19, 30; T6S R96W, S3-5, 7-10, 12-29, 32-36.

Size: 19,185 acres

Elevation: 5,305 to 8,415 feet

General Description: This PCA contains parts of the Parachute Creek drainage, a drainage that is roughly 144,000 acres in size. The PCA contains the riparian areas of Parachute Creek, side-drainages, and surrounding cliff tops of the Roan Plateau. Tributaries lying within the PCA include the East, West, and Middle Forks of Parachute Creek and Garden, Hayes and Wheeler Gulches. Each tributary makes a dramatic plunge off the Roan Plateau over 100 to 200 foot shale cliffs. Parachute Creek and its tributaries cut through sedimentary rocks of the Tertiary period leaving a geologic timeline exposed from cliff top to valley bottom. Going from top to bottom found exposed are the lower part and Parachute Creek member of the Green River formation; Wasatch formation claystone, mudstone and sandstone; and finally there are unconsolidated gravel and alluvial deposits of the Quaternary period along Parachute Creek. The gradient remains fairly steep after falling off the plateau, forming a pool-drop creek system with steep south and north-facing slopes.

Sagebrush (*Artemisia tridentata*), serviceberry (*Amelanchier utahensis*), and mountain spray (*Holodiscus dumosus*) dominate the south-facing slopes, while Douglas fir/spruce-fir forests (*Pseudotsuga menziesii/Picea* spp.) dominate the north-facing slopes. There is lush riparian vegetation in the box canyons where narrowleaf cottonwood (*Populus angustifolia*), box elder (*Acer negundo*), chokecherry (*Prunus virginiana*), skunkbrush (*Rhus trilobata*), and red-osier dogwood (*Cornus sericea*) are common. The gentle slopes dropping off the Roan Plateau support high quality grasslands and sagebrush shrublands.

Two old mining sites, one on Exxon, one on UNOCAL land, have left large scars easily visible on aerial photographs. Neither of these sites appears to be recoverable, although the site on East Fork Parachute Creek has been reseeded with exotic grasses. Portions of West Fork Parachute Creek, near the confluence of Parachute Creek are used as hay meadows and for cattle grazing. The East and Middle Fork tributaries are not grazed in the canyon sections of the creeks.

The high quality riparian habitats support four rare riparian plant communities including cottonwood forests (*Populus angustifolia/Rhus trilobata*, *Populus angustifolia/ Cornus sericea*), foothills riparian shrubland (*Cornus sericea*), and montane riparian deciduous forest (*Acer negundo-Prunus virginiana*). The riparian habitats and associated creeks also support four rare animal species including the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), Great Basin spadefoot (*Spea intermontana*), western yellowbelly racer (*Coluber constrictor mormon*) and midget faded rattlesnake (*Crotalus viridus concolor*). A rare hanging garden community dominated by Mancos columbine (*Aquilegia micrantha*), hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*), and monkeyflower (*Mimulus* sp.) occurs at East Middle Fork Falls. At higher elevations the south-facing slopes of the shale exposures provide important habitat for four rare plant species including Arapien Stickleaf (*Nuttallia argillosa*), Utah Fescue (*Argillochloa dasyclada*), Sun-Loving Meadowrue (*Thalictrum heliophilum*) and Utah Mountain Lilac (*Ceanothus martinii*).

Table 13. Natural Heritage elements at the Parachute Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sens	EO* Rank
Plant Communities							
Acer negundo-Prunus virginiana	Montane Riparian Deciduous Forest	G3	S2				B
Acer negundo-Prunus virginiana	Montane Riparian Deciduous Forest	G3	S2				B
Acer negundo-Prunus virginiana	Montane Riparian Deciduous Forest	G3	S2				B
Populus angustifolia/Rhus trilobata	Narrowleaf Cottonwood/Skunkbrush	G3	S3				B
Populus angustifolia/Rhus trilobata	Narrowleaf Cottonwood/Skunkbrush	G3	S3				B
Populus angustifolia/Rhus trilobata	Narrowleaf Cottonwood/Skunkbrush	G3	S3				C
Cornus sericea	Foothills Riparian Shrubland	G4	S3				A
Populus angustifolia/ Cornus sericea	Cottonwood Riparian Forest	G4	S3				A
Populus angustifolia/ Cornus sericea	Cottonwood Riparian Forest	G4	S3				B
Pinus edulis/Cercocarpus montanus	Mesic Western Slope Pinyon-Juniper Woodlands	G5	S4				E
Pseudotsuga menziesii/Symphoricarpos oreophilus	Western Slope Douglas Fir Forests	G5	S4				E
Pseudotsuga	Western Slope Douglas	G5	S4				E

menziesii/Symphoricarpos oreophilus	Fir Forests						
Plants							
Nuttallia argillosa	**Arapien Stickleaf**	**G3**	**S2**			**BLM**	**A**
Nuttallia argillosa	**Arapien Stickleaf**	**G3**	**S2**			**BLM**	**A**
Nuttallia argillosa	**Arapien Stickleaf**	**G3**	**S2**			**BLM**	**A**
Nuttallia argillosa	**Arapien Stickleaf**	**G3**	**S2**			**BLM**	**A**
Nuttallia argillosa	**Arapien Stickleaf**	**G3**	**S2**			**BLM**	**A**
Nuttallia argillosa	**Arapien Stickleaf**	**G3**	**S2**			**BLM**	**A**
Nuttallia argillosa	Arapien Stickleaf	G3	S2			BLM	B
Nuttallia argillosa	Arapien Stickleaf	G3	S2			BLM	E
Argillochloa dasyclada	Utah Fescue	G3	S3				A
Argillochloa dasyclada	Utah Fescue	G3	S3				B
Argillochloa dasyclada	Utah Fescue	G3	S3				B
Argillochloa dasyclada	Utah Fescue	G3	S3				C
Argillochloa dasyclada	Utah Fescue	G3	S3				C
Argillochloa dasyclada	Utah Fescue	G3	S3				E
Argillochloa dasyclada	Utah Fescue	G3	S3				E
Argillochloa dasyclada	Utah Fescue	G3	S3				E
Argillochloa dasyclada	Utah Fescue	G3	S3				E
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				A
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				A
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				A
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				B
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3				C
Sullivantia hapemanii var purpusii	Hanging-Garden Sullivantia	G3T3	S3			FS	A
Ceanothus martinii	Utah Mountain Lilac	G4	S1				C
Fish							
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T3	S3		SC	BLM	H
Amphibians							
Spea intermontana	Great Basin spadefoot	G5	S3		SC	BLM	H
Reptiles							
Crotalus viridis concolor	Midget faded rattlesnake	G5T4	S3?		SC	BLM	H
Coluber constrictor mormon	Western yellowbelly racer	G5T5	S3				H

*EO=Element Occurrence

Biodiversity Comments: The high quality and undisturbed nature of the plant communities at this PCA are unique, and the area supports a diverse assemblage of rare plant communities. There are numerous occurrences of globally vulnerable (G3S3) plant species, Arapien stickleaf, sun-loving meadowrue, and Utah fescue, all of which are oil-shale endemic species. The PCA also supports upland and riparian plant communities such as the globally vulnerable box elder/chokecherry montane riparian deciduous forest, and narrowleaf cottonwood/skunkbrush riparian forest.

This site contains eight occurrences of Arapien stickleaf, of which six are ranked excellent (A ranked). Arapien stickleaf is restricted to two distinct and widely separated regions: central Utah and west-central Colorado. Its range is only about 30 square miles in Colorado (NatureServe 2000), where it may be locally common. The 21 documented occurrences in Colorado all are found on Green River shale on the Roan Plateau in Garfield County. Hanging garden sullivantia is endemic to Colorado, in Garfield, Gunnison, Montrose, Pitkin, and Rio Blanco counties, where there are 45 documented occurrences and approximately 40,000 individuals (NatureServe 2000). Thirteen occurrences of Utah fescue are known from this PCA, including one ranked excellent (A), and four ranked good (B). Altogether, there are only fifty five documented occurrences of the species in the world, with approximately 23,000 individuals estimated (NatureServe 2000). The grass is restricted to Colorado and Utah. In Colorado, 54 of the 55 occurrences are in Garfield and Rio Blanco counties. The site contains twelve occurrences of the globally vulnerable (G3S3) sun loving meadowrue, including three ranked excellent (A). The sun-loving meadowrue grows on sparsely vegetated, steep shale talus slopes of the Green River Formation. It is restricted to Colorado, in Garfield, Mesa and Rio Blanco counties, with 36 known occurrences and approximately 130,000 individuals. Utah mountain lilac occurs from eastern Nevada to southwest Wyoming, south to northwest Arizona and east to Colorado. It is known from five locations in Colorado, in Garfield and Rio Blanco counties. The Garfield County populations represent the eastern extent of its range, giving them added importance for genetic diversity.

Cutthroat trout are a sensitive species that are native to the Colorado River basin, and have recently been in decline. A population of cutthroat was reported from Parachute Creek in the early 1980s, however, brook trout were also present at a ratio of 20 to 1, brook trout to cutthroat trout. The cutthroat trout occupying Parachute Creek have a high probably of being replaced by the brook trout. The Great Basin spadefoot, as its name implies, is endemic to the Great Basin. There is a historical record of this amphibian from 1972 at this PCA; however, attempts to relocate this population were unsuccessful. This species is considered vulnerable (S3) because of its small range in Colorado and the limited number of occurrences. An adult midget faded rattlesnake was observed here in 1973, but could not be documented during this survey. There are approximately 40 localities of the midget faded rattlesnake documented from Colorado (Hammerson 1999), and many individual populations are highly threatened from human encroachment warranting a vulnerable ranking for this subspecies in Colorado. The subspecies of the racer (*Coluber constrictor*) is known from counties along Colorado's western edge (Livo et al. 1996, Hammerson 1999) including a record from this PCA in Garfield County in 1973. There are 30 known occurrences in Colorado totaling over 1000 individuals. Conservation concern stems from threats associated with road mortality and human residential expansion.

Boundary Justification: The site boundaries for Parachute Creek include most of the creek’s watershed, including upland slopes and the major tributaries: West Fork, Middle Fork, East Middle Fork, and East Fork. These boundaries will ensure continued natural surface flow and maintain a natural hydroperiod through Parachute Creek, which will maintain a dynamic distribution of riparian plant communities along the drainage and support fish populations. These boundaries also include all rare plant occurrences on the shale barrens, with a buffer to protect the occurrences from indirect and direct disturbances. The long-term integrity of the upland plant communities are also encouraged by the site boundaries by allowing natural disturbances, such as fire and insects, to maintain the mosaic of communities found within this PCA.

Protection Rank Comments: Most of this PCA is private land that has no protection status. Oil shale and gas development, haying operations and intense grazing along Parachute Creek currently threaten the area. Mining oil shale at present is not economical due to high production costs. This area has the highest gas well density in the world and the Colorado Oil and Gas Conservation Commission on October 31, 2000, gave approval to increase well density to 32-wells per square mile on 1,900 acres of private land within this PCA. Element occurrences falling within the affected area include the midget faded rattlesnake, Great Basin spadefoot, Arapien stickleaf, Utah fescue, and two natural communities. None of these elements has any legal protection on private land.

Management Comment: A management plan regulating grazing intensity and fencing element occurrences where cattle can easily walk would reduce impacts from grazing which have the potential to destroy the element occurrences. Weeds are becoming problematic in some limited areas and recovery of native grasses and forbs would benefit continued existence of both the rare flora and fauna of the PCA. Implementation of a monitoring program for the rare plants and plant communities would assist in identifying how grazing might affect long-term viability of the occurrences. Monitoring of the rare animals would assist in identifying population trends for species that lack good trend data.

Soils Description: The hanging gardens occur on rock outcrops (shale) while the moist bottomland areas are mapped as Nihill and Torriorfluvents. The Nihill series formed in calcareous alluvium and generally occur on alluvial fans and valley sides. The Nihill series is classified as a loamy-skeletal, mixed (calcareous) Ustic Torriorthents. These soils are often mildly to moderately alkaline and are generally found in the upper reaches of Parachute Creek and its tributaries. Torriorfluvents formed in alluvium, are stratified, and vary widely in texture (Soil Conservation Service 1985).

Restoration Potential: The current land use patterns allow for overuse of this site by livestock. The primary concerns from such activity are uncontrolled non-native species invasions and increased erosion and downcutting of the stream banks. Grazing practices should be minimized or a reasonable method of grazing, such as fencing off much of the riparian areas, implemented in order to improve the health of the riparian vegetation and hence the riparian ecosystem.

Wetland Functional Assessment for the PCA: This site contains a long but narrow riparian area with fairly high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The diversity of habitats, including numerous springs with permanent groundwater discharge in an otherwise arid landscape, provide excellent habitat for avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris for a dense population of trout and give this area a high capability of exporting carbon and other nutrients to downstream ecosystems.

Figure 14. Parachute Creek PCA.

Rifle Stretch Colorado River Potential Conservation Area

Biodiversity Rank: B2 Very High Significance. This site supports a fair occurrence of a globally imperiled plant community and an unranked occurrence of a fish species that is critically imperiled on a global scale.

Protection Urgency Rank: P2 High Urgency. A definable threat is expected in this PCA within the next five years.

Management Urgency Rank: M2 High Urgency. Ongoing, recurrent management action would help to prevent loss of the element occurrences.

Location: This PCA stretches along the Colorado River between Silt, Colorado and DeBeque Canyon

Legal description: U.S.G.S. 7.5 minute quadrangles: North Mamm Peak, Rulison, Silt, Rifle, DeBeque Canyon, Grand Valley, Red Pinnacle and Anvil Points. T6S R92W, S7-11, 15; T6S R93W, S10-20; T6S R94W, S13, 14, 22-24, 26-31, 33, 34; T6S R95W, S25, 33-36; T7S R95W, S2-8, 18; T7S R96W, S12-14, 23, 24, 26, 27, 32-34; T8S R96W, S4-7, 18; T8S R97W, S12-14, 22-24, 26-28, 32-34; T9S R97W, S4, 5, 8, 9, 17.

Size: 12,100 acres

Elevation: 4,928 feet to 5,689 feet

General Description: The Colorado River winds through the center of this long narrow site that starts at Silt, Colorado and ends at the head of DeBeque Canyon. The river here flows down a wide valley dropping at a very low grade for approximately 40 miles from the north to the south boundaries of the site. The PCA is bordered on the north by the Grand Hogback and further downstream, by the steep sandstone cliffs of the Roan Plateau. The southern boundary mainly consists of a series of low elevation mesas, such as Hunter, Grass, Flatiron, Holms, Morrisania, and High Mesas while Battlement Mesa looms further south. The area historically contained numerous wetlands and extensive riparian forests, but the I-70 corridor, Rio Grande-Southern Pacific Railroad, and agriculture practices have modified and/or destroyed many of these areas. Irrigated pastures are interspersed along the river's floodplain with cottonwood galleries composed of narrowleaf cottonwood (*Populus angustifolia*), Rio Grande cottonwood (*Populus deltoides* subsp. *wislizenii*), skunkbrush (*Rhus trilobata*), tamarisk (*Tamarix ramosissima*), and Russian olive (*Elaeagnus angustifolia*). Small patches of the rare Rio Grande cottonwood riparian forest (*Populus deltoides* ssp. *wislizenii/Rhus trilobata*) dot the islands and portions of the floodplain. Most of these patches are only in fair condition due to the influx of non-native shrubs such as tamarisk and Russian olive and improper grazing. There are also sporadic marshes dominated by cattail (*Typha* sp.) and hardstem bulrush (*Scirpus acutus*) and alkaline meadows dominated by Baltic rush (*Juncus balticus*), common threesquare (*Scirpus pungens*), and saltgrass (*Distichlis spicata*) throughout the floodplain.

Human habitation has left its mark on this PCA in the presence of numerous exotics including cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus japonicus*), quackgrass (*Elytrigia repens*), Kentucky bluegrass *(Poa pratensis*), tamarisk, Russian olive, and knapweed, to name only a few. In certain areas the shrub component has been reduced or completely eliminated as a result of grazing. In areas where the PCA extends upslope for short distances it captures small amounts of sagebrush shrubland and pinyon-juniper woodland.

This reach of the river from New Castle into Debeque Canyon supports populations of roundtail chub (*Gila robusta*), flannelmouth suckers (*Catostomas latipinnis*), and mountain whitefish (*Prosopium williamsoni*). In addition, a recovery program for razorback suckers (*Xyrauchen texanus*) stocked 3,498 fish upstream of Parachute, Colorado in 1999. A total of 29,377 juvenile and adult razorback suckers have been released into the Upper Colorado River near Parachute from October 1999 to November 2000; an additional 14,322 suckers have been released into the Gunnison River between April 1994 and November 2000 (Pfeifer and Burdick 2000). In 1999, 174 of these fish were recaptured during electroshocking surveys. Fish disbursement from stocking has been predominately downstream of release sites (Pfeifer Burdick 2000). There are also records of Bald Eagles attempting to nest here in the early 1980s and recent observations of feeding Peregrine Falcons (*Falco peregrinus anatum*) and Sandhill Cranes (*Grus canadensis tabida*). The cottonwood communities found within this PCA should support nesting Bald Eagles, and in time eagles should repopulate this PCA as populations continue to expand after the DDT induced declines of the 1970s and 80s. This is of course if the fishery can support them and if the current quality of the area is maintained or improved upon.

Table 14. Natural Heritage elements at the Rifle Stretch Colorado River site.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sens	EO* Rank
Fish							
Xyrauchen texanus	**Razorback sucker**	**G1**	**S1**	**LE**	**E**		**C**
Gila robusta	**Roundtail chub**	**G2G3**	**S2**		**SC**	**BLM**	**B**
Catostomus latipinnis	Flannelmouth sucker	G3G4	S3		SC	BLM	A
Prosopium williamsoni	Mountain whitefish	G5	S3				C
Plant Communities							
Populus deltoides ssp. *wislizenii/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2				C
Birds							
Haliaeetus leucocephalus	Bald Eagle	G4T?Q	S1B,S3N	LT	T		D
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S2B,SZN				D
Grus canadensis tabida	Greater Sandhill Crane	G5T4	S2B,S4N		SC	FS	C
Amphibians							
Spea intermontana	Great Basin spadefoot	G5	S3		SC	BLM	H
Rana pipiens	Northern leopard frog	G5	S3		SC	FS/BLM	B

*EO=Element Occurrence

Biodiversity Comments: This site supports a fair occurrence of the globally imperiled (G2S2) Rio Grande cottonwood/skunkbrush riparian forest. This association has only been documented from river floodplains of the lower Colorado, Yampa, and San Miguel rivers in extreme western Colorado (Keammerer 1974, Kittel and Lederer 1993). Nearly all the existing stands are considered to be in decline due to altered hydrology from upstream impoundments and the long-term effects of livestock grazing. Sexual regeneration is poor at all sites, and tamarisk is invading stands of this type on many of the aforementioned rivers.

The Colorado River has been stocked with razorback suckers along this stretch. Razorbacks are not abundant in the Colorado River and this population probably is not self-sustaining. Razorbacks are considered critically imperiled at the global (G1) and state levels (S1). Primary factors justifying the ranks include a greatly reduced range, very low number of breeding occurrences, and high threats as a result of current water and fisheries management, i.e. competition from and predation by, non-native game species (Behnke and Benson 1980). The razorback sucker is listed as endangered by the USFWS and Colorado Division of Wildlife. In Colorado, the roundtail chub is considered vulnerable at the global (G3) level and very vulnerable at the state (S2) level because of its restricted range and continued threats to its habitat. A reproducing population of roundtails occupies the Colorado River from approximately Rifle to Grand Junction. Flannelmouth suckers are found in the large rivers of western Colorado, though they have disappeared from some water systems like the Gunnison River above Blue Mesa, where they were displaced by white and longnose suckers (Woodling 1985). Mountain whitefish are known from relatively few occurrences in Colorado, on the western slope in the Yampa and White rivers, but are considered common in Lodore Canyon on the Green River (Kevin Bestgen, pers. Comm.). The mountain whitefish is considered vulnerable (S3) in Colorado because of its limited range and relatively few documented occurrences.

Currently there are approximately 20 breeding pairs of Bald Eagles in Colorado (Colorado Bird Observatory 1997). Although now in recovery, populations of Bald eagles declined during the 1980s because of high pesticide use, poisoning, and poaching (feathers are valuable on the black market. The bald eagle nests at this PCA have not been active since the1980s. Though there are more than 70 known Peregrine Falcon pairs breeding in Colorado, there are fewer than 300 individuals estimated as breeding in Colorado. The Peregrine Falcon record is of a feeding adult bird that was probably nesting somewhere in the cliffs nearby. Human disturbance of nests by recreational rock climbers, illegal capture by falconers, and uncertain breeding status across the state are factors considered important in the conservation of this imperiled species in Colorado.

Boundary Justification: The site boundary encompasses the mainstem of the Colorado River and its floodplain, including the adjacent highway and railroad, which are unavoidably parts of this site. The boundaries incorporate an area that will allow natural hydrological processes such as seasonal flooding, sediment deposition, and new channel formation to maintain viable populations of the elements. The boundaries also provide a small buffer from nearby agriculture fields, roads, and houses where surface runoff may contribute excess nutrients, sediment, and herbicides/pesticides. The site contains old oxbow lakes, sloughs, and ponds that could provide a source of recruitment for native wetland and riparian plant species. It should be noted that the hydrological processes necessary to the elements are not fully contained by the site boundaries. Given that the elements are dependent on natural hydrological processes associated with the Colorado River, any upstream activities such as water diversions, impoundments, and development could potentially be detrimental to the elements. This boundary indicates the minimum area that should be considered for any conservation management plan. The boundary is also drawn to include the canyon cliffsides that provide important nesting habitat for Peregrine Falcons.

Protection Rank Comments: Most of this PCA is privately owned except for a few patches of BLM land. The aesthetic qualities of the area may encourage increased development as populations expand in the Rifle area. Because the land along the Colorado River here is privately owned, realization of this threat is highly probable.

Management Rank Comments: Threats include invasion of weedy exotics, water control, gravel pits, and encroachment from human population expansion. A majority of the area is irrigated and grazed, and parts are maintained as a hunting preserve, but grazing is allowed on these areas to sustain the agricultural tax status. Exclosures to eliminate grazing in the rare plant communities and along the river edge would aid in sustaining the broadleaf community, the native fish population and support regeneration of native grasses and forbs. Monitoring these communities would assist in understanding how release from grazing pressures influence regeneration of native plants. Also, proper management and maintenance of riparian zones are essential to the native fish population.

Change from a broadleaf riparian community to a riparian scrub community can affect leaf fall, energy flow, water flow, natural cover, water temperature and deposition of eroded materials in rivers (Baltz and Moyle 1982); in turn influencing native fisheries. Cattle browsing are a major factor causing the replacement of broadleaf riparian communities with riparian scrub communities (Rucks 1984) and excluding cattle from the riverbank would assist in conserving the native fishery. Restoration of natural river flows by eliminating channel diversion structures and riprap hindering natural meanders would benefit recovery all the rare fish found here, which require low winter flow, high spring flow, cool to warm river temperatures, and flooding. These fish require large stream areas that incorporate diverse habitats including pools, riffles, runs, backwaters, adequate substrate and current diversity. Monitoring these populations biannually in the spring during the breeding season and in late autumn would aid in detecting their presence, abundance, recruitment and presence of nonnative species that could significantly impact the native fish through predation and competition. Adoption of standardized techniques would assure that data is comparable over locations and time. Data on population trends are needed to distinguish between natural fluctuations in abundance and population decline due to human-caused perturbation. Choice of monitoring locations to ensure that all drainages and morphological variants are represented would aid in interpretation of the data.

With the enduring popularity of waterfront development, loss of nesting habitat may remain the biggest threat to Bald Eagles. Bald Eagles avoid areas with nearby human activity and development (Buehler et al. 1991), so maintaining mature tree stands that are in close proximity to water with limited human presence would benefit this species.

Soils Description: The substratum consists of unconsolidated surficial deposits of Quaternary gravel and alluvium in the valley bottom. The soils within floodplain of the Colorado River consist of a mosaic of Torriorfluvents, Halaquepts, and Wann series. The Torriorfluvents formed in alluvium and are located closest to the current river channel. The Wann series is found on slightly higher portions of the floodplain or in areas where soil development has had time to occur. The Wann series is classified as a coarse-loamy, mixed, mesic Fluvaquentic Haplustolls. These soils are deep, somewhat poorly drained soils formed in alluvium derived from sandstone and shale. These soils are calcareous and moderately alkaline (Soil Conservation Service 1985). Halaquepts is a broadly defined soil type that consists of deep, somewhat poorly drained to poorly drained, level, salt-affected soils on low terraces (Soil Conservation Service 1985). Texture in these soils is highly variable with the upper 24 inches ranging from loam to clay, and the underlying layers are generally gravelly. Halaquepts are commonly gleyed from the surface down (Soil Conservation Service 1985).

Restoration Potential: There has been much alteration of natural communities within the floodplain of the Colorado River. The current land use patterns allow for overuse of this site by livestock. The primary concerns from such activity are uncontrolled non-native species invasions and increased erosion and downcutting of the stream banks. Grazing practices should be minimized or a reasonable method of grazing, such as fencing off much of the riparian areas, especially those closest to the river and backchannels, implemented in order to improve the health of the riparian vegetation and hence the riparian ecosystem as a whole. Eradication and control of non-native species, especially tamarisk and Russian olive, would also benefit ecosystem health. There are numerous hay meadows, gravel pits, and roads that could be restored to natural vegetation patterns.

Wetland Functional Assessment for the Rifle Stretch Colorado River PCA:
Proposed HGM Class: Riverine   Subclass: R5
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus deltoides ssp. wislizenii/Rhus trilobata; Distichlis spicata,* plus numerous emergent wetlands.

Table 15. Wetland functional assessment for the riverine wetland at the Rifle Stretch Colorado River site. Functions in **BOLD** are those functioning below normal.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland appears to be functioning slightly below potential as current grazing activity is affecting the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	High	The floodplain is large and extensive and is vegetated with a fairly high density of shrubs and trees, although some areas are sparse due to excessive grazing and agriculture.
Sediment/Shoreline Stabilization	High	The banks of the Colorado are vegetated with shrubs, trees, and herbaceous species, however some areas have been heavily impacted by overgrazing.
Groundwater Discharge/ Recharge	N/A	This wetland floods via overbank flow.
Dynamic Surface Water Storage	N/A	This wetland floods via overbank flow.
Biogeochemical Functions		
Elemental Cycling	Moderate	The presence of aerated water (the river) and large areas of saturated soil (oxbows, sloughs) provide a gradient for various nutrient transformations. However, alteration of the herbaceous understory, such as a decrease in cover and change in species composition (due to excessive grazing) may be disrupting nutrient cycles. The abundance of tamarisk may also be altering nutrient cycles due to the excessive salts tamarisk contributes to the soil (Sala 1996).
Removal of Imported Nutrients, Toxicants, and Sediments.	High	Removal of excess nutrients and sediment (e.g. from upstream and local livestock and agricultural activity) is likely being performed by this wetland considering the large area in which such transformations could occur prior to reaching the river. Toxicants and sediments from nearby roads and rail tracks are likely also intercepted in the floodplain prior to reaching the river.
Biological Functions		
Habitat Diversity	High	Scrub-shrub, forested, emergent, and open water wetlands exist in the area.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, and other large and small mammals and cover, nesting habitat, and food for songbirds and larger predators birds such as eagles, hawks, and falcons. Oxbows and sloughs provide open water for waterbirds.
General Fish/Aquatic Habitat	High	The river supports populations of various species including globally rare species such as the razorback sucker, roundtail chub, and flannelmouth sucker and the state rare mountain whitefish.

Production Export/Food Chain Support	High	A permanent water source and allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. Although some areas lack a diversity of structural vegetation classes (e.g. herbaceous layer is minimal), because the area is so large and encompasses a variety of habitats, food chain support is high.
Uniqueness	High	The wetland supports three globally rare fishes and a globally imperiled plant community and represents an important portion of the Colorado River, where large cottonwood forests occupy such an extensive floodplain.

Figure 15. Rifle Stretch Colorado River PCA.

Bear Creek at Glenwood Canyon Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a fair occurrence of a globally imperiled plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Bear Creek at Glenwood Canyon is located approximately 4 miles east of Glenwood Springs, CO in Glenwood Canyon. The site is within the White River National Forest.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Shoshone. T6S R88W Sections 8, 16, and 17.

Size: 393 acres

Elevation: 7,700 to 8,700 feet.

General Description: Bear Creek is a short tributary of the Colorado River that begins at an elevation of 8,800 feet and drops to 6,000 feet at its confluence with the Colorado River across a distance of approximately 2 miles. The riparian community is dense and species rich. Thinleaf alder (*Alnus incana*), red-osier dogwood (*Cornus sericea*), and a diversity of forbs dominate the middle portion of the creek. On a north-facing slope, about 1/3 of the distance from the headwaters to the Colorado River, is a slope wetland forest dominated by aspen (*Populus tremuloides*) and Rocky Mountain maple (*Acer glabrum*). Behind an old berm, which was probably constructed to create a cattle pond, is a marsh dominated by variety of sedges (*Carex* ssp.), rushes (*Juncus* ssp.), cattail (*Typha* sp.), and watercress (*Nasturtium officinale*).

Table 16. Natural Heritage element occurrences at the Bear Creek at Glenwood Canyon PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Populus tremuloides/Acer glabrum	**Montane riparian forest**	**G2**	**S1/S2**				**C**
Alnus incana/Cornus sericea	Thinleaf alder/red-osier dogwood riparian shrubland	G3G4	S3				B

*EO = Element Occurrence

Biodiversity Comments: The site supports a fair (C-ranked) occurrence of the globally imperiled (G2/S1S2) aspen/Rocky Mountain maple (*Populus tremuloides*/*Acer glabrum*) riparian forest. The site supports a good (B-ranked) occurrence of the state rare (G3G4/S3) thinleaf alder/red-osier dogwood (*Alnus incana*/*Cornus sericea*) riparian shrubland.

Boundary Justification: The boundary encompasses the riparian and wetland areas and surrounding and upstream slopes to ensure hydrological processes remain intact. These processes are necessary for the viability of the elements and maintenance of ecological functions such as a dynamic distribution of aquatic and terrestrial habitat.

Protection Rank Comments: The site is currently managed by the White River National Forest and does not have special protection status.

Management Rank Comments: This area is a popular spot for mountain biking but direct impacts to the elements appear to be minimal at this time. In addition to disrupting natural hydrological flow along Bear Creek, the old berm may pose an erosion threat.

Soils Description: Soils are variable in this area and are not mapped in the Soil Survey due to the small area represented by this wetland. Previous field investigations of the area near the aspen/maple forest and the marsh, during June of 1993, indicated that the water table was 66 cm below the soil surface. A brief soil profile is given below:

A 10 YR 2/1
Bt 10 YR 2/2, with 5% mottling, and very fine and fine roots.
Sulfur or "rotten egg" (sulfides) smell emitted from soils.
pH of soil – 7.0
Structure was difficult to determine due to soil saturation and large amounts of organic matter.

Restoration Potential: Removing the berm would restore natural hydrological patterns to the area.

Wetland Functional Assessment for the PCA: Although this site contains a long riparian area with fairly high cover of woody vegetation, the capacity of this wetland to perform flood attenuation is limited by the steepness of the drainage. However, dense vegetation likely is providing good bank stabilization functions. The diversity of habitats, such as an emergent marsh and forested wetland, provide excellent habitat for avian species and large and small mammals. Since the aspen/Rocky mountain maple forested wetland occurs on a hillside and not along a stream, the capacity of this site to perform flood attenuation and storage and sediment/shoreline stabilization is minimal. Given the presence of periodically saturated soils, and a thick litter layer, there are many potential pathways for nutrient transformations. Thus, important, local biogeochemical functions are likely occurring at this site.

Figure 16. Bear Creek at Glenwood Canyon PCA.

Beaver Creek at Battlement Mesa Potential Conservation Area

Biodiversity Rank: B3 High Significance. This site supports a good occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P2 High Urgency. There are numerous homes along this stretch of Beaver Creek and given the proximity to Rifle, this area could be targeted for increased development.

Management Urgency Rank: M3 Moderate Urgency. Downstream areas are threatened by alteration in hydrological processes and increased erosion brought on by improper grazing and development.

Location: Beaver Creek is located approximately 4 miles southwest of Rifle, CO along County Road 317.

Legal Description: U.S.G.S. 7.5 minute quadrangle: North Mamm Peak. T7S R94W Sections 13, 24, 25, and 26; T7S R95W Sections 19, 30, and 31; T8S R94W Sections 10, 11, and 12.

Size: 3,521 acres

Elevation: 7,400 to 10,400 feet.

General Description: The site spans a wide range in elevation thereby encompassing a variety of riparian plant associations. Thinleaf alder (*Alnus incana*) is persistent along the entire stretch of Beaver Creek that occurs in this site. However, co-dominant species change according to elevation. For example, Colorado blue spruce (*Picea pungens*) occurs with thinleaf alder at higher elevations. Further downstream, aspen (*Populus tremuloides*) becomes the co-dominant species while narrowleaf cottonwood (*Populus angustifolia*) is abundant at lower elevations. Upland slopes are dominated by aspen and Douglas fir (*Pseudotsuga menziesii*) at high elevations and Gambel's oak (*Quercus gambelii*) and juniper (*Juniperus osteosperma*) at lower elevations. Overall species diversity is high, especially in the upstream portion of the site where blue spruce, aspen, thinleaf alder, gooseberry (*Ribes* sp.), mountain willow (*Salix monticola*), and black twinberry (*Lonicera involucrata*) occur with an understory of monkshood (*Aconitum columbianum*), angelica (*Angelica ampla*), baneberry (*Actaea rubra*), marsh bittercress (*Cardamine cordifolia*), twisted-stalk (*Streptopus fassettii*), arrow-leaf groundsel (*Senecio triangularis*), quackgrass (*Elytrigia repens*), small-winged sedge (*Carex microptera*), and fowl mannagrass (*Glyceria striata*). American speedwell (*Veronica americana*) and brookgrass (*Catabrosa aquatica*) are common on gravel bars in the stream channel and mosses are common on boulders within the channel.

Hydrological processes are mostly intact upstream. Near the lower end of the site, the riparian corridor constricts, resulting in a limited buffer between the road and Beaver Creek. Numerous culverts, homes, horse pastures, and cattle grazing have impacted hydrological processes in the creek by altering/restricting flow, loss of floodplain acreage, and deterioration of the streambank. These threats have also impacted species diversity and vegetation structure (i.e. development and diversity of vegetation canopies) within this stretch of the riparian corridor.

Table 17. Natural Heritage element occurrences at the Beaver Creek at Battlement Mesa PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Picea pungens/Alnus incana	**Montane riparian forest**	**G3**	**S3**				**B**
Populus tremuloides/Alnus incana	Montane riparian forest	G3	S3				C

*EO = Element Occurrence

Biodiversity Comments: This site contains two plant communities that are vulnerable (G3/S3) on a global scale. There is a good (B-ranked) occurrence of the blue spruce/thinleaf alder (*Picea pungens*/*Alnus incana*) montane riparian forest, which is known from Wyoming to New Mexico. There are less than 100 occurrences of this community in Colorado. The aspen/thinleaf alder (*Populus tremuloides*/*Alnus incana*) montane riparian forest has only been documented on the western slope in Colorado but is expected in other Rocky Mountain states. A fair (C-ranked) occurrence of this plant community is located at this site.

Boundary Justification: The boundary encompasses the floodplain, surrounding slopes, and upstream drainages to ensure continued surface flow, periodic flooding, and space for the creek's fluvial processes to maintain a dynamic distribution of riparian plant communities. These processes are necessary for the viability of the elements and maintenance of ecological functions.

Protection Rank Comments: There are numerous homes along this stretch of Beaver Creek and given the proximity to Rifle, this area could be targeted for increased development. In addition, above the first U.S. Forest Service tract (the first tract when heading south on County Road 317), there is a large private inholding. Currently, this area does not appear to be developed but recently, there was a new, large road constructed to this area.

Management Rank Comments: As noted above, culverts and development along the floodplain have altered hydrological processes. Cattle and horse grazing along the creek have resulted in deteriorated streambanks and increased erosion in these areas.

Soils Description: The soils along the riparian area are mapped as Torrifluvents, which are recently formed soils derived from alluvium. The soils are stratified and vary widely in depth and texture (Soil Conservation Service 1985).

Restoration Potential: Removing culverts and redirecting the road to a location that results in less impact to the creek (i.e. upslope) would assist in restoring natural hydrological flow and increased bank stabilization in the lower portion of the site. Current grazing methods could be altered so that cattle and horses spend less time along the streambank and/or during a different season (late fall/early winter). This could result in increased diversity of plant species, higher vegetation volume, and increased structural diversity.

Wetland Functional Assessment for the Beaver Creek at Battlement Mesa PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Picea pungens/Alnus incana*; *Populus tremuloides/Alnus incana*

Table 18. Wetland functional assessment for the riverine wetland at the Beaver Creek at Battlement Mesa site. Functions in **BOLD** are those functioning below normal.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential (lower reach)	This wetland appears to be functioning slightly below potential (only in the lower reach) as current grazing activity is affecting the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The riparian area is fairly narrow and thus the floodplain area is limited in extent. The density of woody vegetation varies along the creek according to disturbances and elevation.
Sediment/Shoreline Stabilization	Moderate	Sediment stabilization capacity of upstream reaches are high but streambanks along lower portions are impacted and not functioning to their capacity.
Groundwater Discharge/ Recharge	High	Although no springs or seeps were encountered it is assumed that there are discharge areas upstream (no visit was made to these areas) given the quantity of permanent water in this creek in such an arid landscape.
Dynamic Surface Water Storage	N/A	Flooding at this site is primarily due to overbank or in-channel flow.
Biogeochemical Functions		
Elemental Cycling	High	Given the diversity of plant species and thus diverse types of litter inputs, the presence of aerated water (the stream), and areas with saturated soils, there is likely a stable and persistent cycling of nutrients (as opposed to a quick 'flush'). Thus, important, local biogeochemical functions are likely occurring at this site. Downstream, disturbances have likely disrupted nutrient cycling.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Sediment from the newly created road could be entering the creek. In such a scenario the density of woody vegetation along the creek would help trap excess loads but only during overbank flooding events.
Biological Functions		
Habitat Diversity	Moderate	There is forest and open water (associated with the creek) wetland habitats.
General Wildlife Habitat	Moderate	Avian habitat is good with songbirds and semi-aquatic species, such as dippers, using the area. Moderate habitat diversity, however, limits diversity of wildlife that could potential use the area. The site is also likely used by bear, deer, and elk for forage.
General Fish/Aquatic Habitat	High / Moderate	Nice pool/riffle complex, along with overhanging vegetation and presence of large woody debris, provides great fish habitat. Unsure of which fish species occur in the creek. Downstream areas do not provide high quality fish habitat due to activity in and near the stream, erosion, and minimal streambank vegetation.

Production Export/Food Chain Support	High	A permanent water source and high quantities of allochthonous organic substrates provide carbon and nutrients for downstream ecosystems. The diversity of structural vegetation classes also provide a variety of habitats for invertebrate populations.
Uniqueness	Low	There are other drainages nearby that likely have similar riparian vegetation but not necessarily the same plant communities. In addition, lower portions of this site have been directly disturbed.

Figure 17. Beaver Creek at Battlement Mesa PCA.

Calf Canyon Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M2 High Urgency. Improper grazing is affecting species composition and vegetation volume and structure.

Location: Calf Canyon is located approximately 30 miles north of Loma, CO off of Hwy. 139.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Calf Canyon. T5S R101W Sections 32 and 33; T6S R101W Sections 2 and 3.

Size: 497 acres

Elevation: 6,900 to 7,600 feet.

General Description: This site occurs in a remote canyon surrounded by steep, 500 foot sandstone and shale cliff faces. There are seeps and springs scattered throughout the site. These seeps and springs are crucial to maintaining flow in the creek. At the location in which the elements are found a seep emerges in a small "bowl" of sandstone and shale supporting wetland vegetation. The spring-fed creek supports river birch (*Betula occidentalis*), red-osier dogwood (*Cornus sericea*), Bebb's willow (*Salix bebbiana*), and aspen (*Populus tremuloides*) with a minimal understory of herbaceous plants due to flood scouring. Douglas fir (*Pseudotsuga menziesii*), Utah serviceberry (*Amelanchier utahensis*), snowberry (*Symphoricarpos rotundifolia*), Gambel's oak (*Quercus gambelii*), and wild rose (*Rosa woodsii*) are found growing in mesic areas near the creek.

Table 19. Natural Heritage element occurrences at the Calf Canyon PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Betula occidentalis*/Mesic forb**	**Foothills riparian shrubland**	**G3**	**S2**				**B**

*EO = Element Occurrence

Biodiversity Comments: This site supports a good (B-ranked) occurrence of the globally vulnerable (G3/S2) river birch/mesic forb (*Betula occidentalis*/Mesic forb) riparian shrubland. This community is well documented throughout the western states but is threatened by development and road construction.

Boundary Justification: Surrounding slopes, upstream drainages, and nearby seeps and springs are encompassed in the site boundaries in order to ensure continued hydrological flow and periodic flooding, which are necessary for the continued viability of the elements.

Protection Rank Comments: Oil and gas development in this portion of Garfield county is fairly common. There are numerous oil well pads, along with a natural gas pipeline, further downstream from this site.

Management Rank Comments: There is heavy grazing occurring within the riparian area. Timing and intensity of grazing should be altered in order to maximize plant species diversity and improve vegetation volume/structure.

Soils Description: Soils near the elements are mapped as the Empedrado series, a fine-loamy, mixed, Frigid, Typic Argiborolls. These soils form in alluvium and eolian material and permeability is moderate (Soil Conservation Service 1992). However, considering that the riparian area in this area is very narrow, it is quite possible that the soils supporting the elements are not the Empedrado and are more likely to be some type of entisol. No soil descriptions were taken from this site, thus classification of the true soil type was not feasible.

Restoration Potential: Changing livestock management in this area would benefit vegetation structure, volume, and species composition while also improving bank stability, decrease erosion, and eliminate the potential for disruption of hydrological processes.

Wetland Functional Assessment for the Calf Canyon PCA: Heavy grazing may be altering normal nutrient cycles along the creek and in the seep area by contributing excess carbon/nutrients to the system and by disrupting the soil surface via hoof action, which might increase the rate of certain nutrient transformations in the soil. Although the riparian and seep areas are small, the presence of permanent water within such an arid landscape provides important habitat for numerous birds, mammals, and insects.

Figure 18. Calf Canyon PCA.

Clear Creek Potential Conservation Area

Biodiversity Rank: B3 High Significance. This site supports an excellent occurrence of a globally vulnerable plant.

Protection Urgency Rank: P2 High Urgency. This site is mostly privately owned, and subject to oil and gas development.

Management Urgency Rank: **M4 Low Urgency.** Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: Roan Plateau, about 15 miles ENE of Parachute, 14 mi. NNE of DeBeque

Legal description: U.S.G.S. 7.5 minute quadrangles: Figure Four Spring, Bull Fork, Mount Blaine, Desert Gulch, Long Point. T5S R98W S5-9, 15-18, 21-25, 34-36; T5S R97W S31; T6S R98W S1-6, 9-16, 22, 23, 26-28, 33, 34.

Size: 13,563 acres

Elevation: 5,513 to 8,000 feet

General Description: Clear Creek, a tributary of Roan Creek, is a major drainage of the Roan Plateau, and includes numerous small side drainages. The lower part of the drainage is composed of the Wasatch formation, while the upper part and the steep sides are in the Green River formation, marlstones below and Parachute Creek member above. Significant areas within this large PCA include Red Point, Sheep Gulch, Mud Springs Creek, Camp Gulch, Deer Park Gulch, Scott Gulch, Buck Gulch, Doe Gulch, and Tom's Creek Canyon. The PCA harbors several narrowly endemic plant species that are restricted to the Green River shale on the steep canyon-sides, as well as both rare and common plant communities. The canyon-sides are for the most part sparsely vegetated. The dry, barren slopes with loose fragments of light gray shale are home to the sun-loving meadowrue, Arapien stickleaf, and Utah fescue. Moist crevices of shale outcrops harbor the hanging garden sullivantia, in association with oil shale columbine (*Aquilegia barnebyi*). Near the headwaters of Tom Creek, an interesting wetland community of brookgrass (*Catabrosa aquatica*) and monkeyflower (*Mimulus* sp.) was documented. Associated species included Nebraska sedge (*Carex nebrascensis*) and Baltic rush (*Juncus balticus*).

The PCA is almost completely privately owned, primarily by large oil companies. There are a few small BLM parcels included.

Table 20. Natural Heritage element occurrences at the Clear Creek PCA

Element	Common Name	G rank	S rank	Federal/State status	EO* rank
Plants					
Thalictrum heliophilum	**Sun-loving Meadowrue**	**G3**	**S3**		**A**
Thalictrum heliophilum	**Sun-loving Meadowrue**	**G3**	**S3**		**A**
Thalictrum heliophilum	Sun-loving Meadowrue	G3	S3		B
Nuttallia argillosa	Arapien stickleaf	G3	S2		B
Nuttallia argillosa	Arapien stickleaf	G3	S2		B
Sullivantia hapemannii var. purpusii	Hanging garden sullivantia	G3T3	S3		E
Sullivantia hapemannii var. purpusii	Hanging garden sullivantia	G3T3	S3		E
Sullivantia hapemannii var. purpusii	Hanging garden sullivantia	G3T3	S3		E
Sullivantia hapemannii var. purpusii	Hanging garden sullivantia	G3T3	S3		E
Sullivantia hapemannii var. purpusii	Hanging garden sullivantia	G3T3	S3		E
Sullivantia hapemannii var. purpusii	Hanging garden sullivantia	G3T3	S3		E
Argillochloa dasyclada	Utah fescue	G3	S3		E
Argillochloa dasyclada	Utah fescue	G3	S3		E
Argillochloa dasyclada	Utah fescue	G3	S3		E
Argillochloa dasyclada	Utah fescue	G3	S3		E
Plant communities					
Atriplex confertifolia/Oryzopsis hymenoides	Cold desert shrublands	G2	S2		E
Atriplex confertifolia/Oryzopsis hymenoides	Cold desert shrublands	G2	S2		E
Catabrosa aquatica/Mimulus spp.	Spring wetland	GU	S3		B
Atriplex confertifolia/ Pseudoroegneria spicata	Cold desert shrublands	G3	S2S3		E
Populus angustifolia/Rhus trilobata	Narrowleaf cottonwood/skunkbrush	G3	S3		B
Pinus edulis/ Cercocarpus montanus	Mesic western slope pinyon-juniper woodlands	G5	S4		E
Pseudoroegneria spicata - Oryzopsis hymenoides	Western slope grasslands	G3	SU		E
Pseudotsuga menziesii/ Symphoricarpos rotundifolius	Western slope Douglas Fir forests	G5	S4		E
Pseudotsuga menziesii/ Symphoricarpos rotundifolius	Western slope Douglas Fir forests	G5	S4		E
Mammals					
Vulpes macrotis	Kit fox	G4	S1		E

*EO=Element Occurrence

Biodiversity Comments: The Clear Creek PCA has 25 elements of biodiversity documented. Of highest significance are excellent (A ranked) occurrences of the sun loving meadowrue, good (B ranked) occurrences of the Arapien stickleaf, and unranked (E) occurrences of Utah fescue, all globally vulnerable oil shale endemic species. Moist areas are home to the hanging garden sullivantia and several wetland communities. The PCA also has desert shrub and grassland communities dominated by shadscale (*Atriplex confertifolia*) and Indian rice grass (*Oryzopsis hymenoides*), which are considered to be globally vulnerable (G3S2S3).

The sun-loving meadowrue grows on sparsely vegetated, steep shale talus slopes of the Green River Formation. It is restricted to Colorado, in Garfield, Mesa and Rio Blanco counties, with 36 known occurrences and approximately 130,000 individuals. Arapien stickleaf is restricted to two distinct and widely separated regions: central Utah and west-central Colorado. Its range is only about 30 square miles in Colorado (NatureServe 2000), where it may be locally common. The 21 documented occurrences in Colorado are all found on Green River shale on the Roan Plateau in Garfield County. Hanging garden sullivantia is endemic to Colorado, in Garfield, Gunnison, Montrose, Pitkin, and Rio Blanco counties, where there are 45 documented occurrences and approximately 40,000 individuals (NatureServe 2000). Utah fescue is restricted to Colorado and Utah. Of the 85 occurrences known in Colorado, 37 are in Garfield County, 57 in Rio Blanco County, and one in Mesa County.

Boundary Justification: The boundary is drawn to include Clear Creek and its tributaries, the Green River shale canyon sides, but does not include the mesa tops. It includes springs at the head of tributaries that support the hanging garden sullivantia Some unoccupied habitat for the shale endemic plants is included to allow for movement of the plant populations over time, as landslides open up new sites, and existing sites become too heavily vegetated for the targeted species.

Protection Rank Comments: The PCA is almost entirely owned by private oil companies. Although not currently economical, future oil shale extraction could seriously impact this significant site.

Management Rank Comments: No current management needs are known.

Soils Description: In the upper watershed, specifically the Camp Gulch area where there are numerous springs, the soils are mapped as the Silas series, fine-loamy, mixed Cumulic Cryoborolls (Soil Conservation Service 1985). These soils formed in alluvium mainly from sedimentary bedrock. Near spring sources, organic matter is accumulating, often forming thick organic horizons. The soils along the riparian area in other parts of the site are mapped Cumulic Haploborolls and the Happle series (Soil Conservation Service 1985). Happle series are classified as loamy-skeletal, mixed (calcareous), mesic Ustic Torriorthents.

Restoration Potential: The springs and surrounding uplands in the Camp Gulch area (upper watershed of Clear Creek) are heavily grazed. These areas should be rested from livestock activity or fenced off entirely. This would allow native vegetation to recover from trampling and excessive browse.

Wetland Functional Assessment for the PCA: *(A detailed functional assessment is given for the seep and spring wetlands in the Camp Gulch area on the following page.)* This site contains a long but narrow riparian area with fairly high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The presence of permanent water (riparian areas) within such an arid landscape provides important habitat for numerous birds, mammals, and insects.

Wetland Functional Assessment for the Clear Creek PCA (Camp Gulch seeps and springs):
Proposed HGM Class: Slope   Subclass: S4
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Catabrosa aquatica*/*Mimulus* spp.

Table 21. Wetland functional assessment for the slope wetland at the Clear Creek (Camp Gulch) site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at potential, however current grazing activity is decreasing the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	Moderate	Some of the seeps and spring in the area have small springbrooks associated with them. Most are maintaining sediment/shoreline stabilization functions, however current intensity of grazing has greatly decreased vegetation cover along springbrooks.
Groundwater Discharge/ Recharge	High	The are numerous seeps and spring in the area.
Dynamic Surface Water Storage	High	Although each individual seep or spring is quite small, the collective capacity of all of them within this site to store groundwater water is high due to the buildup of organic soil horizons (which have formed from permanent groundwater discharge). These organic soil horizons restrict water movement and provide storage of discharging groundwater.
Biogeochemical Functions		
Elemental Cycling	High	Saturated soils and a large carbon source maintain vital nutrient cycling processes.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Due to the heavy livestock activity in the area, these wetlands may be alleviating nutrients inputs from livestock before they enter Clear Creek. Otherwise, there is no upstream inputs of excessive imported nutrients/toxicants/sediments.
Biological Functions		
Habitat Diversity	Low	Most seeps and springs are only vegetated with herbaceous species.
General Wildlife Habitat	Moderate	These areas provide a permanent source of water in an otherwise arid landscape, thus many species use these areas for water and forage. Many birds, small mammals, and invertebrate species likely use these seeps and springs but overall low habitat diversity limits the amount of habitat.
General Fish/Aquatic Habitat	N/A	Although some seeps and springs have a small spring-brook associated with them, these small streams did not appear able to support fish populations.
Production Export/Food Chain Support	High	Permanent discharge of groundwater and subsequent organic matter accumulation produces dissolved organic carbon sources, and likely very little in the way of particulate organic carbon, that eventually make their way into Clear Creek. Moist soil and permanent flowing water help support insect populations (many butterflies were observed on wet

		soils in these areas).
Uniqueness	Moderate	Seeps and springs provide an important component to landscape diversity in this part of the county.

Figure 19. Clear Creek PCA.

Conn Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports an excellent occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P2 High Urgency. Threat is expected within five years.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Eight air miles north of the town of DeBeque, Colorado.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Circle Dot Gulch, Red Pinnacle, Long Point, Mount Blaine. T6S R97W Sections 3-10, 15-22, 28-30; T6S R98W Sections 24, 25.

Size: 6,790 acres

Elevation: 6,200 to 8,400 feet

General Description: Conn Creek cuts through the Green River formation on the Roan Plateau, forming a small box canyon before joining Roan Creek. Two hundred foot shale cliffs form the walls of the box canyon, and a dramatic waterfall at the head of the canyon plunges more than 100 feet over the Roan Cliffs. Conn Creek is a small perennial stream with a very high gradient (500 feet per mile). The adjacent side slopes are very steep and vegetated with Gambel's oak (*Quercus gambelii*), mountain mahogany (*Cercocarpus montanus*), and Utah serviceberry (*Amelanchier utahensis*) on lower slopes while the upper and northeast-facing slopes near the cliff are forested with Douglas fir. Occasional landslides provide habitat for rare and endemic shale plants.

The riparian zone of Conn Creek supports a unique low elevation community dominated by box elder maple and choke cherry. It has a very dense, and fairly undisturbed understory of Oregon grape (*Mahonia repens*), skunkbrush (*Rhus trilobata*), serviceberry (*Amelanchier utahensis*), snowberry (*Symphoricarpos rotundifolius*), and black twinberry (*Lonicera involucrata*).

Three rare plants were found on the shale barrens of the steep side slopes: Arapien stickleaf, sun-loving meadowrue and Utah fescue. All three are oil shale endemics, adapted to the Green River shale. A fourth Colorado endemic, hanging garden sullivantia, was found at a waterfall with a plunge pool and seeping cliffs, associated with oil shale columbine (*Aquilegia barnebyi*).

Table 22. Natural Heritage element occurrences at the Conn Creek PCA.

Element	Common Name	G rank	S rank	Federal/State	EO* rank
Plant communities					
Acer negundo/Prunus virginiana	**Montane Riparian Deciduous Forest**	**G3**	**S2**		**A**
Plants					
Nuttallia argillosa	Arapien Stickleaf	G3	S2	BLM	B
Thalictrum heliophilum	Sun-Loving Meadowrue	G3	S3		B
Argillochloa dasyclada	Utah Fescue	G3	S3		
Sullivantia hapemanii var. purpusii	Hanging Garden Sullivantia	G3T3	S3	FS	

*EO=Element Occurrence

Biodiversity comments: An excellent (A ranked) occurrence of a globally vulnerable (G3S2) riparian community, and good (B ranked) occurrences of four rare shale endemic plants are found within the Conn Creek PCA.

The Arapien stickleaf is an endemic perennial found only on steep and barren shale slopes of the Green River Formation. It is restricted to widely separated regions: central Utah and west-central Colorado. Its range is only about 30 square miles in Colorado (NatureServe 2000), where it may be locally common. The 21 documented occurrences in Colorado all are found on Green River shale on the Roan Plateau in Garfield County. The sun-loving meadowrue grows on sparsely vegetated, steep shale talus slopes of the Green River Formation. It is restricted to Colorado, in Garfield, Mesa and Rio Blanco counties, with 36 known occurrences and approximately 130,000 individuals. Utah fescue is one of four species of fescue endemic to the Western U.S. (Welsh *et al*. 1987). Its range is limited to the Green River Formation in Colorado and Utah. Of the 85 occurrences known in Colorado, 37 are in Garfield County, 57 in Rio Blanco County, and one in Mesa County. Hanging garden sullivantia is more widespread in its distribution, but only grows on moist cliff faces (hanging gardens). The species is endemic to Colorado, in Garfield, Gunnison, Montrose, Pitkin, and Rio Blanco counties, where there are 45 documented occurrences and approximately 40,000 individuals (NatureServe 2000).

The lower elevation riparian areas support one of the best examples of a narrowly distributed boxelder/chokecherry community. This community was recently described by Kittel *et al*. (1994) and is not known to occur in any other state. Low elevation riparian communities in Colorado are generally in poor condition due to hydrologic changes, heavy grazing, agricultural use, and development. During CNHP's 1994 riparian vegetation study of the Colorado River, this site was found to be exemplary in its low elevation riparian vegetation.

Boundary Justification: The site boundaries for Conn Creek include the riparian area and its immediate slopes and cliff from the waterfall to its junction with Cascade Canyon. This boundary includes all element occurrences listed. The more significant elements occur on the shale scree slopes and streamsides of the box canyon. In order to protect these elements, especially the riparian zones, a broader, secondary boundary including the entire watershed should be considered. The watershed approach is especially important if mining activity takes place, since oil shale mining can be highly destructive to the drainages. The boundaries are also mapped to include the Sage Sparrow occurrence and over 30 acres of the surrounding big sagebrush habitat. Sage Sparrows require big sagebrush parks of over 30 acres for nesting (Lambeth 1998).

Protection Rank Comments:. No protective status is given to this site. Occidental Oil Company owns both Conn and Cascade Canyons. Few roads or trails are within the Conn Creek PCA, although grazing takes place in both the riparian areas and on the slopes. At current oil prices it is not now economical to mine oil shale. If or when the price of oil goes up and technology is improved, the oil companies will probably mine this site.

Management Rank Comments: This PCA in generally in pristine condition. The only non-native plant observed was wooly mullein (*Verbascum thapsus*). The only management activity recommended at present is to periodically monitor the site for changes. Sage Sparrows are vulnerable to loss and fragmentation of sagebrush habitat and may require sagebrush parks of 100 acres or more (NatureServe 2000). Range improvement programs removing sagebrush and invasion by cheatgrass (*Bromus tectorum*) have the potential to destroy this Sage Sparrow population. Cheatgrass alters the natural fire regime by increasing the frequency, intensity, and size of range fires. Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to annual grassland as the fire cycle escalates, removing habitat for Sage Sparrow (Paige and Ritter 1998). Sage Sparrows can persist with moderate grazing and other land management activities that maintain sagebrush cover and the integrity of native vegetation, but they respond negatively to heavy grazing (Saab *et al*. 1995). Recovery of native grasses, management of fire to prevent loss of sagebrush cover and implementing moderate grazing practices would benefit Sage Sparrows at this PCA.

Soils Description: The soils along the riparian areas are mapped as the Happle series. Happle series are classified as loamy-skeletal, mixed (calcareous), mesic Ustic Torriorthents (Soil Conservation Service 1985).

Restoration Potential: Given the relatively pristine nature of the site, there is little potential for restoration.

Wetland Functional Assessment for the PCA: This site contains a long but narrow riparian area with fairly high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The presence of permanent water (riparian areas) within such an arid landscape provides important habitat for numerous birds, mammals, and insects.

Figure 20. Conn Creek PCA.

Deep Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrences of a globally vulnerable plant and plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: Deep Creek flows east into the Colorado River approximately two miles north of Dotsero, Colorado.

Legal description: U.S.G.S. 7.5 minute quadrangles: Dotsero, Broken Rib Creek, Sweetwater Lake, Carbonate and Deep Lake quadrangles. T3S R89W Sections 22-27, 34-36; T3S R88W Sections 19-23, 25-36; T3S R87W Sections 30-32; T4S R88W Sections 1-6, 10-14, 24

Size: 30,181 acres

Elevation: 6,200 to 10,460 feet

General Description: Beginning at Deep Lake (10,460 feet) on the White River Plateau, Deep Creek plunges more than 4,500 feet in 15 miles to join the Colorado River near Dotsero (6,200 feet). Approximately 1 mile from Deep Lake, Deep Creek carves a rugged and remote limestone gorge, forming a dramatic pristine canyon over 2,500 feet deep and 13 miles long. The headwaters of Deep Creek are subalpine forests of aspen, spruce and fir, interspersed with meadows and many small lakes. The high elevation riparian areas consist of Drummond's willow (*Salix drummondiana*) and mesic forbs in the wide areas, changing to spruce and mesic forbs as the canyon narrows. As the creek drops closer to its confluence with the Colorado River, the landscape becomes more arid and vegetation turns toward pinyon-juniper and sagebrush on the slopes and cottonwood forests in the canyon bottom. The limestone strata have created ideal conditions for the formation of caves. Over forty known caves are within the canyon walls. These include many of the state's most outstanding caves, including Groaning Cave, Colorado's longest at seven miles; Big A, Disappointment Cave, with the largest opening of any in the state; 20 Pound Tick Cave, still being explored and accessible only with scuba gear; and Fixin' to Die Cave, Colorado's second longest at 3 miles. (Parris 1973). Deep Creek stands out from neighboring canyons in its ruggedness, remoteness, and pristine condition. Very little human disturbance is within the canyon. Trails are nonexistent and it is only accessible by traversing the creek itself, during low water. Coffee Pot Road, an unpaved forest service road, is atop the plateau and parallels Deep Creek. The road is the major access for Deep, Heart, and Bison lakes in the headwaters of Deep Creek. Recreational use, cattle grazing, and logging are all popular activities on the plateau. All these activities may or may not have an effect on the canyon itself. To our knowledge there is no grazing or logging within the canyon, and very little recreation. Although several nearby drainages, e.g. Grizzly and No Name Creeks, have a similar appearance with similar landscape composition, none is as pristine as Deep Creek. The canyon proper has one of the most intact canyon landscapes found in Colorado. Although rare elements can be found in the canyon (see table above), Deep Creek is most impressive because of the integrity of the landscape.

Table 23. Natural Heritage elements at the Deep Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal/ State Status	EO* Rank
Plant communities					
Salix monticola/ Mesic Forb	**Montane Riparian Willow Carr**	**G3**	**S3**		**B**
Pseudotsuga menziesii/Paxistima myrsinites	Lower Montane Forests	G2G3	S2S3		B
Festuca idahoensis-Festuca thurberi	Montane Grasslands	G3G4	S3S4		E
Pseudotsuga menziesii/Cornus sericea	Lower Montane Riparian Forests	G4	S2		E
Picea pungens/ Cornus sericea	Montane Riparian Forests	G4	S2		E
Cornus sericea	Foothills Riparian Shrub	G4	S3		A
Populus angustifolia/Cornus sericea	Cottonwood Riparian Forest	G4	S3		B
Salix drummondiana/Mesic Forb	Drummond's Willow/ Mesic Forb	G4	S4		B
Salix drummondiana/Mesic Forb	Drummond's Willow/ Mesic Forb	G4	S4		BC
Quercus gambelii/Symphoricarpos rotundifolius	Mixed Mountain Shrublands	G5	S3S4		E
Carex aquatilis	Montane wet meadows	G5	S4		B
Salix drummondiana/ Carex utriculata	Montane willow carr	GU	S3		E
Picea engelmannii/ Cornus sericea	Montane riparian forest	GU	SU		E
Artemisia tridentata ssp. *vaseyana/Festuca thurberi*	Western slope sagebrush shrublands	GU	S1S2		E
Plants					
Sullivantia hapemanii* var. *purpusii	**Hanging garden sullivantia**	**G3T3**	**S3**		**B**
Sullivantia hapemanii var. *purpusii*	Hanging garden sullivantia	G3T3	S3		E

Draba spectabilis var. *oxyloba*	Showy whitlowgrass	G3?T3Q	S3		E
Mammals					
Gulo gulo	Wolverine	G4	S1	FS	E
Euderma maculata	Spotted bat	G4	S2	FS/BLM	H
Corynorhinus townsendii	Pale lump-nose bat	G4T4	S2	FS/BLM	E
Invertebrates					
Oncopodura subhoffi	A springtail	G3	S?		C

*EO=Element Occurrence

Biodiversity Comments: The Deep Creek PCA has one of the most intact, pristine canyon landscapes found in Colorado. Although rare elements can be found in the canyon, Deep Creek is most impressive because of the integrity of the landscape. Along with a pristine landscape, several state and globally rare elements are found in Deep Creek. The site contains a good (B ranked) occurrence of a plant community which is vulnerable (G3S3) on a global scale. Fifteen other occurrences of natural communities have been identified within the PCA. It also contains two globally vulnerable (G3) plant species, and two state-rare (S2) bats. Another plant, Harrington's beardtongue (*Penstemon harringtonii*), is not listed above since it occurs in the Eagle County part of the PCA, but its habitat extends into Garfield County. It is a large showy penstemon found on the pinyon pine, juniper, and sagebrush covered slopes of the upper Colorado and Eagle River valleys, mostly in Grand and Eagle counties (Colorado Native Plant Society 1989). Hanging garden sullivantia is endemic to Colorado, in Garfield, Gunnison, Montrose, Pitkin, and Rio Blanco counties, where there are 45 documented occurrences and approximately 40,000 individuals (NatureServe 2000).

The low elevation riparian community consisting of narrowleaf cottonwood, red-osier dogwood, with river birch is found from Northern Wyoming to central Colorado (Johnston 1987). Large, near-pristine stands of this community are uncommon on Colorado's west slope (Kittel *et al*. 1994). The B-ranked Deep Creek occurrence, although it is viable and defendable, has several introduced species, thus lowering its rank.

A rare springtail (a cave obligate invertebrate) has been documented at Groaning Cave in this PCA. The springtail occurs at only two other caves, both located in Fremont County, Colorado.

Bald eagle and Peregrine falcon occurrences are mapped in the Eagle County portion of the PCA; however, the birds undoubtedly use the area in Garfield County for hunting. Currently there are 20 breeding pairs of Bald Eagles in Colorado, according to the Colorado Bird Observatory (1997). Threats to this species include high pesticide use, poisoning, and poaching (feathers are valuable on the black market). The small breeding population, the numerous threats that exist, and the varying success of nests from year to year, warrant a critically imperiled rank for breeding Bald Eagles in Colorado (S1B). Federally downlisted to threatened (LT), the Bald Eagle is still protected by the Endangered Species Act and the Eagle Protection Act. The Colorado Division of Wildlife lists the Bald Eagle as threatened. There are estimated to be fewer than 300

Peregrine Falcon individuals breeding in Colorado. Human disturbance of nests by recreational rock climbers, illegal capture by falconers, and uncertain breeding status across the state are factors considered important in the conservation of this imperiled (S2B) species in Colorado.

The pale lump-nose bat record at this PCA represents a traditional roost. Historical sites of the pale lump-nosed bat in Colorado seem to be abandoned or greatly reduced in size (Kirk Navo, pers. comm.). This species is considered imperiled in Colorado (S2) because of the low number of individuals encountered for a colonial species, low population size, and high threats**.** The spotted bat is ranked as imperiled in Colorado (S2) primarily because of the small number of occurrences, assumed small population size and its restricted state range. There are fewer than 20 occurrences of this species in Colorado, and it is known from only a few individuals.

Boundary Justification: The site boundaries for Deep Creek include the entire watershed of Deep Creek. Although the flat and gentle slope areas are not pristine, they form the necessary buffer to protect the roadless, pristine slopes and valley bottom of Deep Creek. The boundary includes the canyon cliffsides that provide important nesting habitat for Peregrine Falcons. The boundary does not contain the entire feeding area of the pale lump-nosed bat, the extent of which is difficult to define.

Protection Rank Comments: Most of Deep Creek is federally owned, with the lower part managed by BLM and the upper part by the US Forest Service. The BLM portion is designated an Area of Critical Environmental Concern. The Forest portion has been recommended for designation as a Research Natural Area and for Wild and Scenic River designation. The Wild and Scenic designation is the preferred alternative in the revision to the White River National Forest Plan which is still in progress at this writing.

Management Rank Comments: Due to its ruggedness, cattle use only the upper and lower stretches of the PCA. Grazing and logging practices on the plateau should be monitored to assess impacts on the canyon's health. Logging, hunting, grazing, and recreation are the major activities. Nearly all these activities take place on the plateau or gentle slopes. A Forest Service campground is maintained at Deep Lake. Many hunting camps are along Coffee Pot Road and at the small lakes.

With the enduring popularity of waterfront development, loss of nesting habitat may remain the biggest threat to Bald Eagles. Bald Eagles avoid areas with nearby human activity and development (Buehler *et al*. 1991), so maintaining mature tree stands at this PCA that are near the stream with limited human disturbance would benefit this species.

Continued existence of Peregrine Falcons in Colorado depends upon protection of traditional nesting sites like the one found at this PCA. Keeping this nest site free of human intrusions during nesting season (February to August) would ensure persistent annual use of this traditional peregrine eyrie.
Needs for the survival of the pale lump-nosed bat include protection of occupied roosts from disturbance (May to mid-September for maternity roosts, October-April for

hibernacula); and evaluation of occupied caves for gate installation. See White and Seginak (1987) for gate designs for protecting caves. Gates can successfully limit human access and disturbance but, if poorly designed, gates may restrict bat access and result in population decline. Conditions for the bats can be improved by maintaining canopy cover in areas surrounding caverns, rock faces, and other sites used for roosting; retaining large diameter snags and stands of old growth; avoiding heavy equipment and blasting near roosts; and avoiding chemical insecticides.

Soils Description: Soils along the riparian areas are mapped as Fluvaquents. Fluvaquents are a broadly defined unit consisting of deep, somewhat poorly drained soils on floodplains and alluvial valley floors which formed in alluvium (Soil Conservation Service 1992).

Restoration Potential: Since this is one of the more pristine canyons in Garfield County there is little opportunity for restoration activities.

Wetland Functional Assessment for the PCA: This site contains a long, extensive, and pristine riparian area with a high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The diversity of habitats, including scrub-shrub, forested, and emergent wetlands, provide excellent habitat for avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris and thus excellent fish habitat.

Figure 21. Deep Creek PCA.

Deep Creek at Clark Ridge Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports an excellent occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: This site occurs within the White River National Forest and is located approximately 13 miles north-northwest of New Castle, CO, near Clark Cabin Spring (which is located on the New Castle-Buford Road).

Legal Description: U.S.G.S. 7.5 minute quadrangle: Meadow Creek Lake. T3S R91W Sections 14, 15, 22, 23, 26, and 27.

Size: 1,749 acres

Elevation: 8,600 to 9,600 feet.

General Description: The creek forms a fairly deep canyon with aspen (*Populus tremuloides*) and Engelmann spruce (*Picea engelmannii*) dominating adjacent slopes. The creek bottom is dominated by mountain willow (*Salix monticola*), planeleaf willow (*S. planifolia*), and beaked sedge (*Carex utriculata*). Overall species diversity is high. The creek is very sinuous and there are numerous beaver ponds located along this stretch of the stream. The area is fairly pristine with very little indication of threats and relatively no non-native species present.

Table 24. Natural Heritage element occurrences at the Deep Creek at Clark Ridge PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Salix monticola/Carex utriculata	**Montane riparian willow carr**	**G3**	**S3**				**A**

*EO = Element Occurrence

Biodiversity Comments: This site supports an excellent (A-ranked) occurrence of the globally vulnerable (G3/S3) mountain willow/beaked sedge (*Salix monticola*/*Carex utriculata*) montane riparian willow carr. This association is only known from thirteen locations in Colorado, but an additional ten to twenty more occurrences are expected in the state. Mountain willow appears to be at the center of its distribution in Colorado, where it frequently forms large thickets with few other willow species present. Literature from Utah, Wyoming, Montana, Idaho, Nevada and Oregon indicate that mountain willow looses importance north and west of Colorado, as it mixes with other willow species.

Boundary Justification: The boundary encompasses the narrow riparian area, beaver ponds, surrounding slopes, and some upstream drainages to ensure continued surface flow, periodic flooding, and space for the creek's fluvial processes to maintain a dynamic distribution of riparian plant communities. These processes are necessary for the viability of the elements and maintenance of ecological functions. However, the entire upstream portion of the watershed was not included in the site boundaries. Complete consideration of hydrological resources would need to include these upstream areas.

Protection Rank Comments: There are no immediate threats to this site. It is currently managed by the United States Forest Service and does not get very much use.

Management Rank Comments: Some logging may occur in the headwaters but it is unlikely that this is occurring on a scale that might affect the elements. There is some recreational and hunting use in and around Deep Creek. Cattle and sheep grazing in the area appears to be minimal.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Very little opportunity for restoration given the pristine nature of the site.

Wetland Functional Assessment for the Deep Creek at Clark Ridge PCA: Due to the presence of beaver ponds in the area, the wetland has a strong potential to retain excess sediments, support nutrient cycles, and provide a diversity of wetland habitats for insects, birds, and small and large mammals.

Figure 22. Deep Creek at Clark Ridge PCA.

East Douglas Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a fair occurrence of a globally imperiled plant community plus high quality seep and spring wetlands.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future and this site is designated as a BLM Area of Critical Environmental Concern (ACEC).

Management Urgency Rank: M2 High Urgency. Effects of grazing are apparent.

Location: East Douglas Creek is located approximately 30 miles north of Fruita, CO and 3 miles east of Douglas Pass (on Hwy. 139).

Legal Description: U.S.G.S. 7.5 minute quadrangle: Brushy Point; Calf Canyon. T4S R100W Section 31; T4S R101 W Sections 34, 35, and 36; T5S R100W Sections 6, 7, and 18; T5S R101W Sections 1, 2, 3, 10-16, and 20-29.

Size: 8,073 acres

Elevation: 6,900 to 8,800 feet.

General Description: East Douglas Creek is a narrow, eroding, sinuous stream that is cutting sharply into steep-sided valley walls. Blue spruce (*Picea pungens*) is the dominant species along the creek in the upper portion of the site. Further downstream, river birch (*Betula occidentalis*) becomes co-dominant. Along point bars and in small, saturated backwater areas, horsetail (*Equisetum arvense*), alkali crowfoot (*Halerpestes cymbalaria* subsp. *saximontana*), beaked sedge (*Carex utriculata*), spikerush (*Eleocharis palustris*), wild mint (*Mentha arvense*), and redtop (*Agrostis gigantea*) are common. Narrowleaf cottonwood (*Populus angustifolia*) also occurs in scattered locations along the creek. Adjacent, partially-shaded, upland slopes are dominated by Douglas fir (*Pseudotsuga menziesii*), Utah serviceberry (*Amelanchier utahensis*), and snowberry (*Symphoricarpos oreophilus*) whereas pinyon pine (*Pinus edulis*), juniper (*Juniperus osteosperma*), and Gambel's oak (*Quercus gambelii*) dominate drier, higher slopes.

Stream-flow in East Douglas Creek is maintained by numerous small seeps and springs scattered throughout the area. These seeps and springs emerge from the Green River shale formation that outcrops throughout most of the site. These areas are dominated by beaked sedge, Nebraska sedge (*Carex nebrascensis*), monkshood (*Aconitum columbianum*), fowl mannagrass (*Glyceria striata*), and alkali crowfoot. There is a unique stand of mature narrowleaf cottonwoods that has established at the base of a large shale cliff, where many small springs had or were emerging. The stand is linear, extensive, and obviously delineates the locations of numerous springs. Most of the springs show no signs of recent grazing, whereas riparian areas downstream have been grazed in recent months. The springs are extremely alkaline at their source, having a water pH ranging from 8.0 to 8.5. This is extremely high and cattle may purposely stay away from such areas due to the high alkalinity. Downstream riparian areas are not as alkaline, probably due to the spring waters being diluted from various sources such as litter decomposition within the stream channel and reaction with stream sediments and wetland soils.

Although no rare butterflies were observed at this site, the dense herbaceous vegetation associated with the seeps and springs support a large population of butterflies including numerous fritillary and crescents (Family *Nymphalidae*), whites and sulphurs (Family *Pieridae*), skippers (Family *Hesperiidae*), and swallowtails (Family *Papilionidae*).

At the confluence of Bear Park Creek and East Douglas Creek there is a large wet meadow in a park-like setting. Near the downstream end of the meadow, there appears to be a remnant of a natural dam that once blocked drainage, in a similar fashion as a beaver dam. The dam, which may have been the result of a landslide, probably created this wet meadow by slowing and/or blocking stream-flow. This resulted in the deposition of many layers of sediments. Evidence for this is suggested by the presence of large dead and dying blue spruce trees located throughout the meadow. The distribution pattern of these trees suggests that they originally established along a historical streambank, whose channel is no longer visible due to the accumulation of sediment in this area. It is likely that the fine soils that have accumulated behind the dam retain a locally high water table which may have stressed and killed the spruce trees.

Table 25. Natural Heritage element occurrences at the East Douglas Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Picea pungens/Betula occidentalis	**Montane riparian woodland**	**G2**	**S2**				**C**

*EO = Element Occurrence

Biodiversity Comments: This site supports a fair (C-ranked) occurrence of the globally imperiled (G2/S2) blue spruce/river birch (*Picea pungens*/*Betula occidentalis*) montane riparian woodland. This plant community appears to mainly occur in foothill canyons of the Colorado Front Range. The occurrence at this site is the only one, thus far, documented on the western slope. This site also harbors some of the most intact and pristine seeps and springs that were observed in western Garfield County during the course of this inventory.

Boundary Justification: This site encompasses the headwaters of East Douglas Creek, including Bear Park Creek and East Park Creek and numerous seeps and springs, to ensure that hydrological processes, such as maintenance of stream-flow and continued channel meandering, supporting the element are not disrupted.

Protection Rank Comments: The site is currently managed by the Bureau of Land Management and is designated as the East Douglas Creek Area of Critical and Environmental Concern.

Management Rank Comments: Much of the lower elevation streams of the White River Basin, such as East Douglas Creek, were heavily grazed from the 1930s into the early 1960s (Kittel et al. 1999). East Douglas Creek was heavily impacted from such activities through excessive bank erosion and invasion of non-native species. Numerous non-native species such as tamarisk (*Tamarix ramosissima*), Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), houndstongue (*Cynoglossum officinale*), sweetclover (*Melilotus officinale*), and dandelion (*Taraxacum officinale*) were present in the lower portions of East Douglas Creek within this site. East Douglas Creek does seem to be recovering from past management activities but future management should ensure that grazing and populations of non-native species do not further degrade the element.

Soils Description: Soils on which the globally imperiled blue spruce/river birch montane riparian woodland occurs are mapped as the Silas series. These soils are fine-loamy, mixed, Cumulic, Cryroborolls and are deep, moderately well drained soils formed in alluvium derived from sedimentary bedrock (Soil Conservation Service 1985). Soils at spring sources often have histic epipedons near the soil surface.

Restoration Potential: Grazing management should be conducive for minimizing bank erosion and additional spread of non-native species. Channel restoration might include planting pole cuttings or live stacks and using bioengineering techniques (e.g. tree revetments) to stabilize bank erosion.

Wetland Functional Assessment for the East Douglas Creek PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Picea pungens/Betula occidentalis*

Table 26. Wetland functional assessment for the riverine wetland at the East Douglas Creek site. Functions in **BOLD** are those functioning below normal.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential (lower reach)	This wetland appears to be functioning slightly below potential (only in the lower reach) as current grazing activity is affecting the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	Due to eroding streambanks and an incised stream in the lower reaches this does not have the capability of performing this function as it should. Upper portions of East Douglas Creek including the large wet meadow appear to be functioning near capacity.
Sediment/Shoreline Stabilization	Moderate	Many areas, especially lower reaches of the creek, have eroding streambanks and sparse vegetation while upper reaches, including the wet meadow are more vegetated.
Groundwater Discharge/ Recharge	High	There are numerous seeps and springs scattered throughout this site.
Dynamic Surface Water Storage	N/A	This wetland floods via overbank flow.
Biogeochemical Functions		
Elemental Cycling	High	The presence of aerated water (the stream) and areas with saturated soils and wetland vegetation (small backwater areas and the wet meadow) suggest there is likely a stable and persistent cycling of nutrients (as opposed to a quick 'flush') in the wetland. Thus, important, local biogeochemical functions are likely occurring at this site.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of sediment from eroding streambanks is likely moderate given the incised nature of the stream. However, the large wet meadow along the creek may allow for sediment removal as the stream was not incised along this reach and there was adequate streamside vegetation.
Biological Functions		
Habitat Diversity	High	Forested along upper reaches, scrub-shrub further downstream, and emergent vegetation within the wet meadow and small backwater areas (and streamside).
General Wildlife Habitat	High	There is a high diversity of wetland habitat types that provide potential habitat for a diversity of wildlife including songbirds, large and small mammals, and insects.
General Fish/Aquatic Habitat	Moderate	There were many small trout (~6 inches) throughout the lower reaches of the creek within the site. There was also a good distribution of pools, riffles, and woody debris within the channel, providing good potential fish habitat, however eroding stream banks could be a threat.
Production Export/Food Chain Support	High	A permanent water source and allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. The diversity of structural vegetation classes (e.g. the

		forb/graminoid, shrub, and tree layers) provide a variety of habitats for invertebrate populations.
Uniqueness	Moderate	This area harbors a globally imperiled plant community.

Wetland Functional Assessment for the East Douglas Creek PCA:
Proposed HGM Class: Slope Subclass: S4
Cowardin System: Palustrine.
CNHP's Wetland Classification: Herbaceous wetlands (*Carex utriculata*, *C. nebrascensis, Aconitum columbianum*, *Glyceria striata*, etc.)

Table 27. Wetland functional assessment for the slope wetlands at the East Douglas Creek site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning under normal expectations.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	N/A	Although some seeps and springs have a small spring-brook associated with them, they have minimal capacity to perform this function.
Groundwater Discharge/ Recharge	High	There are many seeps and springs throughout the site.
Dynamic Surface Water Storage	High	Although each individual seep or spring is quite small, the collective capacity of all of them within this site to store groundwater water is high due to the buildup of organic soil horizons (which have formed from permanent groundwater discharge). These soils restrict water movement through these areas and provides storage of discharging groundwater.
Biogeochemical Functions		
Elemental Cycling	High	Saturated soils and a large carbon source maintain vital nutrient cycling processes for the East Douglas Creek drainage.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	There is little potential for these areas to remove sediments/ nutrients/toxicants as there are no upstream sources of these excess inputs as most of the seeps and springs occur on hillsides or at the base of large cliffs.
Biological Functions		
Habitat Diversity	Moderate	Most seeps and springs are only vegetated with herbaceous species, but some support large shrubs and trees.
General Wildlife Habitat	High	These areas provide a permanent source of water in an otherwise arid landscape, thus many species use these areas for water and forage. Many birds, small mammals, signs of bear and elk, and numerous butterfly species were observed.
General Fish/Aquatic Habitat	N/A	Although some seeps and springs have a small spring-brook associated with them, these small streams did not appear able to support fish populations.
Production Export/Food Chain Support	High	Permanent discharge of groundwater and subsequent organic matter accumulation produces dissolved organic carbon sources, and likely very little in the way of particulate organic carbon, that eventually make their way into East Douglas Creek. Moist soil and permanent flowing water help support insect populations (many butterflies were observed on wet soils in these areas).
Uniqueness	Moderate	Seeps and springs located within East Douglas Creek are in excellent condition.

Figure 23. East Douglas Creek PCA.

East Elk Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site support an excellent occurrence of a globally vulnerable plant and excellent occurrences of two globally vulnerable plant communities.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: The East Elk Creek site is located approximately 4 ½ miles north of New Castle, CO. The site begins at the end of County Road 241 (the beginning of Forest Road 654).

Legal Description: U.S.G.S. 7.5 minute quadrangle: Deep Creek Point. T3S R89W Section 31; T3S R90W Sections 34-36; T4S R89W Sections 6, 7, and 18; T4S R90W Sections 1-4, 9-17, 19-24, and 28-32; T5S R90W Sections 5 and 6.

Size: 10,966 acres

Elevation: 6,400 to 9,600 feet.

General Description: East Elk Creek forms a steep narrow canyon through the Leadville limestone formation. Limestone outcrops are prevalent throughout the area and the canyon is aesthetically similar to Glenwood Canyon. Upland slopes are sparsely vegetated due to the steep limestone outcrops but Gambel's oak (*Quercus gambelii)*, Utah serviceberry (*Amelanchier utahensis*), juniper (*Juniperus osteosperma*), aspen (*Populus tremuloides*), and Douglas fir (*Pseudotsuga menziesii*) were growing in scattered locations. The riparian area is dominated by a mature overstory of narrowleaf cottonwood (*Populus angustifolia*) and river birch (*Betula occidentalis*) along with scattered blue spruce (*Picea pungens*) and a lush and rich understory of herbaceous species. Regeneration of narrowleaf cottonwood appears to be occurring on sporadic point bars. Downstream, the riparian community grades into a community dominated by blue spruce and narrowleaf cottonwood with hay meadows and pastures occupying the floodplain. Flooding still occurs along the creek and hydrological process have not been altered. Grazing does not occur within this site, however, downstream there is grazing within the floodplain. There is an abandoned mine (Gray Eagle Mine) upstream, but no impacts to the stream were observed.

Numerous seeps and springs occur along the adjacent hillsides and occasionally within the floodplain. These springs discharge from the Leadville Limestone, which has been shown to be a major local aquifer (Teller 1983). This aquifer is recharged via precipitation, snowmelt, and stream-flow and has a general subsurface flow toward the south, west, and northwest away from the White River Uplift (Teller 1983). These springs are very important in maintaining the hydrological regime of this site. The water from these springs has a fairly high pH (~8.1) near the source due to a high calcium carbonate content. Floodplain springs support stands of river birch with a diverse understory of forbs and graminoids such as interior sedge (*Carex interior*), beaked sedge (*C. utriculata*), field horsetail (*Equisetum arvense*), scouring rush (*Hippochaete hyemalis*), and wild mint (*Mentha arvense*). Springbrooks (the drainage immediately downstream from spring sources) are dominated by American speedwell (*Veronica americana*), watercress (*Naturtium officinale*), beaked sedge, and the globally vulnerable canyon bog orchid (*Limnorchis ensifolia*), which is also found along the streambanks of East Elk Creek throughout the site. Oil shale columbine (*Aquilegia barneybi*) is the dominant plant near many spring sources. One particular spring is quite unique in that precipitate of calcium carbonate has formed a steep, terraced, seep wetland that is completely dominated by oil shale columbine and various moss species. The terrace formed as a result of groundwater, rich in carbon dioxide, discharging to the surface. This results in the release of large quantities of carbon dioxide creating a disequilibrium between carbon dioxide, carbonate ions, and carbonic acid in the groundwater (Wetzel 1983). As a result of this disequilibrium, calcium bicarbonate precipitates from the groundwater and encrusts the substrate near the spring source. Following many years, the precipitate has formed a large solid wall of calcium carbonate. Along this terrace wall there are small pools which harbor numerous insects. Northern leopard frogs (*Rana pipiens*) were also observed using these pools and were seen throughtout the site.

Overall, this site is in excellent condition. Although this site is not as pristine as Deep Creek, compared to most other creeks of a similar elevation, East Elk Creek is one of the most intact riparian areas observed during the course of this inventory.

Table 28. Natural Heritage element occurrences at the East Elk Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Limnorchis ensifolia	**Canyon bog orchid**	**G4G5T3?**	**S3**				**A**
Plant Communities							
Populus angustifolia/Betula occidentalis	**Montane riparian forest**	**G3?**	**S2**				**A**
***Betula occidentalis/*Mesic graminoid**	**Lower montane riparian shrublands**	**G3**	**S2**				**A**
Amphibians							
Rana pipiens	Northern leopard frogs	G5	S3			FS/BLM	E
Invertebrate							
Glossosoma alascense	Caddisfly	G?	S?				E

*EO = Element Occurrence

Biodiversity Comments: This site supports an excellent (A-ranked) occurrence of the globally vulnerable (G4G5T3?/S3) plant subspecies, the canyon bog orchid (*Limnorchis ensifolia*), the globally vulnerable (G3?/S2) narrowleaf cottonwood/river birch (*Populus angustifolia*/*Betula occidentalis*) montane riparian forest, and the globally vulnerable (G3/S2) river birch/mesic graminoid (*Betula occidentalis*/mesic graminoid) lower montane riparian shrubland. The canyon bog orchid occurs in the southwestern U.S., Nevada, and Oregon. A caddisfly, whose range is unknown at this time, has been documented along East Elk Creek, and is considered a conservation priority for invertebrates by Boris Kontradieff, a Professor of Entomology and Curator of the C.P. Gillette Museum of Arthropod Diversity, at Colorado State University. The narrowleaf cottonwood/river birch community is known from fewer than a dozen locations in Colorado and is expected to occur in Nevada, Wyoming, and South Dakota. This stand has an unusually high diversity of shrubs and herbaceous species in the understory compared to most occurrences. The river birch/mixed graminoid community is well documented in several western states, however, improper livestock grazing, stream-flow alterations, and heavy recreational use threaten it. This stand was in excellent condition as there is no grazing in this area. Overall species diversity in this community was also very high. In addition, East Elk Creek is one of the most pristine riparian areas in Garfield county at this elevation (~6500 ft.).

Boundary Justification: The boundaries were drawn to ensure that all of the springs and small side drainages were protected to ensure continued surface flow, periodic flooding, and space for the creek's fluvial processes to continually maintain existing riparian communities while also creating additional habitat via flood scouring, lateral flow, and channel meandering.

Protection Rank Comments: This site mainly occurs on U.S. Forest Service land and does not seem to receive much use other than occasional fishing and hiking. The Forest Service does not allow camping along the first 3 miles of the creek. In addition, East Elk Creek is the town of New Castle's water supply, thus it would seem unlikely that major land use changes would occur along the creek.

Management Rank Comments: The area does receive some recreational use, mainly fishing. This activity does not appear to be affecting the elements but use should be monitored. Although development of the springs in the area does not seem likely, such activity would have a major detrimental affect on the ecological integrity of this riparian area.

Soils Description: The soils along the creek are mapped as Torrifluvents. These soils formed in alluvium and are highly stratified and vary widely in texture and depth (Soil Conservation Service 1985). Soils were fairly coarse near East Elk Creek. Due to a recent large flood in the canyon, the uppermost horizons had minimal development. Soils near the springs and along the springbrooks were saturated and accumulating organic matter (they had a dark and fairly deep A horizon forming over a C horizon of alluvium).

Restoration Potential: This site is in excellent condition, thus opportunities for restoration activities are minimal. There may be an opportunity to restore the area near Gray Eagle Mine, however the CNHP did not visit this portion of the site, consequently specifics regarding potential restoration opportunities in this location can not be given.

Wetland Functional Assessment for the East Elk Creek PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus angustifolia*/*Betula occidentalis*

Table 29. Wetland functional assessment for the riverine wetland at the East Elk Creek site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning under normal expectations.
Hydrological Functions		
Flood Attenuation and Storage	High	There is a high density of shrubs and trees and a moderate sized floodplain that appears to flood fairly frequently.
Sediment/Shoreline Stabilization	High	Dense growth of herbaceous and woody species along the streambank.
Groundwater Discharge/ Recharge	N/A	This wetland flood via overbank flooding.
Dynamic Surface Storage	N/A	This wetland flood via overbank flooding.
Biogeochemical Functions		
Elemental Cycling	High	A diverse canopy of herbaceous and woody species plus large quantities of woody debris, leaf litter, and soil organic matter suggest intact and functioning nutrient cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low to Moderate	There may be some imported material from the abandoned mine site and adjacent road but overall, there is little use upstream.
Biological Functions		
Habitat Diversity	High	There are forested, scrub-shrub, emergent, and open water wetland habitats.
General Wildlife Habitat	High	The forest, shrub, and herbaceous canopies provide a diversity of vegetation structure, which, along with high vegetation volume, provides excellent habitat for birds, mammals, and insects. The spring wetlands provide habitat for frogs and insects.
General Fish/Aquatic Habitat	High	Trout were observed in the stream. The water in East Elk Creek is amazingly clear. There is a diversity of pools, riffles, and woody debris along this stretch of the creek.
Production Export/Food Chain Support	High	A permanent water source and large quantities of allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. The diversity of structural vegetation classes (the forb/graminoid, shrub, and tree layers) and spring pools provide a variety of habitats for invertebrate populations.
Uniqueness	High	Other than Deep Creek there are very few riparian areas at this elevation in Garfield county, that are in as good of condition as this site.

Wetland Functional Assessment for the East Elk Creek PCA:
Proposed HGM Class: Slope **Subclass: S2** (these springs are supported by alkaline seepage)
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Betula occidentalis*/mesic forb; *Aquilegia barnebyi*

Table 30. Wetland functional assessment for the slope wetland at the East Elk Creek site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning under normal expectations.
Hydrological Functions		
Flood Attenuation and Storage	N/A	Does not flood via overbank flow.
Sediment/Shoreline Stabilization	N/A	These wetlands do not occur along a major stream channel.
Groundwater Discharge/ Recharge	High	There are many seeps and spring in the area.
Dynamic Surface Storage	High	The buildup of organic soils near seep and spring sources and springbrooks restricts water movement through these areas and provides storage of discharging groundwater.
Biogeochemical Functions		
Elemental Cycling	High	Dense herbaceous cover, organic soil horizons, and/or thick soil A horizons suggest that nutrient cycles are intact.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low to Moderate	These wetlands are supported by groundwater discharge and do not receive upstream inputs of imported materials, although some inputs may be contributed by the Forest Service Road.
Biological Functions		
Habitat Diversity	Moderate	There is scrub-shrub, emergent, and open water wetland habitats.
General Wildlife Habitat	Moderate	Moderately diverse wetland types and vegetation structure, presence of permanent flowing water, and sporadic pools of water provide potential habitat for amphibians, mammals, and birds.
General Fish/Aquatic Habitat	N/A	Although some seeps and springs have a small spring-brook associated with them, these small streams did not appear able to support fish populations.
Production Export/Food Chain Support	High	Permanent discharge of groundwater and subsequent organic matter accumulation produces dissolved organic carbon sources, and likely very little in the way of particulate organic carbon, that eventually make their way into East Elk Creek. Moist soil, permanent flowing water, and sporadic pools help support insect populations.
Uniqueness	Moderate	These alkaline springs are common in this part of Garfield county, but very few are in as good of condition as these.

Figure 24. East Elk Creek PCA.

East Rifle Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M2 High Urgency. Heavy recreational use of this site poses a foreseeable threat.

Location: The site is located approximately 11 miles north-northeast of Rifle, CO. The site begins just north of the Rifle Fish Hatchery and encompasses all of Rifle Mountain Park.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Rifle Falls. T3S R92W Sections 34, 35, and 36; T4S R91W Section 6; T4S R92W Sections 1, 2, 3, and 10-15.

Size: 4,388 acres

Elevation: 7,000 to 9,000 feet.

General Description: This site consists of a narrow box canyon surrounded by sheer vertical limestone cliffs. The riparian area is dominated by box elder (*Acer negundo*) and red-osier dogwood (*Cornus sericea*). The understory in this community is lush and exhibits high species diversity. Common understory species include: gooseberry (*Ribes* sp.), red raspberry (*Rubus idaeus*), Wood's rose (*Rosa woodsii*), baneberry (*Actaea rubra* subsp. *arguta*), false-Solomon's seal (*Maianthemum stellatum*), monkshood (*Aconitum columbianum*), Richardson's geranium (*Geranium richardsonii*), black-eyed Susan (*Rudbeckia ampla*), cow parsnip (*Heracleum sphondylium* var. *montanum*), blue wild rye (*Elymus glaucus*), large-leaved avens (*Geum macrophyllum*), and yellow avens (*G. aleppicum*). A few non-native species, such as orchard grass (*Dactylis glomerata*) and Kentucky bluegrass (*Poa pratensis*) are common along trails within the riparian area. Sandbar willow (*Salix exigua*) and common reed (*Phragmites australis*) are common in open wetland areas. There are numerous springs discharging along this stretch of East Rifle Creek. These springs discharge from the Leadville Limestone, which has been shown to be a major local aquifer (Teller 1983). This aquifer is recharged via precipitation, snowmelt, and stream-flow and has a general subsurface flow toward the south, west, and northwest away from the White River Uplift (Teller 1983). Hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*) and oil shale columbine (*Aquilegia barnebyi*) are found growing near seeps located on the canyon walls. A few of these seeps occur in alcoves nestled into the limestone walls. Numerous springs also discharge at the base of the steep limestone walls where they have formed small marshes before discharging into East Rifle Creek. These marshes are mainly dominated by watercress (*Nasturtium officinale*), beaked sedge (*Carex utriculata*), and monkeyflower (*Mimulus guttatus*). The Colorado Division of Wildlife has developed a few of these stream-level springs to supply the Rife State Fish Hatchery, which is located just downstream from this site, with clear, fairly warm water (the spring water is 55^{o} C and slightly warmer than the stream-water from East Rifle Creek) high in calcium carbonate. As a result, many of the springs are currently dry or are discharging less water than prior to development. Common reed is fairly common in these disturbed areas. Upstream, above where the creek enters the narrow limestone canyon, the riparian community mainly consists of blue spruce (*Picea pungens*), red-osier dogwood, and various willow (*Salix*) species. Downstream from the Rifle State Fish Hatchery, there is an increase in non-native species in the understory, with reed canary grass (*Phalaris arundinacea*) and common reed becoming very abundant along the streamsides.

At one time, a large colony of Black Swifts occupied the canyon, as did a nesting pair of Bald Eagles and Peregrine Falcons. Extensive traffic from recreational climbers, however, caused the abandonment of the swift colony and subsequent migration of both the Bald Eagle and Peregrine Falcon nesting pairs.

Table 31. Natural Heritage element occurrences at the East Rifle Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Sullivantia hapemanii var *purpusii*	Hanging garden sullivantia	G3T3	S3			FS	E
Plant Communities							
Acer negundo/Cornus sericea	**Montane riparian deciduous forest**	**G3?**	**S2**				**B**
Invertebrate							
Ochrotrichia trapoiza	Caddisfly	G?	S?				E

*EO = Element Occurrence

Biodiversity Comments: This site supports a good (B-ranked) occurrence of the globally vulnerable (G3?/S2) box elder/red-osier dogwood (*Acer negundo*/*Cornus sericea*) montane riparian deciduous forest. This plant association is known from lower montane canyons in Utah and western Colorado. There are less than fifty known global occurrences while there are less than ten stands known in Colorado. There is also an occurrence of the globally vulnerable, western Colorado endemic, hanging garden sullivantia, a plant species restricted to waterfalls, seeps, and moist cliffs of calcareous substrates. A caddisfly, thus far only known from Colorado, has also been documented from the site and is considered a conservation priority for invertebrates by Boris Kontradieff, a Professor of Entomology and Curator of the C.P. Gillette Museum of Arthropod Diversity, at Colorado State University.

Boundary Justification: The boundaries were drawn to ensure that all or most of the springs and small side drainages would continue to provide a major portion of the hydrological input to the creek and maintain natural water quality conditions, both of which are vital to the viability of the elements. The site boundaries were not intended to encompass the entire upstream watershed, although consideration of these areas is important to ensure adequate hydrological processes.

Protection Rank Comments: A portion of the site is managed by the U.S. Forest Service while the majority is managed by the City of Rifle.

Management Rank Comments: There is heavy recreational use throughout the site. Rock climbing is extremely popular on the limestone walls and there are at least three campgrounds located along the creek within the site. Current recreation use appears to be impacting localized areas but overall, use is mainly limited to canyon walls and campgrounds. Rock-climbing is the only potential direct threat to the hanging garden sullivantia, however most climbing appears to stay clear of the moist cliff walls. There are numerous foot trails throughout the riparian zone but use of these trails is not extremely heavy and adjacent vegetation is so dense that the probability of hikers venturing off trail is minimal. Forest road 832 runs directly through the riparian area and at times is immediately adjacent to the creek. There are non-native species associated with the road and recreation use. Thus far their impact is not overwhelming, but the potential is high. These potential threats and their impact on the elements should be closely monitored.

Soils Description: Soils along the creek bottoms are mapped Torriorthents. These soils formed on colluvial slopes below the steep cliff faces along this drainage. The soils are mostly well drained and vary from loamy to clayey with variable amounts of gravel, cobbles, and stones (Soil Conservation Service 1985). The porous nature of the soils is consistent with the presence of numerous seeps and spring that discharge within the floodplain.

Restoration Potential: Restoring hydrological flow to the numerous springs, which have been developed for the fish hatchery, would ensure viability of this riparian community.

Wetland Functional Assessment for the East Rifle Creek PCA:
Proposed HGM Class: Riverine Subclass: R4
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Acer negundo/Cornus sericea*

Table 32. Wetland functional assessment for the riverine wetland at the East Rifle Creek site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at potential, however current recreational activity and the presence of the road may be decreasing the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	High	There is a high density of shrubs and trees and a moderate sized floodplain.
Sediment/Shoreline Stabilization	High	Dense growth of herbaceous and woody species along the streambank.
Groundwater Discharge/ Recharge	High	The are numerous springs within the floodplain.
Dynamic Surface Water Storage	High	The springs and their associated wetlands have a high capacity of storing groundwater discharge.
Biogeochemical Functions		
Elemental Cycling	High	A diverse canopy of herbaceous and woody species plus large quantities of woody debris, leaf litter, and soil organic matter suggest intact and functioning nutrient cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	High	There is likely imported material from upstream campgrounds, the adjacent road, and recreational activities. Intact nutrient cycles and a dense and diverse cover of vegetation give this site a high rating for this function.
Biological Functions		
Habitat Diversity	High	There are forested, scrub-shrub, emergent, and open water wetland habitats.
General Wildlife Habitat	High	The forest, shrub, and herbaceous canopies provide a diversity of vegetation structure, which, along with high vegetation volume, provides excellent habitat for birds, mammals, and insects. The spring wetlands provide habitat for frogs and insects. However, heavy recreational use may be disturbing wildlife populations.
General Fish/Aquatic Habitat	High	Trout were observed in the stream. The water in East Rifle Creek is amazingly clear. There is a diversity of pools, riffles, and woody debris along this stretch of the creek. The Rifle Creek Fish Hatchery is located downstream of this site.
Production Export/Food Chain Support	High	A permanent water source and large quantities of allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. The diversity of structural vegetation classes (the forb/graminoid, shrub, and tree layers) and spring pools provide a variety of habitats for invertebrate populations.
Uniqueness	Moderate	The site supports a globally rare riparian plant community and plant and numerous springs.

Figure 25. East Rifle Creek PCA.

Fourmile Creek at Sunlight Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports an excellent occurrence of a globally vulnerable willow carr.

Protection Urgency Rank: P2 High Urgency. Residential and recreational development pressures are high in this area.

Management Urgency Rank: M2 High Urgency. Numerous road exists throughout the site, acting as conduits for non-native species and heavy recreational use.

Location: Fourmile Creek is located approximately 4 miles south-southwest of Glenwood Springs, just upstream from Sunlight Ski Area.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Cattle Creek; Center Mountain. T7S R89W Sections 8, 9, 15, 16, 17, 20, 21, 22, 26-29, and 31-35; T7S R90W Sections 35 and 36; T8S R89W Sections 5, 6, 8, and 10-12; T8S R90W Sections 1-3.

Size: 8,212 acres

Elevation: 6,800 to 9,400 feet.

General Description: The eastern portion of this site is characterized by a Gambel's oak-serviceberry (*Quercus gambelii -Amelanchier utahensis*) shrubland dominating dry upland slopes and narrowleaf cottonwood (*Populus angustifolia*), blue spruce (*Picea pungens*), and thinleaf alder (*Alnus incana*) dominating the riparian areas. The upland oak-serviceberry shrublands are dense and include other shrub species such as mountain mahogany (*Cercocarpus montanus*), piñon pine (*Pinus edulis*), Douglas fir (*Pseudotsuga menziesii*), and sagebrush (*Artemisia* sp.). Several drainages cross the oak-serviceberry shrubland, most of which are dominated by aspen (*Populus tremuloides*). Further upstream, spruce-fir (*Picea engelmannii-Abies lasiocarpa*), willows (*Salix drummondiana*, *S. monticola*, and *S. bebbiana*), thimbleberry (*Rubus parviflorus*), and thinleaf alder dominate a moderately wide valley bottom. Large mesic meadows occupy most of Fourmile Park, while Booth's willow (*Salix boothii*), wolf *willow (S. wolfii*), beaked sedge (*Carex utriculata*), and water sedge (*C. aquatilis*) are dominant along Fourmile Creek and the numerous drainages within the park. Near the eastern end of Fourmile Park, on a north-facing slope, is an extremely large willow carr supported by groundwater discharge. This carr is dominated by Booth's willow, wolf willow, strapleaf willow (*Salix eriocephala* var. *ligulifolia*) and a very high diversity of herbaceous species such as small-winged sedge (*Carex microptera*), beaked sedge (*C. utriculata*), golden sedge (*C. aurea*), bluejoint reedgrass (*Calamagrostis canadensis*), brookgrass (*Catabrosa aquatica*), false hellebore (*Veratrum tenuipetalum*), mountain bluebells (*Mertensia ciliata*), American speedwell (*Veronica americana*), Macoun's buttercup (*Ranunculus macounii*), cowbane (*Oxypolis fendleri*), monkeyflower (*Mimulus guttatus*), bog orchid (*Limnorchis dilatata* subsp. *albiflora*), elephantella (*Pedicularis groenlandica*), and alpine bistort (*Bistorta vivipara*). Adjacent, upland slopes in Fourmile Park are generally dominated by mixed aspen-conifer forests.

The site is in good condition overall, however there are a few scattered roads and trails that fragment the PCA. The activity along these pathways is creating erosion and weed problems. Sunlight Ski area is southeast of the PCA. Downstream of the ski area the riparian vegetation is in poor condition.

Table 33. Natural Heritage element occurrences at the Fourmile Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Salix boothii*/Mesic graminoid**	**Willow carr**	**G3**	**S3**				**A**
Salix boothii/Carex utriculata	**Willow carr**	**G4**	**S3**				**B**
Abies lasiocarpa/Rubus parviflorus	Subalpine forests	G5	S2				B
Quercus gambelii-Amelanchier utahensis	Mixed mountain shrubland	G3G5	SU				B

*EO = Element Occurrence

Biodiversity Comments: An excellent (A-ranked) example of the globally vulnerable (G3/S3) Booth's willow/mesic graminoid (*Salix boothii*/mesic graminoid) willow carr with a very high diversity of herbaceous species is found at this site. This community is found in Colorado, Utah, Idaho, and likely occurs in Wyoming and Montana. The site also harbors a good (B-ranked) example of the state rare Booth's willow/beaked sedge (*Salix boothii*/*Carex utriculata*) willow carr, a good (B-ranked) example of the state imperiled fir/thimbleberry (*Abies lasiocarpa*/*Rubus parviflorus*) subalpine forest, and a good (B-ranked) example of the common oak-serviceberry (*Quercus gambelii-Amelanchier utahensis*) shrubland.

Boundary Justification: Surrounding habitat for the oak-serviceberry community is included to act as a buffer against direct disturbances, such as trampling, and indirect disturbances, such as unnatural erosion. Fourmile Park and the numerous streams draining into Fourmile Creek were included to ensure natural hydrological process remain intact for the two riparian communities. The large willow carr is supported by groundwater discharge. The site boundaries do not account for the source of this groundwater and adequate protection for this community should consider those areas that contribute to this groundwater flow.

Protection Rank Comments: This PCA consists of both private land and lands that are publicly owned lands managed by the White River National Forest. Residential and recreational development pressures are high in this area. If Sunlight Ski area is expanded, residential development in this area is expected to follow. Any developments may threaten this site.

Management Rank Comments: There are roads scattered throughout the area, which may cause erosion problems. These roads are also acting as conduits for non-native species, such as Kentucky bluegrass (*Poa pratensis*), yellow sweet clover (*Melilotus officinale*), bindweed (*Convolvulus arvensis*), dandelion (*Taraxacum officinale*), tansy (*Tanacetum vulgare*), curly dock *(Rumex crispus*), smooth brome (*Bromus inermis*), and mullein (*Verbascum thapsus*). Recommended management actions include the implementation of a non-native plant eradication program. One of the best defenses against the spread of these non-native species is to discourage future trails/roadways. A management agreement with private landowners should be pursued.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area. Soils were highly saturated in the large hillside willow carr (*Salix boothii*/Mesic graminoid) and had peat accumulation in the wettest areas. A brief soil profile, taken from the large hillside willow carr, is given below:

O Horizon 2-0 inches 10 YR 2/1
A Horizon 0-12 inches 10 YR 2/1 silty clay

The riparian areas had an abundance of gravel and stones, but there was some soil formation along with organic matter accumulation under the willows.

Restoration Potential: Restoring trails/roadways in the area may help alleviate additional influx of non-native species. Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of the riparian area within Fourmile Park. Rest periods are recommended in order to provide time for plant establishment and recovery. Late summer and fall grazing may benefit sedge species, as these species are protected by a root reserve, but willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen et al. 1985).

Wetland Functional Assessment for the Fourmile Creek at Sunlight PCA:
Proposed HGM Class: Riverine Subclass: R2
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Salix boothii*/*Carex utriculata*; *Abies lasiocarpa*/*Rubus parviflorus*

Table 34. Wetland functional assessment for the riverine wetland at the Fourmile Park at Sunlight site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at potential, however current grazing activity is decreasing the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	High	There is a fairly high density of vegetation along the creek and near the downstream end of Fourmile Park there are a few small beaver ponds.
Sediment/Shoreline Stabilization	High	There is a fairly high density of vegetation along the creek.
Groundwater Discharge/ Recharge	N/A	This wetland floods via overbank flow.
Dynamic Surface Water Storage	N/A	This wetland floods via overbank flow.
Biogeochemical Functions		
Elemental Cycling	High	A dense cover of herbaceous and woody species and accumulation of soil organic matter suggest intact and functioning nutrient cycles. Beaver ponds downstream also provide anaerobic pathways for nutrient transformations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	There may be some excessive nutrient and/or sediment inputs from the numerous cattle in the area, in which case the beaver ponds downstream would provide an effective means of retaining sediments and nutrient laden waters allowing for sedimentation and/or nutrient cycling processes to potentially remove these inputs from the water column.
Biological Functions		
Habitat Diversity	High	Scrub-shrub, forested, and emergent wetland types are present.
General Wildlife Habitat	High	Willows and forested areas provide habitat for bird species while willows and herbaceous species provide browse for large mammals.
General Fish/Aquatic Habitat	Moderate	The creek was fairly small, but overhanging willows, vegetated streambanks and small riffles and pools provide potential habitat.
Production Export/Food Chain Support	High	Dense cover of willows and herbaceous species contribute allochthonous organic substrates to the stream which provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. Beaver ponds provide potential habitat for aquatic insects.
Uniqueness	Low	The site supports a fairly common riparian community in this portion of Colorado.

Wetland Functional Assessment for the Fourmile Park at Sunlight PCA:
Proposed HGM Class: Slope   Subclass: S1
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Salix boothii*/mixed graminoids

Table 35. Wetland functional assessment for the slope wetland at the Fourmile Park at Sunlight site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland is functioning at potential.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	N/A	This wetland does not flood via overbank flow.
Groundwater Discharge/ Recharge	High	This large willow carr is supported by a hillside seep.
Dynamic Surface Storage	High	Peat accumulation is occurring in the wettest places while the remaining portion of the wetland has a thick A horizon indicating that soils are semi-permanently saturated and have a high capacity to store/release groundwater. During large precipitation events, surface flow from the surrounding slope may enter this wetland. The density of willow trees may dissipate energy of the surface flow and allow some retention time.
Biogeochemical Functions		
Elemental Cycling	High	There is a dense and diverse cover of woody and herbaceous species producing a thick litter layer. Large quantities of soil organic matter and in some places, peat, provide energy for microbes to utilize in nutrient mineralization and immobilization processes. The amount of carbon in the litter layer and soil and the high diversity and density of vegetation suggest that nutrient cycles are in balance.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Any inputs would likely be from the nearby forest service road where sediment and possibly heavy metals could enter the wetland. However, there is a decent sized buffer between the road and the wetland. Any inputs reaching the wetland could be removed via energy dissipation of surface water or via nutrient transformations in the soil.
Biological Functions		
Habitat Diversity	Moderate	Scrub-shrub and emergent wetland types are present.
General Wildlife Habitat	Moderate	Willows provide habitat for some bird species while willows and herbaceous species provide browse for large mammals.
General Fish/Aquatic Habitat	N/A	There is no defined creek flowing through this wetland.
Production Export/Food Chain Support	High	Permanent discharge of groundwater and subsequent organic matter accumulation produces dissolved organic carbon sources, and likely very little in the way of particulate organic carbon, that eventually make their way into Fourmile Creek. The diversity of plant species provides potential habitat for invertebrates.
Uniqueness	High	Although, willow carrs are not rare, this particular one is very large and contains a high diversity of plant species.

Figure 26. Fourmile Creek PCA.

Garfield Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a fair occurrence of a globally imperiled plant community.

Protection Urgency Rank: P2 High Urgency. Although the site is managed by the Colorado Division of Wildlife and thus has some protection, there is a lot of residential development occurring in the area.

Management Urgency Rank: M2 High Urgency. Management concerns mainly stem from upstream land and water use.

Location: This site is located approximately 3.5 miles south of the town of New Castle, CO within the Garfield Creek State Wildlife Area.

Legal Description: U.S.G.S. 7.5 minute quadrangle: New Castle. T6S R91W Sections 22-26.

Size: 463 acres

Elevation: 6,100 to 6,500 feet.

General Description: The reach of Garfield Creek contained in this site is best described as a medium sized stream meandering through a long wide valley. Surrounding slopes are dominated by piñon-juniper (*Pinus edulis -Juniperus osteosperma*) and sage (*Artemisia* sp.). Upstream, on adjacent upland areas, there are numerous hay meadows, pasture, new housing developments, and County Road 312. The riparian area along the downstream portion of this site is dominated by a sparse overstory of narrowleaf cottonwood (*Populus angustifolia*), river birch (*Betula occidentalis*), and hawthorn (*Crataegus rivularis*) with Canada goldenrod (*Solidago canadensis*) and Indian hemp (*Apocynum cannabinum*) being fairly common in the understory. Further downstream, there are a series of old beaver dams with high species diversity. Cattail (*Typha latifolia*), beaked sedge (*Carex utriculata*), water speedwell (*Veronica catenata*), spikerush (*Eleocharis palustris*), and hardstem bulrush (*Scirpus acutus*) dominate the wettest areas. Sandbar willow (*Salix exigua*), pale bulrush (*Scirpus pallidus*), wild mint (*Mentha arvense*), showy milkweed (*Asclepias speciosa*), shortawn foxtail (*Alopecurus aequalis*), tall mannagrass (*Glyceria elata*), foxtail barley (*Hordeum jubatum*), tuberous rush (*Juncus nodosus*), wild licorice (*Glycyrrhiza lepidota*), and dock (*Rumex crispus*) occupy saturated areas surrounding the beaver ponds. A small meadow, which appears to have formed behind an old beaver dam and is now elevated above the current stream level, is dominated by woolly sedge (*Carex lanuginosa*), sloughgrass (*Beckmannia syzigachne*), and redtop (*Agrostis gigantea*). There are numerous non-native species that occupy the riparian area, especially the wetlands near the beaver ponds. Non-natives such as redtop, barnyard grass (*Echinochloa crus-galli*), Canada goldenrod, Canada thistle (*Cirsium arvense*), white sweetclover (*Melilotus albus*), smooth brome (*Bromus inermis*), orchard grass (*Dactylis glomerata*), and timothy (*Phleum pratense*) are common in the area. Numerous northern leopard frogs (*Rana pipiens*) were observed in this area as well as signs of recent bear activity.

Table 36. Natural Heritage element occurrences at the Garfield Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Populus angustifolia/Crataegus rivularis	**Narrowleaf cottonwood riparian forest**	**G2?**	**S2?**				**C**
Amphibians							
Rana pipiens	Northern leopard frogs	G5	S3		SC	FS/BLM	E

*EO = Element Occurrence

Biodiversity Comments: This site supports a fair (C-ranked) occurrence of the globally imperiled (G2?/S2?) narrowleaf cottonwood/hawthorn (*Populus angustifolia*/*Crataegus rivularis*) riparian forest. This community type was previously only known from six stands located on the lower slopes of the San Juan Mountains and along tributaries of the San Miguel River, Colorado. Also numerous northern leopard frogs were observed in the area.

Boundary Justification: The site boundaries protect the plant community from direct disturbances associated with development and improper grazing. The boundaries also provide a buffer from nearby populations of non-native species growing on disturbed sites such as housing developments, roads, hay meadows, and pasture. While the boundaries would allow Garfield Creek to maintain natural fluvial processes along this stretch of the creek they do not protect upstream hydrological sources. Thus, any management/conservation plan should address upstream water use and quality.

Protection Rank Comments: The site is currently managed by the Colorado Division of Wildlife as the Garfield Creek State Wildlife Area. Current use appears to mainly be hunting and grazing, although no signs of recent grazing were observed. There are new houses being constructed in the area, thus it is suspected that development pressure in the area is high.

Management Rank Comments: Management concerns mainly stem from upstream land and water use. Non-native species are abundant. Eradication and prevention of further spread of these species needs to be addressed. Upstream water diversions may be impacting stream dynamics at this site, as portions of the stream appear to be entrenching.

Soils Description: The soils along the creek are mapped as Torrifluvents. These soils formed in alluvium and are highly stratified and vary widely in texture and depth (Soil Conservation Service 1985). Organic matter is accumulating in the soils near the beaver ponds and in wet meadows on the floodplain.

Restoration Potential: Control of non-native species would greatly benefit the ecological health of this area. Ensuring continued beaver activity would allow the mosaic of wetlands found along the creek to persist.

Wetland Functional Assessment for the PCA:
Proposed HGM Class: Riverine   Subclass: R3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus angustifolia/Crataegus rivularis*

Table 37. Wetland functional assessment for the riverine wetland at the Garfield Creek site. Functions in **BOLD** are those functioning below normal.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential (lower reach)	This wetland appears to be functioning slightly below potential as current adjacent land use is affecting the functional integrity of the wetland.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The riparian area is narrow and entrenched in some places. Thus, the floodplain is limited in extent. The density of woody vegetation varies along the creek according to disturbances and elevation.
Sediment/Shoreline Stabilization	Moderate	Sediment stabilization capacity varies along the creek. Reaches above the beaver ponds are entrenching whereas areas below the ponds appear to be in balance with fluvial processes.
Groundwater Discharge/ Recharge	N/A	No springs or seeps were encountered a this, however it is assumed that there are discharge areas upstream given the quantity of permanent water in this creek in such an arid landscape.
Dynamic Surface Water Storage	N/A	Flooding at this site is primarily due to overbank or in-channel flow.
Biogeochemical Functions		
Elemental Cycling	High	Given the diversity of plant species and thus diverse types of litter inputs, the presence of aerated water (the stream), and areas with saturated and anaerobic soils, there is likely a stable and persistent cycling of nutrients. Thus, important, local biogeochemical functions are likely occurring at this site. However, non-native species and entrenching of the creek may be impacting cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Sediment from adjacent development sites, roads, and pasture could be entering the creek. Although the density of woody vegetation along the creek is sparse, the beaver ponds would help trap excess loads of imported material.
Biological Functions		
Habitat Diversity	High	There are forested, scrub-shrub, and open water (beaver ponds) wetland habitats.
General Wildlife Habitat	Moderate	Although habitat diversity is high, poor vegetation structure and volume along much of the creek limits avian habitat. Entrenchment of the creek has limited the extent of riparian vegetation.
General Fish/Aquatic Habitat	Moderate	Unsure of which fish species occur in the creek. Some areas do not provide high quality fish habitat due to lack of overhanging vegetation and an apparent imbalance in fluvial processes which has limited the amount of riffles and pools dispersed in the creek.
Production Export/Food Chain Support	High	A permanent water source and high quantities of allochthonous organic substrates provide carbon and nutrients for downstream ecosystems. The diversity of

		wetland vegetation also provide a variety of habitats for invertebrate populations.
Uniqueness	Moderate	The site supports a globally imperiled plant community but it is in fair condition.

Figure 27. Garfield Creek PCA.

Grizzly Creek Canyon Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: This site is located approximately 3.5 miles east of Glenwood springs within the White River National Forest. The site includes the entire Grizzly Creek drainage including Monument, Duck, and Grizzly Lakes.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Broken Rib Creek; Carbonate; Glenwood Springs. T3S R88W Section 31; T3S R89W Sections 35 and 36; T4S R88W Sections 5-11, 14-24, 26-28, 34, and 35; T4S R89W Sections 1, 2, 11-14, and 24; T5S R88W Sections 2-4, 8-10, 15-17, 20-22, 27, 28, 33, and 34.

Size: 16,356 acres

Elevation: 6,100 to 10,800 feet.

General Description: This is a very large site encompassing the entire Grizzly Creek watershed. Near the headwaters, the area consists of an expansive, open, flat area with numerous subalpine lakes connected via a series of large wetlands and small streams. There are numerous large boulders scattered throughout the area and small limestone outcroppings and cliffs. The non-forested, adjacent hillsides are covered with shortfruit willow (*Salix brachycarpa*) while conifers dominate higher slopes. The lakes are surrounded by concentric rings of water and beaked sedge (*Carex aquatilis* and *C. utriculata*, respectively) meadows grading into low-stature willow carrs mainly composed of sedges and planeleaf willow (*Salix planifolia*). There appears to be an ephemeral hydrological surface connection between Monument and Duck Lake, although there may be persistent groundwater flow between the two. There is a permanent stream that connects Duck Lake to Grizzly Lake. Mountain willow (*S. monticola*) and a variety of herbaceous species dominate this stream. Grizzly Creek drains out of Grizzly Lake and heads east where it has cut a steep canyon through limestone down to its confluence with the Colorado River. Mountain willow, Drummond's willow (*S. drummondiana*), marsh bittercress (*Cardamine cordifolia*), beaked sedge, and field horsetail (*Equisetum arvense*) are common along this stretch of Grizzly Creek. Near Grizzly Creek Springs there are a few mesic meadows dominated by Idaho fescue (*Festuca idahoensis*) and Thurber fescue (*Festuca thurberi*). These meadows are interrupted by islands of spruce-fir (*Picea-Abies* sp.) forest while aspens (*Populus tremuloides*) are common adjacent to the meadows. Further downstream, narrowleaf cottonwood (*Populus angustifolia*) is common along the creek while the upland slopes are dominated by Douglas fir (*Pseudotsuga menziesii*), mountain lover (*Paxistima myrsinites*), Gambel's oak (*Quercus gambelii*), snowberry (*Symphoricarpos oreophilus*), and sticky-laurel (*Ceanothus velutinus*). On west and south facing slopes, Douglas fir is often dominate with mountain lover while Gambel's oak and mountain lover are common on east and south facing slopes. About 3.5 miles upstream from the mouth of Grizzly Creek, an aqueduct removes water from the creek and transports it into No Name Creek to supplement Glenwood Springs' city water supply.

Table 38. Natural Heritage element occurrences at the Grizzly Creek Canyon PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Salix monticola/**Mesic forb**	**Montane riparian willow carr**	**G3**	**S3**				**B**
Pseudotsuga menziesii/Paxistima myrsinites	Lower montane forest	G2G3	S2S3				E
*Salix monticola/*Mesic forb	Montane riparian willow carr	G3	S3				E
Festuca idahoensis-Festuca thurberi	Montane grasslands	G3G4	S3S4				E
Salix drummondiana/Carex utriculata	Montane willow carr	G4	S3				E
Quercus gambelii/Paxistima myrsinites	Mixed mountain shrublands	GU	SU				E
Plants							
Draba spectabilis var. *oxyloba*	Whitlowgrass	G3?T3Q	S3				E

*EO = Element Occurrence

Biodiversity Comments: The site supports a good (B-ranked) and an unranked (E) occurrence of the globally vulnerable (G3/S3) mountain willow/mesic *forb (Salix monticola*/mesic forb) montane riparian willow carr. This association is only known from Colorado where over thirty occurrences have been documented. The site also harbors an unranked (E) occurrence of the globally vulnerable (G2G3/S2S3) Douglas fir/Mountain lover (*Pseudotsuga menziesii*/*Paxistima myrsinites*) lower montane forest. This association has a naturally restricted distribution, being found on very steep, well-drained terrain of mostly northern exposures. There are unranked (E) occurrences of the Idaho-Thurber fescue (*Festuca idahoensis-Festuca thurberi*) montane grassland, the state rare (G4/S3) Drummond's willow/beaked sedge (*Salix drummondiana*/*Carex utriculata*) montane willow carr, and the Gambel's oak/Mountain lover (*Quercus gambelii*/*Paxistima myrsinites*) mixed mountain shrubland. An unranked (E) occurrence of the globally vulnerable (G3?T3Q/S3) Whitlow-grass (*Draba spectabilis* var. *oxyloba*) is also found at this site.

Boundary Justification: The boundary encompasses the entire Grizzly Creek watershed and thus, ensures continued hydrological flow and allows natural fluvial processes to dynamically maintain the riparian plant communities found at this site. The boundaries also provide enough area to allow natural disturbances (fire, insects, disease, etc.) to maintain viable upland plant communities.

Protection Rank Comments: The site is managed by the White River National Forest and does not have any special protection status. The area currently receives multiple use from logging, grazing, and recreation users.

Management Rank Comments: Cattle and sheep graze heavily on upland slopes within the upper portion of the site. Management actions should reduce intensity of grazing to minimize potential impacts on the elements. Recreational use has resulted in numerous new roads and trails in the area. This activity should be closely monitored.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Potential restoration of some roads and trails may help alleviate an influx of non-native species.

Wetland Functional Assessment for the PCA: This site contains a long and extensive riparian area with a high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The diversity of habitats, including scrub-shrub, forested, and emergent wetlands, provide excellent habitat for avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris and thus excellent fish habitat.

Figure 28. Grizzly Creek Canyon PCA.

Hanging Lake Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrences of a globally vulnerable plant and plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M2 High Urgency. There is heavy recreational use along the creek up to Hanging Lake and Spouting Rock.

Location: Hanging Lake is located along West Fork of Deadhorse Creek within Glenwood Canyon. The site is approximately 7 miles northeast of Glenwood Springs, CO.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Shoshone. T5S R87W Section 19.

Size: 38 acres

Elevation: 6,300 – 6,700 ft.

General Description: This site encompasses a narrow, steep canyon flanked by 400-600 foot horizontally stratified sandstone and limestone cliffs. Douglas fir (*Pseudotsuga menziesii*) occurs sporadically on these slopes while also occurring in the riparian area along with box elder (*Acer negundo*), blue spruce (*Picea pungens*), and red-osier dogwood (*Cornus sericea*). Hanging Lake, which is located along East Fork Deadhorse Creek just above the confluence with West Fork Deadhorse Creek, is a unique environment with lush vegetation and aqua-blue water. Stream-flow in East Fork Deadhorse Creek is perennial while flow in West Fork Deadhorse Creek, although indicated on maps as perennial, appears to be intermittent. Downstream of the confluence of these two forks, stream-flow is perennial due to drainage from Hanging Lake.

Hanging Lake was formed by a geologic fault, which caused the lake bed to drop away from the valley floor above. The lake receives perennial flow from East Fork Deadhorse Creek via Bridal Veil Falls. The lake edge has built up from dissolved carbonates, which are deposited on the shore and on surrounding slopes as the lake water flows over the edge and makes its way down to the confluence with West Fork Deadhorse Creek. Thus, the lake's edge and the downstream slope are encrusted with a thick deposit of calcium carbonate where species such as oil shale columbine (*Aquilegia barneybi*) and hanging garden sullivantia (*Sullivantia hapemanii* var. *pupusii*) are fairly common. Small wetlands are located upstream of Bridal Veil Falls (near Spouting Rock), along the edge of Hanging Lake, and on the downstream slope where drainage from Hanging Lake saturates the hillside. These areas are dominated by oil shale columbine, hanging garden sullivantia (on steep faces), red-osier dogwood, river birch (*Betula occidentalis*), beaked sedge (*Carex utriculata*), Rocky Mountain rush (*Juncus saximontanus*), bog orchid

(*Limnorchis* sp.), brookgrass (*Catabrosa aquatica*), redtop (*Agrostis gigantea*), leafybract aster (*Aster foliaceus*), and American speedwell (*Veronica americana*). Hornwort (*Ceratophyllum demersum*) is the dominant aquatic species in these areas. The riparian vegetation near Hanging Lake and Spouting Rock consisted of red-osier dogwood, river birch, box elder, and mock-orange (*Philadelphus microphyllus*).

Table 39. Natural Heritage element occurrences at the Hanging Lake PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Sullivantia hapemanii* var. *purpusii	**Hanging garden sullivantia**	**G3T3**	**S3**				**B**
Plant Communities							
Acer negundo/Cornus sericea	**Montane riparian forest**	**G3?**	**S2**				**B**
Birds							
Cypseloides niger	Black Swift	G4	S3B				E

*EO = Element Occurrence

Biodiversity Comments: This site contains a good (B-ranked) occurrence of a globally vulnerable (G3T3/S3) plant subspecies, the hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*), which is endemic to western Colorado. The site also contains a good (B-ranked) occurrence of the globally vulnerable (G3?/S2) box elder/red-osier dogwood (*Acer negundo*/*Cornus sericea*) montane riparian forest. This riparian plant community is known from less than 50 occurrences globally and less than 10 occurrences are known in Colorado. The Black Swift record represents a traditional nesting colony with five to nine nesting pairs. Estimates suggest that over 200 nesting pairs of Black Swifts occur in Colorado, representing between 10% and 20% of the total nesting population of the species (Boyle 1998). This makes Colorado's population an important component of this bird's total population. In addition, Black Swifts restrict their nesting to areas near or behind waterfalls or to caves with running water, because such habitats are uncommon, any that support breeding swift populations are important to protect. This species' low population size, few occurrences, and lack of local trend data are all reasons for its vulnerable ranking in the state.

Boundary Justification: The boundary encompasses the riparian area along Deadhorse Creek and a portion of the adjacent slopes. However, upstream reaches of East and West Fork Deadhorse Creek were not included in the site boundaries. A comprehensive management/protection plan needs to consider these areas to ensure hydrological processes, which are necessary for the viability of the wetland and riparian elements, remain intact. The current boundaries allow fluvial processes along the creek to dynamically maintain riparian and wetland communities. The boundaries, along with the inaccessibility of the Black Swift's particular habitat, prevent direct disturbance to the Black Swift nests.

Protection Rank Comments: The U.S. Forest Service currently manages the site and it is a popular hiking destination. Designating this site as a "Special Interest Area" would assist in protecting the site's unique geologic features and ecological diversity.

Management Rank Comments: There is heavy recreational use along the creek up to Hanging Lake and Spouting Rock. There are few obvious threats to Black Swifts, except where development, such as trails and boardwalks, alters nesting habitat. Protecting stream-flows and the present physical state of the falls at Hanging Lake from alteration and limiting direct access to the falls through the design and placement of trails would ensure continued nesting by the swifts. Diversion of stream water causing reduced flow at the falls could cause swifts to abandon the site and affect the viability of the wetland and riparian plant communities. Heavy recreational use has trampled streamside vegetation in some areas and has resulted in the spread on non-native species such as Kentucky bluegrass (*Poa pratensis*), dandelion (*Taraxacum officinale*), and smooth brome (*Bromus inermis*).

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area. Overall, soils were derived from alluvium except near Hanging Lake, where soil development was often limited due to constant deposition of calcium carbonate. However, those areas that were saturated and on fairly level terrain had accumulated a deep litter layer (O horizon) due to a dense growth of mosses and herbaceous vegetation.

Restoration Potential: Non-native species eradication and restoring growth of native vegetation along the streambanks (i.e. eliminate trampling disturbance) are the predominant opportunities for restoration.

Wetland Functional Assessment for the Hanging Lake PCA:
Proposed HGM Class: Riverine   Subclass: R2
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Acer negundo/Cornus sericea*

Table 40. Wetland functional assessment for the riverine wetland at the Hanging Lake site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland is functioning at potential.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	There is a high density of shrubs and trees but a limited floodplain.
Sediment/Shoreline Stabilization	High	Dense growth of herbaceous and woody species along the streambank.
Groundwater Discharge/ Recharge	N/A	No sign of springs were observed, although it is likely they exist here due to the geology of the area.
Dynamic Surface Water Storage	N/A	This wetland flood via overbank flow.
Biogeochemical Functions		
Elemental Cycling	High	A diverse canopy of herbaceous and woody species plus large quantities of woody debris, leaf litter, and soil organic matter suggest intact and functioning nutrient cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	There may be imported material from recreational activities, such as sediment from trails.
Biological Functions		
Habitat Diversity	High	There are forested, scrub-shrub, emergent, and open water wetland habitats within this site.
General Wildlife Habitat	High	The forest, shrub, and herbaceous canopies provide a diversity of vegetation structure, which, along with high vegetation volume, provides excellent habitat for birds, mammals, and insects. Hanging Lake and associated wetlands provide habitat for frogs, insects, and trout. However, heavy recreational use may be disturbing wildlife populations.
General Fish/Aquatic Habitat	High	Trout are thriving in Hanging Lake, but unsure whether a population exists in the stream since Hanging Lake is disjunct from the stream bed.
Production Export/Food Chain Support	High	A permanent water source and large quantities of allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. The diversity of structural vegetation classes (the forb/graminoid, shrub, and tree layers) and spring pools provide a variety of habitats for invertebrate populations.
Uniqueness	High	The site supports a globally rare riparian plant community and plant plus a unique geologic and aesthetic setting.

Figure 29. Hanging Lake PCA.

Headwaters of Patterson Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports an excellent occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: The site is approximately 13.5 miles north of Glenwood Springs, CO just east of the Elk Lakes. The site partially lies within the Flat Tops Wilderness along an unnamed drainage, near the headwaters of Patterson Creek.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Blair Mountain. T3S R89W Sections 21 and 28.

Size: 305 acres

Elevation: 10,700 to 10,800 feet.

General Description: The site encompasses a narrow subalpine valley bordered by two low ridges. The riparian area consists of a mosaic of willows (*Salix wolfii* and *S. planifolia*) and sedge (*Carex aquatilis*, *C. utriculata*, and *C. microptera*) meadows. Other species found in this mosaic include tufted hairgrass (*Deschampsia cespitosa*), rosecrown (*Clementsia rhodantha*), marsh marigold (*Caltha leptosepala*), marsh bittercress (*Cardamine cordifolia*), and hemlock parsley (*Conioselinum scopulorum*). There are numerous springs, which, along with drainage from the many small lakes in the area, support hydrological flow in this unnamed side-drainage of Patterson Creek. The creek flows due north for a short distance, then turns west down a steep gulch before its confluence with Patterson Creek.

Table 41. Natural Heritage element occurrences at the Headwaters of Patterson Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Salix wolfii*/Mesic forb**	Subalpine riparian willow carr	**G3**	**S3**				**A**
Carex aquatilis-Carex utriculata	Montane wet meadows	**G4**	**S4**				**A**

*EO = Element Occurrence

Biodiversity Comments: The site supports an excellent (A-ranked) occurrence of the globally vulnerable (G3/S3) wolf willow/mesic forb (*Salix wolfii*/mesic forb) subalpine riparian willow carr. This community has a widespread distribution but does not appear to be abundant when it occurs. The site also supports an excellent (A-ranked) occurrence of the common (G4/S4) water sedge/beaked sedge (*Carex aquatilis*/*C. utriculata*) montane wet meadow.

Boundary Justification: The boundary encompasses upstream hydrological sources and provides space for dynamic changes in the distribution of plant communities along the creek. A series of springs, which support a fairly large wetland located northeast of the elements of concern, were also included in the site boundaries due to the potential for this area to provide nearby seed sources and the probability that this area harbors similar elements.

Protection Rank Comments: A large portion of the site occurs within the Flat Tops Wilderness Area. The remaining portion is within the White River National Forest.

Management Rank Comments: Sheep grazing is the main management concern for the site. Current impacts are minimal, but the activity should be monitored. There are very few non-native species present.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Other than altering grazing regimes, there is little opportunity for restoration as most of the site is intact.

Wetland Functional Assessment for the PCA: This mosaic of willows and sedge meadows likely provides much in the way of flood attenuation and sediment/shoreline stabilization. Groundwater discharge is occurring via the numerous springs in the area. This wetland also likely provides excellent habitat for small and large mammals, avian species, and insects. Given the intact nature of the area, nutrient cycles are assumed to be intact which also provides excellent production export.

Figure 30. Headwaters of Patterson Creek PCA.

Meadow Creek at Deep Creek Point Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: This site is located approximately 12 miles north of the town of New Castle, CO within the White River National Forest. The site is also about 1 mile south of the Meadow Creek Cow Camp.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Meadow Creek Lake. T3S R90W Section 19; T3S R91W Sections 23-26, 35, and 36.

Size: 1,565 acres

Elevation: 9,000 to 9,700 feet.

General Description: This portion of Meadow Creek is characterized by a small mountain stream near the creek's headwaters. At the confluence of numerous small drainages, where Meadow Creek forms, there is a fairly large reservoir, Meadow Creek Lake. Downstream from the reservoir, the creek cuts through a narrow limestone canyon. Above the canyon, willows (*Salix* spp.) mainly dominate the riparian area whereas within the canyon Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) increase in abundance. Large willow carrs, dominated by mountain willow (*Salix monticola*), Drummond's willow (*S. drummondiana*), and planeleaf willow (*S. planifolia*), also occur within the confines of the limestone canyon. Further downstream, conifers become the dominant overstory species.

Table 42. Natural Heritage element occurrences at the Meadow Creek at Deep Creek Point PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Salix monticola*/Mesic forb**	Montane riparian willow carr	**G3**	**S3**				**B**

*EO = Element Occurrence

Biodiversity Comments: The site supports a good (B-ranked) occurrence of the globally vulnerable (G3/S3) mountain willow/mesic forb (*Salix monticola*/mesic forb) montane riparian willow carr. This association is only known from Colorado where over thirty occurrences have been documented.

Boundary Justification: The boundary encompasses the entire riparian area along Meadow Creek and a portion of the adjacent slopes. However, upstream reaches of Meadow Creek were not included in the site boundaries. A comprehensive management/protection plan needs to consider these areas to ensure hydrological processes, which are necessary for the viability of the wetland and riparian elements, remain intact. The current boundaries allow fluvial processes along the creek to dynamically maintain riparian and wetland communities.

Protection Rank Comments: The site is managed by the White River National Forest and has no special protection status.

Management Rank Comments: Current management is adequate for the viability of the element. Some grazing is occurring upstream. The upstream reservoir impacts natural hydrological processes but the impacts currently appear to be minimal.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: There are numerous roads and trails in the area that could potentially be revegetated. Although the reservoir has altered hydrological process, the impacts appear to be minimal. This may be due to the fact that it lies at the headwaters of Meadow Creek and thus does not affect inputs from downstream drainages.

Wetland Functional Assessment for the PCA: This riparian area likely does not provide much in the way of flood attenuation give its close proximity downstream from a reservoir and the fact that once Meadow Creek enters the limestone canyon, the gradient greatly increases. This area likely provides excellent habitat for small and large mammals, avian species, and insects. Given the intact nature of the area, nutrient cycles are assumed to be intact which also provides excellent production export.

Figure 31. Meadow Creek at Deep Creek Point PCA.

North Fork Derby Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a poor occurrence of the state endangered boreal toad.

Protection Urgency Rank: P5 This PCA falls completely within the Flat Tops Wilderness Area and protection is complete.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: This PCA is located approximately 14.5 miles southwest of Yampa, Colorado and approximately 0.5 miles south of Bailey Lakes.

Legal description: U.S.G.S. 7.5 minute quadrangle: Dome Peak. T1S R86W, S7, 18; T1S R87W, S12-14.

Size: 1,354 acres

Elevation: 9,970 to 10,732 feet

General Description: This PCA lies within the Flat Tops Wilderness Area of the White River National Forest, approximately 1.5 miles from the nearest trailhead at Stump Park. The remoteness of this PCA leaves it free of disturbance. The site encompasses a high altitude wet meadow, lying between 9,970 and 10,732 feet. The wetland occupies a level floodplain terrace along North Fork Derby Creek and the PCA boundary includes forested areas upslope of the meadow and creek. The meadow includes a rich assemblage of grasses, sedges and rushes common to mesic alpine meadows. The slopes rising from the meadow are forested with spruce-fir (*Picea* sp.-*Abies lasiocarpa*) and aspen (*Populus tremuloides*).

The sole species responsible for this PCA's designation is the boreal toad (Southern Rocky Mountain population). A single boreal toad was observed here in August 2000, without evidence of breeding.

Table 43. Natural Heritage elements at the North Fork Derby Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sens.	EO* Rank
Amphibians							
Bufo boreas population 1	boreal toad (Southern Rocky Mountain population)	G4T1Q	S1	C	E	FS	D

*EO=Element Occurrence

Biodiversity Comments: This PCA includes the boreal toad (Southern Rocky Mountain population), an amphibian that is critically imperiled in the state and imperiled on a global scale (G4T1QS1). The actual occurrence, however, is rated poor (D).

Determination of the size and breeding status of the population is essential. This lack of knowledge contributes to the low ranking of the boreal toad occurrence.

A single adult boreal toad was observed in the wetlands along Derby Creek here in 2000. There were approximately 206 historic localities for the Boreal Toad in Colorado. Presently, only three to four healthy populations exist in Colorado, composed of less than 20 high priority breeding occurrences. None of these breeding sites are known from Garfield County and there are only 4 historical records of boreal toads in Garfield County, the most recent observation dating to 1994. Populations have declined precipitately or disappeared over the past 20 years, and continue to decline. The reasons for the decline are unknown; however, the chytrid fungus, a fungal skin infection, has recently been implicated in present declines.

Boundary Justification: The boundary rings the ponds and wetlands of the area, encompasses downstream riparian communities, and includes buffers on the adjacent slopes. This is intended to protect riparian and wetland vegetation and adjacent forests for the toads. The current hydrologic processes are necessary to allow persistence of the toads and hydrologic modifications to the wetland and the upper watershed supplying it should be avoided. Dispersing individuals may travel outside of the boundaries.

Protection Rank Comments: The PCA is managed by the U.S. Forest Service and protected as wilderness.

Management Rank Comments: Further survey work is required to determine the size, reproductive status and trend of the population. Should populations show significant signs of decline, mitigating measures may become necessary. Without monitoring, however, knowledge of whether disease or management is impacting the population is impossible. Logging is not a concern; however, future revisions of the forest management plan directing hiker activities at the meadow away from the wetlands would limit disturbance and the opportunity for introduction of disease.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area. The soils in the area formed in unconsolidated colluvial deposits resulting from landslides. Sedimentary rock including sandstone and siltstone dating to the Tertiary age is found at higher elevation.

Restoration Potential: Considering how remote the site is and the minimal amount of disturbance, there is little opportunity for restoration activities**.**

Wetland Functional Assessment for the PCA: A functional assessment of this site was not conducted due to a lack of information.

Figure 32. North Fork Derby Creek PCA.

Northwater Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrence of the globally vulnerable Colorado River cutthroat trout.

Protection Urgency Rank: P2 High Urgency. Threat is expected within five years.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Nine miles northwest of Rifle, Colorado, and five miles southeast of Rio Blanco

Legal Description: U.S.G.S. 7.5 minute quadrangle: Anvil Points, Forked Gulch, Rio Blanco. T5S R94W Sections: 8-11, 14-21, 29; T5S R95W Sections: 11-14.

Size: 4,162 acres

Elevation: 7,800 to 9,000 feet

General Description: Northwater Creek is one of three prominent drainages on the southeastern portion of the Roan Plateau. It is a major tributary to East Middle Fork Parachute Creek, a tributary of the Colorado River. It begins as a small stream on the eastern edge of the Roan Plateau and joins Trapper Creek approximately 7 miles later. The first several miles are in an open valley with aspen (*Populus tremuloides*) forests and mountain sagebrush/snowberry (*Artemisia-Symphoricarpos* sp.) shrublands. In the more open gentle gradient areas of upper Northwater Creek, graminoid wetlands, e.g., tufted hair grass (*Deschampsia cespitosa*) and sedges (*Carex* spp.) are common.

The headwaters are too small to support trout but are nonetheless important to the health of the trout population downstream. Approximately 3 miles from the headwaters, the stream gains more volume and begins to cut through the Green River Formation. The stream develops a pool/drop character which creates excellent habitat for the native Colorado River cutthroat trout. The last 2 miles of Northwater Creek is in a narrow canyon with difficult access. This section harbors a dense population of Colorado River cutthroat trout. Part of this canyon is walled on both sides with beautiful cliffs and numerous seeps.

The surrounding landscape is very similar to East Fork Parachute Creek and has slopes of contrasting vegetation. The south-facing slopes are sparsely vegetated on the steep sections right above the creek and more densely vegetated on the more gentle slopes above, dominated by mountain sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and snowberry (*Symphoricarpos rotundifolius*). The north-facing slopes are characterized by spruce-fir (*Picea-Abies* sp.) forests on the steep mesic slopes adjacent to the stream and aspen forests above them on more gentle terrain.

Table 44. Natural Heritage elements at the Northwater Creek PCA.

Element	Common Name	G rank	S rank	Federal/State	EO* rank
Plant communities					
Artemisia tridentata ssp. vaseyana/Festuca thurberi	Western Slope sagebrush shrublands	GU	S1S2		B
Salix monticola/ Carex utriculata	Montane riparian willow carr	G3	S3		D
Plants					
Argillochloa dasyclada	Utah Fescue	G3	S3		E
Birds					
Aegolius funereus	Boreal owl	G5	S2	FS	B
Fish					
Oncorhynchus clarki pleuriticus	**Colorado river cutthroat trout**	**G4T3**	**S3**	**SC, BLM**	**A**

*EO=Element Occurrence

Biodiversity comments: The Northwater Creek PCA supports five elements tracked by the Colorado Natural Heritage Program, including two natural communities, the rare (G4T3S3) endemic Colorado River cutthroat trout, the rare (G3/S3) Utah fescue, and the state-rare (G5S2) Boreal Owl.

The Northwater Creek PCA has an excellent (A ranked) example of a Colorado River cutthroat trout population with estimates of over 1,000 fish in less than 1.5 miles of stream. The primary reasons for conservation concern for the cutthroat at the global and state levels are long-term trend prognoses and threats. Populations continue to decline in many streams (Young *et al.* 1996). Hybridization between this subspecies and non-native trout species poses the greatest threat to the elimination of pure populations. Due to hybridization only 26% of the remaining populations of this trout are considered genetically pure (Young *et al.* 1996).

A breeding Boreal Owl pair was recorded from this PCA in 1996. The Boreal Owl is a rare to locally uncommon resident of the high mountains of Colorado. Surveys by the U.S. Forest Service in the late 1990s have identified 20 breeding pairs in Colorado. The species' apparent low population size and sensitive breeding status are factors that contribute to the imperiled status (S2) in Colorado.

An unranked (E) occurrence of Utah fescue was found in the PCA at 8,300 ft. There are a total of fifty five documented occurrences of Utah fescue, with approximately 23,000 individuals estimated (NatureServe 2000). The grass is restricted to Colorado and Utah. In Colorado, 54 of the 55 occurrences are in Garfield and Rio Blanco counties.

Boundary Justification: The preliminary conservation boundaries for this site include Northwater Creek and its tributaries. The boundary is intended to represent the area needed to protect the elements and the ecological processes affecting them such as intact fluvial processes for the riparian elements and herbivory and fire for upland elements. Buffers to the site are narrow and generally include the headwaters of the side tributaries.

Riparian areas were included because of their importance in maintaining bank stability to protect water quality essential for the cutthroat trout.

Protection Rank Comments: This site, previously owned by the United States Department of Energy, was transferred to the BLM in 1999. Although oil and gas leases will continues, the Glenwood Springs Resource Area management plan for oil and gas leasing and development requires special protection for riparian areas and sensitive species. No surface occupancy is allowed within the area with riparian vegetation, except if granted by the authorizing officer (USDI 1999). We recommend, regardless of ownership, that the biological significance of this conservation site be recognized with a special area designation (i.e. Area of Critical and Environmental Concern).

Management Rank Comments: The primary use of the site is livestock grazing. Over 100 years of cattle and sheep grazing has had an impact on Northwater Creek, especially on the headwater region. The primary, noticeable, adverse effects of livestock grazing to this area are degradation of the riparian vegetation and the stream banks. Nearly all Northwater Creek's riparian plant communities have a high abundance of non-native species or increasers, and in some areas the abundance of willows has been drastically reduced. In addition to altering the plant composition of the riparian vegetation, grazing has increased soil erosion, due primarily to over utilization of the streamside vegetation, resulting in compaction and an abundance of bare ground. The result is accelerated stream bank downcutting, eventually resulting in terraces above the water table. The site would benefit from a management plan, which would include monitoring and improving the riparian vegetation.

An extensive program of electro-shocking would assist in determining species composition, identifying non-native fish and determining the need for and proper location of fish barriers to prevent migration of non-native fishes into the trout habitat. Streamside grazing by livestock is intense in this area. Grazing by livestock can change stream hydrology by increasing sedimentation and reducing streamside shrub cover, stream shade, and ultimately increasing water temperatures. Restricting grazing along Northwater Creek would benefit the cutthroat trout population. Cutthroat trout are susceptible to overharvest if angling is unrestricted, so Colorado has instituted restrictive angling regulations. Strict enforcement of these regulations will help to ensure survival of this population of cutthroats.

Management strategies to benefit Boreal Owls include preservation of snags for nesting cavities, and maintenance of aspen groves with large diameter trees. Uneven-age timber management may be compatible, but clear-cuts are not considered suitable habitat for foraging Boreal Owls (Hayward and Hayward 1993). Long-term stewardship needs include furnishing nesting cavities and forest structure necessary for foraging.

Soils Description: Soils along the creek bottoms are mapped as Torriorthents. These soils formed on colluvial slopes below the steep cliff faces along this drainage. The soils are mostly well drained and vary from loamy to clayey with variable amounts of gravel, cobbles, and stones (Soil Conservation Service 1985).

Restoration Potential: Fencing off riparian areas or altering the grazing regime to benefit ecological process would greatly improve the ecological health of this area.

Wetland Functional Assessment for the PCA: This site contains a long but narrow riparian area with fairly high cover of woody vegetation and herbaceous meadows thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The diversity of habitats provide excellent habitat for avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris for a dense population of trout, specifically the native Colorado cutthroat trout.

Figure 33. Northwater Creek PCA.

Sweetwater Lake Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports two good occurrences of globally vulnerable plant communities.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Sweetwater Lake is located approximately 15 miles northwest of the Town of Gypsum, CO within the White River National Forest.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Sweetwater Lake. T3S R87W Sections 7-9, and 16-20; T3S R88W Sections 12, 13, and 24.

Size: 2,000 acres

Elevation: 7,700 to 9,600 feet.

General Description: This site includes Sweetwater Lake and portions of two of its tributaries, Darnell and Lake Creeks, which actually merge prior to draining into the lake. These creeks are best characterized as steep and narrow with thinleaf alder *(Alnus incana*), aspen (*Populus tremuloides*), subalpine fir (*Abies lasiocarpa*), and mountain willow (*Salix monticola*) dominating the overstory. There is also a fairly large willow carr along Darnell Creek where mountain willow and beaked sedge (*Carex utriculata*) are abundant. The upland slopes are vegetated with spruce-fir forests.

Table 45. Natural Heritage element occurrences at the Sweetwater Lake PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Salix monticola/Carex utriculata	**Montane riparian willow carr**	**G3**	**S3**				**B**
Populus tremuloides/Alnus incana	**Montane riparian forest**	**G3**	**S3**				**B**
Birds							
Plegadis chihi	White-faced Ibis	G5	S2B, SZN				H

*EO = Element Occurrence

Biodiversity Comments: This site supports a good (B-ranked) occurrence of the globally vulnerable (G3/S3) mountain willow/beaked sedge (*Salix monticola*/*Carex utriculata*) montane riparian willow carr. This association is know from thirteen locations in Colorado, but an additional ten to twenty more are expected in the state. Mountain willow appears to be at the center of its distribution in Colorado, where it frequently forms large thickets with few other willow species present. Literature from Utah, Wyoming, Montana, Idaho, Nevada and Oregon indicate that mountain willow looses importance north and west of Colorado, as it mixes with other willow species. A good (B-ranked) occurrence of the globally vulnerable (G3/S3) aspen/thinleaf alder (*Populus tremuloides*/*Alnus incana*) montane riparian forest also occurs at this site. This plant association has only been documented in Colorado but is expected to occur in other Rocky Mountain States. A probable breeding record of the White-faced Ibis (*Plegadis chichi*) was documented from this PCA in 1983, but no further observations have ever been reported.

Boundary Justification: The boundary encompasses the narrow riparian areas, surrounding slopes, and some upstream drainages to ensure continued surface flow, periodic flooding, and opportunity for the creek's fluvial processes to maintain a dynamic distribution of riparian plant communities. These processes are necessary for the continued viability of the elements and maintenance of ecological functions. However, the entire upstream portion of the watershed was not included in the site boundaries. Thus, these areas need to be considered in order to ensure hydrological processes remain intact.

Protection Rank Comments: The site in currently managed by the White River National Forest and does not have any special protection status.

Management Rank Comments: There is a dense network of pack, game, and human trails throughout the area. Improper grazing and trampling are the main concerns for this site. These activities should be monitored. If they increase, their impacts would likely degrade the elements. Non-native species such as Kentucky bluegrass (*Poa pratensis*), dandelion (*Taraxacum officinale*), and smooth brome (*Bromus inermis*) are present in the area.

Soils Description: The soils are not mapped within the boundaries of the PCA, however, just downstream the soils along the riparian area are mapped as Fluvaquents. Fluvaquents are a broadly defined unit consisting of deep, somewhat poorly drained soils on floodplains and alluvial valley floors (Soil Conservation Service 1992). These soils are typically stratified and widely vary in texture. The water table is typically within 2 feet of the soil surface during spring and summer.

Restoration Potential: There are numerous roads and trails in the area that could potentially be revegetated.

Wetland Functional Assessment for the PCA: This riparian area likely does not provide much in the way of flood attenuation given the narrow and steep gradients. This area also likely provides excellent habitat for small and large mammals, avian species, and insects. Given the intact nature of the area, nutrient cycles are assumed to be intact which also provides excellent production export.

Figure 34. Sweetwater Lake PCA.

The Meadows Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports an excellent occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M2 Low Urgency. There is heavy recreational use and timber activity in the area.

Location: This site is located within the White River National Forest, partially within the Flat Tops Wilderness Area, approximately 9 miles south-southwest of Trappers Lake.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Deep Lake. T2S R88W Sections 19, and 30-33; T2S R89W Sections 24, 25, and 36; T3S R88W Sections 4-8, 17, and 18.

Size: 1,976 acres

Elevation: 9,000 – 10,200 ft.

General Description: This is a large site encompassing portions of the Buck Creek and South Fork White River drainages. Headwaters of Buck Creek occur near Heart Lake. This drainage is characterized by open, rocky meadows of various herbaceous and willow species along the valley bottom surrounded by slopes of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). Wolf willow (*Salix wolfii*), Drummond's willow (*S. drummondiana*), Geyer *willow (S. geyeriana*), mountain bluebells (*Mertensia ciliata*), and sedges (*Carex* spp.) dominate a fairly wide and continuous riparian willow carr. Further downstream, Buck Creek narrows as it continues toward its confluence with South Fork White River. Along this long, narrow stretch of the creek (at least a mile in length) subalpine fir, Engelmann spruce, and Drummond's willow dominate the riparian area. At the confluence with South Fork White River is a historic record of the globally critically imperiled boreal toad (*Bufo boreas*). Upstream from this confluence, along the South Fork White River, is a long, wide, open grassland (*Festuca* sp.) on adjacent upland slopes. At higher elevations, aspen (*Populus tremuloides*) and conifers dominate the upland slopes. Booth willow (*Salix boothii*), wolf willow, and various herbaceous species occupy the riparian area.

Table 46. Natural Heritage element occurrences at The Meadows PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Salix wolfii*/Mesic forb**	**Subalpine riparian willow carr**	**G3**	**S3**				**A**
Salix wolfii/Mesic forb	Subalpine riparian willow carr	G3	S3				B

Salix boothii/Mesic forb	Riparian willow carr	G3G4	S3				AB
Abies lasiocarpa-Picea engelmannii/Salix drummondiana	Montane riparian forest	G5	S4				A
Amphibians							
Bufo boreas	Boreal toad	G4T1Q	S1				H

*EO = Element Occurrence

Biodiversity Comments: This site supports an excellent (A-ranked) and good (B-ranked) occurrence of the globally vulnerable (G3/S3) wolf willow/mesic forb (*Salix wolfii*/mesic forb) subalpine riparian willow carr. This community has a widespread distribution but it is never abundant where it is found. Currently, there are less than 30 documented locations of this community in the world but more are expected. There is also a good (B-ranked) occurrence of the state rare (G4G3/S3) Booth willow/mesic *forb (Salix boothii*/mesic forb) riparian willow carr. An excellent (A-ranked) occurrence of the common (G5/S4) subalpine fir-Engelmann spruce/Drummond's willow (*Abies lasiocarpa-Picea engelmannii*/*Salix drummondiana*) riparian forest is also found at this site. There are historical records of both the boreal toad (*Bufo boreas*) and Peregrine Falcon (*Falco peregrinus anatum*) at this PCA. The boreal toad was last recorded from here in 1963, the peregrine in 1986. Neither of these species were located during this survey as attempts to access this area during the survey were unsuccessful.

Boundary Justification: The boundary encompasses the floodplain and surrounding slopes to ensure hydrological processes, such as flooding and natural sedimentation of beaver ponds and subsequent new channel formation, continue to maintain a dynamic distribution of aquatic and terrestrial habitat. These processes are necessary for the viability of the elements.

Protection Rank Comments: A portion of the site is within the Flat Tops Wilderness Area and is extremely remote.

Management Rank Comments: There is heavy recreational use in the area. Timber activity is on-going, both past and proposed. Although much of the timber activity is above the site, potential watershed impacts could occur. Further monitoring and survey work for the boreal toad would aid in determining their status in the area. The solitary nature of this amphibian coupled with an aversion to forming large breeding groups makes detection difficult.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: There are numerous roads and trails associated with heavy recreational use in the area that could potentially be revegetated.

Wetland Functional Assessment for the PCA: This site contains a long riparian area with fairly high cover of woody vegetation and herbaceous meadows and beaver ponds scattered throughout the area, thus the capacity of this wetland to perform flood attenuation and bank stabilization is likely high. The diversity of wetland habitats support populations of avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris and thus good fish habitat.

Figure 35. The Meadows PCA.

Trapper Creek Potential Conservation Area

Biodiversity Rank: B3 High Significance. This site supports an excellent occurrence of the globally vulnerable Utah fescue. It also contains occurrences of the Colorado River cutthroat trout that is vulnerable within the state.

Protection Urgency Rank: P3 Moderate Urgency. This PCA currently has no special protective designation and given that grazing is intense here, consideration for ACEC designation is warranted. Oil and gas development exists as a potential additional threat to this area further justifying ACEC designation.

Management Urgency Rank: M2 High Urgency. This area is heavily impacted from grazing. In a 1996 report, CDOW notes that "grazing impacts (are) heavy in upper Trapper Creek".

Location: This PCA is located 8.7 miles northwest of Rifle, Colorado

Legal description: U.S.G.S. 7.5 minute quadrangles: Rio Blanco, McCarthy Gulch, Anvil Points and Forked Gulch. T4S R94W S34; T5S R94W S3-8, 10; T5S R95W S11, 12.

Size: 2,411 acres

Elevation: 7,680 to 8,400 feet

General Description: Trapper Creek originates from the east edge of the Roan Plateau on the former Department of Energy (DOE) Naval Oil Shale Reserve (NOSR) property near Rifle, Colorado. Trapper Creek flows east to west and joins Northwater Creek from the south to form East Middle Fork Parachute Creek. Spruce-fir (*Picea engelmannii-Abies lasiocarpa*) and aspen (*Populus tremuloides*) forests on north-facing slopes and mountain sage shrubland (*Artemisia tridentata* ssp. *vaseyana*) on the south-facing slopes characterize the drainage. The creek has formed a canyon through layers of sedimentary rock of the Tertiary period including Green River oil shale, marlstone, and siltstone, and siltstone and sandstone of the Uinta formation. The area is publicly owned and administration was recently transferred to the BLM, which manages the area for livestock grazing. The Roan Plateau is believed to have been hunting grounds for native peoples. Along Trapper Creek can be found arrowheads and prehistoric skeletal remains of mountain bison.

The PCA, however, still contains a large occurrence of the rare Utah Fescue (*Argillochloa dasyclada*); a rare grass usually associated with deposits of oil shale and that is endemic to eastern Utah and western Colorado. The vegetation along the riparian corridor includes wet meadow communities dominated by tufted hairgrass (*Deschampsia cespitosa*), Nebraska sedge (*Carex nebrascensis*), beaked sedge (*C. utriculata*), and Baltic rush (*Juncus balticus* var. *montanus*).

Trapper Creek is home to a rare endemic subspecies of cutthroat trout (*Oncorhynchus clarki plueriticus*), but long stretches of the creek experience water temperatures too high to support the trout. Much of the willow community along the creek-bank is degraded or completely destroyed, reducing shade cover over the creek.

Table 47. Natural Heritage elements at the Trapper Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sens	EO* Rank
Plants							
Argillochloa dasyclada	**Utah fescue**	**G3**	**S3**				**A**
Fish							
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T3	S3		SC	BLM	D
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T3	S3		SC	BLM	H

*EO=Element Occurrence

Biodiversity Comments: An excellent (A ranked) population of Utah fescue with many reproducing plants and many age classes is found at the Trapper Creek PCA. The Utah fescue has a narrow and restricted distribution and is found in only four counties in Colorado and Utah. The Colorado populations occupy an area totaling approximately 1000 square miles in Garfield and Rio Blanco counties. Most of the populations occur on oil company land and natural gas and oil development is a real threat.

The cutthroat trout population in Trapper Creek was reported in 1996 to number over 500 individuals. Unfortunately the stream habitat has been severely degraded by the indirect effects of livestock grazing. Cutthroat trout are a sensitive species that are native to the Colorado River basin, and have recently been in decline. Remnant populations still remain in Colorado, Wyoming, and Utah, but they continue to decline in many streams (Young *et al.* 1996).

Boundary Justification: The boundary includes the entire watershed of Trappers Creek. These boundaries will ensure continued natural surface flow and maintain a natural hydroperiod through East Fork Parachute Creek, which will maintain a dynamic distribution of riparian plant communities along the drainage and support fish populations. The boundaries also protect the riparian areas from direct disturbances such as trampling of streamside vegetation and subsequent bank instability, which could result in decreased water quality and thus have detrimental affects on the trout population. Habitat for Utah fescue to establish new individuals over time is included, along with the plants' present location.

Protection Rank Comments: The site is managed by the BLM and does not have any special protection status. This land was formerly part of the Naval Oil Shale Reserve, and was transferred from ownership by the Department of Defense to the BLM in 1997. BLM holds surface and oil and gas rights, while the status of oil shale is still unclear. There is currently no oil or gas development, and the future status of the mineral rights will be determined by the Resource Management Plan currently in progress.

The area has been proposed as wilderness by the Colorado Wilderness Coalition, but found not suitable by BLM. Wilderness could still be one of the alternatives considered in the RMP. Alternatively, Area of Critical and Environmental Concern status would be warranted.

Management Rank Comments: Trapper Creek has a fairly extensive (100+ year) history of grazing use by domestic cattle and sheep. This use was at times rather heavy with large numbers of livestock in the area. Many of the reaches have been severely altered from this long history of grazing. Future management of this site will be determined by the Resource Management Plan that is currently in the scoping stage, and is expected to be completed in 2002. Currently, this area is heavily impacted from grazing. In a 1996 report, CDOW notes that "grazing impacts (are) heavy in upper Trapper Creek". The present grazing management plan that affects this PCA is inadequate. Resting the drainage from grazing combined with a management plan restricting domestic livestock from the drainage bottoms would benefit both the cutthroat trout and the rare plant communities. The Utah fescue appears to be easily impacted by domestic livestock grazing (NatureServe 2000) and a rest from grazing would also assure survival of this rare plant population.

For the cutthroat trout, introduction of nonnative trout that hybridize with it is most likely its greatest threat (Young 1995; Behnke and Benson 1980). Monitoring would aid in detecting the invasion of nonnative fishes and whirling disease into this population of cutthroat trout. If invasion by non-natives is feared, construction of fish barriers to prevent interbreeding between other trout and the cutthroats would be advantageous. Rehabilitation of streambank willow communities to improve water quality by decreasing erosion, sedimentation, and water temperature would assist in conserving the cutthroat trout (Spahr et al. 1991).

Soils Description: Soils along the creek bottoms are mapped Torriorthents. These soils formed on colluvial slopes below the steep cliff faces along this drainage. The soils are mostly well drained and vary from loamy to clayey with variable amounts of gravel, cobbles, and stones (Soil Conservation Service 1985).

Restoration Potential: Resting and/or fencing off the creek from grazing would benefit both the cutthroat trout and the riparian plant communities. Rehabilitation of streambank stability and vegetation cover would improve water quality by decreasing erosion, sedimentation, and water temperature and would assist in conserving the cutthroat trout.

Wetland Functional Assessment for the PCA: This site contains a long riparian area with a below normal cover of woody vegetation, due to improper grazing, thus the capacity of this wetland to perform flood attenuation and bank stabilization is decreased. Streambank instability and loss of vegetation cover and species diversity can affect other functions such as support of fish and wildlife habitat, production export, and nutrient cycling.

Figure 36. Trapper Creek PCA.

Wagonwheel Creek Potential Conservation Area

Biodiversity Rank: B3 High significance. This site supports a good occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P5 This PCA falls completely within the Flat Tops Wilderness Area and protection is complete.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: The site is located approximately 14.5 miles north of Glenwood Springs, CO within the White River National Forest.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Deep Lake. T3S R89W Sections 3, 10, 14, 15, 22, and 23.

Size: 1306 acres

Elevation: 10,500 to 10,600 feet.

General Description: This site consists of a subalpine stream and adjacent spruce-fir (*Picea-Abies* sp.) covered slopes. Near the upstream portion of the site, there are numerous small ponds that serve as the headwaters of Wagonwheel Creek. Short-fruit willow (*Salix brachycarpa*), planeleaf willow (*S. planifolia*), tufted hairgrass (*Deschampsia cespitosa*), marsh marigold (*Caltha leptosepala*), and arrowleaf groundsel (*Senecio triangularis*) dominate the riparian area downstream from these ponds. Further downstream, there is a large wet meadow created by beaver activity where water sedge (*Carex aquatilis*) and beaked sedge (*C. utriculata*) dominate. Downstream from where a small spring-fed stream enters Wagonwheel Creek, is a willow carr dominated by Wolf willow (*Salix wolfii*), shrubby cinquefoil (*Pentaphylloides floribunda*), tufted hairgrass, water sedge, and alpine timothy (*Phleum alpinum*).

Table 48. Natural Heritage element occurrences at the Wagonwheel Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Salix wolfii*/Mesic forb**	**Subalpine riparian willow carr**	**G3**	**S3**				**B**
Carex aquatilis-Carex utriculata	Montane wet meadows	G4	S4				A

*EO = Element Occurrence

Biodiversity Comments: This site supports a good (B-ranked) occurrence of the globally vulnerable (G3/S3) wolf willow/mesic forb (*Salix wolfii*/mesic forb) subalpine riparian willow carr. This community has a widespread distribution, although it is never very abundant where it occurs. The site also supports an excellent (A-ranked) occurrence of the common (G4/S4) water sedge/beaked sedge (*Carex aquatilis*/*Carex utriculata*) montane wet meadow and a good (B-ranked) occurrence of the common short-fruit willow/mesic forb (*Salix brachycarpa*/mesic forb) alpine willow scrub.

Boundary Justification: The boundary encompasses the riparian and wetland areas, surrounding slopes, and nearby/upstream springs and spring-brooks to ensure that hydrological sources and the ability of the creek's fluvial processes to continue flooding, scouring, and sediment deposition are protected. These processes are necessary for the viability of the elements and maintenance of ecological functions such as a dynamic distribution of aquatic and terrestrial habitat and nutrient cycling.

Protection Rank Comments: The site is currently under the management of the White River National Forest and is within the Flat Tops Wilderness.

Management Rank Comments: There is heavy recreation in the area. Improper grazing has caused some downcutting in the stream, trampling of streamside vegetation, and an influx of non-native species such as Kentucky bluegrass (*Poa pratensis*), dandelion (*Taraxacum officinale*), and curly dock (*Rumex crispus*).

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Revegetation of recreation trails would alleviate erosion and help arrest the spread of non-native species. Fencing livestock from the stream would allow streamside vegetation to recover and alleviate further entrenchment of the stream.

Wetland Functional Assessment for the PCA: This mosaic of willows and sedge meadows likely provides much in the way of flood attenuation and sediment/shoreline stabilization. Groundwater discharge is occurring via the numerous springs in the area. This wetland also likely provides excellent habitat for small and large mammals, avian species, and insects. Given the fairly intact nature of the area, nutrient cycles are assumed to be intact which also provides excellent production export.

Figure 37. Wagonwheel Creek PCA.

Brush Creek at Skinner Ridge Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a fair occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 High Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Brush Creek is located approximately 30 miles north of Grand Junction, CO and 16 miles east of Douglas Pass. The site is located between Skinner Ridge and Brush Mountain.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Desert Gulch and Henderson Ridge. T5S R99W Sections 15, 16, and 21-27.

Size: 1,400 acres

Elevation: 6,400 to 8,000 feet.

General Description: Brush Creek has formed a steep valley surrounded by mostly barren shale slopes of the Green River formation. Douglas fir (*Pseudotsuga menziesii*) and Utah serviceberry (*Amelanchier utahensis*) occur at the top of the slopes while Utah serviceberry and Gambel's oak (*Quercus gambelii*) occur near the base of the slopes. Box elder (*Acer negundo*) and choke-cherry (*Prunus virginiana*) dominate the overstory in the riparian areas. Richardson's geranium (*Geranium richardsonii*) is fairly abundant in the understory along the creek as are non-native species such as Kentucky bluegrass (*Poa pratensis*), houndstongue (*Cynoglossum officinale*), and dandelion (*Taraxacum officinale*).

Table 49. Natural Heritage element occurrences at the Brush Creek at Skinner Ridge PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Acer negundo/Prunus virginiana	**Montane riparian deciduous forest**	**G3**	**S2**				**C**

*EO = Element Occurrence

Biodiversity Comments: This site supports a fair (C-ranked) occurrence of the globally vulnerable (G3/S2) box elder/choke-cherry (*Acer negundo*/*Prunus virginiana*) montane riparian deciduous forest. This community is highly threatened by inappropriate stream alterations, heavy recreational use, and improper grazing.

Boundary Justification: The boundary encompasses the narrow riparian area, surrounding slopes, and some upstream drainages to ensure continued surface flow, periodic flooding, and opportunity for the creek's fluvial processes to maintain a dynamic distribution of riparian plant communities. These processes are necessary for the continued viability of the elements and maintenance of ecological functions. However, the entire upstream portion of the watershed was not included in the site boundaries. These areas need to be considered to ensure hydrological processes remain intact.

Protection Rank Comments: The site is currently under private ownership. If oil shale ever becomes an economical extractable resource, oil shale development could pose a threat to the site.

Management Rank Comments: Increased livestock grazing could result in degradation of the elements. There is a road that parallels the creek. Erosion and influx of non-native species from the road corridor are potential threats.

Soils Description: The soils along the riparian area are mapped as the Debeque series, a loamy-skeletal, mixed, frigid, Eutic Haploboroll (Soil Conservation Service 1985).

Restoration Potential: Altering the current grazing regime to benefit ecological process and non-native species control and/or eradication would benefit this site.

Wetland Functional Assessment for the PCA: Heavy grazing may be altering normal nutrient cycles along the creek by contributing excess carbon/nutrients to the system and by disrupting the soil surface via hoof action, which might increase erosion and the rate of nutrient transformations in the soil. The presence of permanent water within such an arid landscape provides important habitat for numerous birds, mammals, and insects.

Figure 38. Brush Creek at Skinner Ridge PCA.

Douglas Pass Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a good occurrence of a state rare plant species.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action with regard to exotic species control would help to maintain the current quality of element occurrences.

Location: Thirty miles north of Fruita, Colorado, on Lookout Mountain Road, west of Colorado State Highway 139 below Douglas Pass.

Legal description: U.S.G.S. 7.5 minute quadrangle: Douglas Pass. T5S R102W S26, 27, 34, 35; T6S R103W S1; T6S R102 S6.

Size: 1,300 acres

Elevation: 7,400 to 8,000 feet

General Description: The Douglas Pass PCA encompasses an area west of Highway 139 and south of Douglas Pass, with steep hillsides and numerous springs. The dry hillsides have a cover of Gambel's oak, Utah serviceberry and other mountain shrubs, while the moist areas harbor a luxuriant plant community with Douglas fir, aspen, and Rocky Mountain maple. Along the sides of Lookout Mountain Road is one of the largest populations known of the globally vulnerable large-flowered globemallow, a spectacular plant with bushy growth and large white or pink flowers. There are several ponds developed from springs in the PCA, and there are historic records of northern leopard frogs occupying them, although none were observed during the 2000 field season.

Table 50. Natural Heritage elements at the Douglas Pass PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Ranks
Plants							
Iliamna grandiflora	**Large-flower globemallow**	**G3?Q**	**S1**				**B**
Plant Communities							
Pseudotsuga menziesii/Acer glabrum	Lower montane forests	G4	S1				B
Amphibians							
Rana pipiens	Northern leopard frog	G5	S3				H

*EO=Element Occurrence

Biodiversity Comments: The Douglas Pass PCA has one of the largest known occurrences of the large flower globemallow, a plant that is very rare in Colorado. It also contains a good occurrence of the state rare lower montane forest community dominated by Douglas fir and Rocky Mountain maple. Large-flower globemallow is considered to be a Colorado endemic species. There were previously only 12 small occurrences of this species in the state, two in Garfield County, and others in Ouray, Routt, Pitkin and Montezuma counties. Three new occurrences were found in Garfield County during this survey, bringing the total to five in the county, and 15 in the state. The Douglas fir/Rocky Mountain maple plant association was found to be in good condition in this PCA. There are eight documented occurrences of this plant community in Colorado, including this one, in seven counties. This is the first documented occurrence for Garfield County.

Boundary Justification: The boundary is drawn to encompass the documented plant and community occurrences. However, the full extent of the forest community has not been established, and it may extend beyond the PCA boundaries.

Protection Rank Comments: The PCA is located primarily on BLM land, although a small amount of adjacent private land is included. There is no special protection in place for the site. The BLM Resource Management Plan (USDI 1987) emphasizes mineral extraction for this area. Oil and gas development may increase to the west of the site, leading to increased traffic and necessity of road maintenance. However, it is unlikely that new development will take place within the PCA boundaries (Tappit, pers. comm.), since there are restrictions on development because of visual impacts near the highway and because the slopes are unstable.

Management Rank Comments: Although the PCA is in generally good condition, the heavily grazed areas around the spring-fed stock ponds are trampled and weedy, with hound's tongue (*Cynoglossum officinalis*), Kentucky bluegrass (*Poa pratensis*), and yellow sweet clover (*Melilotus officinalis*). There is some tamarisk (*Tamarix ramosissima*) in the wet areas. The large-flowered globemallow should probably be protected from direct impacts by road maintenance and weed spraying. However, it appears to prefer roadside habitats, perhaps because of the extra moisture from runoff, and because it seems to need some degree of disturbance. In the most natural sub-populations, which were farthest from the road, there was still a high degree of natural erosion.

Soils Description: Soils near the Douglas fir/Rocky Mountain maple community and large ponds are mapped as the Empedrado series, a fine-loamy, frigid, Typic, Argiboroll (Soil Conservation Service 1985). Soils bordering the pond and those at the spring source and along the springbrook had a dark A horizon, indicating a long-term accumulation of organic matter. Sediment near the edge of pond are mostly organic and anaerobic (sulfur (sulfides) odor), thus indicating the hydrological stability of the pond.

Restoration Potential: The area near the pond receives a lot of recreational use as indicated by loads of trash in the area and also receives some grazing. The pond is very close to Hwy. 139, thus the area probably gets a lot of visitors. Fencing off highly disturbed areas from people and livestock would allow these areas to recover.

Wetland Functional Assessment for the Douglas Pass PCA:
Proposed HGM Class: Slope Subclass: S3
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Pseudotsuga menziesii/Acer glabrum*.

Table 51. Wetland functional assessment for the slope wetland at the Douglas Pass site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	The wetland is functioning at potential, although current grazing regime is threatening the functional integrity of the site.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	Moderate	The springbrook, especially at its confluence with the pond, is trampled and sparsely covered with vegetation. Upslope, within the Douglas fir/maple community, the springbrook is densely vegetated..
Groundwater Discharge/ Recharge	High	Discharge is occurring at the spring sources.
Dynamic Surface Water Storage	High	The organic soils along the springbrook restrict water movement through these areas and the presence of the pond provide storage of discharging groundwater
Biogeochemical Functions		
Elemental Cycling	High	Saturated soils and a large carbon source maintain vital nutrient cycling processes.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	There is little potential for these areas to remove sediments/ nutrients/toxicants as there are no upstream sources of these excess inputs as the spring source occurs at the base of a large cliff. However, local inputs from cattle could be retained/transformed.
Biological Functions		
Habitat Diversity	Moderate	Emergent, forested, and open water wetlands occur in the area.
General Wildlife Habitat	High	These areas provide a permanent source of water in an otherwise arid landscape, thus many species use these areas for water and forage. Many birds, small mammals, tiger salamanders, garter snakes, invertebrates, and numerous butterfly species were observed near the spring.
General Fish/Aquatic Habitat	Low	No fish were observed in the pond and the springbrook is too short and shallow to support fish populations.
Production Export/Food Chain Support	High	Since the pond does not have an outlet, this wetland does not provide much in the way of production export. However, the pond, emergent shoreline vegetation, and large woody debris on shore and in the water support a large amount of invertebrate life (thus low production export and HIGH food chain support).
Uniqueness	Moderate	The wetland supports a rare plant community in Colorado.

Figure 39. Douglas Pass PCA.

Main Elk Creek Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports an excellent occurrence of a state rare plant community.

Protection Urgency Rank: P3 High Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action with regard to exotic species control would help to maintain the current quality of element occurrences.

Location: Main Elk Creek is located approximately 7 miles north of the town of New Castle, CO and is within the White River National Forest.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Blair Mountain; Deep Creek Point; Meadow Creek Lake. T3S R90W Sections 4, 5, 7-24, and 26-32; T3S R91W Sections 25 and 36; T4S R90W Sections 5-7, and 18; T4S R91W Sections 1, 11-16, and 21-23.

Size: 11,633 acres

Elevation: 6,400 to 10,800 feet.

General Description: The lower portion of this site occurs in a beautiful, steep-sided limestone canyon with a narrow riparian area along the canyon bottom. The surrounding canyon walls are dominated by periodic Utah serviceberry (*Amelanchier utahensis*) and spruce-fir (*Picea-Abies* sp.) forest, while other upland areas have a prevalence of Douglas fir (*Pseudotsuga menziesii*), aspen (*Populus tremuloides*), and Gambel's oak (*Quercus gambelii*). The steep limestone walls create a cool, moist, and lush riparian area dominated by narrowleaf cottonwood (*Populus angustifolia*), chokecherry (*Prunus virginiana*), river birch (*Betula occidentalis*), blue spruce (*Picea pungens*), red-osier dogwood (*Cornus sericea*), thinleaf alder (*Alnus incana*), mountain willow (*Salix monticola*), sandbar willow (*S. exigua*), and Drummond's willow (*S. drummondiana*). The understory is composed of a diversity of herbaceous species. Further upstream, various willow species dominate the riparian areas while Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and aspen dominate the upland slopes. Main Elk Creek also supports a population of the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*).

Table 52. Natural Heritage element occurrences at the Main Elk Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Betula occidentalis/Mesic forb	Foothills riparian shrubland	G3	S2				E
Picea	**Montane**	**G4**	**S2**				**A**

pungens/Cornus sericea	**riparian forest**						
Salix drummondiana/Mesic forb	Drummond's willow/Mesic forb riparian shrubland	G4	S4				B
Fish							
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T3	S3				E
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T3	S3				E

*EO = Element Occurrence

Biodiversity Comments: This site supports an unranked (E) occurrence of the globally vulnerable (G3/S2) river birch/mesic forb (*Betula occidentalis*/mesic forb) foothills riparian shrubland, an excellent (A-ranked) occurrence of the state imperiled (G4/S2) blue spruce/red-osier dogwood (*Picea pungens*/*Cornus sericea*) montane riparian forest, and a good (B-ranked) occurrence of the common (G4/S4) Drummond's willow/mesic forb (*Salix drummondiana*/mesic forb) riparian shrubland. The site also contains two unranked (E) occurrences of a globally rare (G4T3/S3) fish subspecies, the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*). Cutthroat trout are a sensitive species that are native to the Colorado River Basin, and have recently been in decline. Remnant populations still remain in Colorado, Wyoming, and Utah. The genetic purity of the cutthroat at this site is rated B-.

Boundary Justification: The boundary encompasses all of Main Elk Creek and its tributaries upstream from the element occurrences. Thus, the floodplain and immediate watershed, which are necessary to protect hydrological sources and the ability of the creek's fluvial processes to continue flooding, scouring, and sediment deposition. These processes are necessary to ensure the long-term maintenance of the riparian ecosystems, including the fish populations.

Protection Rank Comments: Currently, the site is managed by the White River National Forest and has no special protection status. A special interest area designation is warranted for this site.

Management Rank Comments: Non-native species such as hound's tongue (*Cynoglossum officinale*), Canada thistle (*Cirsium arvense*), and timothy (*Phleum pratense*) are prevalent in some portions of the lower part of the site. The purity of the Colorado River cutthroat trout population needs to be reevaluated due to age. There are several roads in the upper reaches, which should be monitored for siltation. The U.S. Forest Service should consider removing rainbow trout from Meadow Creek Lake. Management should include locating and/or erecting a downstream barrier. Installation of fish barriers to prevent further migration of non-native trout into the cutthroat habitat, elimination of the non-native brook trout through chemical treatment, and transplanting genetically pure cutthroat into the rehabilitated habitat (Spahr et al. 1991) would assist in preserving this cutthroat population. Streamside grazing by livestock could change the hydrology of Main Elk Creek by increasing sedimentation and reducing streamside shrub cover, stream shade, and ultimately increasing water temperatures. Restricting grazing along Main Elk Creek would benefit the cutthroat trout population. Cutthroat trout are susceptible to overharvest if angling is unrestricted, so Colorado has instituted restrictive angling regulations. Strict enforcement of these regulations will help to ensure survival of this population of cutthroats.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Fencing off grazing in the riparian areas would benefit the ecological health of the riparian plant community and thus benefit the trout population. Control and eradication of non-native species in the lower reach is also necessary.

Wetland Functional Assessment for the PCA: Heavy grazing may be altering normal nutrient cycles along the creek by contributing excess carbon/nutrients to the system and by disrupting the soil surface via hoof action, which might increase erosion and the rate of nutrient transformations in the soil. This site contains a long riparian area with a fairly high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. The presence of permanent water within such an arid landscape provides important habitat for numerous birds, mammals, and insects.

Figure 40. Main Elk Creek PCA.

Middle Fork Derby Creek Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a concentration of excellent occurrences of plant communities.

Protection Urgency Rank: P5 This PCA falls completely within the Flat Tops Wilderness Area and protection is complete.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: This site is located approximately 5 miles southeast of Trappers Lake within the Flat Tops Wilderness Area in the White River National Forest.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Trappers Lake and Dome Peak. T01S R87W Sections 21, 22, 26-29, 32, and 33.

Size: 1,936 acres

Elevation: 9,700 to 11,000 feet.

General Description: This site consists of a series of subalpine streams and beaver ponds surrounded by aspen (*Populus tremuloides*) and spruce-fir (*Picea-Abies* sp.) forests. The riparian areas are dominated by planeleaf willow (*Salix planifolia*), wolf willow (*S. wolfii*), Drummond's willow (*S. drummondiana*), marsh marigold (*Caltha leptosepala*), and marsh bittercress (*Cardamine cordifolia*). Beaked *sedge (Carex utriculata*), water sedge (*C. aquatilis*), and elephantella (*Pedicularis groenlandica*) dominate around the edges of the beaver ponds.

Table 53. Natural Heritage element occurrences at the Middle Fork Derby Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Salix planifolia/Caltha leptosepala	**Subalpine riparian willow carr**	**G4**	**S4**				**A**
Salix planifolia/Carex aquatilis	Subalpine riparian willow carr	G5	S4				A
Carex utriculata	Beaked sedge montane wet meadow	G5	S4				A
Carex aquatilis	Montane wet meadow	G5	S4				A

*EO = Element Occurrence

Biodiversity Comments: The site supports two excellent (A-ranked) occurrences of common subalpine riparian willow carrs and two excellent (A-ranked) occurrences of common montane wet meadows.

Boundary Justification: The boundary encompasses the entire upper watershed of Middle Fork Derby Creek. Thus, the floodplain and immediate watershed, which are necessary to provide continued hydrological flow and the ability of the creek's fluvial processes to continue flooding, scouring, and sediment deposition, are encompassed. These processes are necessary to ensure the long-term maintenance of the riparian ecosystem.

Protection Rank Comments: The site is currently within the Flat Tops Wilderness Area and is managed by the White River National Forest.

Management Rank Comments: There is some grazing and recreational use in the area but impacts appear to be minimal at this time.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Due to minimal disturbances to this area, there are currently few opportunities for restoration.

Wetland Functional Assessment for the PCA: This site contains a riparian area with a fairly high cover of woody vegetation and herbaceous meadows and beaver ponds scattered throughout the area, thus the capacity of this wetland to perform flood attenuation and bank stabilization is likely high. The diversity of wetland habitats likely support populations of avian species and large and small mammals. Excellent vegetation structure along the creek provides shade and woody debris and thus good fish habitat.

Figure 41. Middle Fork Derby Creek PCA.

Mitchell Creek Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports an excellent occurrence of the globally vulnerable Colorado River cutthroat trout population.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: The Mitchell Creek PCA is located just north of Glenwood Springs Colorado.

Legal Description: U.S.G.S. 7.5 minute quadrangles: Carbonate, Glenwood Springs, Storm King Mountain. T5S R89W Sections: 11-13, 22-24, 26-28, 33, 34; T6S R89W Section: 6.

Size: 2,894 acres

Elevation: 5,800 to 10,600 feet

General Description: The Mitchell Creek PCA is located along Mitchell Creek from just north of its confluence with the Colorado River, and extending to its headwaters in the White River National Forest. The bedrock is composed of Ordovician Formation, a mixture of dolomite, quartz, and Leadville limestone. The dominant vegetation in the area includes aspen (*Populus tremuloides*) forests and stands of Gambel's Oak (*Quercus gambelii*). This PCA contains an excellent occurrence of the Colorado River cutthroat trout, a subspecies which is vulnerable in Colorado. It also contains unranked occurrences of mixed mountain shrublands and montane grasslands, globally vulnerable community types, and the state rare montane riparian forest.

The land owners include Bureau of Land Management and White River National Forest, as well as a small parcel of private land in the southern portion of the PCA. There do not appear to be any definable threats at this time.

Table 54. Natural Heritage element occurrences at the Mitchell Creek PCA.

Element	Common Name	G rank	S rank	Federal/State	EO* rank
Fish					
Oncorhynchus clarki pleuriticus	**Colorado River cutthroat trout**	**G4T3**	**S3**	**FS/BLM**	**A**
Plant communities					
Quercus gambelii-Cercocarpus montanus/ Carex geyeri	Mixed Mountain Shrublands	G3	S3		E
Festuca idahoensis-Festuca thurberi	Montane Grassland	G3G4	S3S4		E
Picea pungens/ Cornus sericea	Montane Riparian Forest	G4	S2		E

*EO=Element Occurrence

Biodiversity comments: This PCA contains an excellent (A ranked) occurrence of the globally vulnerable (G4T3S3) Colorado River cutthroat trout. Unranked (E) occurrences of three natural communities are also present. Cutthroat trout are a sensitive species that are native to the Colorado River Basin, and have recently been in decline. Remnant populations still remain in Colorado, Wyoming, and Utah. A waterfall in Mitchell Creek below the current cutthroat trout distribution prevents invasion by non-native trout, protecting the genetic purity (A+) of this population and increasing its conservation importance.

Boundary Justification: The PCA boundary represents the area required to support the long-term survival of the Colorado cutthroat trout in Mitchell Creek. It includes the headwaters and major tributaries, as well as an upland buffer to limit direct disturbance and local hydrologic alterations. Tributaries and the riparian areas are included because of their importance in maintaining bank stability to protect water quality.

Protection Rank Comments:. The PCA includes private, BLM and National Forest land. The portion of Mitchell Creek that lies within the White River National Forest has been recommended as a Research Natural Area. The forest plan is now in the process of being revised, and this designation should be addressed in the new plan.

Management Rank Comments: Cutthroat trout are susceptible to overharvest if angling is unrestricted, so Colorado has instituted restrictive angling regulations. Strict enforcement of these regulations will help to ensure survival of this population of cutthroats.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Fencing off grazing in the riparian areas would benefit the ecological health of the riparian plant community and thus benefit the trout population.

Wetland Functional Assessment for the PCA: This site contains an extensive riparian area with a high cover of woody vegetation, thus the capacity of this wetland to perform flood attenuation and bank stabilization may be good. Excellent vegetation structure along the creek provides shade and woody debris and thus excellent fish habitat.

Figure 42. Mitchell Creek PCA.

Ranch at the Roaring Fork Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a fair occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M2 High Urgency. Horse grazing, housing developments, nearby pastures and hay meadows, and close proximity to an urban area have resulted in the spread of non-native plant species.

Location: This site is located directly east of Carbondale, CO, along the Roaring Fork River.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Carbondale. T7S R87W Section 31; T7S R88W Sections 25-28, and 34-36.

Size: 1,808 acres

Elevation: 6,100 – 6,300 feet.

General Description: The site includes approximately a three-mile stretch of the Roaring Fork River and its floodplain and is one of the most intact sites observed during the 2000 field season along the lower reaches of this river. The riparian vegetation includes a continuous mosaic of narrowleaf cottonwood (*Populus angustifolia*), thinleaf alder (*Alnus incana*), black twinberry (*Lonicera involucrata*), red-osier dogwood (*Cornus sericea*), silverberry (*Shepherdia argentea*), and sandbar willow (*Salix exigua*). In a few small patches, a rare orchid, yellow lady's slipper (*Cypripedium calceolus* ssp. *parviflorum*), is found associated with false-Solomon's seal (*Maianthemum stellatum*). In similar habitats, but distinct locations, another rare orchid, canyon bog-orchid (*Limnorchis ensifolia*), was documented. Cattail (*Typha latifolia*) marshes and a mosaic of wet meadows dominated by woolly sedge (*Carex lanuginosa*), water sedge (*C. aquatilis*), beaked sedge (*C. utriculata*), reed canary grass (*Phalaris arundinacea*), checkermallow (*Sidalcea candida*), and a variety of rushes (*Juncus* spp.) are found along old sloughs and near a series of ponds in the north-central part of the site. These ponds also support a diverse mix of native bird species. On the south side of the river there are private homes scattered within the historic floodplain. Islands in the river are covered by dense stands of sandbar willow. The adjacent upland areas rise 200 feet above the floodplain and support piñon-juniper (*Pinus edulis*-*Juniperus osteosperma*) communities and mixed shrublands.

Table 55. Natural Heritage element occurrences at the Ranch at the Roaring Fork PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Populus angustifolia/Alnus incana	**Montane riparian forest**	**G3?**	**S3**				**C**
Plants							
Cypripedium calceolus ssp. *parviflorum*	Yellow lady's slipper	G5	S2				B
Limnorchis ensifolia	Canyon bog-orchid	G4G5T3	S3				C

*EO = Element Occurrence

Biodiversity Comments: This is the largest, intact riparian area observed in the lower Roaring Fork Valley. It supports a fair (C-ranked) example of the globally vulnerable (G3?/S3) narrowleaf cottonwood/thinleaf alder (*Populus angustifolia*/*Alnus incana*) montane riparian forest. This site also supports one globally vulnerable (G4G5T3/S3) orchid, canyon bog-orchid, and one state imperiled (G5/S2) orchid, yellow lady's slipper. A small rookery of great blue herons (*Ardea herodias*), including approximately four nests, is found within this site. Great blue heron rookeries often include several hundred pairs of birds. There are approximately 100 great blue heron rookeries in Colorado. This colonial bird species appears to be increasingly common in the state but is quickly being threatened by habitat alteration (Pague et al. 1997). The mountain whitefish (*Prosopium williamsoni*) is also known to occur in the Roaring Fork River from Glenwood Springs and Woody Creek. There are few rivers in Colorado known to contain this species as it is mostly restricted to the northwestern portion of the state.

Boundary Justification: The site boundary encompasses a large portion of the Roaring Fork River's floodplain east of Carbondale to south of Catherine. The site boundaries incorporate an area that will allow natural hydrological processes such as seasonal flooding, sediment deposition, and new channel formation to maintain viable populations of the elements. The boundary also provides a buffer from nearby agriculture fields, roads, and houses where surface runoff may contribute excess nutrients, sediment, and herbicides/pesticides. The site also contains old oxbow lakes, sloughs, and ponds that could provide a source of recruitment for native wetland and riparian plant species. It should be noted that the hydrological processes necessary to the elements are not fully contained by the site boundaries. Given that the elements are dependent on natural hydrological processes associated with the Roaring Fork River, any upstream activities such as water diversions, impoundments, and development could potentially be detrimental to the elements.

Protection Rank Comments: The Ranch at the Roaring Fork is a private housing community which has chosen to leave this large stretch of the river's floodplain intact and to allow low impact recreational uses such as hiking and birding.

Management Rank Comments: Historically, horse ranching and coal mining occurred within this site. Horse grazing, housing developments, nearby pastures and hay meadows, and close proximity to an urban area have resulted in the spread of non-native plant species such as houndstongue (*Cynoglossum officinale*), cheatgrass (*Bromus tectorum*), sweetclover (*Melilotus officinale*), oxeye-daisy (*Leucanthemum vulgare*), plumeless thistle (*Carduus acanthoides*), Canada thistle (*Cirsium arvense*), and tansy (*Tanacetum vulgare*) throughout the site. Tansy is the most aggressive non-native species found at the site and should be controlled. Russian olive (*Elaeagnus angustifolia*) extends in a narrow band for about 50 feet along the Roaring Fork River and its removal should also be considered. The elements should be protected from road, ditch, powerline and railroad maintenance activities. Additional information is needed about the reproduction ecology of the yellow lady's slipper and the canyon bog-orchid to enhance management objectives. Great blue herons are known to abandon nests and colonies with increased encroachment by human activities. A minimum buffer of 300 meters, where no human activity should take place during courtship and nesting seasons, is recommended (Butler 1992).

Soils Description: The soils along the riparian areas are mapped as Fluvaquents, Atencio series, and Redrob series. Fluvaquents are a broadly defined unit consisting of deep, somewhat poorly drained soils on floodplains and alluvial valley floors (Soil Conservation Service 1992). These soils are typically stratified and widely vary in texture. The water table is typically within 2 feet of the soil surface during spring and summer. Fluvaquents are found immediately adjacent to the river at this site. The Atencio series is classified as a fine-loamy over sandy or sandy-skeletal, mixed Aridic Argiustolls (Soil Conservation Service 1992). Atencio soils are deep, well drained soils on fans and terraces, which have formed in alluvium. The Redrob series is classified as fine-loamy over sandy or sandy-skeletal, mixed (calcareous), frigid Fluvaquentic Haplaquolls (Soil Conservation Service 1992). Redrob soils are somewhat poorly drained and are found on alluvial valley floors, low terraces, and floodplains along major streams. The Redrob occupies the largest area of the floodplain at this site.

Restoration Potential: Control and eradication of non-native species is greatly needed at this site. The roads within the site’s riparian areas should be closed and maintained as trails or revegetated.

Wetland Functional Assessment for the Ranch at the Roaring Fork PCA:
Proposed HGM Class: Riverine Subclass: R5
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus angustifolia/Alnus incana*

Table 56. Wetland functional assessment for the riverine wetland at the Ranch at the Roaring Fork site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at potential..
Hydrological Functions		
Flood Attenuation and Storage	High	The floodplain is large and extensive and is vegetated with a fairly high density of shrubs and trees, although some areas are void of woody vegetation due to roads and hay fields.
Sediment/Shoreline Stabilization	High	The banks of the Roaring Fork and its braided channels are vegetated with shrubs, trees, and herbaceous species, depending on location.
Groundwater Discharge/ Recharge	N/A	This wetland floods via overbank flow.
Dynamic Surface Water Storage	N/A	This wetland floods via overbank flow.
Biogeochemical Functions		
Elemental Cycling	High	The presence of aerated water (the river) and large areas of saturated soil (oxbows, sloughs) provide a gradient for various nutrient transformations. However, alteration of the herbaceous understory, such as a decrease in cover and change in species composition (due to influx of non-native species) may be disrupting nutrient cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	High	Removal of excess nutrients and sediment (e.g. from upstream and local livestock and agricultural activity) is likely being performed by this wetland considering the large area in which such transformation could occur prior. Toxicants and sediments from nearby roads and housing developments are likely also intercepted in the floodplain prior to reaching the river.
Biological Functions		
Habitat Diversity	High	Scrub-shrub, forested, emergent, and open water wetlands exist in the area.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, and other large and small mammals and cover, nesting habitat, and food for songbirds and larger predators birds such as eagles and hawks. Oxbows and sloughs provide open water for waterbirds.
General Fish/Aquatic Habitat	High	The river supports populations of various species of fish.
Production Export/Food Chain Support	High	A permanent water source and allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems. A diversity of wetland habitats support invertebrate populations.
Uniqueness	High	This site is one of the few remaining large, relatively intact riparian areas along the Roaring Fork River.

Figure 43. Ranch at the Roaring Fork PCA.

Trappers Lake Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a concentration of excellent occurrences of common plant communities, good occurrences of Barrow's Goldeneye, and a poor occurrence of the boreal toad.

Protection Urgency Rank: P4 Low Urgency. No threat is known for the foreseeable future.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: This site is located approximately 33 miles east of Meeker, CO at Trappers Lake, within the White River National Forest. The site is partially within the Flat Tops Wilderness Area.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Big Marvine Peak; Devils Causeway and Trappers Lake. T1N R87W Sections 31 and 32; T1S R87W Sections 5-8, 17-20, and 30; T1S R88W Sections 1, 2, 10-15, and 21-26.

Size: 6,219 acres

Elevation: 9,600 – 11,200 feet.

General Description: This is a very large site composed of numerous subalpine lakes, ponds, willow carrs, and forested streams within a large matrix of a subalpine forest dominated by subalpine fir (*Abies lasiocarpa*), blue spruce (*Picea pungens*), and Engelmann spruce (*P. engelmannii*). Most of the site occurs in a beautiful, wide subalpine basin surrounded by cliffs and escarpments, which form the slopes of an elevated plateau. Numerous lakes atop the plateau drain into the subalpine basin, where smaller lakes are formed in depressions and from beaver activity. Eventually, these small creeks drain into Trappers Lake, which forms the headwaters of the North Fork White River. Planeleaf willow (*Salix planifolia*), wolf willow (*S. wolfii*), marsh marigold (*Caltha leptosepala*), water sedge (*Carex aquatilis*), beaked sedge (*C. utriculata*), and bluejoint reedgrass (*Calamagrostis canadensis*) are common along the creeks and edges of beaver ponds and lakes. Short-fruit willow (*Salix brachycarpa*), Ross sedge (*Carex rossii*), small-winged sedge (*Carex microptera*), and tufted hairgrass (*Deschampsia cespitosa*) are common in mesic/wet meadows found throughout the area. A boreal toad (*Bufo boreas*) was observed near the edge of Trappers Lake and much of the wetland/riparian habitat within this site could provide potential habitat for the boreal toad. The numerous subalpine meadows dispersed throughout the site are potential habitat for the Theano alpine (*Erebia theano*), a state rare butterfly. A few of the lakes within the site support a breeding population of Barrow's Goldeneye (*Bucephala islandica*). Fraser Creek, one of the main tributaries draining into Trappers Lake, supports a population of the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*).

Table 57. Natural Heritage element occurrences at the Trappers Lake PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
***Salix brachycarpa*/Mesic forb**	**Alpine willow scrub**	**G4**	**S4**				**A**
Salix planifolia/Caltha leptosepala	**Subalpine riparian willow carr**	**G4**	**S4**				**A**
Salix wolfii/Carex aquatilis	**Subalpine riparian willow carr**	**G4**	**S4**				**A**
Deschampsia cespitosa	**Mesic alpine meadow**	**G4?**	**S4**				**A**
Carex utriculata	**Beaked sedge montane wet meadow**	**G5**	**S4**				**A**
Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	**Montane riparian forest**	**G5**	**S5**				**A**
Fish							
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T2T3	S2			FS	E
Birds							
Bucephala islandica	Barrow's Goldeneye	G5	S2B, SZN		SC	BLM	B
Bucephala islandica	Barrow's Goldeneye	G5	S2B, SZN		SC	BLM	B
Amphibians							
Bufo boreas	Boreal toad	G4T1Q	S1	C	E	FS	D
Insects							
Erebia theano	Theano alpine	G4	S3				E

*EO = Element Occurrence

Biodiversity Comments: This site supports six excellent (A-ranked) occurrences of globally common (G4/S4, G4?/S4, G5/S4, and G5/S5) wetland and riparian plant communities. These were the best occurrence of these communities observed during the 2000 field season, however there are likely other excellent locations of these communities in the county. There are also two good (B-ranked) occurrence of the state imperiled Barrow's Goldeneye (*Bucephala islandica*) located within the site. A poor (D-ranked) occurrence of the state imperiled (G4T1Q/S1) boreal toad (*Bufo boreas*) and unranked (E) occurrences of the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) and Theano alpine (*Erebia theano*) are also contained in the site.

Boundary Justification: The site boundaries encompass the numerous subalpine lakes, ponds, willow carrs, and forested streams in the area. The site boundaries incorporate most of the upstream watershed, however there are many small lakes and ponds scattered atop the elevated plateau that may contribute groundwater flow to the streams and ponds within the site. Protection of the upstream watershed will allow fluvial processes to maintain a dynamic distribution of aquatic and terrestrial habitat thereby sustaining viable populations of riparian and wetland plant communities which are also critical to the viability of the Colorado River cutthroat trout. The boundaries also encompass habitat needs for the populations of Barrow's Goldeneye, Theano alpine, and boreal toad.

Protection Rank Comments: Most of the site is within the Flat Tops Wilderness Area. However, there is a popular lodge and campground located downstream of Trappers Lake. The lodge includes many different buildings and cabins. The potential for further development of this area is unknown.

Management Rank Comments: There is a high level of recreation throughout the site. Fishing, hiking, and equestrian use are common, especially around Trappers Lake. Sheep grazing also occurs in the area.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Currently there are few restoration opportunities at this site given that most of the site is protected within the Flat Tops Wilderness. Increased recreational use may require trail closings and subsequent revegetation of these areas.

Wetland Functional Assessment for the Trappers Lake PCA:
Proposed HGM Class: Riverine Subclass: R2
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Salix brachycarpa*/mesic forb; *Salix planifolia*/*Caltha leptosepala*; *Salix wolfii*/*Carex aquatilis*; *Carex utriculata*; and *Abies lasiocarpa-Picea engelmannii*/*Mertensia ciliata*.

Table 58. Wetland functional assessment for the riverine wetlands at the Trappers Lake site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at potential.
Hydrological Functions		
Flood Attenuation and Storage	High	The numerous interconnected streams and beaver ponds scattered throughout the area, which are densely vegetated with willows and herbaceous vegetation provides excellent flood attenuation.
Sediment/Shoreline Stabilization	High	Sediment stabilization capacity is high due to densely vegetated streambanks and beaver ponds which capture suspended sediment.
Groundwater Discharge/ Recharge	High	No springs or seeps were encountered but due to the amount of water being stored in organic soils and behind beaver dams it is assumed that there some recharge is occurring in the area.
Dynamic Surface Water Storage	High	Beaver ponds and organic rich soils store large quantities of surface water.
Biogeochemical Functions		
Elemental Cycling	High	Given the diversity of plant species and thus diverse types of litter inputs, the presence of aerated water (the stream), and areas with saturated soils, there is likely a stable and persistent cycling of nutrients. Thus, important, local biogeochemical functions are likely occurring at this site.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Due to the relatively pristine nature of the area, there is little upstream input of imported nutrients, toxicants, and or sediments. However, if some upstream disturbance did occur this site has a high potential for removal.
Biological Functions		
Habitat Diversity	High	There is forest, scrub-shrub, emergent, and open water wetland habitats.
General Wildlife Habitat	High	Avian habitat is good with songbirds and waterbird species, such as dippers and Barrow’s Goldeneye, using the area. The site is also likely used by bear, deer, and elk for forage.
General Fish/Aquatic Habitat	High	Nice pool/riffle complex along with overhanging vegetation, beaver ponds, and presence of large woody debris provides great fish habitat. Unsure of which fish species occur in the creek.
Production Export/Food Chain Support	High	A permanent water source and high quantities of allochthonous organic substrates provide carbon and nutrients for downstream ecosystems. The diversity of structural vegetation classes also provide a variety of habitats for invertebrate populations.
Uniqueness	Low	There are other drainages nearby that likely have similar riparian vegetation.

Figure 44. Trappers Lake PCA.

Turret Creek Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a good occurrence of a state rare plant.

Protection Urgency Rank: P5 This PCA falls completely within the Flat Tops Wilderness Area and protection is complete.

Management Urgency Rank: M4 Low Urgency. Although not urgently required, management may be needed in the future to maintain the current quality of element occurrences.

Location: This site is located approximately 17 miles northwest of Gypsum, CO within the Flat Tops Wilderness Area.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Sweetwater Lake. T2S R87W Sections 30 and 31.

Size: 13 acres

Elevation: 9,600 feet.

General Description: This is a very small site encompassing a subalpine pond surrounded by Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*) and Douglas fir (*Pseudotsuga menziesii*). Two, small, ephemeral inlets lead into the pond while a small outlet drains from a beaver dam. Pondweed (*Potamogeton* sp.) occupies portions of the pond while beaked sedge (*Carex utriculata*) was common around the pond edges. Bluejoint reedgrass (*Calamagrostis canadensis*) was common near the beaver dam and narrowleaf burreed (*Sparganium angustifolium*) was found growing at the mouth of the inlets. Upslope from pond edge, large-leaved avens (*Geum macrophyllum*), Kentucky bluegrass (*Poa pratensis*), wild strawberry *(Fragaria virginiana*), Richardson' geranium (*Geranium richardsonii*), field horsetail (*Equisetum arvense*), brook saxifrage (*Saxifraga odontoloma*), dandelion (*Taraxacum officinale*), and bedstraw (*Galium trifidum*) are common in a wet meadow. The state rare lesser panicled sedge (*Carex diandra*) is found growing on partially submerged logs within the pond.

Table 59. Natural Heritage element occurrences at the Turret Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plants							
Carex diandra	**Lesser panicled sedge**	**G5**	**S1**				**B**

*EO = Element Occurrence

Biodiversity Comments: This site supports a good (B-ranked) occurrence of the state critically imperiled (G5/S1) lesser panicled sedge. This species, while globally common, is very rare in Colorado.

Boundary Justification: The site boundaries incorporate the entire pond and most of the two small inlets. This will allow natural hydrological and ecological processes, such as continued beaver activity and dynamic fluctuations in pond levels to sustain viable populations of the lesser panicled sedge.

Protection Rank Comments: This site is within the Flat Tops Wilderness Area.

Management Rank Comments: There is minimal to no direct disturbances of this site. There are, however, a few non-native species, such as Kentucky bluegrass, dandelion, and redtop (*Agrostis gigantea*) present.

Soils Description: Soils at this site are not mapped by the county soil survey. The U.S. Forest Service in Glenwood Springs may have soil maps for this area.

Restoration Potential: Due to lack of disturbances, current restoration potential is minimal.

Wetland Functional Assessment for the PCA: The sedge meadows, emergent vegetation, and beaver ponds likely provide much in the way of flood attenuation and sediment/shoreline stabilization. This wetland also likely provides excellent habitat for small and large mammals, avian species, and insects. Given the intact nature of the area, nutrient cycles are assumed to be intact which also provides excellent production export.

Figure 45. Turret Creek PCA.

West Elk Creek Potential Conservation Area

Biodiversity Rank: B4 Moderate significance. This site supports a fair occurrence of a globally vulnerable plant community.

Protection Urgency Rank: P2 High Urgency. There are a lot of private homes within the site and many additional lots are currently for sale.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: West Elk Creek is located approximately 9 miles northwest of New Castle, CO.

Legal Description: U.S.G.S. 7.5 minute quadrangle: Rifle Falls. T4S R91W Sections 6, 7, and 18; T4S R92W Sections 1, 12, 13, and 24.

Size: 1,289 acres

Elevation: 7,300 to 8,800 feet.

General Description: This site includes the upper portion of West Elk Creek. The creek is dominated by aspen (*Populus tremuloides*), narrowleaf cottonwood (*Populus angustifolia*), river birch (*Betula occidentalis*), chokecherry (*Prunus virginiana*), and a diversity of herbaceous species in the understory. Much of the creek, at least along the lower portions of the creek within the site, has been heavily altered from development and agricultural practices. However, a relatively pristine remnant of the riparian community exists along a small portion of the creek. The canyon bog-orchid (*Limnorchis ensifolia*) was found growing near West Elk Reservoir within this remnant riparian community.

Table 60. Natural Heritage element occurrences at the West Elk Creek PCA.

Element	Common Name	Global Rank	State Rank	Federal Status	State Status	Federal Sensitive	EO Rank*
Plant Communities							
Populus angustifolia/Betula occidentalis	**Montane riparian forest**	**G3?/S2**					**C**
Plants							
Limnorchis ensifolia	Canyon bog-orchid	G4G5T3	S3				E

*EO = Element Occurrence

Biodiversity Comments: Near the downstream end of the site is a small, yet pristine remnant of the globally vulnerable (G3?/S2) narrowleaf cottonwood/river *birch (Populus angustifolia*/*Betula occidentalis*) montane riparian forest. This occurrence is surprisingly intact, yet its small size puts into question the viability of this community at this particular location. There is also an unranked (E) occurrence of the globally vulnerable (G4G5T3/S3) canyon bog-orchid.

Boundary Justification: The site boundaries incorporate the entire upstream portion of West Elk Creek and thus encompass upstream hydrological sources.

Protection Rank Comments: There are a lot of private homes within the site and many additional lots are currently for sale.

Management Rank Comments: There are a lot of direct disturbances within the riparian corridor associated with development and agricultural activities. Impacts from these threats must be minimized to protect the integrity of the elements.

Soils Description: Soils along the riparian area are mapped as the Holderness variant series, a fin, montmorillonitic, frigid Aridic Haploborolls (Soil Conservation Service 1985). These soils formed in alluvium derived from shale and sandstone and are deep, well drained soils. It is a variant of the Holderness series because it is calcareous to the surface (Soil Conservation Service 1985).

Restoration Potential: As development continues along this stretch of West Elk Creek, restoration activities may be difficult due to inevitable increases in water diversions, runoff from housing developments, and agricultural conversions. Establishing a buffer zone around this area may help alleviate some of these threats, such as increased imported sediments and nutrients and influx of non-native species. However, avoiding impacts from increased water diversion may be difficult.

Wetland Functional Assessment for the PCA: This site contains a narrow riparian area with a fairly high cover of woody vegetation in sporadic locations, while other portions of the creek have been heavily impacted by development and agricultural conversion. Thus, the capacity of this wetland to perform flood attenuation and bank stabilization is low and below normal expectations. Because of the encroachment of human activities, this site also does not provide high quality habitat for wildlife and fish. Nutrient cycles have likely been altered by the alteration of this stretch of the creek.

Figure 46. West Elk Creek PCA.

Kaiser Stevens Ditch Potential Conservation Area

Biodiversity Rank: B5 General biodiversity significance.

Protection Urgency Rank: P3 Moderate Urgency. Although there is a definable threat to the area, it is unknown when it will affect the occurrence.

Management Urgency Rank: M3 Moderate Urgency. Ongoing, recurrent management action would help to maintain the current quality of element occurrences.

Location: Two miles northwest of Carbondale, Colorado, in the Roaring Fork Valley

Legal Description: U.S.G.S. 7.5 minute quadrangle: Cattle Creek, Carbondale. T7S R88W S 19, 20, 29.

Size: 94 acres

Elevation: 6,000 to 6,200 feet

General Description: This site supports a small patch of riparian vegetation at an elevation of about 6,100 feet. In the past, the riparian vegetation seen here stretched for miles along the Roaring Fork River. It is fragmented now by a county road on the west, and a housing/golf course development to the north. It is dominated by coyote willow (*Salix exigua*) stands interspersed with aquatic sedge (*Carex aquatilis*) and rush (*Juncus* spp.) meadows. This riparian area supports an occurrence of a globally vulnerable orchid subspecies.

Table 61. Natural Heritage element occurrences at the Kaiser Stevens Ditch PCA.

Element	Common Name	G rank	S rank	Federal/State	EO* rank
Limnorchis ensifolia	**Canyon bog orchid**	**G4G5T3**	**S3**		**B**

*EO=Element Occurrence

Biodiversity comments: This site includes a good (B ranked) occurrence of a globally vulnerable (G4G5T3) orchid subspecies within a low quality riparian area. The canyon bog orchid grows in moist or wet soil in mountain meadows, marshes, swamps, fens, open or dense forests, on stream banks and open seepage, and frequently about springs. It has a wide range, from Oregon to Mexico, but good habitat is limited. The orchid's survival depends on a reliable year-round supply of moisture.

Boundary Justification: This site is a fragment of a larger riparian community along the Roaring Fork. It is bound by a county road and a housing/golf course development. The site follows these boundaries and only includes this small riparian patch and the rare plant occurrence. A larger area should be considered necessary to protect the hydrological setting at this site.

Protection Rank Comments:. This site is privately owned. A golf course/housing subdivision is immediately adjacent to the site. This small area has been set aside as open space by the golf course designers. The small area is probably not currently threatened, but it may be developed in the future.

Management Rank Comments: A management agreement with the private land owner to provide protection for the rare plant species is recommended. This small area is not currently being used for human activities and management strategies should aim to continue this status. Due to the disturbances and complete habitat destruction surrounding this site, exotic plants such as hay grasses, thistles (*Cirsium* spp.), and sweetclover (*Melilotus officinale*) are common in this area and are moving into this site. At present, these species have not been found to occur with the canyon bog-orchid (*Limnorchis ensifolia*) and should be controlled to maintain this status. Road maintenance on County Road 109 may affect the site and should be considered in a management plan for this site. The orchids should be monitored every other year to detect changes in population size or condition.

Soils Description: The soils along the riparian areas are mapped as Fluvaquents, Evanston series, Almy series, and Goslin series. Fluvaquents are a broadly defined unit consisting of deep, somewhat poorly drained soils on floodplains and alluvial valley floors (Soil Conservation Service 1992). These soils are typically stratified and widely vary in texture. The water table is typically within 2 feet of the soil surface during spring and summer. Fluvaquents are found immediately adjacent to the river at this site. Evanston series are classified as fine-loamy, mixed, frigid Aridic Argiborolls, which formed in alluvium (Soil Conservation Service 1992). Almy soils are classified as fine-loamy, mixed Borollic Haplargids and formed in alluvium derived from calcareous redbed sandstone and shale (Soil Conservation Service 1992). Goslin soils are classified as coarse-loamy, mixed (calcareous), frigid Ustic Torriorthents and formed in reddish sandy alluvium (Soil Conservation Service 1992).

Restoration Potential: Control and eradication of non-native species.

Wetland Functional Assessment for the PCA: Due to the small size of this riparian area and the amount of disturbances up and downstream, the functional integrity of this wetland has been greatly impacted.

Figure 47. Kaiser Stevens Ditch PCA.

Sutank Potential Conservation Area

Biodiversity Rank: B5 General biodiversity significance.

Protection Urgency Rank: P4 Low Urgency. Land owners are aware of the occurrences and are interested in their protection.

Management Urgency Rank: M3 Moderate Urgency. Management of exotic species will help to preserve the orchids.

Location: The Sutank PCA is located ¼ of a mile west of Carbondale, Colorado

Legal Description: U.S.G.S. 7.5 minute quadrangle: Carbondale. T7S R88W Sections: 28, 29, 33.

Size: 107 acres

Elevation: 6,000 feet

General Description: The Sutank PCA is a narrow strip of riparian vegetation located along the Crystal River between the confluence of the Roaring Fork River and Edgerton Creek. The geology is characterized by quaternary alluvium. The area is dominated by narrowleaf cottonwood (*Populus angustifolia*), and stands of coyote willow (*Salix exigua*), Rocky Mountain willow (*S. monticola*), alder (*Alnus incana*), and black twinberry (*Lonicera involucrata*) with an understory of field horsetail (*Equisetum arvense*), false Solomon's seal (*Maianthemum stellatum*), and rush species (*Juncus spp*). This PCA includes good occurrences of two orchid species, the canyon bog orchid (*Limnorchis ensifolia*), a plant which is vulnerable in the state, and the yellow lady's-slipper (*Cypripedium calceolus* ssp. *parviflorum*), a plant which is imperiled in the state. The mountain whitefish was also observed in this PCA and is vulnerable in Colorado. The mountain whitefish (*Prosopium williamsonii*) is also known to occur in Roaring Fork River from Glenwood Springs to near Woody Creek, and unverified occurrences have been reported between Woody Creek and Aspen. There are few rivers in Colorado known to contain this fish species. It is mostly restricted to the northwestern portion of the state. The land is privately owned and does not seems to be under any direct development pressure. The current landowners are aware of the orchid occurrences and are interested in protecting the species.

Table 62. Natural Heritage element occurrences at the Sutank PCA.

Element	Common Name	G rank	S rank	Federal/State	EO* rank
Plants					
Limnorchis ensifolia	**Canyon Bog Orchid**	**G4G5T3?**	**S3**		**B**
Cypripedium calceolus ssp *parviflorum*	Yellow lady's-slipper	G5	S2		B
Fish					
Prosopium williamsonii	Mountain whitefish	G5	S3		E

*EO=Element Occurrence

Biodiversity comments: The PCA includes good (B ranked) occurrences of two orchid species, one that is vulnerable (G4G5T3?S3) and the other imperiled (G5S2) in the state, and an unranked (E) occurrence of the mountain whitefish. Canyon bog orchids grow in moist or wet soil in mountain meadows, marshes, swamps, fens, open or dense forests, on stream banks and open seepage, frequently about springs. The species has a wide range, from Oregon to Mexico, but good habitat is limited. The orchid's survival depends on a reliable year-round supply of moisture. Yellow lady's-slipper is known from 26 locations throughout Colorado, as well as the continental U.S., Alaska and Canada. However, it is sparsely distributed and uncommon. The mountain whitefish is a species which is vulnerable and occurs in relatively few rivers in Colorado.

Boundary Justification: The boundary of this PCA was drawn to protect the populations of the orchid species, and to provide additional habitat for new colonization.

Protection Rank Comments:. This property is privately owned and is not presently in danger of development. The current landowners are interested in conservation and excited about the elements found on their property.

Management Rank Comments:. Exotic plant species in the PCA include hound's tongue (*Cynoglossum officinale*), orchard grass (*Dactylis glomerata*), Kentucky blue grass (*Poa pratensis*), tansy (*Tanacetum vulgare*), and Russian olive (*Elaeagnus angustifolia*). Management of these species, especially hound's tongue and Russian olive, are essential to prevent the loss of the element occurrences. Trampling of vegetation was observed, and re-routing of foot paths could preserve the integrity of these occurrences. An irrigation ditch is presently located parallel to the Crystal river. Its impacts on present conditions are unknown; however any changes may be considered for their effect on the orchid species. Orchid species generally have a narrow ecological amplitude and changes to the hydrology may affect the current populations.

Soils Description: The soils along the riparian areas are mapped as Redrob series, Evanston series, Dahlquist series, and Atencio series. The Redrob series is classified as fine-loamy over sandy or sandy-skeletal, mixed (calcareous), frigid Fluvaquentic Haplaquolls (Soil Conservation Service 1992). Redrob soils are somewhat poorly drained and are found on alluvial valley floors, low terraces, and floodplains along major streams. Evanston series are classified as fine-loamy, mixed, frigid Aridic Argiborolls, which formed in alluvium (Soil Conservation Service 1992). Dahlquist soils are classified as loamy-skeletal, mixed Borollic Haplargids and formed in alluvium (Soil Conservation Service 1992). The Atencio series is classified as a fine-loamy over sandy or sandy-skeletal, mixed Aridic Argiustolls (Soil Conservation Service 1992). Atencio soils are deep, well drained soils on fans and terraces, which have formed in alluvium.

Restoration Potential: Reestablish any disturbances to natural hydrological flow resulting from the ditch. Close and/or reroute trails to allow vegetation to recover from trampling.

Wetland Functional Assessment for the PCA: Due to the small size of this riparian area and the amount of disturbances up and downstream, the functional integrity of this wetland has been greatly impacted.

Figure 48. Sutank PCA.

Coulter Creek Site of Local Significance

Location: This site is located approximately 5 ½ miles northeast of Carbondale, CO, near the Garfield-Eagle county line.

Legal Description: U.S.G.S. 7.5-min. quadrangle: Carbondale. T06S R87W Sections 31 and 32; T07S R87W Sections 4-9.

Size: 987 acres

Elevation: 7,200-7,500 feet.

General Description: Groundwater discharge and irrigation water support a large wet meadow dominated by beaked sedge (*Carex utriculata*), Nebraska sedge *(C. nebrascensis*), redtop (*Agrostis gigantea*), and Baltic rush (*Juncus balticus*) along Coulter Creek. Additional species found within the meadow include timothy (*Phleum pratense*), reed canary grass (*Phalaris arundinacea*), slimstem reedgrass (*Calamagrostis stricta*), and tufted hairgrass (*Deschampsia cespitosa*). Most of the area was inundated with approximately an inch of water. The area is surrounded by hay meadows and pasture. Upstream, heavy grazing is occurring along Coulter Creek. No grazing appears to be occurring within the large wet meadow. The area does not appear to have been mowed all summer (for haying). A historical school house is located in the southeast corner of the site where the large wet meadow exists. Coulter Creek eventually joins Cattle Creek near the south/southeast portion of the site. Downstream from this confluence, willow species, such as mountain willow (*Salix monticola*), become more abundant.

This site was designated a Site of Local Significance due to the important functions provided by this large wetland complex. The wet meadows and willow dominated riparian areas improve water quality by trapping sediments and retaining excess nutrients from livestock activity. This is an important local function given the amount of development in the area (sediment) and livestock activity (sediment and nutrients). These areas also provide much in the way of flood attenuation and local wildlife habitat. In areas with increasing development, such as this site, open space, especially areas with a permanent water source, forage, and areas of cover, are vital to local wildlife populations.

Protection and Management Comments: The entire site is privately owned. Livestock grazing is the dominant land use while housing developments are increasing in the area. There is also a network of county and private roads scattered throughout the area. The large wet meadow may be too wet for livestock grazing and haying activities as these used do not appear to be occurring in this area.

Soils Description: Soils in the site are mapped as Fluvaquents, Kilgore series, Forelle series, and Atencio series. Fluvaquents are a broadly defined unit consisting of deep, somewhat poorly drained soils on floodplains and alluvial valley floors (Soil Conservation Service 1992). These soils are typically stratified and widely vary in texture. The water table is typically within 2 feet of the soil surface during spring and summer. Fluvaquents are found immediately adjacent to the river at this site. Kilgore soils are fine-loamy over sandy or sandy-skeletal, mixed Cumulic Cryaquolls (Soil Conservation Service 1992). The Kilgore series consists of deep, poorly drained soils on alluvial valley floors, floodplains, low terraces, and alluvial fans. Kilgore soils are found in most of the willow dominated areas. The large wet meadow is not mapped as Kilgore, but rather as the Tridell series, which is an upland soil. This could indicate that the area was previously not as wet as current conditions, thus suggesting irrigation water may be the dominant hydrological source, or that this wet meadow is simply an inclusion inside the mapped upland soil. The Atencio series is classified as a fine-loamy over sandy or sandy-skeletal, mixed Aridic Argiustolls (Soil Conservation Service 1992). Atencio soils are deep, well drained soils on fans and terraces, which have formed in alluvium.

Restoration Potential: Management of livestock should be altered to benefit the ecological health of the wetland and riparian areas. Fencing may be required in some locations. A more thorough understanding of the hydrology of the site (i.e. irrigation vs. groundwater discharge) would allow better management and or conservation decisions.

Figure 49. Coulter Creek Site of Local Significance.

Dry Rifle Creek Site of Local Significance

Location: This site is located approximately 5 ½ miles northeast of Rifle, CO between Harvey Gap Reservoir and Rifle Gap Reservoir.

Legal Description: U.S.G.S. 7.5-min. quadrangle: Rifle Falls. T5S R92W Sections 1-4 and 9-12.

Size: 1,058 acres

Elevation: 6,000-6,400 feet

General Description: Dry Rifle Creek is a small drainage that begins approximately 3 ½ to 4 miles east of Rifle Gap Reservoir. The creek drains into East Rifle Creek prior to entering the reservoir. Along the entire length of Dry Rifle Creek is a lush growth of wetland vegetation. Species such as cattail (*Typha latifolia*), reed canary *grass (Phalaris arundinacea*), hardstem bulrush (*Scirpus acutus*), threesquare (*S. pungens*), alkali bulrush (*S. maritimus*) and Baltic rush (*Juncus balticus*) occur in a mosaic along the creek bottom. Seepage from the Grass Valley Canal, which runs along the upper watershed boundary of Dry Rifle Creek, supports hydrological flow in this creek. There are numerous large seeps in the "headwater" area, which eventually drain into the creek. The creek bottom appears to have, at one time, entrenched itself. However, a permanent, although artificial, water source has allowed the creek to establish an equilibrium between sediment deposition and erosion, thereby creating a small, flat floodplain whose soils are semi-permanently saturated. Biologist from the Bureau of Land Management, Glenwood Spring Field Office, recently shocked the stream and identified the following dace and brown trout (Mike McGuire pers. commun. 2001). Instream flow rights were also sought for this creek.

Although this site is supported by unnatural hydrological flow, it is providing important local functions such as fish habitat, browse and cover for wildlife, and nutrient/sediment retention.

Protection and Management Comments: Ownership of along the creek includes both private and BLM parcels. Grazing is occurring along most of the drainage, especially within BLM parcels. Some private parcels are not being grazed and exhibit lush vegetation and highly saturated soils. Their contrast to the adjacent, heavily grazed BLM parcels, where excessive grazing is reducing vegetation cover and in some locations resulting in increased erosion, is striking. Near the downstream end of the site, increased erosion and heavy hoof action within the floodplain, has resulted in entrenchment of the stream, where the channel now lies one to two feet below the soil surface.

Soils Description: Soils along the creek appear to be the Heldt series, a fine, montmorillinotic, mesic Usteric Camborthids (Soil Conservation Service 1985). These soils are deep, well drained and formed in alluvium.

Restoration Potential: Assuming this area was naturally a dry creek, hence its name, true restoration would entail eliminating artificial water sources to restore the area back to an ephemeral creek. However, under current conditions there are a few management issues that could be addressed to restore functional quality to this drainage. Grazing regimes should be changed to alleviate further entrenchment of the creek and allow wetland vegetation to recover. There appear to have been a few narrowleaf cottonwoods (*Populus angustifolia*) planted along the creek. These areas may be being targeted for current restoration efforts. Without instream flow rights, the viability of this area is highly dependent on management of the Grass Valley Canal.

Figure 50. Dry Rifle Creek Site of Local Significance.

Fisher Creek Site of Local Significance

Location: Fisher Creek is located approximately 5 miles north of Carbondale, CO .

Legal Description: U.S.G.S. 7.5 minute quadrangle: Carbondale. T6S R88W Sections 35 and 36; T7S R88W Sections 1 and 2.

Size: 252 acres

Elevation: 6,800 to 7,400 feet.

General Description: This site encompasses a moderately wide valley along the upper portion of Fisher Creek. The valley mainly consists of mesic and wet meadows. North-facing slopes are dominated by Gambel's *oak (Quercus gambelii*) and Utah serviceberry (*Amelanchier utahensis*) while south-facing slopes are vegetated by piñon pine (*Pinus edulis*) and juniper (*Juniperus osteosperma*). An old homestead exists on the site and sits adjacent to a spring. The spring appears to have perennial flow (although it only flows a short distance before infiltrating back into the ground) and supports a moderate size wet meadow of Nebraska sedge (*Carex nebrascensis*), beaked sedge (*C. utriculata*), woolly sedge (*C. lanuginosa*), spikerush (*Eleocharis palustris*), cattail (*Typha latifolia*), and monkeyflower (*Mimulus glabratus*). Non-native species such as barnyard grass (*Echinochloa crus-galli*), redtop (*Agrostis gigantea*), Canada thistle (*Cirsium arvense*), and common plantain (*Plantago major*) are abundant within, but mostly at the edge, of this wet meadow. Houndstongue (*Cynoglossum officinale*), another non-native species, is abundant in the adjacent mesic grassland. River birch (*Betula occidentalis*) and choke cherry (*Prunus virginiana*) are common along Fisher Creek. There is a lot of housing development occurring in surrounding areas. Thus, the importance of this site for general open space and wildlife habitat is high.

Protection and Management Comments: There is a lot of housing development occurring nearby, however this area was recently acquired by the Bureau of Land Management via a land exchange. It appears to be managed for big game, grazing, cultural values (the homestead), and general recreation (roads have been closed but pedestrian and horse can access via an old two-track road).

There is an abundance of non-native species present, especially near the old homesite and spring. Attempts should be made to eradicate and/or limit the spread of the more aggressive species. Improper grazing may result in increased spread of non-native species and trampling of riparian and wetland vegetation.

Soils Description: The wetland and riparian soils are not mapped at this site since due to the small area they occupy. However, a soil pit determined that soils in the spring area had an A horizon that had a silty-clay texture with a lot of organic matter accumulation. Deeper horizons were not described. Soils in this area were permanently saturated from groundwater discharge.

Restoration Potential: This site is still recovering from years of use by homesteaders. Non-native species are abundant, thus eradication and control would benefit the ecological health of the wetland. Heavy grazing also appears to still be occurring in the area. Fencing the riparian areas and spring wetland would allow this area to recover from past disturbances.

Figure 51. Fisher Creek PCA.

Spring Valley Site of Local Significance

Location: This site is located approximately 3 miles south-southwest of Glenwood Springs, CO.

Legal Description: U.S.G.S. 7.5-min. quadrangle: Glenwood Springs; Shoshone; and Carbondale. T6S R88W Sections 19, 20, 28-30, 32, and 33; T6S R89 Section 24; T7S R88W Sections 4 and 5.

Size: 1,304 acres

Elevation: 6,850-7,000 feet.

General Description: This site consists of a large montane valley comprised of large wet and mesic meadows. Much of the site is currently under agricultural production and used for hay meadows and pasture. Numerous ditches are scattered throughout the site. There are a few large springs located along the eastern side of the valley. A few of the springs appear to have the potential for the presence of organic soils (these areas were not visited on foot, but rather were observed from the roadside). Most of the wetlands in the valley have been altered from agricultural and livestock activity. However, the large extent of wetlands in this valley and their associated functions led to the designation of this area as a Site of Local Significance.

Protection and Management Comments: The entire area is privately owned and actively managed for agriculture and livestock operations. County roads exist along the perimeter of the valley while smaller, private roads are scattered throughout the area.

Soils Description: Soils are mapped as the Kilgore and Empedrado series. Kilgore soils are fine-loamy over sandy or sandy-skeletal, mixed Cumulic Cryaquolls (Soil Conservation Service 1992). The Kilgore series consists of deep, poorly drained soils on alluvial valley floors, floodplains, low terraces, and alluvial fans. Kilgore soils are found along the wet areas of this site. Empedrado soils are fine-loamy, mixed Typic Argiborolls. They are deep, well drained soils formed in alluvium and eolian material (Soil Conservation Service 1992). Empedrado soils are found adjacent to the Kilgore soils in mesic areas.

Restoration Potential: This area has a lot of restoration potential given the amount of anthropogenic disturbances impacting the site. Livestock operations and agricultural activity could be eliminated in the lowest portions of the valley, where restoration of wetland vegetation is most feasible. Springs need to be fenced off to protect the hydrological source of the wetlands. Simply implementing these two restoration efforts would likely result in lush growth of wetland vegetation and increase many wetland functions.

Figure 52. Spring Valley Site of Local Significance.

West Rifle Creek Site of Local Significance

Location: This site is located approximately 11 miles northwest of Rifle, CO along West Rifle Creek.

Legal Description: U.S.G.S. 7.5-min. quadrangle: Rio Blanco. T3S R93W Section 31; T3S R94W Sections 35 and 36; T4S R93W Sections 6 and 7; T4S R94W Sections 1, 2, 12, and 13.

Size: 2,097 acres

Elevation: 7,100-7,800 feet.

General Description: Upstream from Harris Reservoir, there are numerous seeps along the hillsides and within the floodplain along West Rifle Creek. These seeps support meadows of Nebraska sedge (*Carex nebrascensis*), beaked sedge (*C. utriculata*), redtop (*Agrostis gigantea*), curly dock (*Rumex crispus*), Canada thistle (*Cirsium arvensis*), Baltic rush (*Juncus balticus*), timothy (*Phleum pratense*), smooth *brome (Bromus inermis*), mullein (*Verbascum thapsus*), and foxtail barley (*Hordeum jubatum*). These seeps form the headwaters to West Rifle Creek. Downstream, willows, such as mountain willow (*Salix monticola*) and sandbar willow (*S. exigua*), become more abundant along the creek. Grazing also increases downstream along with non-native species such as orchard grass (*Dactylis glomerata*), timothy, Canada thistle, and reed canary grass (*Phalaris arundinacea*). This area performs significant local functions such as providing water, forage, cover, and nesting habitat for wildlife in an otherwise arid landscape, groundwater discharge, and potentially sediment and nutrient retention.

Protection and Management Comments: Grazing is the main land use of this site. However, although little development is occurring at this time, information from the Garfield County Assessors Office and a conversation with a landowner in the area indicated that this area is quickly being purchased by a Front Range real estate company, with the assumed purpose of selling 35 acres, or potentially smaller, parcels.

Soils Description: Soils along the riparian area are mapped as the Holderness variant series, a fin, montmorillonitic, frigid Aridic Haploborolls (Soil Conservation Service 1985). These soils formed in alluvium derived from shale and sandstone and are deep, well drained soils. It is a variant of the Holderness series because it is calcareous to the surface (Soil Conservation Service 1985).

Restoration Potential: Management of livestock could be altered to benefit the ecological health of the wetland and riparian areas. Fencing may be required in some locations.

Figure 53. West Rifle Creek Site of Local Significance.

Natural History Information

Rare and imperiled plants

Six rare wetland plant species are known from Garfield County. Five of these, shown in bold type in the chart below, have been included in the PCAs for Garfield County. Descriptions are given below for those in PCAs. The one species shown in regular type is not included in PCA as it is based on a historic record.

In the chart below, in addition to scientific and common names and the CNHP global and state ranks, the plants' federal status under the Endangered Species Act, and their status within federal agencies is given. LE or LT refers to Listed as Endangered or Threatened under the ESA. BLM and USFS indicate that the Bureau of Land Management or U.S. Forest Service considers the species to be of special concern. Colorado has no legal state list of threatened and endangered plant species (Buckner and Bunin 1992).

Table 63. Rare and imperiled wetland plant of Garfield County

Element	Common name	Global rank	State rank	Federal/ State status
Carex diandra	**Lesser panicled sedge**	**G5**	**S1**	
Cypripedium calceolus* ssp. *parviflorum	**Yellow lady's-slipper**	**G5**	**S2**	
Iliamna grandiflora	**Large-flower globe-mallow**	**G3?Q**	**S1**	
Limnorchis ensifolia	**Canyon bog-orchid**	**G4G5T3 ?**	**S3**	
Listera borealis	Northern twayblade	G4	S2	
Sullivantia hapemanii* var. *purpusii	**Hanging garden sullivantia**	**G3T3**	**S3**	

***Carex diandra* Schrank (Lesser panicled sedge)**

Taxonomy:
Class: Monocotyledoneae
Order: Cyperales
Family: Cyperaceae
Genus: *Carex*

Taxonomic Comments: *Carex* is the largest genus of plants in Colorado, and species are often distinguished by very technical characteristics.

CNHP Ranking: G5 S1

State/Federal Status: None.

Phenology: *Carex diandra* is a grass-like plant that is characterized by its densely clumped habit and narrow leaves. The plants flower from May to July, and bear fruit in late July and August.

Habitat Comments: The ecology of sedges is extremely varied. They grow in all natural-climatic zones from sea level to high mountain areas (Egorova 1999) and are often the dominant plant in many communities. *Carex diandra* belongs to a group of sedges which grow in shallow water on the shores of rivers and lakes, from 8400 to 11,000 feet in elevation. In Garfield County, the sedge was found in clumps growing on partially submerged logs in a small permanent pond.

Global Range: species is circumboreal in its distribution, but is rarely encountered south of the Canadian border in North America (Hurd et. al.1998).

State Range: This In Colorado, it is known only from three locations, one each in Garfield, Boulder and Larimer counties.

Distribution/Abundance: Because of its limited distribution in the U.S., all locations for this species deserve to be protected.

Known Threats and Management Issues: Potential threats to the species include hydrological modifications such as dams and diversions that would alter its habitat, and logging close to the site.

Potential Conservation Areas which support *Carex diandra*: Turret Creek

Cypripedium calceolus ssp. parviflorum (yellow lady's-slipper)

Taxonomy:
Class: Monocotyledoneae
Order: Orchidales
Family: Orchidaceae
Genus: *Cypripedium*

Taxonomic Comments: Recently the genus has been moved from the orchid family (*Orchidaceae*) to a new family, the *Cypripediaceae*, based on several unique characters (Weber 1996).

CNHP Ranking: G5 S2

State/Federal Status: BLM Sensitive

Phenology: Yellow lady's slipper is a large flowered yellow orchid species. It is the showiest orchid in Colorado. Its flowers are usually solitary and have a prominent lip which gives this species its common name.

Habitat Comments: It is found in wetlands and in rich, humus and decaying leaf litter in wooded areas in aspen and ponderosa pine/ Douglas-fir zones. Associated species in the Garfield County sites include starry false Solomonseal *(Maianthemum stellatum*), coyote willow *(Salix exigua*), Rocky Mountain willow (*Salix* monticola), thinleaf alder (*Alnus incana*), woods rose (*Rosa woodsii*), rushes (*Juncus* spp.), horsetails (*Equisetum arvense*), and black twinberry (*Lonicera involucrata*).

Global Range: This species is known from 26 locations throughout Colorado, as well as the continental U.S., Alaska and Canada. However, it is sparsely distributed and uncommon.

State Range: It is known from Routt, Summit, Jackson, Larimer, Grand, Boulder and Eagle counties.

Distribution/Abundance:

Known Threats and Management Issues: Threats to this species include trampling, exotic plant invasion, logging, and alterations of the hydrology on which its wetland habitats depend. Constant moisture is very important to this species during germination and early development. According to William Weber (1996), "all species of *Cypripedium* are rare and potentially endangered, and should not be disturbed".

Potential Conservation Areas which support *Cypripedium calceolus ssp. parviflorum*: Sutank and Ranch at Roaring Fork.

***Iliamna grandiflora* (Large-flower globe-mallow)**

Taxonomy:
Class: Dicotyledoneae
Order: Malvales
Family: Malvaceae
Genus: *Iliamna*

Taxonomic Comments: There is some question as to the taxonomic distinctiveness of this species, as it is very similar, and possibly synonymous, with the more common *I. rivularis*. The two species are distinguished mainly by size, and are suspected to intergrade in Colorado. However, those found in Garfield County in 2000 appear to fall within the upper range of flower size.

CNHP Ranking: G2G3Q S1

State/Federal Status: None.

Phenology: Large-flower globe-mallow is a handsome, bushy plant with rose-pink to white flowers. The plants grow up to 5 feet tall and have large maple-like leaves.

Habitat Comments: It is found on banks, slopes, meadows, and along streams (Harrington 1954). In Garfield County, several occurrences were along roads in moist forested areas, where the plants may benefit from extra moisture from run-off. The plants seem to thrive on disturbed soils, both along roadsides and in areas with natural erosion. Associated species included Douglas fir (*Pseudotsuga menziesii*), aspen (*Populus tremuloides*), Rocky Mountain maple (*Acer glabrum*) and Gambel's oak (*Quercus gambelii*).

Global Range: It is considered to be a Colorado endemic species.

State Range: There were previously only 12 small occurrences of this species in the state, two in Garfield County, and others in Ouray, Routt, Pitkin and Montezuma counties. Three new occurrences were found in Garfield County during this survey, bringing the total to five in the county, and 15 in the state.

Distribution/Abundance: Because of its limited distribution in the U.S., all locations for this species deserve to be protected.

Known Threats and Management Issues: No populations have any protection to date. Threats to the species include logging and road maintenance activities such as weed spraying and grading. Effects of grazing are not known, although herbivory by cattle has been observed.

Potential Conservation Areas which support *Iliamna grandiflora*: Douglas Pass

***Platanthera sparsiflora var. ensifolia* (canyon bog-orchid)**

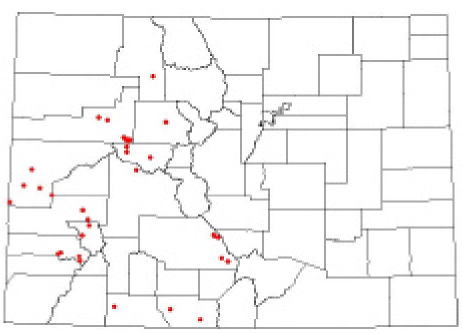
Taxonomy:
Class: Monocotyledoneae
Order: Orchidales
Family: Orchidaceae
Genus: *Limnorchis*

Taxonomic Comments: It is also known as *Limnorchis ensifolia.*

CNHP Ranking: G4G5T3? S3

State/Federal Status: no special status

Phenology: The canyon bog-orchid has been reported in flower from mid-June to mid-September and may fruit as early as late July and continue through mid-September.



Colorado Distribution

Habitat Comments: This orchid can be found in wet, marshy areas in the mountains between 6,000-10,000 feet.

Global Distribution: This species is known from Arizona, Colorado and Nevada.

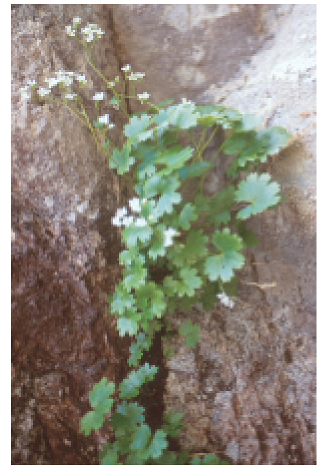
State Distribution: This species is found in 12 Colorado counties (Gunnison, Conejos, Montrose, Saguache, Eagle, Mesa, Ouray, Routt, Pitkin, Garfield, Arhuleta, and San Miguel). In Garfield County, it is known from eight locations, one in East Elk Creek, one in West Elk Creek, and six in the Roaring Fork Valley.

Distribution/Abundance: A minimum number of individuals is estimated at 5000. Thirty-five locations are known at this time.

Known Threats and Management Issues: Grazing, recreation, and hydrological modifications are the main threats to this species. The canyon bog-orchid has been found on BLM, FS and private properties.

Potential Conservation Areas which support *Limnorchis ensifolia*: Kaiser Stevens Ditch, Ranch at the Roaring Fork, East Elk Creek, West Elk Creek, and Sutank.

Sullivantia hapemanii var. _purpusii_ (hanging garden sullivantia)



Taxonomy:
Class: Dicotyledoneae
Order: Rosales
Family: Saxifragaceae
Genus: Sullivantia

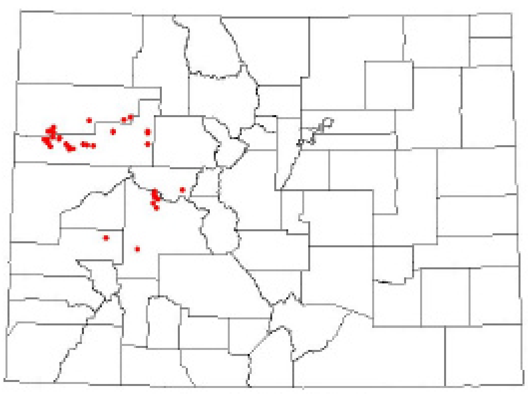
Taxonomic Comments: This taxon is sometimes considered a distinct species (*Sullivantia purpusii*).

CNHP Ranking: G3T3 S3

Federal/State Status: Forest Service sensitive species

Phenology: This plant flowers from mid-June to late July and fruits July-August (Spackman et al. 1997).

Habitat: This species can be found in hanging gardens, wet cliffs and boulders of various geologic origin between (7,000-10,000 feet).



Colorado Distribution

Global Distribution: This variety is only known from Colorado (USDA 1999).

State Distribution: There are 45 locations known from Rio Blanco, Gunnison, Garfield, Pitkin, and Montrose counties.

Distribution/Abundance: It is estimated that there are approximately 40,000 individuals worldwide.

Known Threats and Management Issues: This species is somewhat naturally protected by its inaccessible hanging garden habitat. Although, rock climbing may disturb or destroy individuals, while alteration of hydrology is needed for the survival of these locations. Most occurrences occur on Forest Service, Bureau of Land Management or Naval Oil Shale properties.

Potential Conservation Areas which support _Sullivantia hapemanii_ var. _purpusii_: 4A Ridge, Bear Point, Clear Creek, Conn Creek, Deep Creek, East Fork Parachute Creek, East Rifle Creek, Hanging Lake, Horse Ridge, Parachute Creek and Upper 4A Mountain.

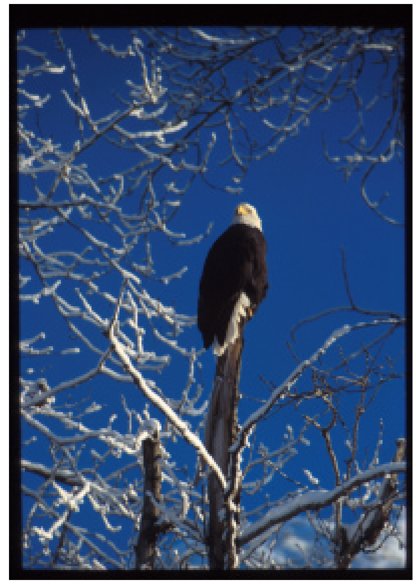
Rare and Imperiled Animals Dependent on Wetlands of Garfield County

Within the boundaries of Garfield County there are numerous ecosystems supporting a rich diversity of flora. From this diversity in vegetation comes a diversity in animal life that includes rare lizards on the arid western lands to a rare alpine butterfly found in the Flat Tops Wilderness Area. This is truly a unique county with an amazing richness of rare fauna well worth preserving for future generations. A total of 33 animal species that are rare or imperiled, globally or in Colorado, have been documented from Garfield County during the last ten years. Fifteen are known to depend on wetlands and riparian area for their survival. They are described below.

Table 64. Rare and imperiled animals dependent on wetlands of Garfield County.

Element	Common name	Global rank	State rank	Federal/ State status
Amphibians				
Bufo boreas pop 1	Boreal toad (Southern Rocky Mountain population)	G4T1Q	S1	C/CO-E
Rana pipiens	Northern leopard frog	G5	S3	
Spea intermontana	Great Basin spadefoot	G5	S3	
Birds				
Accipiter gentilis	Northern Goshawk	G5	S3B,SZN	
Bucephala islandica	Barrow's Goldeneye	G5	S2B,SZN	
Cypseloides niger	Black Swift	G4	S3B	
Grus canadensis tabida	Greater Sandhill Crane	G5T4	S2B,S4N	
Haliaeetus leucocephalus	Bald Eagle	G4T?Q	S1B,S3N	LT
Plegadis chihi	White-Faced Ibis	G5	S2B,SZN	
Fish				
Catostomus latipinnis	Flannelmouth sucker	G3G4	S3	BLM
Gila robusta	Roundtail chub	G2G3	S2	
Oncorhynchus clarki pleuriticus	Colorado River cutthroat trout	G4T3	S3	
Prosopium williamsoni	Mountain whitefish	G5	S3	
Xyrauchen texanus	Razorback sucker	G1	S1	LE/CO-E
Invertebrates				
Erebia theano	Theano Alpine	G4	S3	

Bald Eagle (*Haliaeetus leucocephalus*)



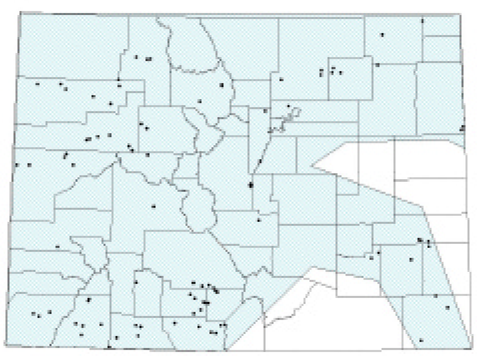
Taxonomy:
Class: Aves
Order: Falconiformes
Family: Accipitridae
Genus: *Haliaeetus*

Taxonomic Comments: none.

CNHP Ranking: G4 S1B,S3N

State/Federal Status: Federally threatened

Habitat Comments: Bald Eagles that nest in Colorado use large, mature cottonwoods or pines, often along rivers, to hold their heavy nests (CBBA 1998). Wintering populations will use major rivers, reservoirs, and prairie dog towns (MBW).



Distribution: Bald Eagles live throughout North America - from Alaska to Newfoundland, and from the tip of Florida to southern California, and nest across Colorado (CBBA 1998).

Important Life History Characteristics: Bald Eagles begin nesting in late February, and can often be observed feeding their young into late June (CBBA 1998).

Known Threats and Management Issues: Continued threats to this species include high pesticide use, poisoning, poaching, and loss of nesting habitat due to the enduring popularity of waterfront development (CNHP 1997).

Potential Conservation Areas supporting *Haliaeetus leucocephalus*: Rifle Stretch Colorado River and Kaiser Stevens Ditch.

Barrow's Goldeneye (*Bucephala islandica*)

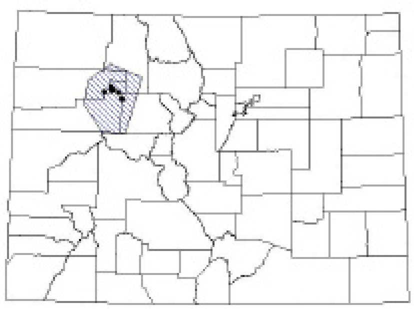
Taxonomy:
Class: Aves
Order: Anseriformes
Family: Anatidae
Genus: *Bucephala*

Taxonomic Comments: Subfamily Anatinae

CNHP Ranking: G5 S2B,SZN

State/Federal Status: BLM Sensitive, State special concern

Habitat Comments: Barrow's Goldeneyes are cavity nesters, and find nest holes among beetle-killed trees in the vicinity of montane lakes (CBBA 1998).



Distribution: Colorado is at the southern margin of this bird's range, and the state's occurrences may be disjunct (CNHP 1997). Taxonomists recognize no subspecies, but Barrow's goldeneye in Colorado belong to a unique population that breeds and winters inland on freshwater lakes, reservoirs, and rivers in Idaho, Montana, Wyoming, and Colorado (CBBA 1998).

Important Life History Characteristics: Courtship begins in late May and fledged young are observed into late July (CBBA 1998) Barrow's goldeneye is a secondary cavity nester, and relies upon primary cavity nesters to excavate nest sites. This bird competes with fish for the aquatic invertebrate foods upon which it relies. Lakes that are unsuitable or unoccupied by fish are preferred by this species. In more northern parts of the range, this species breed in alkaline lakes that cannot support fish. In Colorado, we find them on lakes that lack continuous oxygen replenishment from mountain streams or freeze through during winter. Under these circumstances, insect populations during the summer are found along the shorelines, but there are no fish with which to compete (CBBA 1998).

Known Threats and Management Issues: This species is threatened by the small number of breeding localities, uncertain population status, and the small number of protected occurrences within Colorado (CNHP 1998). A high degree of sensitivity to alterations in breeding habitat also renders this species vulnerable to logging impacts (CBBA 1998).

Potential Conservation Areas supporting *Bucephala islandica*: Trappers Lake

Black Swift (*Cypseloides niger*)

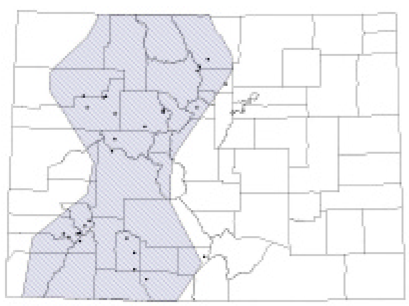
Taxonomy:
Class: Aves
Order: Apodiformes
Family: Apodidae
Genus: *Cypseloides*

Taxonomic Comments: Subfamily Cypseloidinae

CNHP Ranking: G4 S3B

State/Federal Status: USFS Sensitive

Habitat Comments: Black Swifts nest on vertical rock faces, near waterfalls or in dripping caves (Lack 1956). Beyond that requirement, they inhabit a variety of landscapes, from seacoasts to the high elevations of the Rocky Mountains (CBBA 1998).



Distribution: Black swifts breed in scattered colonies in western North America, from southeast Alaska to central Mexico, and migrate to the Neotropics in the winter (Stiles and Negret 1994). In Colorado, black swifts breed most commonly in the San Juan mountains, with scattered colonies in four other mountain ranges -- Sangre de Cristo, Flat Tops, Gore, and Front (CBBA 1998).

Important Life History Characteristics: After arriving in Colorado in June, black swifts take all summer to raise a single nestling (CBBA 1998). The cool microclimates they select for nesting presumably slows the developmental metabolism of the nestlings. Since nestlings are typically fed only once per day after the adults return from a day of foraging, slower development rates would help the survival.

Known Threats and Management Issues: There are few obvious threats to this species, except where development alters nesting habitat. The Colorado Breeding Bird Atlas (1998) hypothesizes that at least 20% of all black swifts breed in Colorado.

Potential Conservation Areas supporting *Cypseloides niger*: Hanging Lake

Boreal Toad (*Bufo boreas boreas*)

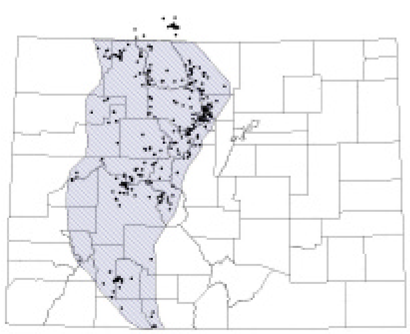
Taxonomy:
Class: Amphibia
Order: Anura
Family: Bufonidae
Genus: *Bufo*

Taxonomic Comments: Prior to the 1990s, morphological, biogeochemical, and vocal differences were noted between toads of the *Bufo boreas* complex in the southern Rocky Mountains and those in the Pacific Northwest (Burger and Bragg 1947, Hubbard 1972). Goebel (1996) described *Bufo boreas* in the southern Rocky Mountains as genetically distinct from those in the Pacific Northwest. These differences may warrant recognition as one or more distinct species. Until this change is formally accepted, Hammerson (1999) has offered the common name of Mountain Toad for the interim, and suggests that the Latin name may become *Bufo pictus*. For the purposes of this report, we are referring all naming to boreal toad (*Bufo boreas boreas*).

CNHP Ranking: G4T1Q S1

State/Federal Status: USFWS candidate for listing (warranted but precluded), USFS Sensitive, State endangered

Habitat Comments: The boreal toad breeds in still or slowly-moving water such as can be found in marshes, ponds, and lakes. Successful breeding generally requires permanent or semi-permanent water sources. Post breeding, one may find the boreal toad in more terrestrial environments. Though they still tend to linger near water in damp environments, some females will use drier, more densely vegetated areas. Rocks, logs and rodent burrows provide cover while away from water during periods of inactivity (Hammerson 1999).



Distribution: The southern Rocky Mountain population of boreal toads is likely distinct from other populations (A. Geobel, unpbl. data). Although relationships among populations of this toad are not resolved, recent genetic evaluations suggest that the southern Rocky Mountain population ranges from southern Idaho to New Mexico (Goettl 1997; Steve Corn pers. comm.; A. Goebel unpbl. data). In Colorado, this species occurs throughout the mountains above approximately 8,000 feet in elevation. There are approximately 206 historical localities for the boreal toad in Colorado, while currently there are just 35 known active breeding sites.

Important Life History Characteristics: Boreal toads are long-lived, reaching ages of nine years or more (Campbell 1976). Reproductive maturity does not occur until age four in males and six in females (Carey 1976). Other important considerations include sensitivity to toxicants, relatively short breeding season (starting as the winter snowpack begins to thaw), and slow metabolic rates of the larvae (Hammerson 1999).

Known Threats and Management Issues: Presently, only three to four healthy populations remain across the entire range, comprised of less than 40 high priority breeding sites (Steve Corn, pers. comm.; Lauren Livo, pers. comm.). Based on the small numbers of egg masses, it is estimated that there are currently fewer than 1,000 breeding adults. Although there is an abundance of "protected" habitat, populations have declined precipitously or disappeared over the past 20 years, and continue to do so (Goettl 1997). The reasons for this decline are varied and largely unknown and the factors important to the persistence of this species are not well understood.

Potential Conservation Areas supporting *Bufo boreas boreas*: Trappers Lake, The Meadows and North Fork Derby Creek

Colorado River Cutthroat Trout (*Oncorhynchus clarki pleuriticus*)

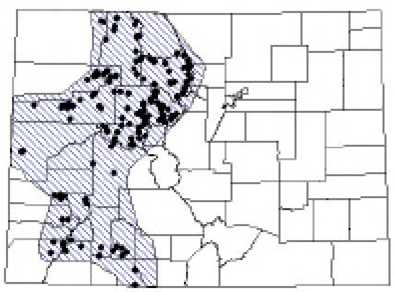
Taxonomy:
Class: Actinopterygii
Order: Salmoniformes
Family: Salmonidae
Genus: *Oncorhynchus*

Taxonomic Comments: Subclass - Neopterygii

CNHP Ranking: G4T3 S3

State/Federal Status: USFS sensitive, BLM sensitive, State species of special concern

Habitat Comments: The historical habitat included most clearwater streams and rivers of western Colorado (Behnke 1992). The trout remains only in smaller order streams and a few high elevation lakes of the mountainous country.



Distribution: This subspecies is the only trout native to the upper Colorado River basin. Its native range extends southward to the Escalante River on the west and San Juan drainage on the east sides of the basin, including the Green, Yampa, Gunnison, Dolores, and San Juan river systems (CDOW 1986, CDOW 1987, Proebstel 1994, Young et al. 1996). Currently, remnant populations remain in Colorado, Wyoming, and Utah.

Important Life History Characteristics: Competition and hybridization with non-native salmonids occurs. This trait has contributed to the current preferences of this native trout for lakes, beaver ponds, and small streams. Clean, cold water running over a boulder-cobble substrate marks the preferred habitat of this trout (Trotter 1987).

Known Threats and Management Issues: The Colorado River cutthroat trout is heavily managed and studied. Presently, there are 42 populations in Colorado judged to be genetically pure (Proebstel 1994). However, the primary reasons for conservation concern at the global and state levels are long-term trend prognoses and threats. Populations continue to decline in many streams (Young et al. 1996); hybridization between this species and non-native trout species (Rainbow trout *Oncorhynchus mykiss*) poses the greatest threat to the elimination of pure populations. Competition with non-native trout species and exotic fish diseases also pose threats, and declines have been hastened by loss of habitat to grazing, clearcutting, water diversions, and stream channelization (Trotter 1987).

Potential Conservation Areas supporting *Oncorhynchus clarki pleuriticus*: Northwater Creek, East Parachute Creek, Parachute Creek, Butler Creek, Main Elk Creek, Trappers Lake and Mitchell Creek.

Flannelmouth Sucker (*Catostomus latipinnis*)

Taxonomy:
Class: Actinopterygii
Order: Cypriniformes
Family: Catostomidae
Genus: *Catostomus*

Taxonomic Comments:

CNHP Ranking: G3G4 S3

State/Federal Status: BLM Sensitive Species; no state status

Habitat Comments: The Roundtail chub occurs in large streams and intermediate sized rivers (Page and Burr 1991).

Distribution: The flannelmouth sucker is moderately widespread (10,000-1,000,000 sq. miles) and occurs throughout the Colorado River Basin, from southwestern Wyoming to southern Arizona. It is more widespread in the upper basin than the lower basin and declining in at least some areas.

Important Life History Characteristics: In Colorado this fish is found in the large rivers of western Colorado and in the study site it occupies the Colorado River from Rifle, Colorado downstream to the Mesa County and beyond.

Known Threats and Management Issues: Threats include alteration of the hydrologic and thermal characteristics of river habitats, blocked migration routes due to dam construction, hybridization with other *Catostomus* species and predation and competition by non-native fish species (Arizona Game and Fish Department 1995, 1996). Elevated sediments, channelization, modified flow regimes, stream dewatering and contaminants have also contributed to reduced populations. This species has disappeared from some water systems like the Gunnison River above Blue Mesa were it was displaced by the nonnative species white and longnosed suckers (Woodling 1985). Flannelmouth suckers hybridize with the humpback, white and longnosed suckers (Sigler and Miller 1963). This fish may be fairly resistant to nondestructive intrusion (W. Fertig pers. comm. 1997). Protection of this fish in Colorado requires prohibiting introduction of nonnative species to waters with stable populations of flannelmouth suckers and returning natural flow characteristics to the major rivers it now occupies.

Potential Conservation Areas supporting *Catostomus latipinnis*: Rifle Stretch Colorado River

Great Basin Spadefoot (*Spea intermontana*)

Taxonomy:
Class: Amphibia
Order: Anura
Family: Pelobatidae
Genus: *Spea*

Taxonomic Comments:

CNHP Ranking: G5 S3

State/Federal Status: BLM Sensitive Species; State Special Concern.

Habitat Comments: The theano alpine inhabits small marshes or wet meadows in alpine zone; also, taiga and grassy openings in pine forests.

Distribution: The Great Basin spadefoot, as its name implies, is endemic to the Great Basin. Colorado defines the southeastern edge of this species' range (Stebbins 1985). There are 10 to 20 locations totaling 3,000 to 10,000 individuals in four western Colorado counties north of the Uncompahgre Plateau. There are four historical records of Great Basin spadefoots in Garfield County, most dating from the turn of the century and one from 1972. There is a more recent record (1996) at Ripley Gulch in the Parachute Creek drainage.

Important Life History Characteristics:

Known Threats and Management Issues:

Potential Conservation Areas supporting *Spea intermontana*: Rifle Stretch Colorado River and Parachute Creek

Greater Sandhill Crane (*Grus canadensis tabida*)

Taxonomy:
Class: Aves
Order: Gruiformes
Family: Gruidae
Genus: *Grus*

Taxonomic Comments:

CNHP Ranking: G5T4 S2B, S4N

State/Federal Status: Forest Service Sensitive Species; State Threatened.

Habitat Comments: Along river valleys of the eastern plains, and valleys and parklands of the western mountains of Colorado

Distribution: The Greater Sandhill Crane winters in southern North America and Central America and breeds in northern North America (National Geographic Society 1987). Sandhill Cranes are abundant spring and fall migrants in the San Luis Valley and occasional to irregular migrants along river valleys of the eastern plains, and valleys and parklands of the western mountains of Colorado (Andrews and Righter 1992). Renner et al. (1991) reported 50 known breeding occurrences and approximately 118 recorded nest sites. In the San Luis Valley, peak migration counts may be as high as 17,000 individuals. Non-breeders very rarely summer in the San Luis Valley (Andrews and Righter 1992). The Breeding Bird Survey indicates a large continental increase (>3% per year) for Sandhill Cranes (Mike Carter pers. comm.), but does not distinguish the Greater subspecies (*G. c. tabida)*. A pair of Greater Sandhill Cranes was observed along the Colorado River (Rifle Stretch Colorado River PCA) in appropriate breeding habitat in 1997, but breeding has never been confirmed here.

Important Life History Characteristics:

Known Threats and Management Issues: The draining and subsequent vegetative encroachment on preferred mud flats and sandbar habitats in river and meadow systems along migratory routes is a key conservation concern for this species in Colorado (Renner et al. 1991). Availability of spilled grains in adjacent agricultural areas is an additional conservation consideration for this species in Colorado. Breeding populations of this species in Colorado are ranked S2B because of the restricted range and relatively low numbers of breeding occurrences. The Colorado Division of Wildlife monitors nesting activity of this species.

Potential Conservation Areas supporting *Grus canadensis tabida*: Rifle Stretch Colorado River

Mountain Whitefish (*Prosopium williamsoni*)

Taxonomy:
Class: Osteichthyes
Order: Salmoniformes
Family: Salmonidae
Genus: *Prosopium*

Taxonomic Comments:

CNHP Ranking: G5 S3

State/Federal Status: No federal or state status.

Habitat Comments: They prefer cold mountain lakes (to depths of at least 10 m) and fast, clear or silty streams with large pools.

Distribution: This species ranges from Canada's Northwest Territories, south into the northwestern U.S., south to Nevada, Utah and Colorado (Page and Burr 1991). Colorado is at the southeastern periphery of the species' range. In Colorado this species is known from relatively few occurrences on the western slope in the Yampa and White rivers, but is considered common in Lodore Canyon on the Green River (Kevin Bestgen pers. comm.). Mountain Whitefish have been found in the Colorado River between Rifle and Debeque Canyon, but this is marginal whitefish habitat and it amounted to about 5% of the total fish caught during electroshocking surveys in 1994 and 1995.

Important Life History Characteristics: Stream populations spawn in riffles over gravel and small rubble. Lake populations move into tributaries to spawn or seek gravel shallows in lake. Eggs stick to bottom substrate and nests are not constructed. White fish are bottom-oriented predators (Moyle 1976), but will occasionally feed at the surface (Sigler and Sigler 1987). Whitefish actively feed on aquatic and terrestrial insects, some fish eggs and occasionally on fishes.

Known Threats and Management Issues: There are no quantitative data that indicate the species trends, however, there is no evidence of declines (Kevin Bestgen pers. comm.).

Potential Conservation Areas supporting *Prosopium williamsoni*: Rifle Stretch Colorado River

Northern Goshawk (*Accipiter gentilis*)

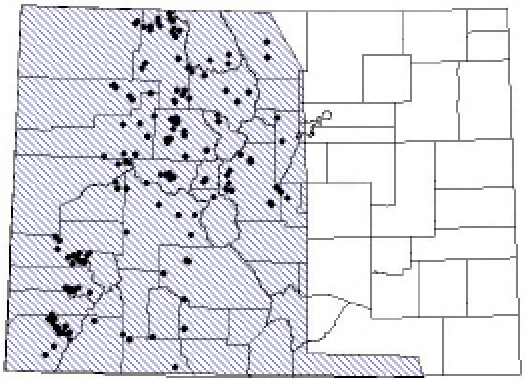
Taxonomy:
Class: Aves
Order: Falconiformes
Family: Accipitridae
Genus: *Accipiter*

Taxonomic Comments: none

CNHP Ranking: G5 S3B,SZN

State/Federal Status: USFS sensitive, BLM sensitive

Habitat Comments: In northwestern Colorado, northern goshawks typically nest in aspen, sometimes in conifer stands less than 100 years old, and up to 10,000 feet in elevation (CBBA 1998). Goshawks tend to choose nest trees on shallow slopes, flat benches in steep country, and fluvial pans on small stream junctions (CBBA 1998).



Distribution: The northern goshawk is found throughout the state of Colorado above 7500 feet in elevation (Andrews and Righter 1992). The Colorado Breeding Bird Atlas (1998) shows them to be well distributed in the San Juan Mountains and across the northern mountain ranges.

Important Life History Characteristics: This species requires large blocks of forest for nesting and foraging (CBBA 1998). Goshawks reuse the same territory year after year and sometimes reuse the same nest. Pairs typically have one or more alternate nests within the same territory and may desert one nest and then return to it in a later year (CBBA 1998).

Known Threats and Management Issues: This species apparently responds negatively to some form of forest fragmentation (Reynolds 1983). Stokes and Stokes (1996) indicated that populations are declining in the western U.S. due to fragmentation and development, small estimated population sizes, and lack of detailed knowledge about this species. Human disturbances around nesting sites may also upset breeding goshawks (CBBA 1998).

Potential Conservation Areas supporting *Accipiter gentilis*: Deep Creek, Four Mile Creek at Sunlight and Main Elk Creek

Northern Leopard Frog (*Rana pipiens*)

Taxonomy:
Class: Amphibia
Order: Anura
Family: Ranidae
Genus: *Rana*

Taxonomic Comments:

CNHP Ranking: G5 S3

State/Federal Status: Forest Service and BLM Sensitive Species; State Special Concern.

Habitat Comments: This species inhabits many aquatic and wetland habitats (Hammerson 1999).

Distribution: This frog has a large range throughout much of the U.S. and southern Canada. It is still common in many areas and in a diverse array of pristine and disturbed habitats; populations have declined in some areas due to habitat loss and degradation, overexploitation, interactions with non-native species, and unknown causes, but the overall range remains essentially undiminished. Most locational records in Colorado are below 11,000 feet elevation (CDOW 1994). There are 15 records from the late 1990s of northern leopard frogs spread throughout Garfield County, including four at the Rifle Stretch Colorado River PCA. There are estimated to be less than 100 occurrences in Colorado, most of which are historical. Population in the state is estimated to be between 3,000 and 10,000 individuals. Trends for this species are unclear, although local trends are variable, and the overall population in Colorado appears to be declining.

Known Threats and Management Issues: Threats include habitat loss, commercial overexploitation, and competition/predation by bullfrogs. Apparent trends for this frog are puzzling. This species has become scarce in many areas of Colorado where it was formerly abundant (Hammerson 1999, Corn 1994) and has been extirpated from several sites (Lauren Livo pers. com.). However, the species has returned to some areas that previously suffered substantial declines (Steve Corn pers. comm.). Reasons for population declines are not known but appear to be complex. Bullfrogs have been suggested as causing declines, but declines and local extinction's have occurred in areas where bullfrogs are not present (Hammerson 1999, Livo 1994). While still common, conservation concern for the northern leopard frog stems from the declining trends and poorly defined, but apparent threats. Decline in the Rocky Mountains (Corn et al. 1989) is not due to acidification of breeding habitats (Corn and Vertucci 1992). Laboratory results suggests that there may be an interaction between crowding, temperature, and mortality from bacterial infection (e.g., red-leg disease).

Potential Conservation Areas supporting *Rana pipiens*: Rifle Stretch Colorado River; Garfield Creek

Roundtail Chub (*Gila robusta*)

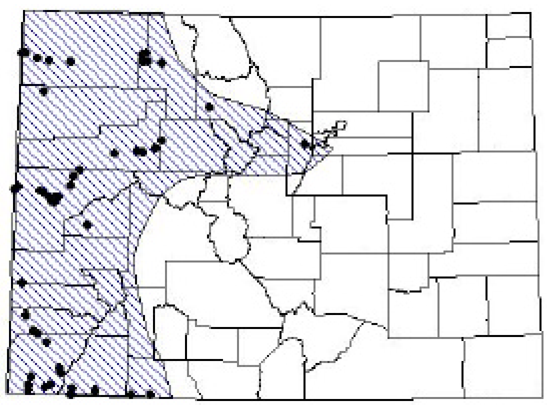
Taxonomy:
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: *Gila*

Taxonomic Comments: Subclass Neopterygii

CNHP Ranking: G2G3 S2

State/Federal Status: BLM sensitive, State species of special concern

Habitat Comments: The Roundtail chub occurs in large streams and intermediate sized rivers (Page and Burr 1991).



Distribution: The Roundtail Chub is endemic to the Colorado River basin (Page and Burr 1991). In Colorado, this species occurs in the Colorado River mainstem and its larger tributaries, including the White, Yampa, Dolores, San Juan, and Gunnison rivers (CNHP 1997).

Important Life History Characteristics: Rountail chub occupies slow moving water adjacent to areas of faster water. Gravel substrates are required for spawning (Woodling 1985).

Known Threats and Management Issues: The main threats to this species are habitat degradation and its restricted range (CNHP 1997). Warm water temperatures are required during the summer for breeding, and the release of cold water from dam facilities during the summer may contribute to the decline of this species (Woodling 1985).

Potential Conservation Areas supporting *Gila robusta*: Rifle Stretch Colorado River

Theano Alpine (*Erebia theano*)

Taxonomy:
Class: Insecta
Order: Lepidoptera
Family: Nymphalidae
Genus: *Erebia*

Taxonomic Comments:

CNHP Ranking: G4 S3

State/Federal Status: No federal or state status.

Habitat Comments: The theano alpine inhabits small marshes or wet meadows in alpine zone; also, taiga and grassy openings in pine forests.

Distribution: This butterfly is widespread occupying greater than 1,000,000 sq. miles of North America, but it is a local arctic species, also occurring in the alpine of the Rocky Mountains. Because of its widespread but local distribution, some groups are quite isolated. There are widely scattered colonies of the theano alpine in the Rockies as far south as the San Juan range of southern Colorado. Approximately 14 colonies are reported from six Colorado counties including Hinsdale, Boulder, Clear Creek, San Miguel, Gilpin and Garfield. In Garfield County a theano alpine colony was documented in 1996 near Wall Lake in the Flat Tops Wilderness Area. Although we surveyed historical locations of this species in Garfield County none were observed.

Important Life History Characteristics: Host plants are from the family Poaceae.

Known Threats and Management Issues: This relatively permanent and resistant species is not threatened on a range-wide basis, although it may be threatened in minor portions of its range; particularly from grazing pressures of sheep in alpine zones and subsequent reduction in distribution of host plants.

Potential Conservation Areas supporting *Erebia theano*: Trappers Lake

White-faced Ibis (*Plegadis chihi*)

Taxonomy:
Class: Aves
Order: Ciconiiformes
Family: Threskiornithidae
Genus: *Plegadis*

Taxonomic Comments:

CNHP Ranking: G5 S2B, SZN

State/Federal Status: Forest Service and BLM Sensitive Species; no state status.

Habitat Comments: White-faced Ibis inhabit marshes, swamps, ponds and rivers (AOU 1983) and build nests in low trees, on the ground in bulrushes or reeds, or on a floating mats.

Distribution: The White-faced Ibis breeds locally in the western half of the U.S. It is a year-round resident in the Gulf-coast region, southern California and Mexico. It winters in coastal and southern Mexico (Ryder and Manry 1994). In Colorado, there are eight confirmed breeding locations (Andrews and Righter 1992). Statewide numbers are unavailable, but approximately 115-150 pairs nest at Monte Vista and Alamosa National Wildlife Refuges (Andrews and Righter 1992). The record at Sweetwater Lake indicates a probable breeding bird observed in 1983, but breeding has never been verified. While this species is globally secure (G5), breeding populations in Colorado are imperiled (S2B) based on continued threats to habitat and small numbers of breeding localities.

Important Life History Characteristics: They feed on crayfishes, frogs, fishes, insects, newts, earthworms and crustaceans (Terres 1980).

Known Threats and Management Issues: Breeding Bird Survey data indicate a large population increase (>3% per year) on a continental scale (Mike Carter pers. comm.). Nesting populations and numbers of colonies in North America decreased precipitously in the 1960s and 1970s because of pesticide contamination and loss of habitat. The recovering population is attributable, in part, to improved nesting habitat management in federal and state refuges, increased planting of alfalfa, the banning of DDT and other pesticides, and improved breeding success (Ryder and Manry 1994). Population trends are unclear in Colorado but probably follow the national trend. Habitat deterioration due to wetland degradation, cattle grazing and human encroachment pose threats to this species (Ryder and Manry 1994). The fluctuating level of water at reservoirs where breeding is attempted is another problem.

Potential Conservation Areas supporting *Plegadis chihi*: Sweetwater Lake

Razorback Sucker (*Xyrauchen texanus*)

Taxonomy:
Class: Osteichthyes
Order: Cypriniformes
Family: Catostomidae
Genus: *Xyrauchen*

Taxonomic Comments:

CNHP Ranking: G1 S1

State/Federal Status: Endangered both in Colorado and Federally

Habitat Comments: Habitats include slow areas, backwaters and eddies of medium to large rivers.

Distribution: Razorback suckers are confined to the Colorado River system, where a large decline has occurred due mainly to alteration and destruction of habitat by dams and interactions with non-native fishes. Razorbacks were historically widespread and common in warm water reaches of many medium and large-sized streams and rivers of the Colorado River Basin from Wyoming south to Mexico. They were more common in the lower than the upper Colorado River Basin (Behnke and Benson 1980). The Colorado distribution included the lower Yampa, Green, Colorado, Gunnison, Dolores, and San Juan rivers (Tom Nesler pers. comm., Kevin Bestgen pers. comm.). Colorado's populations are in the upper limits of the watershed distribution. The razorback sucker remains in the lower Green, lower Yampa, and occasionally in the Colorado River near Grand Junction (Bestgen 1990).

Important Life History Characteristics: Razorbacks utilize flooded lowlands and lower portions of tributary streams as resting-feeding areas during breeding season (Tyus and Karp 1990). Razorbacks are often associated with sand, mud and rock substrate in areas with sparse aquatic vegetation, where temperatures are moderate to warm (Sigler and Miller 1963). In nonbreeding season, adults are most common in shoreline runs and along mid-channel sand bars, with average water depth of less than 2 m and average velocity of less than 0.5 m/sec (Tyus and Karp 1989). They are planktonic, plantivorous and benthic feeders consuming algae, crustaceans and aquatic insect larvae.

Known Threats and Management Issues: In 1998 and 1999 a total exceeding 50,000 razorback suckers were released into the Upper Colorado River Basin including 25,000 just north of Parachute, Colorado (Bob Burdick pers. comm.). A number of problems confront razorbacks including habitat change (e.g., high winter flows, reduced high spring flows, altered river temperatures and reduced flooding resulting primarily from dam construction), competition and especially predation on larvae and juveniles by introduced fishes (USFWS 1990), paucity of spawning adults and hybridization with other suckers (Tyus and Karp 1990, Minckley et al. 1991). See USFWS (1990) for many details on habitat changes that have affected this species. Primary factors justifying the ranks include a greatly reduced range, very low number of breeding occurrences, and the fisheries management problems previously listed.

Potential Conservation Areas supporting *Xyrauchen texanus*: Rifle Stretch Colorado River

Rare and Imperiled Wetland and Riparian Plant Communities of Garfield County.
The following chart shows wetland and riparian plant communities documented in Garfield County in the CNHP data system. Note that this is not a complete list of all the communities that occur here, but only those that are tracked by CNHP.

Table 65. Rare and imperiled wetland and riparian plant communities of Garfield County.

Element	Common Name	Global Rank	State Rank	Federal and State Status
Plant Communities				
Abies lasiocarpa-Picea engelmannii/Alnus incana	Montane riparian forests	G5	S5	
Abies lasiocarpa-Picea engelmannii/Ribes spp.	Coniferous wetland forests	G5	S3	
Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	Montane riparian forests	G5	S5	
Abies lasiocarpa-Picea engelmannii/ Salix drummondiana	Montane riparian forests	G5	S4	
Abies lasiocarpa/ Rubus parviflorus	Subalpine forests	G5	S2	
Acer negundo-Populus angustifolia/Cornus sericea	**Narrowleaf cottonwood riparian forests**	**G2**	**S2**	
Acer negundo/ Cornus sericea	**Montane riparian deciduous forest**	**G3?**	**S2**	
Acer negundo/ Prunus virginiana	**Montane riparian deciduous forest**	**G3**	**S2**	
Alnus incana-Cornus sericea	Thinleaf alder-red osier dogwood riparian shrubland	G3G4	S3	
Betula occidentalis/ mesic forb	**Foothills riparian shrubland**	**G3**	**S2**	
Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	Alpine wetlands	G4	S4	
Carex aquatilis	Montane wet meadows	G5	S4	
Carex aquatilis-Carex utriculata	Montane wet meadows	G4	S4	
Carex nebrascensis	Wet meadows	G4	S3	
Carex utriculata	Beaked sedge montane wet meadows	G5	S4	
Catabrosa aquatica-Mimulus spp.	Spring wetland	GU	S3	
Cornus sericea	Foothills riparian shrubland	G4	S3	
Deschampsia cespitosa	Mesic alpine meadow	G4?	S4	
Distichlis spicata	Salt meadows	G5	S3	
Juncus balticus var. montanus	Western Slope wet meadows	G5	S5	
Picea engelmannii/ Cornus sericea	Montane riparian forests	GU	SU	
Picea pungens/ Alnus incana	**Montane riparian woodland**	**G3**	**S3**	
Picea pungens/ Betula occidentalis	**Montane riparian woodland**	**G2**	**S2**	
Picea pungens/ Cornus sericea	Montane riparian forest	G4	S2	
Populus angustifolia/ Alnus incana	**Montane riparian forest**	**G3?**	**S3**	
Populus angustifolia/	**Montane riparian forest**	**G3?**	**S2**	

Element	Common Name	Global Rank	State Rank	Federal and State Status
Betula occidentalis				
Populus angustifolia/ Cornus sericea	Cottonwood riparian forest	G4	S3	
Populus angustifolia/Crataegus rivularis	**Narrowleaf cottonwood riparian forest**	**G2?**	**S2?**	
Populus angustifolia/ Rhus trilobata	**Narrowleaf cottonwood/skunkbrush**	**G3**	**S3**	
Populus balsamifera	Montane riparian woodland	GU	SU	
Populus deltoides ssp. wislizenii/Rhus trilobata	**Rio Grande cottonwood riparian forests**	**G2**	**S2**	
Populus tremuloides/ Acer glabrum	**Montane riparian forests**	**G2**	**S1S2**	
Populus tremuloides/ Alnus incana	**Montane riparian forests**	**G3**	**S3**	
Populus tremuloides/ Pteridium aquilinum	Aspen wetland forests	G4	S3S4	
Pseudotsuga menziesii/Acer glabrum	Lower montane riparian forests	G4	S1	
Pseudotsuga menziesii/Cornus sericea	Lower montane riparian forests	G4	S2	
Salix boothii/Carex utriculata	Willow carr	G4	S3	
***Salix boothii/*mesic graminoid**	**Riparian willow carr**	**G3**	**S3**	
***Salix boothii/*mesic forb**	**Booth's willow/mesic forb**	**G3**	**S3**	
*Salix brachycarpa/*mesic forb	Alpine willow scrub	G4	S4	
Salix drummondiana/ Carex utriculata	Montane willow carr	GU	S3	
Salix drummondiana/ mesic forb	Drummond’s willow/mesic forb	G4	S4	
Salix monticola/ Carex utriculata	**Montane riparian willow carr**	**G3**	**S3**	
***Salix monticola/*mesic forb**	**Montane riparian willow carr**	**G3**	**S3**	
Salix planifolia/ Caltha leptosepala	Subalpine riparian willow carr	G4	S4	
Salix planifolia/ Carex aquatilis	Subalpine riparian willow carr	G5	S4	
Salix wolfii/Carex aquatilis	Subalpine riparian willow carr	G4	S3	
***Salix wolfii/*mesic forb**	**Subalpine riparian willow carr**	**G3**	**S3**	

Abies lasiocarpa /Alnus incana
Subalpine fir /thinleaf alder montane riparian forest.

Global Rank: G5
Global Rank Comments: This is a common community on first- and second-order streams in the subalpine zone in all Rocky Mountain states.
State Rank: S5
State Rank Comments: This is a common community on first- and second-order streams above 9,000 feet in elevation. There are over 1000 miles of this type on Colorado's upper montane streams.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* (subalpine fir-Engelmann spruce/thinleaf alder) plant association occurs on heavily forested stream reaches where *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests also occur on adjacent hillslopes. Tall *Alnus incana* (thinleaf alder) and *Salix drummondiana* (Drummond willow) grow in a thick band along the edge of the stream. At lower elevations, *Alnus incana* is more abundant than *Salix drummondiana*. At mid-elevations, the two shrubs can be codominant. At higher elevations, *Salix drummondiana* becomes dominant and *Alnus incana* drops out, forming the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association.

Recognition/Classification Problems: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia-Salix drummondiana* plant association has been split into two closely related plant associations: the *Abies lasiocarpa-Picea engelmannii/Alnus incana* plant association, which occurs at lower elevations and has *Alnus incana* in the understory; and the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association, which occurs at higher elevations and has very little to no *Alnus incana* in the understory (Kittel *et al.* (1996). Stands with both *Alnus incana* and *Salix drummondiana* appear to be transitional between these two plant associations.

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett 1995), Utah (Padgett *et. al*. 1989), eastern Idaho, western Wyoming (Youngblood *et al*. 1985), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa, San Miguel/Dolores (Kittel and Lederer 1993), Gunnison (Kittel *et al*. 1995), Colorado (Kittel *et al* 1994), and South Platte River Basins Kittel *et al.* 1996), the San Juan, Rio Grande and Routt National Forests (Richard *et al*. 1996, Kittel *et al.* 1999, Kettler and McMullen 1996), and Rocky Mountain National Park (Baker 1989).

Elevation Range in Colorado: 7200-10,300 ft (2200-3100 m).

Site Geomorphology: This plant association generally occurs in narrow, 150-800 ft (40-250 m), V-shaped valleys on stream benches and banks. It usually occurs within 15-20 ft (5-6 m) of the channel edge and is rarely more than 2 ft (0.5 m) above the stream bank. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and steep (Rosgen's Channel Type: A2, A3, A4), moderately wide with a moderate gradient (Rosgen's Channel Type: B1-B6) or wide and very sinuous (C2, C3, C4).

Soils: Soils are shallow, dark-colored, loamy sands, silty loams, and sandy clay loams. There is generally high organic matter in the top 50 inches (20 cm) and mottles at 100 inches (40 cm), becoming skeletal at 150 inches (60 cm).

Vegetation: *Picea engelmannii* (Engelmann spruce) and/or *Abies lasiocarpa* (subalpine fir) dominates the upper canopy with up to 80% cover, with *Picea engelmannii* present more often that *Abies lasiocarpa*. Other tree species occasionally present are up to 15% cover of *Populus angustifolia* (narrowleaf cottonwood), up to 20% cover each of *Picea pungens* (Colorado blue spruce) and *Pinus contorta* (lodgepole pine), and up to 1% cover of *Populus tremuloides* (aspen). *Abies concolor* (white fir) is present with up to 15% cover in stands in the southwestern part of the state.

An open to dense mid-canopy of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is always present with 5-90% cover. *Salix drummondiana* (Drummond willow) can occur with up to 20% cover as a narrow band bordering the stream channel. In one stand in the Routt National Forest, *Cornus sericea* (red-osier dogwood) was present with 55% cover.

The herbaceous undergrowth is usually rich in forb species having an overall cover of 20-70%. Characteristic forb species include *Mertensia ciliata* (mountain bluebell), *Mertensia franciscana* (flagstaff bluebell), *Cardamine cordifolia* (heartleaf bittercress), *Heracleum lanatum* (cow parsnip), *Geum macrophyllum* (large-leaved avens), *Saxifraga odontoloma* (brook saxifrage), and *Geranium richardsonii* (Richardson geranium). Graminoid cover is minimal in western slope stands. In the South Platte River Basin, overall graminoid cover can be as high as 50% and include up to 25% cover of *Calamagrostis canadensis* (bluejoint reedgrass), 5-10% cover of *Carex disperma* (softleaf sedge), and up to 15% cover of *Glyceria* spp. (mannagrass). One plot had 43% cover of *Equisetum arvense* (field horsetail).

Successional and Ecological Processes: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia* plant association appears to be a late-seral, or at least a long-lived, riparian community that may also represent a successional change from a deciduous-dominated overstory to a conifer-dominated overstory at lower elevations (Padgett *et al.* 1989). This successional shift may be attributed to a lack of fire in the association (Manning and Padgett 1995).

Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated “climax” forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtops *Abies lasiocarpa*. However, *Abies lasiocarpa* is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle. During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Management: The dense shrub layer of the *Abies lasiocarpa-Picea engelmannii/Alnus incana* (subalpine fir-Engelmann spruce/thinleaf alder) plant association may limit livestock access (Manning and Padgett 1995). *Alnus incana* is not particularly palatable to livestock, but can be damaged as animals search for more palatable forb species (Hansen *et al.* 1995).

Alnus incana is an excellent stream bank stabilizer due to its rhizomatous roots. Young stands can re-sprout after flood damage or fire and can tolerate a short duration of standing water. *Cornus sericea* (red-osier dogwood) could also be considered for stabilization projects since it quickly establishes from seed or transplanted seedlings along stream edges (Hansen *et al.* 1995).

This plant association is sensitive to timber harvesting activities due to high soil moisture content. Timber activity should be restricted to the driest sites. Timber productivity is fairly low. Management usually considers *Picea engelmannii* the most productive species. However, consideration must be given to the uneven-aged structure and the inability of *Picea* to regenerate without providing protection for seedling survival. Small clearcuts, shelterwood, or group or individual tree selection methods should be designed to prevent seedling mortality from frost, desiccation from winter winds, sunscald, and soil movement (Youngblood and Mauk 1985).

This type is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1990).

Abies lasiocarpa/Mertensia ciliata

Subalpine fir/mountain bluebells montane riparian forest.

Global Rank: G5
Global Rank Comments: This is a very common community on first- and second-order streams in the subalpine zone of all Rocky Mountain States.
State Rank: S5
State Rank Comments: This community occurs in all mountain ranges and national forests in Colorado, comprising approximately 2000+ miles in Colorado alone.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* (subalpine fir-Engelmann spruce/mountain bluebells) plant association is a heavily shaded forest with no shrubs and a thick line of wildflowers lining the stream edge. It is a common community in the subalpine zone along first- and second-order streams. *Mertensia ciliata* in nearly always present but can sometimes be absent. Other forbs consistently present include *Cardamine cordifolia* (heartleaf bittercress), *Micranthes odontoloma* (brook saxifrage) and *Senecio triangularis* (arrowleaf groundsel). *Salix drummondiana* (Drummond willow), *Lonicera involucrata* (honeysuckle), and *Ribes* (currant) species can be present, but with less than 10% cover. At high elevations, *Vaccinium myrtillus* (Rocky Mountain whortleberry), typically an upslope species, can intergrade with this riparian plant association on the stream banks.

Regional Distribution: This association occurs in Montana, Utah (Padgett *et al*. 1989), New Mexico (Johnston 1987), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This is a common plant association throughout the southern Rocky Mountains of Colorado (Alexander 1981, Baker 1984, Boyce 1977, DeVelice *et al.* 1985, Dix 1974, Dix and Richards 1976, Johnston 1987, Kettler and McMullen 1996, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Peet 1981, as cited in Baker 1989, Richard *et al*. 1996, Steen and Powell 1985, as cited in Johnston 1987).

Elevation Range in Colorado: 8200-11,500 ft (2500-3500 m).

Site Geomorphology: This plant association occurs in narrow to wide valleys, 35-350 feet (10-100 m) wide, and is limited to the immediate stream channel edge and overflow areas. It usually establishes within 15 feet (5 m) of the channel and within 2 feet (0.5 m) of channel bankfull height. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Typically this association occurs along steep (2-15% gradient), narrow streams (Rosgen's Channel Type: A2-A6, G3), but can also be found along moderate gradient stretches (Rosgen's Channel Type: B2-B6).

Soils: Soils range from a thin layer of skeletal sandy loams to somewhat deep, mottled loamy sands over colluvial boulders. Total soil depth is never more than 7 feet (2 m), and is typically less than 3 feet (1 m). Consistent to all profiles is a deep, dark brown color and high organic content. Some of the soils from the Colorado River Basin classify as fragmental to fine clayey Cryorthents, Cryaquepts, Cryofluvents, Cryoborolls.

Vegetation: Either *Picea engelmannii* (Engelmann spruce) or *Abies lasiocarpa* (subalpine fir) is present, although they are not always present together. The tree canopy can be very thick, completely overhanging the stream, or it can be quite open, with a wide gap over the stream. Cover values range from 1-70% cover. There is generally very little shrub cover. *Vaccinium myrtillus* (Rocky Mountain whortleberry), can be abundant with 1-50% cover, however it was present in only 40% of the stands sampled. Other shrub species may be present (<30% frequency) include: *Salix drummondiana* (Drummond willow) (3-10% cover), *S. planifolia* (plane-leaf willow) (1-20% cover), *S. monticola* (yellow willow) (1-20% cover), *Alnus incana* ssp. *tenuifolia* (thinleaf alder) (2-24% cover), *Lonicera involucrata* (honeysuckle) (1-10%), and several *Ribes* species (currant)(1-10% cover).

The dense, mossy forb layer is the diagnostic part of this vegetation type. The forb layer is usually very narrow, often well under a meter wide (3 feet), clinging to and undulating with the side of the narrow stream channel. It is species rich with 20-80% total combined forb cover. No single forb species is consistently present in every stand, however a distinct suite of species are present in varying combinations. This suite of forb species include *Cardamine cordifolia* (bittercress) (present in 93% of stands with 1-50% cover), *Mertensia ciliata* (mountain bluebells) (present in 86% of stands with 1-40% cover)*,* *Senecio triangularis* (arrowleaf groundsel) (present in 81% of stands with 1-22% cover), *Oxypolis fendleri* (cowbane) (present in 79% of stands with 1-20%), *Micranthes odontoloma* (brook saxifrage) (present in 72% of stands with 1-20%), *Mitella pentandra* (bishops cap) (present in 57% of stands with 1-10% cover), *Streptopus amplexifolius* (twisted-stalk) (present in 53% of stands with 1-10%), and *Arnica cordifolia* (heartleaf arnica) (present in 45% of stands with 1-15%). A large variety of other forb and graminoid species are often present as well, with individual cover ranging from 1-10%.

Successional and Ecological Processes: Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number of riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop *Abies lasiocarpa*. However, Abies lasiocarpa is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (Dendroctonus rufipennis). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Management: Forage value of this plant association is minimal due to the limited understory. Soils may be easily compacted by livestock grazing along the wet, mossy stream banks (Hansen *et al.* 1995).

This type is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992)

Abies lasiocarpa/Ribes (montigenum, lacustre, inerme, wolfii)
Subalpine fir /one of several gooseberry species

Global Rank: G5
Global Rank Comments: This is a common subalpine forest of the Rocky Mountains. It is known from northern Nevada, Idaho, southern Montana, Wyoming, Utah, east-central New Mexico, and Colorado.
State Rank: S3
State Rank Comments: This is a common, if small community in Colorado

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Ribes* spp. (subalpine fir-Engelmann spruce/current) is a heavily shaded forest with a very open shrub layer of just a few individual shrubs. It has a wide elevational range, 8300-12,200 ft (2500-3700 m), and is a common and facultative riparian community. It occurs along very steep streams where the riparian area is narrow and dominated by species of the surrounding forest. *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce) dominate the tree canopy, while any of the following four *Ribes* (currant) species dominate the shrub layer: *Ribes inerme* (whitestem gooseberry), *R. lacustre* (prickly currant), *R. montigenum* (gooseberry currant), or *R. wolfii* (Wolf currant).

Regional Distribution: This plant association occurs in Nevada, Idaho, Montana, Wyoming, Utah, New Mexico (Bourgeron and Engelking 1994, Johnston 1987), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout the state. It has been documented from the Flat Tops Plateau in the White and Colorado River Basins and in the San Juan, Rio Grande, Gunnison, White River, Routt, San Isabel and Pike National Forests (Kittel *et al.* 1994, Kittel *et al.* 1999, Kettler and McMullen 1996, Johnston 1987, and Kittel *et al*. 1999).

Elevation Range in Colorado: 8300-12,200 ft (2500-3700 m).

Site Geomorphology: In Wyoming, this plant association occurs on plateaus and moderate to steeper slopes. In Colorado, this plant association occurs along narrow to moderately wide streams in steep ravines and valleys. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and steep (Rosgen's Channel Type: A2, A5) or moderately wide and sinuous with a moderate gradient (Rosgen's Channel Types: B4)

Soils: Soils are sands or loam over sand, gravel, and cobbles. In the White and Colorado River Basins, the soils classify as loamy-fragmental, and fragmental aeric Cryaquepts to clayey Cryaquepts.

Vegetation: This community is very similar to the *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* plant association. In fact, it has very similar overstory and herbaceous characteristics. The difference lies in the consistent present of a shrub layer dominated by the genus *Ribes*. *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce) dominate the tree canopy with 1-80% cover.

The shrub layer is dominated by 1-30% cover of usually one and occasional a mix of any of the following *Ribes* (current) species- *Ribes inerme, R. lacustre, R. montigenum,* or *R. wolfii*. Other shrubs that may be present include *Lonicera involucrata* (honeysuckle) (10-20% cover) and *Sorbus scopulina* (mountain ash) (1-17%. Willows may be present (< 53% frequency) along the stream edge, but usually in less abundance than the *Ribes*: *Salix drummondiana* (Drummond willow) (3-30% cover), *S. monticola* (10-20% cover), *S. bebbiana* (20% cover), or *S. boothii* (10% cover).

The forb layer includes *Cardamine cordifolia* (bittercress) (2-10% cover), *Senecio triangularis* (arrowleaf groundsel) (1-20% cover), *Micranthes odontoloma* (brook saxifrage) (1-9%), *Heracleum sphondylium* (cowbane) (1-10%) *Actaea rubra* (baneberry) (3-13% cover), *Arnica mollis* (hairy arnica) (13-14%), *Oxypolis fendleri* (cowbane) (3-12%), *Carex utriculata* (beaked sedge) (10% cover), and *Elymus canadensis* (Canadian wildrye) (10% cover).

Successional and Ecological Processes: Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number of riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated “climax” forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop *Abies lasiocarpa*. However, Abies lasiocarpa is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (*Dendroctonus rufipennis*). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years.

Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Management: This plant association is sensitive to timber harvesting activities due to high soil moisture content (Hansen *et al*. 1995). Timber productivity is fairly low. Management usually considers *Picea engelmannii* the most productive species. However, consideration must be given to the uneven-aged structure and the inability of *Picea* to regenerate without providing protection for seedling survival. Small clear cuts, shelterwood, or group or individual tree selection methods should be designed to prevent seedling mortality from frost, desiccation from winter winds, sunscald, and soil movement (Youngblood and Mauk 1985).

This type is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992).

Abies lasiocarpa/Rubus parviflorus
Sub-alpine fir/thimbleberry

Global Rank: G5
Global Rank Comments: Arizona, Colorado, New Mexico
State Rank: S2
State Rank Comments:
Recognition and Classification Problems:.

General Description and Comments:

Regional Distribution:

Distribution in Colorado:

Elevation Range in Colorado:

Site Geomorphology:

Soil:

Vegetation:

Successional and Ecological Processes:).

Management:

Abies lasiocarpa/Salix drummondiana
Sub-alpine fir/Drummond willow

Global Rank: G4
Global Rank Comments: This is a common and well-documented plant association by Rocky Mountain researchers.
State Rank: S4
State Rank Comments: In Colorado, this community occurs on rocky second- and third-order streams and is fairly resistant to heavy recreational use.

Recognition and Classification Problems: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia-Salix drummondiana* has been split into two closely related plant associations: the *Abies lasiocarpa-Picea engelmannii/Alnus incana* plant association, which occurs at lower elevations and has *Alnus incana* in the understory; and the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association, which occurs at higher elevations and has very little to no *Alnus incana* in the understory (Kittel *et al.* 1996). Stands with both *Alnus incana* and *Salix drummondiana* appear to be transitional between these two plant associations.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* (subalpine fir-Engelmann spruce/Drummond willow) plant association is a heavily forested type found along steep, narrow second and third-order streams above 9,000 feet (2700 m) where *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests also occur on adjacent hillslopes. Tall *Alnus incana* (thinleaf alder) and *Salix drummondiana* (Drummond willow) grow in a thick band along the edge of the stream. At lower elevations, *Alnus incana* is more abundant than *Salix drummondiana*. At mid-elevations, the two shrubs can be co-dominant. At higher elevations, *Salix drummondiana* becomes dominant and *Alnus incana* drops out, forming the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association. *Picea pungens* is occasionally present at the stream edge and represents a variation of this type.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the San Juan Mountains (Richard *et al.* 1996, Kittel *et al*. 1998), and the Colorado, Gunnison, Arkansas, and South Platte River Basins (Kittel *et al.* 1994, Kittel *et al*. 1995, Kittel *et al*. 1996, and Kittel *et al*. 1999).

Elevation Range in Colorado: 8400-10,900 ft (2600-3300 m).

Site Geomorphology: Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This plant association is commonly found on steep (2-25% gradient), narrow (<10 m), first-order streams in moderate to deep V-shaped valleys (Rosgen's Channel Type: A2, A3, A4, A5). The thick shrub canopy is restricted to a narrow band along the rocky stream bank. It can also occur in wider valleys along moderate gradient reaches with channel bottoms that range from bedrock to gravel (Rosgen's Channel Type: B1, B2, B3, and B4). One site in the Gunnison River Basin occurs along a braided stream channel (Rosgen's Channel Type: D2).

Soil: Soils are typically shallow (<1 m) sandy loams to sandy clay loams packed between large angular boulders and cobbles with a thin layer of partially decomposed organic matter under the litter layer.

Vegetation: This plant association has a dense canopy of 20-90% cover of *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce). *Picea pungens* (Colorado blue spruce) is occasionally present with 5-10% cover in lower elevation, wet stands, and *Pinus contorta* is present with 3-21% cover in drier, early-seral stands. A narrow but dense strip of shrubs consists of 1-90% cover of *Salix drummondiana* (Drummond willow) that is always present. Other shrubs that occur with less frequency (<65%) include: *Salix monticola* (mountain willow) (1-40%), *Salix brachycarpa* (shortfruit willow) (1-3% cover), *Salix planifolia* (planeleaf willow) (1-30% cover), *Lonicera involucrata* (honeysuckle) (1-17% cover), *Alnus incana* (thinleaf alder) (3-40%) and *Cornus sericea* (red-osier dogwood) (1-7% cover). The dense herbaceous undergrowth is characterized by (species occurring with >40% frequency): *Oxypolis fendleri* (cowbane) (1-15% cover), *Mertensia ciliata* (mountain bluebells) (1-20% cover), *Calamagrostis canadensis* (Canadian reedgrass) (1-30%), *Heracleum sphondylium* (cow parsnip) (1-20%), *Cardamine cordifolia* (bittercress) (1-15%), *Senecio triangularis* (arrowleaf groundsel) (1-30% cover), *Geranium richardsonii* (Richardson geranium) (1-17% cover) and *Equisetum arvense* (field horsetail) (1-20% cover).

Four stands sampled in the Gunnison River Basin (94JB07, 94MD11, 94MD22, 94MD23) had significant cover of *Alnus incana*, 10-30%. These stands appear to represent a transition between higher elevation occurrences where *Salix drummondiana* dominates the shrub canopy and lower elevation occurrences where *Alnus incana* becomes more abundant.

Successional and Ecological Processes: The dense *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) overstory, thick *Salix drummondiana* (Drummond willow) shrub canopy, and thick forb undergrowth of this plant association indicate that it is late-seral. High forb cover suggests that with time and further upper canopy closure, this association may shift to an *Abies lasiocarpa/Mertensia ciliata* (subalpine fir/bluebells) plant association. With a more open forest canopy, shrubs such as *Alnus incana* (thinleaf alder) or *Salix drummondiana* may be present. Stands with high cover of both *Salix drummondiana* and *Alnus incana* in the understory may be transitional as *Salix drummondiana* replaces *Alnus incana* at higher elevations.

Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number of riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated “climax” forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop *Abies lasiocarpa*. However, Abies lasiocarpa is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (Dendroctonus rufipennis). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Management: Forage value is high in this plant association when forb growth is abundant. However, grazing during wet periods can churn wet soil and destroy plant cover (Hansen *et al.* 1995). This riparian association is sensitive to timber harvesting activities due to high soil moisture content. It is also is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992)

Acer negundo-Populus angustifolia/Cornus sericea
Boxelder-narrowleaf cottonwood/red-osier dogwood

Global Rank: G2
Global Rank Comments: This community is known only from western Colorado.
State Rank: S2
State Rank Comments: Only one large functioning example of this community occurs along the Yampa River. Several tiny (<5 acres) stands have been documented north and south of the Yampa in the White and Gunnison River watersheds.

Classification and Recognition Problems: Two varieties of *Acer negundo* are recognized in Colorado. *Acer negundo* var. *interius* is native to Western Colorado and the semiarid Intermountain West (Dawson and Ehleringer 1993). *Acer negundo* var. *violaceum* is a known introduced variety in Colorado, planted as a shade tree. Over the past 100 years it has spread and become naturalized along some rivers and streams east of the Continental Divide (Weber and Wittmann 1996). It can also occur on the Colorado western slope, along railroad lines and at homestead sites (Weber and Wittmann 1996).

General Description and Comments: The *Acer negundo-Populus angustifolia/Cornus sericea* (box elder-narrowleaf/red-osier dogwood) plant association is a tall (12-25 ft., 4-8 m), multi-layered, deciduous riparian forest. It is grows on broad alluvial floodplains with strongly meandering stream channels, where it can form extensive riparian forests. It can also occur in small stands on narrow stream at high elevations.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: The largest and best example of this association occurs on the Yampa River (Kittel and Lederer 1993, The Nature Conservancy 1996). Small, relict stands occur on the White and Colorado Rivers (Kittel *et al*. 1994) and on San Juan National Forest (Richard *et al*. 1996).

Elevation Range in Colorado: 6200-7500 ft (1900-2300 m).

Site Geomorphology: This plant association occurs along moderately sinuous stream reaches within narrow valleys or broad alluvial floodplains. It occurs at 2-10 feet (0.5-2 m) in height above the bankfull channel level. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are slightly meandering (Rosgen's Channel

Type: B2, B4, B5) to strongly meandering (Rosgen's Channel Type: C3, C4). **Soil:** Soil textures range from loamy sand to silty clay loam with minimal skeletal fraction. Mottling may occur at about 20-25 inches (50-60 cm).

Vegetation: This community is characterized by a tall gallery forest of *Populus angustifolia* (narrowleaf cottonwood) with 3-60% cover and a subcanopy of *Acer negundo* (boxelder) with 1-80% cover. In most of the stands sampled, *Acer negundo* (box elder) formed a subcanopy underneath the taller canopy of narrowleaf cottonwoods. However, patches of *Acer negundo* (box elder) do occur on the floodplain without the cottonwood overstory as part of the overall mosaic of different aged stands. These are thought to be older stands where the cottonwood has died (Holly Richter, *pers. comm*.). Occasionally, a few conifers are present in small amounts. Conifer species include *Juniperus scopulorum* (Rocky Mountain juniper) (3-10%), *Pseudotsuga menziesii* (Douglas fir) (1-10%), and *Picea pungens* (Colorado blue spruce) (1-15%).

Mesic shrubs form a dense and diverse mid-canopy layer. *Cornus sericea* (red-osier dogwood) is the most abundant and dominant shrub 20-70% cover. Other shrub species may be present, but occur in fewer than half of the stands sampled (<50% frequency). Shrubs include *Alnus incana* (thinleaf alder) (1-15% cover), *Rosa woodsii* (woods rose) (1-16% cover), *Acer glabrum* (Rocky Mountain maple) (10% cover), *Rhus trilobata* (skunkbrush) (1-10% cover), *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (1-50% cover), *Salix monticola* (yellow willow) (21% cover), *Salix boothii* (Booth willow) (10% cover), *Salix lasiandra* var. *caudata* (whiplash willow) (20% cover).

Forb and graminoid cover is usually low, but can be abundant . Species include *Maianthemum racemosum* (false Solomon's seal) (1-20%), *Rudbeckia laciniata* (cutleaf coneflower) (1-20%), and *Solidago gigantea* (goldenrod) (1-80%). In disturbed stands *Cirsium arvense* (Canada thistle) can occur with 1-50% cover, *Agrostis gigantea* (red top) with 3-30% cover, and *Taraxacum officinale* (dandelion) with 1-20% cover.

Successional and Ecological Processes: The *Acer negundo-Populus angustifolia/Cornus sericea* (boxelder-narrowleaf cottonwood/red-osier dogwood) plant association appears to be late-seral. This is evident from the mature *Populus angustifolia* trees and dense stands of *Cornus sericea* within the closed forest canopy. Young, early-seral stands of regenerating cottonwoods may be found on the inside bends of the channel and on point bars and lower terraces. Channel migration and meander movement may cut into the mature forest on the outside of meander bends, leaving the stands immediately adjacent to, yet potentially several meters above, the channel. Over time, the riparian communities can convert to upland plant associations. In narrow canyons on elevated sites no longer subject to channel activity, upland species such as *Pseudotsuga menziesii* (Douglas-fir) and, in the San Juan Mountains, *Pinus strobiformis* (Mexican white pine) become established.

In addition, further research along the Yampa River floodplain suggests that *Acer negundo* survives longer than *Populus angustifolia*, and may be the climax deciduous community on the floodplain (Holly Richter, *personal communication*, The Nature Conservancy, 1996). Padgett *et al*. (1989) suggest that stands dominated by *Acer negundo* (boxelder) may be a riparian climax type until the site becomes drier from channel migrating or downcutting. *Acer negundo* appears to flourish in narrow canyons with natural flood regimes or altered flows (*e.g.* Black Canyon of the Gunnison). With scouring floods, *Acer negundo* may survive only if it grows on upper colluvial slopes. This may provide a seed source for regeneration after flooding and deposition.

The age-class and sex distribution of *Acer negundo* along riparian corridors is distinct. Juvenile trees obtain water directly from the stream channel or from the upper soil horizons that have been recharged by stream water (Dawson and Ehleringer 1991). Mature trees, however, tap into the deeper groundwater. The use of groundwater by adult trees may provide a constant source of water as stream flows drop in the late summer, thus reducing their chance of mortality during summer droughts (Dawson and Ehleringer 1991). In the Wasatch Mountains, Donovan and Ehleringer (1991) found that nearly half of the juveniles died during the later summer, while all of the adults survived at the same site. In the San Juan National Forest in Colorado, many stands have significant cover of mature *Acer negundo* situated well above the stream channel in relatively xeric conditions with little regeneration (Richard *et al.* 1996).

In addition, Donovan and Ehleringer (1991) found that female *Acer negundo* trees have higher growth rates than male trees and are more abundant on wet sites along the channel edge. Male trees are more tolerant of dry conditions and frequently occur on elevated banks and terraces away from the stream channel.

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set" by flooding disturbance. Cottonwood communities are early, mid- or late-seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a very large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Management: Because the regeneration and establishment of new stands of *Populus angustifolia* (narrowleaf cottonwood) and *Acer negundo* (boxelder) are dependent upon flooding events, any alterations to the natural flow regime of a river can affect the *Populus angustifolia* ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that would allow for *Populus angustifolia* stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Riparian forage productivity can be high and very palatable to livestock. *Populus angustifolia* seedlings and saplings are frequently browsed by cattle. *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream" plant (i.e. it is readily eaten and is a preferred browse species) to livestock and wildlife. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. *Populus angustifolia* dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity.

Cornus sericea (red-osier dogwood) provides good stream bank stability due its rhizomatous growth. *Acer negundo* (boxelder) is not rhizomatous, but has strong roots that also provide stream bank stability (Padgett *et al*. 1989). Grazing can severely damage standing trees and reduce the success of *Acer negundo* (boxelder) reproduction. Female trees of the dioecious *Acer negundo* are better adapted to growing along the channel edge and are recommended over male trees used for restoration of disturbed stream banks.

Acer negundo/Cornus sericea
Boxelder/red-osier dogwood

Global Rank: G3?
Global Rank Comments: This community is known from lower montane canyons in Utah and western Colorado. There are less than fifty known occurrences. The question mark in the rank indicates more occurrences are expected to occur, but have not been documented.
State Rank: S2
State Rank Comments: This community is known from less than ten stands in Colorado. These stands are highly threatened by heavy recreation use and improper grazing.

Classification and Recognition Problems: Two varieties of *Acer negundo* are recognized in Colorado. *Acer negundo* var. *interius* is native to Western Colorado and the semiarid Intermountain West (Dawson and Ehleringer 1993). *Acer negundo* var. *violaceum* is a known introduced variety to Eastern Colorado, where it is planted as a shade tree. Over the past 100 years it spread and become naturalized along some rivers and streams east of the Continental Divide (Weber and Wittmann 1996). It can also occur on the western slope, along railroad lines and at homestead sites (Weber and Wittmann 1996).

General Description and Comments: The *Acer negundo/Cornus sericea* (boxelder/red-osier dogwood) plant association is a medium-tall (5-15 ft., 1.5-4.5 m) deciduous woodland. It flourishes in narrow, shady canyons, often with a controlled stream flow.

Regional Distribution: The *Acer negundo/Cornus sericea* plant association occurs in Utah, Idaho, Wyoming (Padgett *et al.* 1989), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Colorado River Basin (Kittel *et al.* 1994) and the San Juan National Forest (Richard *et al.* 1996).

Elevation Range in Colorado: 7000-7700 ft. (2100-2300 m).

Site Geomorphology: This plant association occurs within narrow, 40 ft (12 m) wide, box canyons about 10 ft. (2-3 m) above the channel bankfull level. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3) or moderately wide and sinuous (Rosgen's Channel Type: B4).

Soils: The soil textures are sandy loams to clay loams with minimal skeletal fraction.

Vegetation: *Acer negundo* (boxelder) dominates the overstory with 15-70% cover. The shrub layer is dense and diverse. *Cornus sericea* (red-osier dogwood) is the dominant shrub with 40-60% cover. Other shrub species (present with 50% or less frequency) include *Ribes inerme* (prickly current) (3-60%), *Alnus incana* (thinleaf alder) (12-26%), *Acer glabrum* (Rocky Mountain maple) (42%) *Salix exigua* (coyote willow) (20%), *Quercus gambelii* (Gamble oak) (12%), and *Salix irrorata* (bluestem willow) (10%). Forb and graminoid species include *Heracleum maximum* (cow parsnip) (1-15%),*Geranium richardsonii* (Richards geranium) (1-10%), *Actaea rubra* (baneberry) (2-10%), *Rubus idaeus* (wild raspberry) (3-10%), and *Mertensia franciscana* (chiming bells) (12%).

Successional and Ecological Processes: Padgett *et al*. (1989) suggest that *Acer negundo* (boxelder) may be a riparian climax type, unless the site becomes too dry due to channel migration and downcutting. *Acer negundo* appears to flourish in narrow canyons with natural flood regimes or altered flows (e.g. Black Canyon of the Gunnison). With scouring floods, *Acer negundo* may survive only if it grows on upper colluvial slopes. This may provide a seed source for regeneration after flooding and deposition.

The age-class and sex distribution of *Acer negundo* along riparian corridors is distinct. Juvenile trees obtain water directly from the stream channel or from the upper soil horizons that have been recharged by stream water. Mature trees, however, use deeper groundwater. The use of groundwater by adult trees may provide a constant source of water as stream flows drop in the late summer, thus reducing their chance of mortality during summer droughts (Dawson and Ehleringer 1991). In the Wasatch Mountains, Donovan and Ehleringer (1991) found that nearly half of the juveniles died during the later summer, while all of the adults survived at the same site. In the San Juan National Forest in Colorado, many stands have significant cover of mature *Acer negundo* situated well above the stream channel in relatively xeric conditions with little regeneration (Richard *et al* 1996).

In addition, Donovan and Ehleringer (1991) found that female *Acer negundo* trees have higher growth rates than male trees and are more abundant on wet sites along the channel edge. Male trees are more tolerant of dry conditions and frequently occur on elevated banks and terraces away from the stream channel.

Management: Grazing can severely damage standing trees and reduce the success of *Acer negundo* (boxelder) reproduction. *Cornus sericea* (red-osier dogwood) is considered to be an “ice cream” plant to livestock and wildlife. Browsing of these species can be high if there is access into the community (Hansen *et al*. 1995).

Cornus sericea (red-osier dogwood) provides good stream bank stability due to its rhizomatous growth. Female trees of the dioecious *Acer negundo* are better adapted to growing along the channel edge and are recommended over male trees for restoration of disturbed stream banks (Dawson and Ehleringer 1993). *Acer negundo* is not rhizomatous, but has strong roots that provide stream bank stability (Padgett *et al*. 1989).

Acer negundo/Prunus virginiana
Boxelder/chokecherry

Global Rank: G3
Global Rank Comments: Fewer than two-hundred stands are known globally.
State Rank: S2
State Rank Comments: This association is limited to western slope streams in very arid climates. It is highly threatened by inappropriate stream alterations, heavy recreational use, and improper grazing.

Classification and Recognition Problems: Two varieties of *Acer negundo* are recognized in Colorado. *Acer negundo* var. *interius* is native to western Colorado and the semiarid Intermountain West (Dawson and Ehleringer 1993). *Acer negundo* var. *violaceum* is a known introduced variety to Colorado as a shade tree and over the past 100 years has become naturalized along some rivers and streams east of the Continental Divide (Weber and Wittmann 1996).

General Description and Comments: The *Acer negundo/Prunus virginiana* (box elder/chokecherry) plant association is characterized by dense to scattered cover of *Acer negundo* (boxelder) and a dense thicket of *Prunus virginiana* (chokecherry). It grows on broad alluvial floodplains at warm elevations. When left undisturbed, the shrub canopy can be very thick and nearly impenetrable. However, many stands in Colorado are in severely degraded states with very sparse shrub canopies.

Regional Distribution: This plant association occurs in Montana (Hansen *et al.* 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the White and Colorado River Basins (Kittel *et al*. 1994).

Elevation Range in Colorado: 6000-6900 ft (1800-2000).

Site Geomorphology: This association occurs on moderately wide, flat valley bottoms. It can also occur on colluvial deposits and narrow, confined terraces where the stream channel has been downcut. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels were mostly straight, narrow and steep (Rosgen's Channel Type: A2, A3), some channels are wider and slightly sinuous (Rosgen's Channel Type: B2, B3), one channel is very steep and entrenched (Rosgen's Channel Type: G3).

Soils: The soils of Colorado River basin stands classify as fragmental Ustic Torrifluvents to clayey Aridic Ustorthents. On terraces, the soils classify as Pachic Haplustolls to loamy calcareous Torrifluvents.

Vegetation: The overstory of this plant association is dominated by 10-80% cover of different age classes of *Acer negundo* (boxelder). Other tree species that may be present (with < 40% frequency) include *Populus angustifolia* (narrowleaf cottonwood) (1-30%) and *Pseudotsuga menziesii* (Douglas-fir) (1-10%). The shrub diversity can be high in less disturbed stands, with *Prunus virginiana* (chokecherry) (1-20%), *Amelanchier utahensis* (Utah serviceberry) (1-20%), *Symphoricarpos rotundifolia* (snowberry) (1-30%), *Ribes inerme* (whitestem gooseberry) (1-20%), *Acer glabrum* (Rocky Mountain maple) (1-10%), *Cornus sericea* (red-osier dogwood) (1-20%), *Holodiscus dumosa* (ocean spray) (1-10%), and *Rhamnus smithii* (buckthorn) (10%).

The understory can be dense with forb species including up to 50% cover of *Geranium richardsonii* (Richardson's geranium) and up to 40% cover of *Urtica gracilis* (stinging nettle). Graminoid cover is minor.

Successional and Ecological Processes: Padgett *et al*. (1989) suggest that *Acer negundo* (boxelder) may be a riparian climax type until the site becomes drier from channel migrating or downcutting. *Acer negundo* appears to flourish in narrow canyons with natural flood regimes or altered flows (e.g. Black Canyon of the Gunnison). With scouring floods, *Acer negundo* may survive only if it grows on upper colluvial slopes. This may provide a seed source for regeneration after flooding and deposition.

The age-class and sex distribution of *Acer negundo* along riparian corridors is distinct. Juvenile trees obtain water directly from the stream channel or from the upper soil horizons that have been recharged by stream water. Mature trees, however, use deeper groundwater. The use of groundwater by adult trees may provide a constant source of water as stream flows drop in the late summer, thus reducing their chance of mortality during summer droughts (Dawson and Ehleringer 1991). In the Wasatch Mountains, Donovan and Ehleringer (1991) found that nearly half of the juveniles died during the later summer, while all of the adults survived at the same site. In the San Juan National Forest in Colorado, many stands have significant cover of mature *Acer negundo* situated well above the stream channel in relatively xeric conditions with little regeneration (Richard *et al* 1996).

In addition, Donovan and Ehleringer (1991) found that female *Acer negundo* trees have higher growth rates than male trees and are more abundant on wet sites along the channel edge. Male trees are more tolerant of dry conditions and frequently occur on elevated banks and terraces away from the stream channel.

In Montana, an *Acer negundo/Prunus virginiana* (boxelder/chokecherry) habitat type occurs in the Great Plains region of the state (Hansen *et al.* 1988, Hansen *et al.* 1989). It establishes along alluvial fans, narrow streams or woody draws. In Colorado, many stands of this association appear to be in advanced stages of degradation. They are open with little to no regeneration of boxelder, little shrub cover, and compacted soils. With time, the boxelder trees will die and topple.

Management: Grazing can severely damage standing *Acer negundo* (boxelder) trees and reduce their reproductive success. Thick stands of *Prunus virginiana* (chokecherry) may preclude use by livestock (Hansen *et al.* 1989), while open stands may provide adequate grazing opportunities. Hansen *et al*. (1989) suggest that with moderate grazing, the canopy may open up and less palatable species, such as *Rosa woodsii* (woods rose) and *Crataegus* (hawthorn) species, will invade. With excessive browsing, shrub densities may be reduced altogether. Season-long grazing can also increase the abundance and vigor of non-native grasses. *Prunus virginiana* (chokecherry) provides low quality forage for livestock and eating excessive amounts of the leaves can be fatal (Hansen *et al.* 1995). Normally, livestock do not eat fatal quantities, except when other forage is scarce (Wasser 1982, Johnson and Nichols 1982).

Prunus virginiana (chokecherry) provides thermal cover for fish, livestock, large mammals and upland birds as well as providing fruit for birds and mammals. It is a relatively fire-resistant shrub and will vigorously sprout from surviving root crowns after a fire. This shrub can be used in controlling erosion along stream banks (Hansen *et al*. 1995).

Female trees of the dioecious *Acer negundo* are better adapted to growing along the channel edge and are recommended over male trees for restoration of disturbed stream banks (Dawson and Ehleringer 1993). *Acer negundo* is not rhizomatous, but has strong roots that provide stream bank stability (Padgett *et al*. 1989).

Alnus incana ssp. tenuifolia-Cornus sericea
thinleaf alder-red-osier dogwood

Global Rank: G3G4
Global Rank Comments: This plant association is widespread throughout the Rocky Mountains. However, all of the occurrences are small and threatened by improper grazing and stream impoundments. The double rank indicates the total number of estimated occurrences is thought to be between 20 and 100.
State Rank: S3
State Rank Comments: There are less than 100 stands of this plant association is Colorado. This association is threatened by improper livestock grazing, stream impoundments, and heavy recreational use.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia-Cornus sericea* (thinleaf alder-red-osier dogwood) plant association is a narrow thicket of medium to tall shrubs lining the stream bank. It is an uncommon association restricted to small tributaries and narrow, constricted reaches of larger rivers. Due to heavy shading, there is usually a limited herbaceous understory.

Regional Distribution: This plant association occurs in Nevada, Utah (Padgett *et al.* 1989, Manning and Padgett 1995), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa, Colorado, Gunnison, San Juan, Arkansas and Rio Grande River Basins (Johnston 1987, Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Richard *et al.* 1996, Kittel *et al*. 1999).

Elevation Range in Colorado: 6400-8600 ft. (2000-2600 m).

Site Geomorphology: This plant association occurs on narrow, rocky banks and benches of small channels as well as narrow, constricted reaches of larger rivers. It can also occur along overflow channels and narrow tributaries. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A2, A3, A4), wider and moderately sinuous (Rosgen's Channel Type: B3, B4), or wider and highly sinuous (Rosgen's Channel Type: C2, C3).

Soils: Soils range from loamy sand to sandy clay loam. Mottling is evident at approximately 12 inches (30 cm) and gravel or cobble layers appear at 20-40 inches (50-100 cm) beneath the surface. In the Colorado River Basin, the soils classify as recently buried Typic Cryaquolls, sandy Typic Cryoborolls, Histosols, Typic Cryaquents, loamy to clayey Cryofluvents and fragmental Cryaquents

Vegetation: This plant association is characterized by a dense thicket of shrubs dominated by 10-80% cover each of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and *Cornus sericea* (red-osier dogwood). *Salix exigua* is often present (42% frequency) with 1-10% cover. A wide variety of other shrub species may be present, but with < 37% frequency, including *Salix eriocephala* var.

ligulifolia (strapleaf willow) (3-30%) and *Salix lasiandra* var. *caudata* (whiplash willow) (3-30%), *Salix monticola* (mountain willow) (1-20%), *Lonicera involucrata* (honeysuckle) (1-20%), *Rosa woodsii* (woods rose) (1-20%), *Betula occidentalis* (river birch) (3-20%)*, Salix bebbiana* (Bebb willow) (8-70%), and *Rubus idaeus* (raspberry) (3-9%). One stand in the Yampa River Basin had 70% cover of *Salix bebbiana*. Tree species are scattered and not consistently present.

Forb cover is highly variable depending on the amount of light that penetrates through the canopy. Forb species include *Rudbeckia laciniata* (cutleaf coneflower) (1-20%) *Heracleum maximum* (cow parsnip) (1-17%), *Maianthemum stellatum* (false Solomon seal) (1-10%) and *Osmorhiza depauperata* (blunt-fruit sweet cicely) (1-10%), *Ligusticum porteri* (southern ligusticum) (1-3%). Graminoid cover is usually low, but can include *Poa pratensis* (Kentucky bluegrass) (1-45%) and *Equisetum arvense* (meadow horsetail) (1-10%).

Successional and Ecological Processes: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After establishment, young stands of *Alnus incana* are continually flooded. As stands mature, the stems can slow flood waters and trap sediment. Fine-textured sediments accumulate on top of the coarser alluvial material and the land surface eventually rises above annual flood levels. Flooding is then less frequent and soils begin to develop (Padgett *et al.* 1989).

Alnus incana is shade-intolerant (Viereck 1970, Chapin *et al*. 1994), and many mature stands in Colorado are restricted to stream bank edges, possibly because these are the only sites where light can penetrate the neighboring overstory canopy. *Alnus incana* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 10 to 150 times that deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

In Colorado, the *Alnus incana* ssp. *tenuifolia-Cornus sericea* (thinleaf alder-red-osier dogwood) plant association is tolerant of flooding and requires a high water table each spring. It appears to be a stable, long-lived association where succession to other types can be very slow (Manning and Padgett 1995).

Management: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is not particularly palatable to livestock, but can be trampled as animals search for more palatable forb species (Hansen *et al*. 1995). *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream" plant (e.g. it is readily eaten and is a preferred browse species) for livestock and wildlife. However, dense stands of *Alnus incana* ssp. *tenuifolia* and *Cornus sericea* hinder livestock access. Season-long grazing reduces the native forb cover and allows non-native grasses to increase (Padgett *et al.* 1989, Hansen *et al.* 1995).

According to Hansen *et al*. (1995), most fires kill *Alnus incana* (thinleaf alder) dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death. *Cornus sericea* can survive all but the hottest fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al.* 1995). Frequent fire may sift this community to *Cornus sericea* dominated types.

Both *Alnus incana* ssp. *tenuifolia* and *Cornus sericea* are capable of sprouting and have rhizomatous roots which provide good stream bank stabilization. *Alnus incana* ssp. *tenuifolia* sprouts quickly when cut at 4-5 year intervals. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on streambanks (Hansen *et al*. 1995). *Alnus incana* ssp. *tenuifolia* and *Cornus sericea* may be useful for revegetating higher gradient streams where seasonal, scouring floods occur (Hansen *et al*. 1995)

Betula occidentalis/Mesic Forbs
river birch/Mesic Forbs

Global Rank: G3
Global Rank Comments: This association is well documented in the western states.
State Rank: S2
State Rank Comments: In Colorado, fewer than thirty stands are documented, and while more are estimated to occur, this association is highly threatened by development, road building, and recreation.

General Description and Comments: The *Betula occidentalis/*Mesic Forbs (river birch/Mesic Forbs) plant association is a tall (5-8 ft., 1.5-2.5 m), narrow band of shrubs lining a stream channel. The undergrowth can be sparse or a thick carpet of grasses and forbs. In undisturbed stands, forb species richness can be high, with over thirty species in one stand. At higher elevations, conifer trees on the upslopes intermix with *Betula occidentalis* at the stream bank.

Regional Distribution: The *Betula occidentalis/*Mesic Forbs (river birch/Mesic Forbs) plant association occurs in Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Gunnison River (Kittel *et al.* 1995), Colorado River (Kittel *et al.* 1994), and Rio Grande and Closed Basins (Colorado Natural Heritage Program 1997). It also occurs along the Colorado Front Range and in the Arkansas River Basin (Cooper and Cottrell 1990, Kittel *et al.* 1996).

Elevation Range in Colorado: 6400-8800 ft (2000-2700 m).

Site Geomorphology: This plant association occupies moderately wide stream benches and floodplains in narrow to moderately wide valleys and on hillside seeps. At lower elevations along sunny valley bottoms, well-developed, large occurrences occupy relatively flat stream benches and often extend away from the channel edge. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide, rocky/cobble-bottomed, moderately steep, and sinuous (Rosgen's Channel Type: B2, B3, B4), wide, cobble-bottomed, less steep, and highly sinuous (Rosgen's Channel Type: C3), or braided from beaver activity (Rosgen's Channel Type: D6). This association also occurs along small floodplains of steep-gradient, narrow streams where the valley side slope meets the stream edge (Rosgen's Channel Type: A2). In these stands, *Betula occidentalis* (river birch) is squeezed between large boulders and herbaceous growth is limited to small pockets. This association also occurs around seeps adjacent to the stream channel and along isolated springs on hillslopes away from the valley bottom.

Soil: Soils are fairly shallow, ranging from 12 to greater than 25 inches (30 to >60 cm). Most soils have a surface layer of 50-90% organic matter. Subsurface layers are clay loams, sandy clays, and sandy loams. Most profiles have signs of saturation (mottles) at about 4-10 inches (10-25 cm) depth. Skeletal layers, derived from alluvium, occur at a greater depth. Stands along narrow, steep stream channels occur between large alluvial and colluvial boulders and have almost no soil development. In the Colorado River Basin, the soils classify as fragmental calcareous Lithic Cryorthents, fine-loamy Ustic Torrifluvents.

Vegetation: *Betula occidentalis* (river birch) forms a nearly continuous tall-shrub to small-tree canopy along the stream bank with 15-90% cover. Other shrubs that may be present (in order of decreasing frequency) include: *Alnus incana* spp. *tenuifolia* (thinleaf alder) (1-40%), *Cornus sericea,* (red-osier dogwood) (1-37%), *Salix exigua* (coyote willow) (1-16%), *Jamesia americana* (cliff jamesia) (5-21%), *Amelanchier utahensis* (Utah serviceberry) (20%), *Prunus virginiana* (chokecherry) (1-17%), and *Salix monticola* (Rocky Mountain willow) (1-14%). Along narrow valleys at higher elevations, conifers may overhang the stream edge, thus appearing (according to the stand table) to be within the *Betula* shrubland, when in reality they occur on adjacent, higher ground. Conifer species include: *Pseudotsuga menziesii* (Douglas-fir) (1-66%), *Abies lasiocarpa* (subalpine fir) (30%), *Picea pungens* (Colorado blue spruce) (8-20%), and *Pinus ponderosa* (ponderosa pine) (7-17%).

Due to the dense shrub canopy, herbaceous undergrowth is usually limited (<10% cover). However, some stands have considerable herbaceous cover. Forb cover can include species such as: *Maianthemum stellatum* (false Solomon seal) (1-40% cover)*, Heracleum maximum* (cow parsnip) (1-34%), *Thalictrum fendleri* (Fendler meadowrue) (1-21%), and *Rudbeckia laciniata* (cutleaf coneflower) (1-10%). Graminoid cover is usually low, but can include: *Poa pratensis* (Kentucky bluegrass) (1-34%), *Equisetum arvense* (horsetail) (1-23%), *Carex utriculata* (beaked sedge) (1-23%), *Juncus balticus* (Baltic rush) (1-17%), *Calamagrostis canadensis* (Canadian reedgrass) (1-14%), *Agrostis stolonifera* (red-top) (4-13%), and *Phleum pratense* (timothy) (10%). An abundance of non-native grass species is considered an indication of past or current heavy grazing.

Successional and Ecological Processes: The *Betula occidentalis*/Mesic Forbs (river birch) plant association is considered a mid-seral type. With heavy grazing, this association may succeed to a *Salix* (willow) dominated association (Hansen *et al.* 1995). On wetter sites, the undergrowth potential may be for mesic grasses such as *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex* spp. (sedge). This association may also be an early successional stage for conifer-dominated associations (Padgett *et al.* 1989).

Betula occidentalis can tolerate flooding (Hansen *et al.*1988), but not a permanent inundation of water. *Betula occidentalis* occurs at slightly lower elevations and on lower- gradient stream reaches than *Alnus incana* spp. *tenuifolia* (thinleaf alder). Because *Betula occidentalis* communities occupy low elevation, foothill habitats in Colorado, they are more threatened by development and stream impoundments than *Alnus incana* spp. *tenuifolia* or *Cornus sericea* (red-osier dogwood) riparian communities. Consequently, few large, undisturbed, and unaltered stands of the *Betula occidentalis*/Mesic Forbs plant association exist today.

Management: Due to the dense shrub cover, stands of this plant association may hinder livestock access. In the Arkansas River Basin, this plant association has a lush undergrowth dominated by native grasses and forbs in areas where livestock grazing is minimal. With season-long grazing, however, non-native grasses, such as *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop), may begin to dominate the undergrowth. Livestock grazing can also reduce stream bank stability and cause sloughing. *Betula occidentalis* provides shade, organic matter, and overhanging banks for fish habitat (Hansen *et al.* 1988).

Betula occidentalis is an effective streambank stabilizer. Nursery grown seedlings can be successfully transplanted and will typically grow quickly (Hansen *et al.* 1988). Fire can easily kill *Betula occidentalis* shoots due to the shrub's thin bark. However, new shoots will resprout from uninjured basal buds (Hansen *et al.* 1988).

***Betula occidentalis*/mesic graminoid**
River Birch/mesic graminoid

Global Scientific Name: *Betula occidentalis*/Mesic Graminoids
Global Common Name: river birch/Mesic Graminoids
State Scientific Name: *Betula occidentalis*/Mesic Graminoids
State Common Name: river birch/Mesic Graminoids

Global Rank: G3
Global Rank Comments: This association is well documented in several western states, however, it remains threatened by improper livestock grazing, stream flow alterations, and heavy recreational use.
State Rank: S2
State Rank Comments: In Colorado, fewer than ten stands have been documents, however twenty to thirty stands are estimated to occur. It is threatened by poor livestock management, stream flow alterations, and heavy recreational use.

General Description and Comments: The *Betula occidentalis*/Mesic Graminoids plant association is a tall (5-8 ft., 1.5-2.5 m), narrow band of shrubs lining a stream channel. The undergrowth is a sparse to thick carpet of grasses and grass-like plants with only a few forbs present. It occupies wetter sites than the *Betula occidentalis/*mesic forb plant association. In Colorado, large, near pristine stands are rare.

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the San Juan National Forest (Richard *et al.* 1996) and in the San Miguel River Basin (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7700 ft. (2300 m).

Site Geomorphology: This plant association generally occurs on moderately wide to wide floodplains in bands up to 115 feet (35 m) wide, that often extend well away from the channel edge (Manning and Padgett 1995). This association also occurs in small patches at higher elevations and around seeps and isolated springs on hillslopes away from the valley bottom.

Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide, meandering, and cobble-bottomed (Rosgen's Channel Type: C3).

Soil: Soils are deep pockets of sandy loams with signs of mottling within the top 12 inches (30 cm).

Vegetation: *Betula occidentalis* (river birch) forms a dense canopy of 40-60% cover, often associated with 10% cover of *Ribes inerme* (whitestem gooseberry) and <5% cover of *Salix bebbiana* (Bebb willow). *Alnus incana* (thin-leaf alder) may be present with as much as equal abundance as that of the birch. *Picea pungens* (Colorado blue spruce) and *Juniperus scopulorum* (Rocky Mountain juniper) can be present, but usually with low cover. Stands with a dense shrub canopy, have an herbaceous undergrowth that is limited in cover (<10%), but contain a diversity of species. Forb cover includes 1% cover each of *Achellia millefolium* (yarrow), *Cardamine cordifolia* (bittercress), *Heracleum maximum* (cow parsnip), *Maianthemum stellatum* (false Solomon's seal), and *Vicia americana* (American vetch). Graminoid cover, especially *Carex* (sedge) species, is high. *Carex lanuginosa* (woolly sedge) dominates with 40% cover. Other *Carex* species include <5% cover each of *Carex deweyana* (Dewey sedge) and *Carex utriculata* (beaked sedge).

Successional and Ecological Processes: The *Betula occidentalis*/Mesic Graminoids (river birch/Mesic Graminoids) plant association occupies wetter habitats than the *Betula occidentalis/*mesic forb plant association. According to Manning and Padgett (1995), stands dominated by *Carex lanuginosa* (woolly sedge) or *Carex deweyana* (Dewey sedge) indicate undisturbed sites. Grazing pressure can convert the native sedges to non-native grasses, including *Agrostis stolonifera* (redtop) and *Poa pratensis* (Kentucky bluegrass). In Utah, the presence of scattered deciduous and coniferous trees in the canopy of *Betula occidentalis* stands may indicate that the stand will become a tree-dominated type (Padgett *et al.* 1989).

Betula occidentalis can tolerate flooding (Hansen *et al.*1988), but not a permanent inundation of water. *Betula occidentalis* occurs at slightly lower elevations and on lower-gradient stream reaches than *Alnus incana.* Because *Betula occidentalis* communities occupy low elevation, foothill habitats in Colorado, they are more threatened by development and stream impoundments than *Alnus incana* (thinleaf alder) or *Cornus sericea* (red-osier dogwood) riparian communities. Consequently, few undisturbed and unaltered stands exist today.

Adjacent riparian vegetation: *Populus angustifolia* (narrowleaf cottonwood) woodlands or *Amelanchier alnifolia* (serviceberry) shrublands occur along narrow reaches with limited floodplains. *Salix monticola* (Rocky Mountain willow) shrublands occur on wider floodplains.

Adjacent upslope vegetation: At higher elevations, *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine) forests occur on adjacent hillslopes. At lower elevations, *Pinus edulis-Juniperus osteosperma* or *J. monosperma* (pinyon pine-Utah or one-seeded juniper) woodlands are present.

Management: With season-long grazing, non-native grasses, such as *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop), may begin to dominate the undergrowth of this plant association. Improper livestock grazing can also reduce stream bank stability and cause sloughing. *Betula occidentalis* (river birch) provides shade, organic matter, and overhanging banks for fish habitat (Hansen *et al.* 1988).

Betula occidentalis is an effective streambank stabilizer. Nursery grown seedlings can be successfully transplanted and will typically grow quickly (Hansen *et al.* 1988). Fire can easily kill *Betula occidentalis* shoots due to the shrub's thin bark. However, new shoots will resprout from uninjured basal buds (Hansen *et al.* 1988).

Cardamine cordifolia-Mertensia ciliata-Senecio triangularis
heartleaf bittercress-mountain bluebells-arrowleaf groundsel

Global Rank: G4
Global Rank Comments: This association is common in the upper subalpine and lower alpine of the Colorado Rocky Mountains. It has not been reported outside of Colorado, but is expected to occur in similar habitats in other western states.
State Rank: S4
State Rank Comments: This association is found throughout its habitat in Colorado.

General Description and Comments: The generally small stands of the *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* (heartleaf bittercress-mountain bluebells-arrowleaf groundsel) plant association are found in and near running water of small streams, seeps, and springs. Associated taxa may vary greatly with this plant association, but the dominance of *Cardamine cordifolia*, *Mertensia ciliata* or *Senecio triangularis* is clear. All of these species may be present or only one of the three.

Regional Distribution: This association occurs in Colorado (Johnston 1987, Komarkova 1976, Cooper 1993, Colorado Natural Heritage Program 1997) and is expected to occur throughout the western states.

Distribution in Colorado: This association occurs throughout upper subalpine areas and lower alpine areas in central and south-central Colorado (Sanderson and Kettler 1996, Johnston 1987, Komarkova 1976, Cooper 1993, Kittel *et al*. 1999, Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 9,000-12,300 ft. (2700-3800 m)

Site Geomorphology: Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association typically occurs on moderately steep to very steep first order streams (Rosgen's Channel Type: A2, A3), but can occur on less steep stream reaches as well (Rosgen's Channel Type: B2, B4). In many cases this habitat probably experiences a long period of snow cover (Sanderson and Kettler 1996).

Soils: Soils can be moderately deep (40 cm) sandy clay loam and sand, but in general are quite thin and skeletal

Vegetation: This association is easy to recognize. It is a narrow band of forbs and mosses with one or more of the following three forb species being abundantly present: *Cardamine cordifolia* (bittercress) (1-70%), *Mertensia ciliata* (chiming bells) 1-62%) and/or *Senecio triangularis* (arrowleaf groundsel) (1-50%). All of these species may be present or only one of them. In addition, this type is always rich in forbs. Stand generally have at least fifteen species, and often have as many as 45 forb species present. A wide variety of forb species comprise this diversity, some can be quite abundant.

Other forb species include: *Saxifraga odontoloma* (brook saxifrage) (1-9%), *Mitella pentandra* (fivestar miterwort) (2%), *Oxypolis fendleri* (Fendler cowbane) (1-8%), *Delphinium barbeyi* (tall larkspur) (1-30%), *Epilobium* spp. (willowherb) (1-7%), *Caltha leptosepala* (marsh marigold) (1-30%), *Geranium richardsonii* (geranium) (1-8%), *Arnica cordifolia* (pathfinder) (1-7%), *Conioselinum scopulorum* (hemlock parsley) (1-2%), *Sedum integrifolium* (rose crown) (1-30%), *Primula parryi* (1-13%) (primula), *Corydalis caseana* ssp. *brandegei* (Corydalis) (55%), *Senecio taraxacoides* (groundsel) (19%) *Heracleum maximum* (Cow parsnip) (14%), and *Ligusticum porteri* (Ligusticum) (9%), among others.

Successional and Ecological Processes: The *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* plant association appears to be a stable community. However, with excessive grazing by sheep, it may be converted to communities dominated by various increaser species (Padgett *et al.* 1989). Hansen *et al.* (1995) suggest this type of habitat is early-seral and experiences frequent fluvial depositions, keeping any invading conifers from advancing beyond the sapling stage.

Management: Perennial wet soils, steep gradients and a short growing season make this association vulnerable to heavy disturbance. Forage value and productivity is low for this community. Excessive grazing by sheep may convert this association to one dominated by various increaser species (Padgett *et al.* 1989). Wet soils are susceptible to compaction and churning. If possible, it is best to keep livestock out of these very wet areas (Hansen *et al.* 1995).

Carex aquatilis
Water sedge Montane Grassland

Global Rank: G5
Global Rank Comments: This is a common association that is well documented throughout the western states.
State Rank: S4
State Rank Comments: This is a common association in Colorado. It is well documented throughout its range. Many stands are protected within National Park and Wilderness Area boundaries. However, many acres are improperly grazed by livestock and remain in severely degraded condition.

General Description and Comments: The *Carex aquatilis* is a common, wide spread plant association that can occur as large meadows in high montane valleys or as narrow strips bordering ponds and streams at lower elevations. It occurs in a variety of environmental settings in the montane and subalpine zones. A clear dominance by *Carex aquatilis* and low cover of *Carex utriculata* or *Pedicularis groenlandica* sets this plant association apart from closely related types.

Regional Distribution: This common type is widespread throughout the Rocky Mountain region. It occurs in Montana (Hansen *et al.* 1988), eastern Idaho, western Wyoming (Youngblood *et al.* 1985.), Utah (Johnston 1987, Padgett *et al.* 1989) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: The *Carex aquatilis* plant association has been reported from Arapaho-Roosevelt, White River, Routt, Gunnison , and Rio Grande National Forests (Kettler and McMullen 1996, Sanderson and Kettler 1996, Kittel *et al.* 1995, Kittel *et al.* 1996, Colorado Natural Heritage Program 1998), and from Rocky Mountain National Park (Johnston 1987).

Elevation Range in Colorado: 8100-11,400 ft. (2460-3500 m).

Site Geomorphology: This plant association occurs in a variety of valley types, but the largest expanses occur in broad, low-gradient valleys where large snow-melt fed swales and slopes dominate the landscape. It can also grow in fine sediments at the margins on lakes and beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The largest occurrences are found adjacent to narrow, deep, sinuous streams (Rosgen's Channel Type: E4, E5, E6). Some stands occur along steep streams (Rosgen's Channel Type: A3), others along wide, shallow streams (Rosgen's Channel Type: B3), as well as where beaver dams and ponds have altered the channel morphology.

Soils: Soils are mostly deep, dark colored heavy clays, silts or organic layers over more skeletal layers. Soils are often saturated to the surface, and if not, mottling is commonly present within 10 cm of the surface.

Vegetation: This plant association is characterized by a dense rhizomatous meadow of *Carex aquatilis* (water sedge) (10-80%), usually accompanied a few other graminoids species such as *Calamagrostis canadensis* (Canadian reedgrass) (1-40%) or *Deschampsia cespitosa* (tufted hairgrass) (1-16%). *Eleocharis quinqueflora* (spikerush) can be abundant on organic substrates (1-49%). *Carex utriculata* (beaked sedge) was present in 38% of the stands sampled stands with 1-20% cover. When present, *Carex utriculata* is usually not more than one third the cover of *Carex aquatilis* (aquatic sedge) cover. If it is more than that, the stand may be a *Carex aquatilis-Carex utriculata* or C*arex utriculata* plant association. Forbs are often present, although sometimes inconspicuously. Species include: *Epilobium* spp. (willowherb) (1-3%), *Pedicularis groenlandica* (elephant head) (1-5%), *Caltha leptosepala* (marsh marigold) (1-48%), *Cardamine cordifolia* (bittercress) (1-3%), *Mertensia ciliata* (chiming bells) (1-39%),

Successional and Ecological Processes: Presence of *Carex utriculata* may indicate the site has progressed from the more wet *Carex utriculata* community to the current less mesic conditions, and may become dominated by *Salix planifolia* or *Salix wolfii* (Youngblood *et al*. 1985). Wilson (1969) reports that *Carex aquatilis* associations trap sediment from overbank flows which forms a clay pan, eventually raising the water table. This process drives retrogressive succession and a plant association dominated by *Carex utriculata* takes over on these sites (Wilson 1969).

Management: The *Carex aquatilis* plant association occurs on soils that are typically wet throughout the growing season, and livestock grazing can often cause compaction, pitting and hummocking of the soil (Padgett *et al.* 1989). *Carex aquatilis* is highly palatable to cattle and horses and provide valuable source of forage (Youngblood *et al.* 1985). Kovalchik and Elmore (1992) suggest early-spring grazing of sedge dominated systems, with later-season rest to allow for root reserve buildup.

Overgrazing by livestock can dry the site, increase non-native grass cover, and reduce the vigor of root structure. The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. In order to maintain productivity and vigor of the plants and prevent damage to the soils, livestock grazing should be deferred until soils dry (Hansen *et al*. 1995). Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because if there are adjacent willows, they are vulnerable to pruning damage due to limited regrowth before the end of the growing season (Hansen *et al*. 1995, Kovalchik and

Elmore 1992). Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic plants including willows and sedges. The trapping of sediment behind beaver dams, along with plant reproduction, raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) . However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after burning. This is necessary in order to keep livestock from damaging young, palatable regrowth and to allow for root reserve build up. Prescribed burning is also an effective method of rejuvenating decadent clumps of willows. The willow species in this plant association vigorously sprout following quick, hot fires. Slow burning fires can actually damage the plants. (Hansen *et al*. 1995).

Carex aquatilis–Carex utriculata
water sedge-beaked sedge Montane Grassland

Global Rank: G3G4
Global Rank Comments: This is a common community, well documented throughout the western states.
State Rank: S4
State Rank Comments: In Colorado, over one-hundred stands have been documented and many enjoy formal protection within National Parks or Wilderness Areas.

General Description and Comments: This plant association is recognized by the presence of both *Carex aquatilis* and *Carex utriculata* in roughly equal proportions. This is a common association that generally occurs in small to moderate size patches in very shallow, slow-moving to still water or on saturated soils near low-order streams, lakes, and backwater areas of larger rivers.

Recognition and Classification Problems: There remains some question as to whether the *Carex aquatilis-Carex utriculata* plant association is a distinct type or simply an intermixing of the *Carex aquatilis* and *Carex utriculata* plant associations (Padgett *et al.* 1989). In Colorado, while we recognize the latter two associations as clear, distinct types, there are stands where the two species are so intermingled and the environment uniform across the stand, that separating them, or calling the stand an ecotone just isn't possible. So, a third plant association, *Carex aquatilis-Carex utriculata* was developed. Further research may reveal that these mixed stands represent a transition in time between the *Carex aquatilis* and the *Carex utriculata* plant associations.

Regional Distribution: This plant association occurs in subalpine meadows throughout the Rocky Mountains including Montana (Hansen *et al*. 1989), Idaho, Utah, Wyoming (Girard *et al*. 1995) and Colorado (Johnston 1987, Komarkova 1986, as cited in Reid and Bourgeron 1994, Hess and Wasser 1982, Colorado Natural Heritage Program 1997). It also may occur in Arizona and Nevada (Bourgeron and Engelking 1994).

Distribution in Colorado: This association occurs throughout the Rocky Mountains of Colorado (Hess and Wasser 1982, Johnston 1987, Kettler and McMullen 1996, Kittel *et al*. 1994, Kittel *et al*. 1995, Komarkova 1986, as cited in Reid and Bourgeron 1994, Richard *et al*. 1996, Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8200-11,100 ft. (2500-3400 m).

Site Geomorphology: This plant association occurs in broad, glaciated, subalpine meadows that remain saturated with snowmelt runoff for most of the growing season. It is also often associated with beaver activity. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow, deep, and sinuous (Rosgen's Channel Type: E4, E6), or wide and shallow (Rosgen's Channel Type: B2 and B4). **Soil:** Soils are often organic, thick peat or sandy clays and sandy clay loams originating from glacial till. In the Colorado River Basin, soils classify as loamy, clayey or sandy Typic and Cumulic Cryaquolls.

Vegetation: This plant association has relatively low species diversity due to saturated soil conditions. *Carex aquatilis* (water sedge) (10-90%) and *Carex utriculata* (beaked sedge) (10-40%) co-dominate the association. Both species are present in equal or near equal amounts. For example, a stand with 10% cover of each *Carex* species would classify as this type, however a stand with 10% *Carex aquatilis* and 80% *Carex utriculata* would classify as a *Carex utriculata* plant association. Other graminoid and forb species may also be present. Graminoid species include: *Carex microptera* (small-winged sedge) (1-10%), *Carex rossii* (Ross sedge) (20-50%), *Deschampsia cespitosa* (tufted hairgrass) (1-40%) *Poa pratensis* (Kentucky bluegrass) (1-11%), *Juncus balticus* (arctic sedge) (1-8%), *Carex nebrascensis* (Nebraska sedge) (35%), and *Carex canescens* (pale sedge) (10%). Forb species include: *Caltha leptosepala* (marsh marigold) (3-20%), *Sedum rhodanthum* (pink stonecrop)(1-10%), *Cardamine cordifolia* (bittercress) (1-3%), *Senecio triangularis* (arrowleaf groundsel) (1-3%), *Pedicularis groenlandica* (Elephant's head) (1-3%), Epilobium spp. (willow herb) (1%), and *Sedum rhodanthum* (pink stonecrop) (1-10%).

Successional and Ecological Processes: The difficulty in classifying mixed stands of *Carex aquatilis* and *Carex utriculata* has been discussed in the literature and attempts have been made to differentiate the types based on soil characteristics. Sanderson and Kettler (1996) note a dominance of *Carex utriculata* on organic soils and *Carex aquatilis* on mineral soils. Kittel *et al.* (1995) note the opposite trend where *Carex aquatilis* appears to occur more often on rich Histosols, while *Carex utriculata* occurs on less nutrient rich soils. Richard *et al.* (1996) note that pure stands of *Carex utriculata* tend to occur on mineral soils with some organic epipedons, a trend also noted by Padgett *et al.* (1989).

Water availability appears to be a stronger factor in determining relative dominance of these two sedge species. *Carex utriculata* appears to tolerate standing water and may be a pioneering species since it readily establishes on exposed, saturated mineral soil (Padgett *et al.* 1989, Hansen *et al.* 1988). In Colorado, *Carex utriculata* occurs more often in standing water and often grades into a mesic terrestrial habitat where *Carex aquatilis* is commonly dominant. The *Carex aquatilis*-*Carex utriculata* plant association may, therefore, represent a spatial transition between a wet *Carex utriculata* association and a mesic *Carex aquatilis* association.

Management: Palatable *Carex* (sedge) species can be heavily utilized by livestock in riparian areas in mid- to high-elevation rangelands. Overgrazing by livestock can dry sites, increase non-native grass cover, and result in decreased vigor of native species root structure that can eventually eliminate them from the site. The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. In order to maintain productivity and vigor of the plants and prevent damage to the soils, livestock grazing should be deferred until soils dry (Hansen *et al*. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant regrowth. Late summer and fall grazing is not recommended if there are adjacent willow shrublands, as willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams create a high water table, abate channel downcutting, bank erosion, and movement of sediment by slowing the stream flow and reducing stream gradients. Beaver dams raise the water table across the floodplain and provided year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex aquatilis* (aquatic sedge) and *Carex utriculata* (beaked sedge). However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after to prevent livestock from damaging young, palatable regrowth and to allow for root reserve build up (Hansen *et al*. 1995).

Carex aquatilis and *Carex utriculata* (beaked sedge) are effective stream bank stabilizers due to their rhizomatous root growth. They tend to form a dense, thick sod that is highly resistant to erosion (Hansen *et al*. 1995).

Carex nebrascensis
Nebraska sedge

Global Rank: G4
Global Rank Comments: This is a common community documented from many western states.
State Rank: S3
State Rank Comments: In Colorado, this is a common but declining association. It is threatened by improper livestock grazing, stream flow alterations and heavy recreational use.

General Description and Comments: *Carex nebrascensis* (Nebraska sedge) is a widespread species and generally forms small- to medium-size meadows. It forms an open wetland meadow occurring along the margins of stream banks, lakes and seeps on the plains. The soils are generally saturated for much of the growing season and are subject to compaction by livestock.

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett 1995), Montana (Hansen *et al.* 1995), Idaho, Wyoming (Youngblood *et al*. 1985, Jones and Walford 1995), Utah (Padgett *et al.* 1989), New Mexico (Durkin *et al.* 1994, Durkin *et al.* 1995, Bourgeron and Engelking 1994), and Colorado (Johnston 1987, Cooper and Cottrell 1990, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa River Basin (Kittel and Lederer 1993), the White and Colorado River Basins (Kittel *et al.* 1994) and the South Platte River Basin (Baker 1982, as cited in Johnston 1987, Cooper and Cottrell 1990, Kittel *et al*. 1996, Kittel *et al*. 1997).

Elevation Range in Colorado: 4100-7900 ft (1200-2400 m).

Site Geomorphology: This plant association appears to be restricted to saturated soils of flat floodplains bordering ponds or pools adjacent to stream channels. It can also occur along flat, marshy areas surrounding springs. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are low-gradient (0.5-0.75%), moderately narrow, and sinuous (Rosgen's Channel Type: C6, F6) or very narrow and sinuous (Rosgen's Channel Type: E6).

Soils: Soils are heavy clays and silty clay loams with high organic matter content. Anoxic conditions often occur within 8 inches (20 cm) of the surface either in the form of a gleyed layer or abundant mottling.

Vegetation: *Carex nebraskensis* (Nebraska sedge) contributes the dominant cover (10-80%) and is the diagnostic species (has 100% constancy) for this type. A wide variety of other graminoids and forbs may be present, depending on the elevation and wetness of the site, such as *Carex utriculata* (beaked sedge), with 70% cover in one stand. All associated species have a constancy of 33% or less, with the exception of *Poa pratensis* (Kentucky bluegrass), with 50% constancy. Other graminoids species that can be abundant (10-40% cover) include *Eleocharis palustris* (common spikerush), *Carex praegracilis* (clustered field sedge), and *Scirpus pungens* (threesquare bulrush) . Forb cover is generally low, but can be high in moist locations. Common forb species include *Ranunculus cymbalaria* (buttercup), *Mentha arvense* (field mint), *Mimulus glabratus* (monkey flower), and *Melilotus officinalis* (sweetclover). In one very wet site, *Potamogeton* sp. (pondweed) was abundant with 34% cover.

Successional and Ecological Processes: In Montana, the *Carex nebrascensis* (Nebraska sedge) type is considered a grazing-disclimax. Under season-long grazing, *Carex nebrascensis* increases in abundance, replacing former dominant species (Hansen *et al*. 1995). However, under extreme grazing conditions and a resulting drop in the water table, *Juncus balticus* (Baltic rush) or *Poa pratensis* (Kentucky bluegrass) can eventually replace *Carex nebrascensis*. In Nevada, sites dominated by *Carex nebrascensis* are considered the Potential Natural Community (Manning and Padgett 1995), which appears to be the case in undisturbed stands in Colorado.

Management: *Carex nebrascensis* is highly palatable to livestock in the spring and early summer when stems and leaves are tender. Forage production in this association is high and grazing pressure can be heavy. However, *Carex nebrascensis* can withstand heavy grazing due to its rhizomatous growth. Since the saturated soils of this association are easily compacted by livestock in the spring and early summer, late season grazing is recommended in order to prevent trampling damage to plants and to allow for regrowth (Hansen *et al*. 1995). On the Rio Grande National Forest in south-central Colorado, livestock disperse more readily in the spring, and tend to concentrate on the wetter sites in the late summer, such that less damage occurs with spring and summer grazing on this association (Dean Erhard, Forest Ecologist, *pers. comm*.).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel down cutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water table across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

According to Hansen *et al*. (1995), *Carex nebrascensis* is well-suited to prescribed burning, but livestock need to be removed for a year prior to burning to build up root reserves. Fire will reduce litter accumulation and temporarily increase plant productivity. Fire apparently does not shift the species composition away from dominance by *Carex nebrascensis* (Hansen *et al*. 1995

Carex nebrascensis/Catabrosa aquatica
Nebraska Sedge - Water Whorl Grass Herbaceous Vegetation

Global Rank: G1?
Global Rank Comments: This association has only been documented at two sites on the western slope of the southern Rocky Mountains in Colorado (Baker 1982a). Both species are quite common at suitable habitats in the southern Rocky Mountain region and occur in close proximity near springs in the San Luis Valley of southern Colorado (Sarr and Sanderson 1998).
State Rank: S1?
State Rank Comments: Western slope.
Recognition and Classification Problems:. This association is also known as Catabrosa aquatica-Mimulus sp. Spring wetland in Colorado. Although this association is currently ranked a G1, is likely more common than indicated.

General Description and Comments: This association is typically found near springs.

Regional Distribution: Both species are quite common at suitable habitats in the southern Rocky Mountain region and occur in close proximity near springs in the San Luis Valley of southern Colorado (Sarr and Sanderson 1998). Stands with significant percentages of both dominant species are much less common and usually of small size (Sanderson pers. comm. 1997). Springs which support associations of this type are usually heavily utilized by domestic livestock and very susceptible to invasion by non-native species, particularly *Nasturtium officinale* and *Cirsium spp*.

Distribution in Colorado: This association has only been documented at two sites on the western slope of the southern Rocky Mountains in Colorado (Baker 1982a). The Villa Grove fen in northern Saguache County supports extensive stands of *Carex nebrascensis* with scattered *Catabrosa aquatica* (Sarr pers. obs. 1997).

Elevation Range in Colorado:

Site Geomorphology: Typically, slopes, where groundwater discharge is occurring. Carex nebrascensis is also commonly found in wet meadows but Catabrosa and Mimulus ssp. are almost always associated with flowing water (either groundwater discharge or streams).

Soil: Vary. When found near springs, there is often a histic epipedon.

Vegetation: Dominate species include Carex nebrascensis, Catabrosa aquatica, Mimulus sp., Juncus balticus.

Successional and Ecological Processes:).

Management: *Carex nebrascensis* is highly palatable to livestock in the spring and early summer when stems and leaves are tender. Forage production in this association is high and grazing pressure can be heavy. However, *Carex nebrascensis* can withstand heavy grazing due to its rhizomatous growth. Since the saturated soils of this association are easily compacted by livestock in the spring and early summer, late season grazing is recommended in order to prevent trampling damage to plants and to allow for regrowth (Hansen *et al*. 1995).

Carex utriculata
Beaked sedge

Global Rank: G5
Global Rank Comments: This association is well documented throughout the western states.
State Rank: S4
State Rank Comments: This association is well documented throughout its habitat in Colorado.

Classification and Recognition Problems: *Carex utriculata* has been incorrectly identified as *Carex rostrata* in previous Colorado literature (Weber and Whitman 1992).

General Description and Comments: : The *Carex utriculata* (beaked sedge) plant association is a common wet meadow community that occurs around the edges of montane lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains. The water table is usually near the surface for most of the growing season.

Regional Distribution: This plant association occurs in Oregon (Kovalchik 1987), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Idaho, Wyoming (Youngblood *et al.* 1985, Jones and Walford 1995), Montana (Hansen et al. 1995), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in Rocky Mountain National Park, the Roosevelt, Arapaho, White River, Routt, Gunnison and San Juan National Forests, (Johnston 1987, Kettler and McMullen 1996, Richard *et al.* 1996), and the Yampa, San Miguel/Dolores (Kittel and Lederer 1993), White, Colorado (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995), Arkansas (Kittel *et al.* 1996), South Platte River Basins (Kittel *et al.* 1997) and the Rio Grande and Closed Basins (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7500-9600 ft (2300-2900 m).

Site Geomorphology: *Carex utriculata* (beaked sedge) grows in standing water or saturated soils of wet swales and overflow channels along low-gradient streams. It also occurs along the margins of lakes and beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and slightly sinuous (Rosgen's Channel Type: B5 and B6), to wide and more sinuous (Rosgen's Channel Type: C6) .

Soils: Soils are saturated organics or fine silty clays to clays over cobbles and alluvium. Mottling often occurs within a few centimeters of the surface. In the Colorado River Basin, the soils classify as very-fine clayey to loamy skeletal calcareous Cumulic or Typic Cryaquolls, Aquepts, fine-loamy and sandy-skeletal Typic Cryaquents, and Histic Cryaquepts.

Vegetation: This plant association is characterized by stands dominated by *Carex utriculata* (beaked sedge) with cover ranging from 20% to 99%. Stands often appear to be nearly pure *Carex utriculata*, but a variety of other graminoid species may be present as well. Other *Carex* (sedge) species present include *C. lenticularis* and *C. microptera* (small-wing sedge), but usually with low cover (1-30%) relative to the amount of *Carex utriculata* (beaked sedge) present. Other graminoid species that may be present include: *Glyceria striata* (fowl mannagrass), *Calamagrostis canadensis* (Canadian reedgrass), and *Juncus balticus* (mountain rush). Forb cover is very inconspicuous and can include: *Mentha arvense* (field mint), *Mimulus guttatus* (monkey flower), and *Geum macrophyllum* (broad-leaved geum) (1-20%).

Willow carrs (shrublands) are often adjacent and a few scattered willows will occur within the *Carex utriculata* (beaked sedge) stand. Individual willows tend to be very short if present, either from limiting growth conditions (extremely cold and/or extremely wet), or because of heavy browsing by wildlife or livestock. Willow species observed in and adjacent to *Carex utriculata* (beaked sedge) stands include: *Salix monticola* (mountain willow), *S. drummondiana* (Drummond willow), *S. geyeriana* (Geyer willow), *S. planifolia* (planeleaf willow) and *S. exigua* (coyote willow), depending on the elevation of the site.

Successional and Ecological Processes: The *Carex utriculata* plant association occurs on the wettest sites of the riparian or wetland area, such as low-lying swales, and shallow margins of lakes and ponds, often in standing water. It is an early-seral community and is known to invade margins of newly formed beaver ponds, as well as the freshly exposed silt beds of drained beaver ponds (Padgett *et al.* 1989). With time, the *Carex utriculata* plant association will grade into a *Carex aquatilis* and *Calamagrostis canadensis* associations. *Calamagrostis canadensis* dominates the driest sites with the lowest water tables and colonizes drying stands of *Carex utriculata* and *C. aquatilis* (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment of the riparian area. Flooding events can result in sediments deposited on the floodplain, raising the surface higher above the water table (Cooper 1986). As aggradation, or build up, of the floodplain proceeds, the site can become drier and the dominant graminoid cover changes.

Abandoned beaver ponds also go through a similar succession. With time, ponds become silted-in and *Carex utriculata* establishes on the new, saturated substrate. As the site becomes firm and raised above the old pond level, *Carex aquatilis* and willows may become established. With further aggradation and time *Calamagrostis canadensis* may become established in the undergrowth. Depending on site characteristics, various willow species may become established in the overstory as well, creating the *Salix monticola/Carex utriculata* plant association and the *Salix geyeriana/Calamagrostis canadensis* plant association, for example.

Distance from the stream channel can also differentiate the graminoid dominance spatially within the riparian mosaic. *Carex utriculata* commonly occurs at the stream channel edge where the water table is close to or at the ground surface. As the floodplain surface becomes higher with increased distance from the channel edge, the ground becomes slightly less saturated and shifts to mesic meadows of *Carex aquatilis*, or on higher surfaces, to slightly drier meadows of *Calamagrostis canadensis* (Kittel 1994).

Management: *Carex utriculata* generally occupies the wettest habitats in the riparian area. The soils are highly susceptible to compaction and churning. Heavy use by livestock can dry the site, increase non-native grass cover, and reduce the vigor of willow root structure. However, *Carex utriculata* has a low palatable, especially late in the season (Herman 1970). The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. In order to maintain productivity and vigor of the plants and prevent damage to the soils, livestock grazing should be deferred until soils dry (Hansen *et al*. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because adjacent willow individuals are vulnerable to pruning damage due to limited regrowth before the end of the growing season (Hansen *et al*. 1995, Kovalchik and Elmore 1992).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic plants including willows and sedges. The trapping of sediment behind beaver dams, along with plant reproduction, raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995). Burning of this plant association temporarily increases the productivity of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) . However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after burning. This is necessary in order to keep livestock from consuming young, palatable regrowth. Prescribed burning is also an effective method of rejuvenating decadent clumps of willows. The willow species in this plant association vigorously sprout following quick, hot fires. Slow burning fires can actually damage the plants. (Hansen *et al*. 1995).

Cornus sericea
red-osier dogwood

Global Rank: G4
Global Rank Comments: This association is a common riparian type that occurs in several western states.
State Rank: S3
State Rank Comments: In Colorado, this is a common association, however, it is threatened by poor livestock management.

General Description and Comments: The *Cornus sericea* (red-osier dogwood) plant association is a medium-height (3-6 ft., 1-2 m), shrubland that often forms continuous, narrow bands along stream banks, benches, and bars. It can form very dense, small stands with limited disturbance, often at the base of a cliff.

Regional Distribution: This association occurs in Montana (Hansen *et al.* 1988), Nevada (Manning and Padgett 1995), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the White and Colorado River Basins (Kittel *et al*. 1994) and the San Juan National Forest (Richard *et al.* 1996).

Elevation Range in Colorado: 6500-8300 ft (2000-2500 m).

Site Geomorphology: This plant association occurs adjacent to stream channels and near seeps on moist toeslopes of canyon walls. It also occurs on narrow benches in ravines and on narrow terraces of wider valleys. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996).Stream channels are narrow and moderately steep with gravel streambeds (Rosgen's Channel Type: A4, B4).

Soil: The soils are relatively deep mollic silty to sandy clay loams with stratified layers. In the Colorado River Basin, the soils classify as fine loamy to coarse-loamy (calcareous) cumulic or pachic Cryoborolls, oxyaquic and mollic Cryorthents, fine clayey Haplustolls, fragmental ustic Torriorthents, and loamy Ustorthents.

Vegetation: This plant association is characterized by a dense stand of 20-99% cover of *Cornus sericea* (red-osier dogwood). Several other shrub species may be present, but no one species is consistently present. These include *Rosa woodsii* (woods rose), *Symphoricarpos rotundifolius* (snowberry), *Amelanchier utahensis* (service berry), *Ribes inerme* (whitestem gooseberry), *Betula occidentalis* (river birch), *Crataegus rivularis* (river hawthorn), *Acer glabrum* (Rocky Mountain maple), and *Alnus incana* (thinleaf alder) depending on the location and elevation of the site.

While trees occasionally occur in or adjacent to and overhang some stands, typically this shrubland has no overstory canopy. Scattered tree species may include mature *Populus angustifolia* (narrowleaf cottonwood), *Picea pungens* (Colorado blue spruce), *Pinus ponderosa* (ponderosa pine), or *Pseudotsuga menziesii* (Douglas-fir) (10-20%). The herbaceous undergrowth is highly variable, and depends on the amount of sunlight reaching the ground. Commonly encountered forbs include *Maianthemum stellatum* (false Solomon's seal), *Geranium richardsonii* (Richard's geranium), *Mertensia ciliata* chiming bells), and *Urtica dioica* (stinging nettle). Some stands had absolutely no herbaceous understory.

Successional and Ecological Processes: *Cornus sericea* forms a relatively stable community because of its strong rhizomes and stolons (Hansen *et al.* 1988). Subsequent succession takes place over a long period of time (Padgett *et al.*1989). In Montana, this plant association is considered to be early-seral since it colonizes stream bars and adjacent floodplains (Hansen *et al.* 1995). With time, the association may eventually become dominated by conifer or deciduous tree species.

Management: *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream plant" (e.g., it is readily eaten as a preferred browse species) for livestock and has moderate to high forage production. In open areas, livestock use can be quite high. Dense stands of *Cornus sericea*, however, may restrict livestock access. (Hansen *et al*. 1995).

Cornus sericea is a very effective stream bank stabilizer due to its strong, rhizomatous root structure and should be considered for revegetating degraded sites. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on stream banks. It can also resprout after burial by fluvial deposition. *Cornus sericea* can survive all the but the most severe fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al*. 1995).

Deschampsia cespitosa
tufted hairgrass

Global Rank: G4
Global Rank Comments: This is a common association that is well documented throughout its range.
State Rank: S4
State Rank Comments: This is a common association in Colorado, however few pristine stands have been documented. It is highly threatened by improper livestock grazing, invasion by non-native species, and reduced fire frequency.

General Description and Comments: This dense, bunch-grass meadow occurs in broad, nearly flat, valley bottoms in openings of willow carrs and coniferous forests in subalpine regions across Colorado. It is characterized by uniform to patchy cover of *Deschampsia cespitosa* (tufted hairgrass) with minor cover of other graminoids and forbs. Drier phases of this association grows on gentle slopes above the valley floor.

Regional Distribution: This plant association occurs in Oregon, Washington (Dyrness 1973, as cited in Hansen *et al*. 1995), Nevada (Manning and Padgett 1995), Montana (Hansen *et al*. 1995, Cooper *et al.* 1997), Idaho, Wyoming (Youngblood *et al*. 1985, Girard *et al*. 1995), Utah (Padgett *et al*. 1989), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association has been documented from the White River Basin (Kittel *et al*. 1994), the Colorado River Basin (Sanderson and Kettler 1996), and the Routt, San Juan, and Rio Grande National Forests (Kettler and McMullen 1996, Richard *et al*. 1996, Kittel *et al*. 1999).

Elevation Range in Colorado: 9000-12,300 ft (2800-3800 m).

Site Geomorphology: This meadow plant association generally occurs in broad, glaciated valleys on well-drained ridges and hummocks adjacent to low to moderate gradient streams. It occurs on sites with a moderately high water table (indicated by the presence of mottles or gleying in the soil at a depth of 8 in, 20 cm) and other environmental conditions similar to the *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) plant associations. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and moderately sinuous (Rosgen's Channel Type: C4) or narrow and highly sinuous (Rosgen's Channel Type: E6).

Soils: Soils are a shallow to deep organic layer over stratified sandy or silty loams and loamy sands. Mottles and/or gleying may be present below 50 inches (20 cm) depth.

Vegetation: This plant association is a meadow dominated by *Deschampsia cespitosa* (tufted hairgrass) (13-70%). Other graminoids may be abundant depending on local conditions, but no one species is consistently present. These include *Carex aquatilis* (water sedge) (1-50%), *Carex utriculata* (beaked sedge) (1-20%), and *Calamagrostis canadensis* (bluejoint reedgrass) (6-10%). Forb cover is highly variable, *Caltha leptosepala* is the most present in almost all stands with 1-45% cover. Other forbs often, but not always, present include: *Ranunculus alismifolius* (buttercup), *Sedum rhodanthum* (rose crown), *Veronica wormskjoldii* (speedwell), and *Pedicularis groenlandica* (elephants head). Occasionally, a few shrub stems from adjacent stands occur within this association, including *Pentaphylloides floribunda* (shrubby cinquefoil), *Salix planifolia* (planeleaf willow), and *Salix brachycarpa* (barrenground willow).

Successional and Ecological Processes: The *Deschampsia cespitosa* (tufted hairgrass) plant association can continue to occupy sites indefinitely under relatively stable conditions (Manning and Padgett 1995). *Deschampsia cespitosa* occurs along a broad moisture gradient from mesic and dry-mesic environments to those that are very wet (Padgett *et al*. 1989). As sites become drier, *Deschampsia cespitosa* cover gradually decreases and *Pentaphylloides floribunda* (shrubby cinquefoil) cover may increase on sites with well-drained soils. In contrast, if a site becomes wetter, *Carex* (sedge) species may become dominant (Girard *et al*. 1995).

The absence of native increaser species such as *Juncus balticus* (mountain rush) and exotic species such as *Poa pratensis* (Kentucky bluegrass) and *Taraxacum officinale* (dandelion) may indicate low disturbance conditions (Padgett *et al.* 1989). As disturbance levels increase, *Poa pratensis* may replace *Deschampsia cespitosa*. Many subalpine areas now dominated by *Poa pratensis* may have supported *Deschampsia cespitosa* communities in the past (Padgett *et al*. 1989).

Sheep grazing in the alpine areas of Montana appear to increase the abundance of *Poa pratensis* (Kentucky bluegrass) and *Juncus balticus* (mountain rush) in moist and wet sites, indicating these areas are most susceptible to alteration of species composition from grazing (Cooper *et al.* 1997).

Management: *Deschampsia cespitosa* (tufted hairgrass) is highly palatable to livestock and is therefore, subject to heavy grazing pressure. To maintain vigor and prevent damage to soils and vegetation, grazing should be deferred until soils dry and grazing levels should be light to moderate. On moderately disturbed sites, livestock grazing should take place after surface soils have dried and after maturation of the seed heads. On more severely disturbed sites, intensive rehabilitation is required when there is a high cover of exotic and increaser species. Rest periods from grazing are necessary in order to provide time for plant regrowth (Hansen *et al*. 1995). *Deschampsia cespitosa* can be relatively resistant to extensive trampling (Rich McEldowney, Colorado State University Range Ecosystem Science graduate student, *personnel communication*). On the Rio Grande National Forest, *Deschampsia cespitosa* (tufted hairgrass) has been observed to increase for a time under moderate to heavy grazing, but then become reduced and eventually replaced by *Poa pratensis* (Kentucky bluegrass) (Dean Erhard, Forest Ecologist, *personnel communication*).

Deschampsia cespitosa is relatively resistant to fire. However, with repeated burning, rhizomatous species such as *Poa pratensis* (Kentucky bluegrass) may be favored. Livestock grazing should be deferred immediately after burning in order to protect the young, palatable regrowth (Hansen *et al*. 1995).

The typically wet soils of this plant association are easily compacted by vehicles and livestock use (Padgett *et al*. 1989). *Deschampsia cespitosa* is not very useful as a stream bank stabilizer due to its fibrous root structure. However, this is a useful species for revegetation and mine reclamation efforts (Hansen *et al*. 1995).

Distichlis spicata var. spicata
Inland saltgrass

Global Rank: G4
Global Rank Comments: This is a common association especially in the Intermountain west.
State Rank: S3
State Rank Comments: This is a common association in Colorado. However, it had declined in abundance since Anglo settlement. Large, pristine stands are virtually unknown. This association is threatened by agricultural conversion and groundwater development.

General Description and Comments: This plant association is characterized by open to thick stands of pure *Distichlis spicata* var. *spicata* (inland saltgrass) growing on alkaline or saline soils in basins, swales or on pond margins.

Regional Distribution: This plant association and similar types occur in Montana (Hansen *et al*. 1995), Saskatchewan, Wyoming, Nebraska, Kansas, Oklahoma, Utah, and Colorado (Johnston 1987, Baker 1984, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association has been documented along the Colorado Front Range (Baker 1984), on the eastern plains (Steve Kettler, *personnel communication*), in the San Luis Valley in south-central Colorado (Colorado Natural Heritage Program 1997), and in the Yampa, White and Colorado River Basins (Kittel and Lederer 1993, Kittel *et al*. 1994).

Elevation Range in Colorado: 5000-7550 ft. (1530-2300 m).

Site Geomorphology: This plant association occurs on alkaline or saline soils; soils that have been formed from the accumulation of bases and soluble salts in poorly drained areas. This association occurs along narrow streams or the margins of playa lakes. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996).

Soil: Soils are alkaline and have textures of sandy clay, sandy loams, and sandy clay loams with gravel and cobbles. The soils may be heavily gleyed and can have fine, distinct mottles at a depth of about 20 inches (50 cm). Soils in the Colorado River Basin classify as loamy (calcareous) typic Cryaquents.

Vegetation: This plant association is characterized by almost pure stands of *Distichlis spicata* var. *spicata* (inland saltgrass) with 3-90% cover. Occasionally several stems of *Chrysothamnus nauseosus* (rubber rabbitbrush) or *Sarcobatus vermiculatus* (greasewood) can be present with less than 3% cover. In degraded stands, *Iva axillaris* (poverty weed) can be present with 10-20% cover.

Successional and Ecological Processes: *Distichlis spicata* var. *spicata* (inland saltgrass) is a warm season grass and grows from early summer until fall primarily from rhizomes. *Distichlis spicata* var. *spicata* can tolerate low to moderately alkaline soils and is resistant to trampling by livestock. Cover of *Distichlis spicata* var. *spicata* increases when grazing reduces competition from other plants, but eventually *Hordeum jubatum* (foxtail barley) will take over if heavy grazing persists (Jones and Walford 1995).

Management: *Distichlis spicata* var. *spicata* (inland saltgrass) is not particularly palatable to livestock and forage production is low in this plant association. With prolonged heavy grazing, *Hordeum jubatum* (foxtail barley) may replace *Distichlis spicata* var. *spicata*. In heavily grazed stands of *Sporobolus airoides* (alkali sacaton), *Distichlis spicata* var. *spicata* will increase significantly. *Distichlis spicata* var. *spicata* can be effective in revegetating degraded saline and alkaline sites due to its rhizomatous growth (Hansen *et al*. 1995).

Juncus balticus var. montanus
Baltic rush

Global Rank: G5
Global Rank Comments: This is an abundant community throughout the western states.
State Rank: S5
State Rank Comments: This is a common association, increasing in abundance due to improper grazing throughout Colorado.

General Description and Comments: This plant association occurs as small, dense patches on flat stream benches, along overflow channels, and near springs. It is characterized by a dense sward of *Juncus balticus* (mountain sedge) and often minor cover of *Carex* (sedge) species. Forb cover is generally low. This association is often considered to be a grazing-induced community since it increases with disturbance.

Regional Distribution: This plant association occurs in Oregon, Nevada (Manning and Padgett 1995), Montana (Hansen *et al*. 1995), Idaho, Wyoming (Youngblood 1985, Jones and Walford 1995), Utah (Padgett *et al*. 1989), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout Colorado. It has been quantitatively sampled in the Yampa (Kittel and Lederer 1993), White and Colorado River Basins (Kittel *et al*. 1994), the Rio Grande and Closed Basin and in the Arkansas River Basin (Colorado Natural Heritage Program 1998) as well as in San Juan National Forest (Richard *et al.* 1996).

Elevation Range in Colorado: 6400-11,600 ft (2000-3500 m).

Site Geomorphology: This plant association occurs as small, dense patches on flat stream benches, along overflow channels, and near springs. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are highly variable and can be narrow and deeply entrenched (Rosgen's Channel Type: G5, G6), moderately wide and moderately sinuous (Rosgen's Channel Type: B4), moderately wide and very sinuous (Rosgen's Channel Type: C2,C6), narrow and very sinuous (Rosgen's Channel Type: E6), or braided (Rosgen's Channel Type: D5).

Soils: The soil textures are variable. They range from sandy and well drained, to silty clay loams, to pure organic matter, however most stands occur on coarse-textured sandy loams with a high percentage of cobbles and gravel. Mottles or gleyed horizons are often present. Soils in the Colorado River Basin classified to sandy and clayey typic Cryoborolls, fine-loamy typic Hydraquents, and fine-clayey Aquepts. One stand in San Juan National Forest classified to a Cumulic Haploboroll.

Vegetation: This plant association very easy to recognize with its band of dark green following the channel path. *Juncus balticus* (mountain rush) is the dominated and indicator species for this community. The canopy cover ranges from 3-80%. Because it occurs over a broad elevational and latitudinal range in Colorado, associated species are variable. Some of the more frequently encountered species include *Carex aquatilis* (water sedge) (1-20%), *Carex praegracilis* (clustered field sedge) (10-20%), *Glyceria striata* (mannagrass) (10-16%) and *Carex utriculata* (beaked sedge) (10-30%), *Distichlis spicata* (salt grass) (10-30%) and *Sporobolus airoides* (alkali sacaton) (10-20%).

Forb cover is usually minor, and may include 1-20% cover of *Viola adunca* (violet), *Achillea millefolium* (yarrow), *Mentha arvense* (field mint) or *Trifolium* spp.(sweet clover). Degraded stands and grazing induced stands of *Juncus balticus* can have high abundance (10-40%) of *Poa pratensis* (Kentucky bluegrass), *Phleum pratensis* (timothy), *Taraxacum officinale* (dandelion). Occasionally, a few tree or shrub seedlings may be present with 3-15% cover, including *Populus angustifolia* (narrowleaf cottonwood), *Pentaphylloides floribunda* (shrubby cinquefoil), and *Salix exigua* (coyote willow).

Successional and Ecological Processes: In low-disturbance areas, this plant association appears to be a stable, climax community. It occupies frequently inundated swales and wet, low- to mid-elevation sites (Kittel and Lederer 1993). However, in some areas, this association is considered to be grazing-induced (Padgett *et al.* 1989). *Juncus balticus* is considered an increaser due to its low forage value and high tolerance to grazing (USDA 1937, Hansen *et al*. 1995). It usually increases in abundance on sites formerly dominated by *Deschampsia cespitosa* (tufted hairgrass) or *Calamagrostis canadensis* (bluejoint reedgrass). Nearly pure stands of *Juncus balticus* (mountain rush) indicate that the site may have been heavily grazed in the past (Hansen *et al*. 1995).

Management: Stands of the *Juncus balticus* (mountain rush) plant association are productive, but forage value is relatively low. Livestock grazing occurs when plants are young and tender, but as *Juncus balticus* matures, its palatability declines. Heavy grazing results in an increase of unpalatable forbs. The rhizomatous roots of *Juncus balticus* (mountain rush) can withstand grazing pressure and is fairly good at stabilizing stream banks (Hansen *et al*. 1995).

Picea engelmannii/Cornus sericea
Engelmann Spruce / Red-osier Dogwood Woodland

Global Rank: G3
Global Rank Comments: This community has a broad range, and the environmental conditions capable of supporting the community (i.e. alluvial terraces) are not uncommon. Although it has been impacted by human activities like logging and stream channelization, it is nevertheless a relatively common riparian type in areas where lack of disturbance has allowed succession from cottonwood to spruce dominated communities. In addition, this type is the result of merging two G3 associations, and should be maintained until more range information is available.
State Rank: SU
State Rank Comments:
Recognition and Classification Problems:. *Picea engelmannii* and/or *Picea engelmannii X glauca* (hybrids) are the diagnostic overstory species in this woodland plant association. The *Picea (engelmannii X glauca, engelmannii) / Cornus sericea* Forest (CEGL000407) in Montana has been merged with the *Picea engelmannii / Cornus sericea* Woodland (CEGL000892) into a single entity which could include pure *Picea engelmannii* and the *Picea engelmannii X glauca* hybrid, or both. This type was described in Montana as *Picea* spp. / *Cornus stolonifera* habitat type by Hansen et al. (1995); and in eastern Idaho and western Wyoming as *Picea* spp. / *Cornus stolonifera* habitat type by Youngblood et al. (1985). Hansen et al. (1995) explained that the frequent absence of mature cones, similar morphology, and ecological amplitudes lead them to lump *Picea engelmannii* and *Picea glauca* (hybrids) into a single type. Youngblood et al. (1985) reported that the similar ecological amplitudes lead them to lump *Picea engelmannii* and *Picea pungens* into a single type. Therefore we have adopted *Picea* spp. as the diagnostic species regardless of overstory dominance.

General Description and Comments: This community is restricted to flat or gently sloping alluvial terraces or benches and, less frequently, moist toeslopes or margins of fens or marshes. Stands may be temporarily flooded in the spring, and due to its location in riparian zones, the water table is usually within 1 m of the surface. Water flow and aeration in the rooting zone is usually good.

Regional Distribution: This woodland is found on cool, moist sites in the mountains of the northern Rockies west into Oregon and Washington.

Distribution in Colorado:

Elevation Range in Colorado: This community occurs from 820-2300 m in elevation across its range.

Site Geomorphology:

Soil:

Vegetation: The overstory canopy is dominated by *Picea engelmannii* or *Picea (engelmannii X glauca)* hybrids. Other conifers or *Populus* spp. are often present. Shrub cover is typically high, with *Cornus sericea* usually the dominant shrub, although other species like *Alnus incana* or *Ribes lacustre* are often present. Forb species richness is high but cover is low.

Successional and Ecological Processes:).

Management:

Picea pungens/Alnus incana ssp. tenuifolia
Colorado blue spruce/thinleaf alder

Global Rank: G3
Global Rank Comments: This association is known from Wyoming to New Mexico. Stands are not large and are threatened by development, road building and maintenance, heavy recreational use, improper livestock grazing, and stream flow alterations.
State Rank: S3
State Rank Comments: Fewer than 100 stands exist in Colorado, and very few of these are in pristine condition. This association is threatened by development, road building and maintenance, heavy recreational use, improper livestock grazing, and stream flow alterations.

General Description and Comments: The *Picea pungens/Alnus incana* ssp. *tenuifolia* (Colorado blue spruce/thinleaf alder) plant association occurs in montane riparian areas in Colorado. It occurs in deep, shaded canyons and narrow valleys along relatively straight stream reaches. It generally forms small patches, but can be continuous for several river miles.

Regional Distribution: This plant association occurs in Wyoming and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Routt National Forest, the Yampa, White, Colorado, Gunnison, and San Miguel/Dolores River Basins, and the San Juan and Rio Grande National Forests (Kettler and McMullen 1996, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Richard *et al.* 1996, Johnston 1987, Baker 1989).

Elevation Range in Colorado: 6100-9400 ft. (1900-2900 m).

Site Geomorphology: This plant association occurs along narrow to moderately wide floodplains and stream benches in canyons subject to cold air drainage and limited sunlight. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3, A4), moderately broad and slightly sinuous (Rosgen's Channel Type: B3, B4), or broad and highly sinuous (Rosgen's Channel Type: C3, C4).

Soils: Soils are generally shallow and range from loamy sand to silty clay loams with heavy organic matter content over gravel, cobbles, and boulders. In stands in the White and Colorado

River Basins, the soils classify as sandy typic and oxyaquic Cryorthents, loamy typic and oxyaquic Cryoborolls, and fragmental typic Cryochrepts.

Vegetation: *Picea pungens* (Colorado blue spruce) dominates the overstory with 10-70% cover. There are typically many seedling and saplings as well as mature trees. *Abies lasiocarpa* (subalpine fir) may also be present with 0-25% cover. The thick shrub understory is confined to a narrow band lining the stream channel. Shrub species include 10-70% cover of *Alnus incana* (thinleaf alder), 0-40% cover of *Salix drummondiana* (Drummond willow), 0-30% cover each of *Salix monticola* (mountain willow) and *Acer glabrum* (mountain maple), and 0-10% cover each of *Cornus sericea* (red-osier dogwood) and *Lonicera involucrata* (honeysuckle).

The forb layer is species rich with up to 40 species and dense, with a total of up to 50% cover. Forb species include *Actea rubra* (baneberry), *Conioselinum scopulorum* (hemlock parsley), *Oxypolis fendleri* (cowbane), *Geranium richardsonii* (Richardson geranium), *Heracleum lanatum* (cow parsnip), *Maianthemum stellatum* (false Solomon seal), *Mertensia ciliata* (mountain bluebells), *Rudbeckia laciniata* (cutleaf cornflower), and *Equisetum arvense* (field horsetail).

Successional and Ecological Processes: In deep, narrow canyons with swift-moving streams and narrow floodplains and stream benches, *Picea pungens* (Colorado blue spruce) appears to be a climax riparian species. *Picea pungens* will remain until removed or damaged by a catastrophic flood. More information is needed about the establishment requirements and successional role of *Picea pungens*.

Alnus incana ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After establishment, young stands of *Alnus incana* are continually flooded. As stands mature, the stems can slow flood waters and trap sediment. Fine-textured sediments accumulate on top of the coarser alluvial material and the land surface eventually rises above annual flood levels. Flooding is then less frequent and soils begin to develop (Padgett *et al.* 1989).

Alnus incana is shade-intolerant (Viereck 1970, Chapin *et al*. 1994), and many mature stands in Colorado are restricted to stream bank edges, possibly because these are the only sites where light can penetrate the neighboring overstory canopy. *Alnus incana* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

Management: Due to heavy shading, this plant association provides low forage value for livestock. Dense stands of *Alnus incana* (thinleaf alder) hinder livestock access into this plant association. *Alnus incana* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species. Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995).

Most fires kill *Alnus incana* dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death. *Alnus incana* sprouts quickly when cut at 4-5 year intervals and can be used for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow growing sprouts (Hansen *et al*. 1995).

Picea pungens/Betula occidentalis
Colorado blue spruce/river birch

Global Rank: G2
Global Rank Comments: This association is known only from Colorado.
State Rank: S2
State Rank Comments: This association appears to be limited to foothill canyons of the Colorado Front Range. It is threatened by development, road building and maintenance, recreational use, stream flow alterations and improper livestock grazing.

General Description and Comments: The *Picea pungens/Betula occidentalis* (Colorado blue spruce/river birch) plant association is a cool, moist riparian woodland occurring in deep, narrow canyons in the foothills and at lower montane elevations. *Betula occidentalis* forms a thick band along the stream banks with branches overhanging the stream. Mature *Picea pungens* shade the *Betula occidentalis* along narrow floodplains.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is documented only from foothill canyons of the Colorado Front Range in the South Platte River Basin (Kittel *et al*. 1997).

Elevation Range in Colorado: 7200-8700 ft. (2200-2700 m).

Site Geomorphology: This plant association is limited to deep, 100-600 feet (30-180 m), narrow canyons where it occurs on terraces, stream banks, and narrow floodplains. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep (6-10%) and narrow (Rosgen's Channel Type: A3, A4) or moderately wide with a moderate gradient (1-2%) (Rosgen's Channel Type: B2-B5).

Soils: Soils are generally sandy loams to clay loams with mottling at a depth of 35-110 inches (15-45 cm).

Vegetation: *Picea pungens* (Colorado blue spruce) dominates the canopy with 10-60% cover. Occasionally, *Populus tremuloides* (quaking aspen) is present with 0-30% cover. *Betula occidentalis* (river birch) is always present in the shrub understory with 20-40% cover. *Alnus incana* (thinleaf alder) can be a co-dominant shrub with 0-35% cover. Other shrubs present include 0-30% cover of *Salix exigua* (coyote willow) and 0-10% cover each of *Salix bebbiana* (Bebb willow) and *Cornus sericea* (red-osier dogwood). The herbaceous undergrowth can be dense to sparse. Forbs present include 0-15% cover of *Rudbeckia laciniata* (cutleaf coneflower), 0-10% cover of *Heracleum sphondylium* (cow parsnip), and 0-5% cover each of *Fragaria* *virginiana* (wild strawberry) and *Mertensia ciliata* (mountain bluebells). Graminoids present include 0-40% cover of *Calamagrostis canadensis* (bluejoint reedgrass). *Equisetum arvense* (field horsetail) is always present with 1-10% cover, indicating wet and/or frequently flooded sites.

Successional and Ecological Processes: The *Picea pungens/Betula occidentalis* (Colorado blue spruce/river birch) plant association appears to be stable and late-seral. In deep, narrow canyons with swift-moving streams and narrow floodplains and benches, *Picea pungens* (Colorado blue spruce) appears to be a climax riparian species. *Picea pungens* (Colorado blue spruce) will remain until removed or damaged by a catastrophic flood. *Betula occidentalis* (river birch) can tolerate flooding but not permanent inundation (Hansen *et al.*1988). Fire disturbance results in *Betula occidentalis* (river birch) resprouting and the replacement of this type with an early-seral plant association such as *Populus tremuloides/Betula occidentalis* (quaking aspen/river birch).

Betula occidentalis (river birch) occurs at slightly lower elevations and on lower-gradient stream reaches with less aerated water than *Alnus incana* (thinleaf alder). Because *Betula occidentalis* (river birch) communities occupy low elevation, foothill habitats in Colorado, they are more threatened by development and stream impoundments than *Alnus incana* (thinleaf alder) or *Cornus sericea* (red-osier dogwood) riparian communities. Consequently, few undisturbed and unaltered stands exist today.

Management: Due to heavy shading, this plant association provides low forage value for livestock. Fire can easily kill *Betula occidentalis* shoots due to the shrub's thin bark. However, new shoots will resprout from uninjured basal buds (Hansen *et al.* 1988). *Betula occidentalis* is an effective stream bank stabilizer and will typically grow quickly from transplanted nursery grown seedlings (Hansen *et al.* 1988).

Picea pungens/Cornus sericea
Colorado blue spruce/red-osier dogwood

Global Rank: G4
Global Rank Comments: This plant association is known from Wyoming to Arizona.
State Rank: S2
State Rank Comments: In Colorado, fewer than twenty stands are documented. This association is highly threatened by road improvements and maintenance, improper grazing, heavy recreational use, and development.

General Description and Comments: The *Picea pungens/Cornus sericea* (Colorado blue spruce/red-osier dogwood) plant association is a cool, moist riparian woodland occurring in deep narrow canyons. It was once a more common type and represents slightly more stable habitats than those of the *Picea pungens/Alnus incana* (Colorado blue spruce/thinleaf alder) plant association. The *Picea pungens/Cornus sericea* association is characterized by an open to thick understory of *Cornus sericea*, deeply shaded by *Picea pungens* (Colorado blue spruce).

Regional Distribution: This plant association occurs in Arizona, northern New Mexico (DeVelice *et al.* 1985, Bourgeron and Tuhy 1989), western Wyoming (Youngblood *et al.* 1985), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the San Miguel/Dolores, Gunnison, Colorado, and White River Basins, and on the Routt and San Juan National Forests (DeVelice *et* *al.* 1985, as cited in Johnston 1987, Hess and Wasser 1982, Johnston 1987, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Komarkova 1986, and Richard *et al*. 1996).

Elevation Range in Colorado: 7000-8500 ft. (2100-2600 m).

Site Geomorphology: This plant association occurs on floodplains and benches in narrow valleys, 20-100 feet (7-30 m) wide, with variable stream gradients (1-10%). Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). It occurs along broad, slightly meandering channel reaches (Rosgen's Channel Type: B2, B3, B4) and occasionally along steep and narrow reaches (Rosgen's Channel Type: A3, A6).

Soil: The soils of this plant association are deep, dark-colored clay loams to sandy loams, often with signs of mottling. Coarse fragments range from up to 50% with the percentage increasing with depth. There may be high organic matter in the top layers.

Vegetation: The upper canopy of this plant association is dominated by *Picea pungens* (Colorado blue spruce) with 15-60% cover. It is present in all stands. Other tree species present with less than 40% frequency include *Populus tremuloides* (quaking aspen) (1-50% cover), *Populus angustifolia* (narrowleaf cottonwood) (1-40%), *Abies lasiocarpa* (subalpine fir (3-10%) and *Picea engelmannii* (Engelmann spruce) (1-30%). The shrub canopy is dominated by *Cornus sericea* (red-osier dogwood), which is present in all stands and forms an open to dense thicket with 5-80% cover. *Symphoricarpos rotundifolia* (snowberry) (1-10% cover) and *Lonicera involucrata* (honeysuckle) (1-10% cover) are present in >60% of sampled stands. Other shrubs with lower frequency but noticeably high abundance include: *Alnus incana* (thinleaf alder) (1-10%), *Betula occidentalis* (river birch) (10-50%), *Salix monticola* (yellow willow) (3-30%), *Salix drummondiana* (Drummond willow) (10-20% cover), *Acer glabrum* (Rocky Mountain maple) (10%), Prunus virginiana (chokecherry) (10%), and *Amelanchier utahensis* (Utah serviceberry) (1-10%).

The herbaceous understory is highly variable, depending on the site conditions and the amount of past disturbance. No one forb or graminoid species is present in all stands. Frequently encountered (>50% frequency) herbaceous species include: *Equisetum arvense* (field horsetail) (1-30% cover), *Maianthemum stellatum* (false Solomon's seal) (1-10% cover), and *Geranium richardsonii* (Richard's geranium) (1-10%). Less frequent but abundant species include: *Rudbeckia laciniata* (cone flower) (1-10%), *Clematis ligusticifolia* (virgin's bower) (1-10%) and *Thlaspi montanum* (penny cress) (10% cover).

Successional and Ecological Processes: In deep, narrow canyons with swift-moving streams and narrow floodplains and benches, *Picea pungens* (Colorado blue spruce) appears to be a climax riparian species. *Picea pungens* will remain until removed or damaged by a catastrophic flood (Padgett *et al.* 1989). *Cornus sericea* (red-osier dogwood) is more abundant on level sites where water tables are periodically high (Johnston 1987). *Picea pungens* (blue spruce) is a slow-growing, long-lived tee which regenerates from seed (Burns and Honkala 1990). Seedlings are shallow rooted and require perennially moist soils for establishment and optimal growth. *P. pungens* (blue spruce) is intermediate in shade tolerance, being somewhat more tolerant than *Pinus ponderosa* (Ponderosa pine) or *Pseudotsuga menziesii* (Douglas fir), and less tolerant than *Abies lasiocarpa* (subalpine fir)or Picea engelmannii (Engelmann spruce).

Management: Due to heavy shading, this plant association provides low forage value for livestock. *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream" plant (e.g. it is readily eaten and is a preferred browse species) for livestock and has moderate to high forage production. In open areas, livestock use can be quite high. Dense stands of *Cornus sericea*, however, may restrict livestock access (Hansen *et al*. 1995). *Cornus sericea* can survive all the but the most severe fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al*. 1995).

Cornus sericea is a very effective stream bank stabilizer and should be considered for revegetating degraded sites. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on stream banks (Hansen *et al*. 1995).

Populus angustifolia/Alnus incana ssp. tenuifolia
Narrowleaf cottonwood/thinleaf alder

Global Rank: G3?
Global Rank Comments: This association is known from New Mexico and Colorado. Although not well documented from other states, it is expected to occur throughout the range of *Populus angustifolia* in the Rocky Mountains. The question mark in the Global Rank indicates the community is probably more abundant, but new locations have not been documented.
State Rank: S3
State Rank Comments: In Colorado, this is a common community along montane streams, but few high quality examples exist. This association is highly threatened by improper livestock grazing, development and stream flow alterations.

General Description and Comments: The *Populus angustifolia/Alnus incana* ssp. *tenuifolia* (narrowleaf cottonwood/thinleaf alder) plant association is characterized by a dense stand of *Alnus incana* lining the stream bank and an open to nearly closed canopy of *Populus angustifolia*. Other shrubs may occur but *Alnus* (thinleaf alder) has at least 10-20% cover and is the most abundant of all other shrubs within the stand. It occurs along narrow, fast-moving stream reaches in montane areas.

Recognition and Classification Problems: Both *Populus angustifolia* and mixed *Populus angustifolia*-confer plant associations are in the classification. The criteria for identifying a *Populus angustifolia* dominated associations is that *Populus angustifolia* has at least 20% canopy cover. If any conifer species are present, they have a canopy cover total of no more than 10%.

Regional Distribution: This plant association occurs in New Mexico (Durkin *et al.* 1994) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs on the West Slope in the Yampa, Gunnison, and San Miguel River Basins, and the San Juan and Rio Grande National Forests (Kittel *et al.* 1993, Kittel *et al.* 1994, Kittel *et al*. 1999, Colorado Natural Heritage Program 1997, Richard *et al*. 1996). It also occurs along the Front Range in the Arkansas and South Platte River Basins (Kittel *et al.* 1996, Kittel *et al.* 1997).

Elevation Range in Colorado: 6200-8900 ft. (1900-2700 m).

Site Geomorphology: This plant association occurs on active floodplains in narrow to broad valleys. It forms a narrow, dense band along stream banks and benches. Some of the stands have signs of recent flooding. Stream gradient and channel width are highly variable. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Some sites occur along steep, narrow reaches with little sinuosity (Rosgen's Channel Type: A2-A4). Other sites occur along low gradient, moderately sinuous, broad channel reaches (Rosgen's Channel Type: B2-B5), low gradient, highly sinuous reaches (Rosgen's Channel Type: C3, C4), or very narrow and highly sinuous stream sections (E5, E6).

Soils: Soils are mostly coarse textured ranging from deep sands to shallow sandy loams. Some profiles show stratification with loams to clay loams alternating with sands. Most profiles become skeletal at an average depth of 12 inches (30 cm).

Vegetation: The dominance of *Populus angustifolia* and *Alnus incana* are the key diagnostic characteristics of this plant association. Several other tree and shrub species may be present, but none equal the abundance of the diagnostic species. The overstory is an open to dense canopy of *Populus angustifolia* (narrowleaf cottonwood), which is always present, if sometimes only as sapling-sized individuals (83% frequency as mature trees with 5-89% cover, 23% frequency as saplings with 3-20% cover, and 17% frequency as seedlings with 1-6% cover). Other tree species that may be present include: *Pseudotsuga menziesii* (Douglas fir) (3-12% cover), *Juniperus scopulorum* (Rocky Mountain juniper) (1-10%), *Populus tremuloides* (quaking aspen) (3-48%), *Pinus ponderosa* (ponderosa pine) (3-13%), *Populus acuminata* (lance-leaved cottonwood) (48%), *Abies concolor* (white fir) (7%), or *Picea pungens* (Colorado blue spruce) (4%).

The shrub understory is dominated by a dense band of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) (5-89% cover) lining the stream bank. A variety of other shrubs may be present, intermingling with the alder but always less than the total alder cover. Other shrub species include: *Salix bebbiana* (Bebb willow) (1-10% cover), *Salix monticola* (mountain willow) (1-14%), *Salix drummondiana* (Drummond willow) (3-35%), *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (1-17%), *Salix lucida* var. *caudata* (whiplash willow) (8-25%), *Salix exigua* (coyote willow) (1-32%), *Cornus sericea* (red-osier dogwood) (1-31%), *Rosa woodsii* (woods rose), *Acer glabrum* (Rocky Mountain maple) (1-10%), and *Betula occidentalis* (river birch) (3-10%).

The herbaceous undergrowth is generally sparse. Herbaceous species include: *Poa pratensis* (1-29%), *Taraxacum officinale* (dandelion) (1-18%), *Equisetum arvense* (field horsetail) (1-18%), *Rudbeckia laciniata* (coneflower) (1-20%), *Heracleum maximum* (cow parsnip) (1-12%), Maianthemum stellatum (False Solomon's seal) (1-12%), Trifolium repens (sweet clover (1-48%), *Calamagrostis canadensis* (Canadian reedgrass) (1-17%), *Oxypolis fenderli* (cowbane) (1-11%), *Cardamine Cordifolia* (bittercress) (1-22%), *Carex rossii* (Ross sedge) (3-90%), *Carex praegracilis* (field sedge) (1-30%), and *Carex nebraskensis* (Nebraska sedge) (70%).

Successional and Ecological Processes: The *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) plant association is considered a mid-seral community (not the youngest and not the oldest stands of cottonwoods within a reach). In the San Luis valley, stands have high diversity of shrubs, with many willow species also present, although alder is the clear dominant shrub, forming the bulk of the biomass in the understory. With time and without flooding disturbance, the *Populus angustifolia/Alnus incana* stands may become dominated by invading conifers from adjacent upslope communities such as *Pseudotsuga menziesii* (Douglas fir), Juniperus (juniper), or *Picea engelmannii* (Engelmann spruce).

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set" by flooding disturbance. Cottonwood communities are early, mid- or late seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952).

Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a very large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Alnus incana ssp. *tenuifolia* (thinleaf alder) is also adapted to thrive on the floodplain environment. It is one of the first species to establish on fluvial or glacial deposits and even on placer mining spoils (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, and Hansen *et al.* 1989). After establishment, young stands of *Alnus incana* are continually flooded. As stands mature, the stems can slow flood waters and trap sediment. Fine-textured sediments accumulate on top of the coarser alluvial material and the land surface eventually rises above annual flood levels. Flooding is then less frequent and soils begin to develop (Padgett *et al.* 1989).

Alnus incana is shade-intolerant (Viereck 1970, Chapin *et al*. 1994), and many mature stands in Colorado are restricted to stream bank edges, possibly because these are the only sites where light can penetrate the neighboring overstory canopy. *Alnus incana* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Alnus incana (thinleaf alder) is a nitrogen fixer and increases ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder ranges from 16-150 kg/ha/yr, as much as 150 times the annual atmospheric deposition over the same area (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich alder detritus speeds soil development and bank stability. It also provides an important source of nutrients for aquatic invertebrates.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Forage productivity for this plant association is high and very palatable to livestock. Cottonwood seedlings and saplings and the nitrogen-rich *Alnus incana* (thinleaf alder) leaves are frequently browsed by cattle. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Cottonwood dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen *et al.* 1995).

Alnus incana is an excellent stream bank stabilizer because of its rhizomatous roots. Young stands can re-sprout after flood damage or fire and can tolerate a short duration of standing water (Hansen *et al.* 1995). In addition, alder provides overbank shading, and nutrient inputs, important for fish and other aquatic critters.

Populus angustifolia/Betula occidentalis
Narrowleaf cottonwood/river birch

Global Rank: G3
Global Rank Comments: This association is documented from Colorado and Utah and is expected to occur in Nevada, Wyoming, and South Dakota.
State Rank: S2
State Rank Comments: This association is known from less than a dozen locations in Colorado and is highly threatened by development, expansion and maintenance of roads and railroads, stream flow alterations, improper grazing and heavy recreation.

General Description and Comments: This plant association is a lush deciduous community of *Populus angustifolia* (narrowleaf cottonwood) and *Betula occidentalis* (river birch) growing in a thick band along the stream banks. The community is one of the wetter *Populus angustifolia* plant associations which indicates a perennial source of water and possibly lateral seepage to the channel. Some stands occur on hillside seeps.

Classification Problems: Both *Populus angustifolia* and mixed *Populus angustifolia*-confer plant associations are in the classification. The criteria for identifying a *Populus angustifolia* dominated associations is that *Populus angustifolia* has at least 20% canopy cover. If any conifer species are present, they have a canopy cover total of no more than 10%.

Regional Distribution: The *Populus angustifolia/Betula occidentalis* (narrowleaf cottonwood/river birch) plant association occurs in Utah (Padgett *et al.* 1989) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Colorado (Kittel *et al.* 1994), San Miguel/Dolores (Colorado Natural Heritage Program 1997), Arkansas (Kittel *et al.* 1996), South Platte River Basins (Kittel *et al.* 1997, Cooper and Cottrell 1990).

Elevation Range in Colorado: 7400-8400 ft. (2300-2600 m).

Site Geomorphology: This plant association occurs on stream banks and benches along narrow, somewhat steep streams with little to moderate floodplain development. It also occurs on immediate stream banks or steep-sided overflow channel areas along larger streams with well-developed floodplains. Streams were classified according to the Rosgen Classification of Natural

Rivers (Rosgen 1996). Stream channels are steep and narrow with rocky beds (Rosgen's Channel Type: A3, A4) or broad and meandering (Rosgen's Channel Type: B3, C3).

Soil: Soils have a surface layer of partially decomposed organic matter 2-4 inches (5-10 cm) thick. Subsurface layers are very coarse with 10-60% gravel or cobbles. Subsurface textures range from clay loams to loamy sands. One profile had 40% mottles at 4 inches (10 cm) depth with a strong anoxic odor.

Vegetation: This plant association is characterized by an overstory of 7-80% cover of *Populus angustifolia* (narrowleaf cottonwood) and a thick shrub understory of *Betula occidentalis* (river birch) (20-67%). Other tree species that can be present include: *Pseudotsuga menziesii* (Douglas fir) (1-21%) and *Juniperus scopulorum* (Rocky Mountain Juniper) (1-14%). Other shrubs that can be abundant, but never more so than birch and are not consistently present include: *Alnus incana* (thinleaf alder) (1-60%), *Acer glabrum* (mountain maple) (1-10%), *Cornus sericea* (red-osier dogwood) (1-20%), *Salix bebbiana* (Bebb willow) (1-18%), *Crataegus rivularis* (hawthorn) (1-20%), *Ribes inerme* (prickly currant) (1-10%), *Salix eriocephala* var. *ligulifolia* (strap leaf willow) (1-6%), *Rhus trilobata* (skunk brush) (1-10%), *Salix irrorata* (bluestem willow) (13%), *Rubus parviflorus* (thimble berry), and *Prunus virginiana* (chokecherry) (1-11%).

Graminoid and forb cover is minor, except in degraded stands, where introduced, non-native species can occur abundantly, such as *Poa pratensis* (Kentucky bluegrass) (1-20%), *Taraxacum officinale* (dandelion) (1-11%), *Melilotus* spp. (sweet clover) (10%)
Native herbaceous species include: *Maianthemum stellatum* (false Solomon's seal) (1-5%), *Rudbeckia laciniata* (black-eyed Susan) (5%), *Carex utriculata* (beaked sedge) (20%), and *Angelica ampla* (angelica) (1-10%).

Successional and Ecological Processes: Cottonwood woodlands grow within an alluvial environment that is continually changing due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set"' by flooding disturbance. Cottonwood communities are early, mid- or late-seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is well documented. Periodic flooding events can leave sandbars of bare, mineral substrate. Cottonwood seedlings germinate and become established on newly-deposited, moist sandbars. In the absence of large floods in subsequent years, seedlings begin to trap sediment. In time, the sediment accumulates and the sandbar rises. The young forest community is then above the annual flood zone of the river channel.

In this newly elevated position, with an absence of excessive browsing, fire, and agricultural conversion, this cottonwood community can grow into a mature riparian forest. At the same time, the river channel continually erodes stream banks and creates fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

The *Populus angustifolia/Betula occidentalis* plant association is considered to be early- to mid-seral. *Betula occidentalis* (river birch) becomes abundant along stream banks with perennial stream flow and well-aerated soils. With continued aggradation of the alluvial surface and shading from a thick shrub canopy, successful *Populus angustifolia* (narrowleaf cottonwood) reproduction may cease and the stand may become a *Betula occidentalis* dominated shrubland with a graminoid understory (Hansen *et al.* 1995). *Populus angustifolia* appears to be reproducing in two of the stands sampled, however, the individuals may be sprouting from roots rather than developing from seeds.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Forage productivity for this plant association is high and very palatable to livestock. Cottonwood seedlings and saplings as well as *Betula occidentalis* (river birch) shrubs are frequently browsed by cattle. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Moist soils also make this community susceptible to soil compaction. Cottonwood-dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen *et al.* 1995).

Populus angustifolia/Cornus sericea
Narrowleaf cottonwood/red-osier dogwood

Global Rank: G4
Global Rank Comments: A widespread community for Nevada, Idaho, Wyoming, New Mexico, and Colorado.
State Rank: S4
State Rank Comments: Many stands occur in Colorado, but they are highly threatened by improper livestock grazing, development, highway corridors, and stream flow alterations. No large, pristine stands remain in Colorado.

General Description and Comments: The *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association is found along moderate-size rivers in the montane zone. It is highly variable in the number of conifer and shrub species present along the reach. However, it is generally recognized by a clear dominance of *Populus angustifolia* with less than 10% cover of other tree species and a thick understory of *Cornus sericea*.

Recognition and Classification Problems: Distinguishing *Populus angustifolia* (narrowleaf cottonwood) plant associations from mixed *Populus angustifolia*-conifer plant associations requires that there be at least 20% cover of *Populus angustifolia* and less than 10% cover of conifers along the entire reach.

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett, 1995), Idaho (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989), Wyoming (Johnston 1987), Colorado (Johnston 1987 and Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout the Rocky Mountains of Colorado (Johnston 1987, Hess and Wasser 1982, Jankovsky-Jones 1994, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Richard *et al*. 1996).

Elevation Range in Colorado: 6000-8700 ft. (1800-2700 m).

Site Geomorphology: The *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association occurs in narrow to wide valleys, 30-500 ft (10-150 m), having variable gradients (1-16.5%) and moderately steep stream channels (2-5% gradient). This association occurs on narrow benches along narrow stream channels and on large floodplains along broad, meandering rivers. This association usually occurs between 2 to 10 feet (0.5-2 m) above the stream channel. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels vary widely in slope and width including broad, moderately sinuous, and moderate-gradient reaches (Rosgen's Channel Type: B2-B6), and broad, highly sinuous, low-gradient, reaches (Rosgen's Channel Type: C2, C3, C5). Occasionally, stream channels are steep and narrow (Rosgen's Channel Type: A5). **Soil:** Soils are highly variable and stratified. Soil textures include silty clays, silty clay loams, clay loams, sandy clays, sandy clay loam, and loamy sands. The soils are 1.5-3 feet (0.5-1 meter) deep and become skeletal at depth. Soils in the White and Colorado River Basins classify as argic pachic Cryoborolls on terraces, and typic or oxyaquic Cryorthents, typic Craquents, lithic ustic Torriorthents, udic Ustorthents and sandy oxyaquic Cryofluvents on lower floodplains

Vegetation: This is one of the most diverse cottonwood-dominated riparian plant associations. The upper canopy can consist of several species, but *Populus angustifolia* (narrowleaf cottonwood) is always dominant with 20-70% cover. Other tree species that may be present include: *Picea pungens* (Colorado blue spruce) (1-40%), *Populus tremuloides* (quaking aspen) (1-30%), *Pseudotsuga menziesii* (Douglas-fir) (1-20%), *Pinus ponderosa* (ponderosa pine) (10-15%), and *Abies lasiocarpa* (subalpine fir) (1-20).

The shrub layer is dense and diverse with 1-98% cover of *Cornus sericea* (red-osier dogwood). Other shrub species may be as abundant, but not exceeding *Cornus.* Shrub species include: *Alnus incana* (thinleaf alder) (1-60%), *Amelanchier* spp. (serviceberry) (1-30%), *Rosa woodsii* (woods rose) (1-40%), *Symphoricarpos rotundifolius* (snowberry) (1-40%), *Acer glabrum* (Rocky Mountain maple) (1-30%), *Prunus virginiana* (chokecherry) (1-30%), *Quercus gambelii* (Gambel oak) (1-29%), *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (1-22%), *Crataegus rivularis* (river hawthorn) (1-70%), *Lonicera involucrata* (honeysuckle) (1-30%), *Salix exigua* (coyote willow) (1-31%) , *Betula occidentalis* (river birch) (3-40%), *Salix drummondiana* (Drummond willow) (1-20%), *Salix lasiandra* var. *caudata* (whiplash willow) (10-20%), and *Salix monticola* (Rocky Mountain willow) (1-10%).

Stands vary in aspect and shade provided, some are relatively moist and shady, others are relatively dry and open. In the moister environments, the herbaceous cover can be high (>50%). Forb species include: *Maianthemum stellatum* (false Solomon seal) (1-20%), *Heracleum lanatum* (cow parsnip) (1-20%), *Rudbeckia laciniata* (black-eyed Susan) (1-17%), *Achellia millefolium* (yarrow) (1-3%), and *Osmorhiza depauperata* (blunt-fruit sweet cicely) (1-10%). Graminoid cover can also be high: *Poa pratensis* (Kentucky bluegrass) (1-70%), *Equisetum arvense* (field horsetail) (1-10%), *Agrostis stolonifera* (redtop) (1-40%), *Glyceria striata* (mannagrass) (1-20%), and *Dactylis glomerata* (orchard grass) (1-20%).

Successional and Ecological Processes: In Colorado, some stands of the *Populus angustifolia/Cornus sericea* association appear to be mid- to late-seral mature cottonwood forests that are isolated from frequent flooding and sediment deposition. A seasonally high water table is required to maintain a vigorous *Cornus sericea* layer (Padgett *et al.* 1989). Stands of this association growing at lower elevations and on high, drier terraces have greater cover of *Amelanchier utahensis* (Utah serviceberry), *Amelanchier alnifolia* (serviceberry) and *Crataegus rivularis* (river hawthorn) and may have undergone over-grazing in the past.
In Utah, Padgett *et al.* (1989) suggest that the *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association may be an early- to mid-seral association due to its proximity to the channel. If the channel and terraces remain stable, this association may be replaced by a conifer/*Cornus sericea* type.

In Montana, Hansen *et al*. (1989) describe three stages of disturbance of the *Populus angustifolia/Cornus sericea* plant association. Relatively undisturbed sites have a dense, rich shrub layer of *Cornus sericea* (red-osier dogwood), *Amelanchier alnifolia* (serviceberry), *Prunus virginiana* (chokecherry), and several *Salix* (willow) and *Ribes* (currant) species. Moderately disturbed sites have *Symphoricarpos* (snowberry) and *Rosa* (rose) species that increase in abundance as the previously mentioned shrub species decrease in cover. With continued disturbance, *Rosa* and *Symphoricarpos* species may become quite abundant until eventually, shrub cover begins to decline and the site dries out.

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being “re-set” by flooding disturbance. Cottonwood communities are early, mid- or late seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by “moving” up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Forage productivity for this plant association can be high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle and *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream" plant (e.g. it is readily eaten and is a preferred browse species) to livestock and wildlife. Excessive grazing and browsing in this association will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Cottonwood dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen *et al.* 1995). *Cornus sericea* (red-osier dogwood) provides good stream bank stability due its rhizomatous growth.

Populus angustifolia/Crataegus rivularis

Narrowleaf cottonwood/river hawthorn

Global Rank: G2Q
Global Rank Comments: This association is a newly described, tentative type known from six stands located on the lower slopes of the San Juan Mountains, and along tributaries of the San Miguel River, Colorado.
State Rank: S2Q
State Rank Comments: A new, tentative association known from six locations in the San Juan National Forest, and one tributary of the San Miguel River.

General Description and Comments: The *Populus angustifolia/Crataegus rivularis* (narrowleaf cottonwood/river hawthorn) plant association is characterized by having dense to sparse canopy cover of mature *Populus angustifolia* (narrowleaf cottonwood) trees. The understory is typically very dense and consists of *Crataegus rivularis* (river hawthorn) and other shrub species including *Cornus sericea* (red-osier dogwood) and various tall *Salix* (willow) species. Graminoid and forb cover is minimal. This association generally occurs away from the immediate stream bank in moderately wide valleys. It also occurs along dry back channels or ephemeral streams.

Classification and Recognition Problems: The *Populus angustifolia/Crataegus rivularis* plant association is similar to the *Populus angustifolia/Cornus sericea* and *Populus angustifolia/Alnus incana* plant associations. The key diagnostic characteristic is the abundance of *Crataegus rivularis* under the cottonwood canopy or in thick bands on the same fluvial surface as the cottonwood trees. *Cornus sericea* and/or *Alnus incana* may be present, but their abundance does not exceed that of the *Crataegus.*

Regional Distribution: The *Populus angustifolia/Crataegus rivularis* (narrowleaf cottonwood/river hawthorn) plant association is described only from Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the San Juan National Forest (Richard *et al.* 1996) and from the San Miguel/Dolores River Basin (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6900-8000 ft. (2400 m).

Site Geomorphology: This plant association occurs in moderate to wide valleys back from the main channel, along dry backchannels or along ephemeral streams. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and moderately to highly sinuous (Rosgen's Channel Type: B3 and C6).

Soils: The soils are sandy clays and highly stratified alluvium.

Vegetation: *Populus angustifolia* (narrowleaf cottonwood) forms an open to dense overstory canopy with 3-57% cover. *Crataegus rivularis* (river hawthorn) forms a dense shrub canopy with 10-70% cover, and *Rosa woodsii* (woods rose) forms a sub-shrub canopy of 3-10%. These three species were present in every stand sampled . Other tree species may be present, including *Pinus ponderosa* (ponderosa pine) (3-20% cover) and *Pseudotsuga menziesii* (Douglas fir) (25%). The shrub canopy is usually diverse, but no single species is co-present with *Crataegus* in all stands. Shrub species that occur in more than 50% of stands sampled include: *Symphoricarpos rotundifolius* (snowberry) (3-19%), *Quercus gambelii* (Gambel oak) (1-15%), *Pentaphylloides floribunda* (shrubby cinqfoil) (2-10%), and *Cornus sericea* (red-osier dogwood) (1-30%). Other shrubs that occurred in fewer than 50% of the stands sampled include: *Salix bebbiana* (Bebb willow) (10%), *Salix eriocephala* var. *ligulifolia* (yellow willow) (3-20%), and *Salix monticola* (Rocky Mountain willow) (10-20%).

Graminoid and forb cover is typically low due to dry soil conditions. Two species are present in all sampled stands: *Taraxacum officinale* (dandelion) (1-3%) and *Iris missouriensis* (wild iris) (1%). Other herbaceous species present include: *Maianthemum stellatum* (false Solomon's seal) (1-10%), *Poa pratensis* (Kentucky bluegrass) (1-3%), *Thermopsis montana* (golden Banner) (1-3%), *Thalictrum fendleri* (meadow rue) (1-9%), *Rudbeckia laciniata* (black-eyed Susan) (1-10%), *Carex praegracilis* (field sedge) (10%), and *Delphinium nuttallianum* (Delphinium) (10%).

Successional and Ecological Processes: Cottonwood woodlands grow within an alluvial environment that is continually changing due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set"' by flooding disturbance. Cottonwood communities are early, mid- or late-seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is well documented. Periodic flooding events can leave sandbars of bare, mineral substrate. Cottonwood seedlings germinate and become established on newly-deposited, moist sandbars. In the absence of large floods in subsequent years, seedlings begin to trap sediment. In time, the sediment accumulates and the sandbar rises. The young forest community is then above the annual flood zone of the river channel.

In this newly elevated position, with an absence of excessive browsing, fire, and agricultural conversion, this cottonwood community can grow into a mature riparian forest. At the same time, the river channel continually erodes stream banks and creates fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the landsurface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example a high terrace, the cottonwoods will be replaced by upland shrub or tree species that may comprise the climax plant association for that area.

An abundance of *Crataegus rivularis* (river hawthorn) may indicate a late seral stage of the cottonwood stand. *Crataegus* occupies the driest part of the riparian habitat, and may indicate the surface is no longer flooded. In Montana, thickets of *Crataegus* are considered a grazing disclimax. Cattle will browse *Crataegus* and heavy pressure can cause thickets to become open and increaser species such as *Rosa woodsii* (rose), *Symphoricarpos* (snowberry) and *Poa pratensis* Kentucky bluegrass) become established and abundant (Hansen *et al.* 1995).

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Forage productivity for this plant association can be high and very palatable to livestock. Since cottonwood seedlings and saplings are frequently browsed by cattle, cottonwood dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen *et al.* 1995).

In Montana, thickets of *Crataegus* are considered a grazing disclimax. Cattle will browse *Crataegus* and heavy pressure can cause thickets to become open and increaser species such as *Rosa woodsii* (rose), *Symphoricarpos* (snowberry) and *Poa pratensis* Kentucky bluegrass) become established and abundant (Hansen *et al.* 1995).

Crataegus is fire tolerant and has been known to send up sucker sprouts after a fire. Dense thickets provide excellent hiding cover for wildlife species and the berries are food source many birds (Hansen *et al.* 1995).

Populus angustifolia/Rhus trilobata
Narrowleaf cottonwood/skunkbrush

Global Rank: G3
Global Rank Comments: This community is known from Colorado, Nevada and Utah.
State Rank: S3
State Rank Comments: This association is limited to the southwest and south central

General Description and Comments: The *Populus angustifolia/Rhus trilobata* (narrowleaf cottonwood/skunkbrush) plant association is characterized by a scattered overstory of *Populus angustifolia* with an occasional *Populus* x *acuminata* (lanceleaf cottonwood) or *Populus* *deltoides* subsp. *wislizenii* (Rio Grande cottonwood). The shrub understory is a dense layer of *Rhus trilobata*. It occurs in sandstone canyons and on streams adjacent to sand dunes.

Regional Distribution: This plant association occurs in Nevada (Padgett *et al.* 1989), Utah (Manning and Padgett 1995), and Colorado (Colorado Natural Heritage Program).

Distribution in Colorado: This association occurs on theUncompahgre Plateau in the San Miguel and Dolores River Basins (Kittel and Lederer 1993), the Colorado River Basin (Kittel *et al*. 1994), the San Juan and Rio Grande National Forests (Richard *et al*. 1996, Kittel *et al*. 1999), and in the San Luis Valley (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5000-7100 ft. (1500-2200 m).

Site Geomorphology: This plant association occurs on immediate river banks, floodplain meanders and narrow benches in narrow to wide, 65-500 feet (20-150 m), sandstone canyons. Stands generally occur within 3 feet (1 m) of the high water mark, but can also occur on higher terraces, up to 10 feet (3 m) above the channel. In the western portion of the Colorado River drainage, this association occurs on small streams in shale canyon areas. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and highly sinuous (Rosgen's Channel Type: C3, C4, C6) or wide and moderately sinuous (Rosgen's Channel Type: B3). Occasionally, stream channels are narrow and steep (Rosgen's Channel Type: A3).

Soil: The soils associated with this plant association are often alkaline and of a calcareous parent material. The soil textures are fine sandy loams, clay loams, silty clay loams, and silty clay. In the Colorado River Basin, the soils classify as ustic Torriorthents, Ustifluvents, mesic ardic Ustorthents, and ustalfic Haplargids.

Vegetation This plant association is characterized by the presence and abundance of *Rhus trilobata* (skunkbrush) (1-80% cover) with *Populus angustifolia* (narrowleaf cottonwood) (1-80% cover), or *P. acuminata* (lance-leaf cottonwood) (3-60% cover). The cottonwoods may be young trees (sapling sized <12 cm dbh) or mature trees. Other trees that may be present in the overstory include *Acer negundo* (boxelder) (1-30%), *Juniperus osteosperma* (Utah juniper) (10%), *Juniperus scopulorum* (Rocky Mountain juniper) (3-10%). *Pinus ponderosa* (Ponderosa pine) (40%), *Pseudotsuga menziesii* (Douglas fir) (30%), *Pinus edulis* (one-seeded pine) (1%) and *Ulmus pumila* (Siberian elm) (1%).

The shrub layer is dominated by 10-70% cover of *Rhus trilobata* (skunkbrush). Other shrubs that may be present include: *Clematis ligusticifolia* (virgin's bower) (74% frequency, 1-54% cover), *Rosa woodsii* (woods rose) (59% frequency, 1-30% cover), *Quercus gambelii* (Gambel oak) (44% frequency, 1-20% cover), *Salix exigua* (coyote willow) (33% frequency, 1-30% cover), *Amelanchier utahensis* (Utah serviceberry) (30% frequency, 1-10% cover), *Cornus sericea* (red-osier dogwood) (22% frequency, 1-10% cover), *Forestiera pubescens* (wild privet) (15% frequency, 10-90% cover), *Prunus virginiana* (chokecherry) (15% frequency, 3-31% cover), *Berberis fendleri* (barberry) (15% frequency, 1-26% cover), *Shepherdia argentea* (silver buffalo berry) (11% frequency, 3-30% cover), and *Acer glabrum* (Rocky Mountain maple) (7% frequency, 3-70% cover).

The herbaceous undergrowth is usually sparse, but can include: *Maianthemum stellatum* (false Solomon seal) (1-21%), *Mahonia repens* (Oregon grape) 1-50% cover), *Thermopsis montana* (golden banner) (3-10% cover), *Pascopyron smithii* (western wheat grass) (1-21% cover), *Galium boreal* (bedstraw) (1-5% cover), *Poa pratensis* (Kentucky bluegrass) (1-30% cover), and *Melilotus officinale* (yellow sweet clover) (1-3% cover).

Successional and Ecological Processes: In Utah, the *Populus angustifolia/Rhus trilobata* (narrowleaf cottonwood/skunkbrush) plant association is considered a late successional community within the riparian area (Padgett *et al.* 1989). In southwestern Colorado, *Rhus trilobata* is present in both young and old cottonwood stands. As the stand matures, *Rhus trilobata* becomes denser and excludes other shrubs. On higher terraces that are less frequently flooded, *Populus angustifolia* does not reproduce. This indicates succession to an upland community. The presence of *Quercus gambelii* (Gambel oak) in some stands may indicate a trend toward an oak upland shrub community (Padgett *et al.* 1989).

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set" by flooding disturbance. Cottonwood communities are early, mid- or late seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Forage productivity for this plant association is high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle. However, in California, *Rhus trilobata* is considered to be useless browse for livestock and only fair to poor browse for wildlife (Padgett *et al.*

1989). In areas with limited cover of palatable species, *Rhus trilobata* may be more heavily browsed. Excessive grazing and browsing of both *Populus angustifolia* and *Rhus trilobata* will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Cottonwood dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen *et al*. 1995).

Populus balsamifera
Balsam poplar Riparian Woodland

Global Rank: GU
Global Rank Comments: There is not enough information to rank this plant association.
State Rank: SU
State Rank Comments: There is not enough information to rank this plant association.

General Description and Comments: The *Populus balsamifera* (balsam poplar) plant association is a minor type in Colorado. *Populus balsamifera* has a limited distribution and rarely forms stands larger than a few hundred yards long. *Populus balsamifera* is distinguished from *Populus angustifolia* (narrowleaf cottonwood) by its broad leaves and large, sticky-resinous buds.

Classification Problems: This plant association is uncommon in Colorado. *Populus balsamifera* (balsam poplar) has been misidentified as *Populus angustifolia* (narrowleaf cottonwood) in the past. Because *Populus balsamifera* (balsam poplar) is so limited, all stands, regardless of understory species composition, are included within this single plant association.

Regional Distribution: This plant association occurs in Alaska (Viereck *et al.* 1992), Canada (Johnston 1987) , north and east of the Great Plains Region (McGregor *et al.* 1986) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: *Populus balsamifera* has a limited distribution in Colorado and is somewhat restricted to the north-central regions of the state (Harrington 1954, McGregor *et al.* 1986). Colorado may be the southern limit of the range of *Populus balsamifera* (USDA PLANTS). Stands observed in the Gunnison River Basin expand its distribution south to a latitude of approximately 38.5. Other stands occur in the Routt National Forest (Kettler and McMullen 1996), on tributaries of the Colorado River near Eagle, and along the Cache la Poudre River (Colorado Natural Heritage Program 1998).

Elevation Range in Colorado: 7700-8700 ft (2300-2700 m).

Site Geomorphology: This plant association occurs along a variety of streams (first through fourth order) in moderate to wide, 200-600 feet (60-180 m), glacial out-wash valleys. This association appears to be limited to immediate stream banks, overflow channels, and floodplains. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are broad and slightly meandering (Rosgen's Channel Type: B2 and B4).

Soils: Soils are fairly deep, fine sandy and silty loams over skeletal alluvial deposits. Pale mottles may be present within the top 12 inches (30 cm).

Vegetation: Mature trees and saplings of *Populus balsamifera* (balsam poplar) create an overstory canopy of 25-50% cover. Other trees that may be present include: *Picea pungens*

(Colorado blue spruce) (10%). A thick band of shrubs can occur along the stream edge including: *Alnus incana* (thinleaf alder) (30%), *Salix drummondiana* (Drummond willow) (23-33%), *Rosa woodsii* (woods rose) (10%), *Lonicera involucrata* (honeysuckle) (3%), *Ribes inerme* (whitestem gooseberry) (3%), and *Sambucus racemosa* (red elderberry) 1%). The herbaceous undergrowth includes mesic forbs such as *Heracleum lanatum* (cow parsnip) (10-20%), *Geranium richardsonii* (Richardson's geranium) (8-10%), *Osmorhiza depauperata* (blunt-fruit sweet-cicely) (3-8%), *Equisetum arvense* (field horsetail) (3-5%), *Poa pratensis* (Kentucky bluegrass) (3-6%), *Hydrophyllum fenderli*(Fendler's waterleaf) (8%), and *Maianthemum stellatum* (false Solomon's seal) (3%).

Successional and Ecological Processes: *Populus balsamifera* (balsam poplar) is a common horticultural addition to urban landscapes and may become established from cultivated areas. Careful observation is required to determine if stands in the wild are dominated by the native species.

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set" by flooding disturbance. Cottonwood communities are early, mid- or late seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.
If not damaged by a large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Cottonwood seedlings and saplings are frequently browsed by cattle. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Cottonwood-dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen *et al* 1995).

Populus deltoides ssp. wislizenii/Rhus trilobata
Rio Grande cottonwood/skunkbrush

Global Rank: G2
Global Rank Comments: This association has only been documented from river floodplains of the lower Colorado, Yampa, and San Miguel rivers in extreme western Colorado (Keammerer 1974, Kittel and Lederer 1993), it has also been reported to occur in degraded stands along the Rio Grande in northern New Mexico (Durkin 1997, personal communication). Nearly all the existing stands are considered to be in decline due to altered hydrology from upstream impoundments and the long-term effects of livestock grazing. Sexual regeneration is poor at all sites, and tamarisk (*Tamarix ramosissima*) is invading stands of this type on the
State Rank: S2
State Rank Comments: See Global comments.

General Description and Comments: The *Populus deltoides* ssp. *wislizenii/Rhus trilobata* (Rio Grande cottonwood/skunkbrush) woodland is documented from western Colorado in the Colorado, Yampa, and San Miguel/Dolores River Basins below 5500 ft. in elevation. An ecologically similar association with a different subspecies of cottonwood, *Populus deltoides* ssp. *monilifera* (plains cottonwood), is known from southeastern Colorado. Both of these associations represent a late-seral stage of maturing cottonwoods. The trees are usually large and widely-spaced with thick patches of *Rhus trilobata* (skunkbrush) in-between and underneath the overstory canopy. The following discussion is for the Western Slope occurrences.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 19997).

Distribution in Colorado: This plant association has been found in the Grand and Parachute Creek Valleys on the Colorado western slope (Reid and Bourgeron 1991). It also occurs along the San Miguel River between Vancorum and Uravan and the Yampa River near the confluence with the Green River (Kittel and Lederer 1993). A similar plant association occurs in the Comanche National Grasslands in southeastern Colorado (Culver *et al*. 1996).

Elevation Range in Colorado: 4800-5300 ft (1400-1600 m).

Site Geomorphology: The *Populus deltoides* spp. *wislizenii*/*Rhus trilobata* (Rio Grande cottonwood/skunkbrush) plant association is found on immediate stream banks and the upper terraces of wide alluvial floodplains. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The stream channels are highly sinuous, low gradient. (Rosgen's Channel Type: C4), and less sinuous, lightly steeper gradient streams (Rosgen's Channel Type: B4). **Soil:** Soils are deep, stratified clay loams to sandy loams with fresh, alluvial sand and gravels on point bars.

Vegetation: This association has large, spreading *Populus deltoides* spp. *wislizenii* (Rio Grande cottonwood) trees with 10-50% cover, and an open shrub canopy of *Rhus trilobata* (skunkbrush)

(1-50% cover). Other trees that may be present include: *Populus x acuminata* (lanceleaf cottonwood) (20%), *Picea pungens* (Colorado blue spruce) (3%), and *Acer negundo* (box negundo) (1%). Other shrubs that may be present include: *Shepherdia argentea* (silver berry) (1-20%), *Tamarix ramosissima* (salt-cedar) (1-3%), *Betula occidentalis* (river birch) (60%), *Alnus incana* (thinleaf alder) (3-10%), Lonicera involucrata (honeysuckle) (3-10%), *Symphoricarpos occidentalis* (snowberry) (30%), *Berberis fendleri* (barberry) (10%), *Salix lasiandra* var. *lasiandra* (pacific willow) (3%), and *Salix exigua* (coyote willow) (1%).

The herbaceous understory is usually sparse and consists mainly of *Elytrigia repens* (quackgrass) (1-50%), *Solidago canadensis* (goldenrod) (1-10%), *Maianthemum stellatum* (false Solomon's seal) (1-40%), *Bromus tectorum* (cheat grass) (1-30%), *Carex aquatilis* (aquatic sedge) (40%), *Cirsium arvense* (thistle) (1-3%), *Asclepias speciosa* (showy milkweed) (1%), *Melilotus alba* (sweetclover), *Poa pratensis* (Kentucky bluegrass) (1-30%), and *Bromus inermis* (smooth brome) (1-20%).

Succession and Ecological Processes: As *Populus deltoides* spp. *wislizenii* mature and grow large, *Rhus trilobata* shrubs first become more abundant and then more widely spaced. The presence of *Artemisia tridentata* (sagebrush) indicates that *Populus deltoides/Rhus trilobata* (Rio Grande cottonwood/skunkbrush) on higher terraces may be a successional stage to an upland shrub or woodland community dominated by *Artemisia tridentata*. A similar successional trend has been observed in the *Populus angustifolia/Rhus aromatica* var. *trilobata* (narrowleaf cottonwood/skunkbrush) community type in Utah (Padgett *et al.* 1989).

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set" by flooding disturbance. Cottonwood communities are early, mid- or late seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time, a healthy riparian area supports all stages of cottonwood communities.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Management: In order to maintain cottonwood riparian forests, recognition of the early seral stage of this plant association is important for long-term management. Activities such as bank stabilization (rip-rap) and channelization restrict channel migration, and may reduce the maturation of seedling/sapling stands into mature cottonwood riparian forests. Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alterations to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that would allow for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Riparian forage productivity can be high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Cottonwood dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity.

Populus tremuloides/Acer glabrum
Quaking aspen/Rocky Mountain maple

Global Rank: G2
Global Rank Comments: This association is known only from less than 10 locations in Colorado.
State Rank: S1S2
State Rank Comments: This association is known from less than 10 locations in the central and south-central mountain regions of Colorado.

General Description and Comments: The *Populus tremuloides/Acer glabrum* (quaking aspen/Rocky Mountain maple) forest occurs along narrow streams and gulches and in broader valleys where shading, aspect, or hillslope springs create moist soil conditions away from the stream channel. This forest is not restricted to riparian habitats, and will occur on steep, moist hillsides as well as following stream courses.

Regional Distribution: This association is known from Colorado (Colorado Natural Heritage Program 1998).

Distribution in Colorado: This association occurs in scattered locations on the western slope (Colorado Natural Heritage Program 1998).

Elevation Range in Colorado: 8400-9600 ft. (2560-2300 m).

Site Geomorphology: This association occurs on north to north-east facing slopes on alluvial terraces in narrow and medium valleys, on stream banks, floodplains and moist steep hillslopes. It is located 0.3-50 ft (1-15 m) lateral distance from the channel, and 0.25-6 ft. (0.10-1.72 m) above the annual high water mark in the channel. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Streams are often quite steep (5-7%), and very rocky (Rosgen's Channel Type:A2).

Soils: Soils are shallow sandy loams and silty clay loams, highly skeletal, with high organic matter in the to 4 inches (10 cm)

Vegetation: This association is dominated by an overhead canopy of the broad-leaved deciduous tee *Populus tremuloides* (quaking aspen) with 3-79% canopy cover. Other trees that may be present include: *Populus balsamifera* (balsam poplar) (no percentage available), *Populus tremuloides* (quaking aspen) (5%), *Abies lasiocarpa* (subalpine fir) (3%), and *Pseudotsuga menziesii* (Douglas fir) (3%). The shrub canopy is dominated by *Acer glabrum* (Rocky Mountain Maple), with 20-61% cover. Other shrubs that may be present include: *Cornus sericea* (red-osier dogwood) (3-8%), *Ribes* spp. (currant) (10%), *Sambucus racemosa* (elderberry) (1%), *Amelanchier alnifolia* (service berry) (1-5%), *Mahonia repens* (Oregon grape) (no percentage available) and *Prunus virginiana* (chokecherry) (10%).

The herbaceous undergrowth is often rich in forbs, their combined total cover reaching as much as 60%. Forb species that may be present include: *Thalictrum fenderli* (meadow rue) (1-5%), *Epilobium angustifolia* (fireweed) (1-26%), *Maianthemum stellatum* (false Solomon's seal) (4-20%), and *Actaea rubra* (baneberry) (3%). Graminoids are less abundant and include: *Calamagrostis canadensis* (Canadian reedgrass) (1-8%), and *Elymus* spp. (1%).

Successional and Ecological Processes: In the San Juan National Forest, this association maybe seral to the *Abies lasiocarpa/Cornus sericea* (subalpine fir/red-osier dogwood) or *Abies concolor/Cornus sericea* (white fir/red-osier dogwood) plant association.

Management: Aspen stands are considered prime habitat for establishment of ruffle grouse.

Populus tremuloides/Alnus incana ssp. tenuifolia
Quaking aspen/thinleaf alder

Global Rank: G3
Global Rank Comments: This plant association has been documented only in Colorado. It is expected to occur in other Rocky Mountain States.
State Rank: S3
State Rank Comments: This plant association is known from throughout the western slope of the Colorado Rocky Mountains.

General Description and Comments: The *Populus tremuloides/Alnus incana* ssp. *tenuifolia* (quaking aspen/thinleaf alder) plant association is located in narrow ravines and along first and second-order streams where upland *Populus tremuloides* forests intermix with riparian shrub vegetation and at lower elevations where *Populus tremuloides* persists only in the riparian zone. The presence of obligate riparian species distinguish this association from upland *Populus tremuloides* communities.

Regional Distribution: This plant association has not been documented outside of Colorado.

Distribution in Colorado: This association occurs in the Routt National Forest, and the Colorado, Arkansas, North Platte, Rio Grande, White River, and Gunnison River Basins (Kettler and McMullen 1996, Kittel *et al*. 1994, Kittel *et al*. 1995).

Elevation Range in Colorado: 8400-9600 ft (2600-2900 m).

Site Geomorphology: This plant association occurs in narrow, 25-225 feet (10-70 m) wide, valleys along stream banks of first- and second-order streams. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3, A4) and occasionally, of moderate gradient and width (Rosgen's Channel Type: B3). Stream gradients range from 1-30%.

Soils: Soils are generally skeletal, shallow, sandy and sandy clay loams or deeper sandy clay loams. In the Colorado River Basin, the soils classify as coarse loamy to sandy cumulic Cryaqualls or Cryoborolls to oxyaquic Cryorthents.

Vegetation: This plant association has a tall, 20-40 foot (6-12 m), overstory of 10-70% cover of *Populus tremuloides* (quaking aspen). Several conifer species can occur, however the aspen is clearly the dominant tree canopy, at least along the stream banks. Other tree species that may be present include: *Pinus contorta* (lodgepole pine) (20%), *Abies lasiocarpa* (subalpine fir) (10%), *Picea pungens* (Colorado blue spruce) (3-10%), and *Pseudotsuga menziesii* (Douglas-fir) (3-10%).

The shrub and forb canopy along the immediate stream bank distinguish this riparian plant association from the adjacent forests. The shrub layer is dominated by 10-70% cover of *Alnus incana* (thinleaf alder). Other shrubs that may or may not be present in this association include: *Salix drummondiana* (Drummond willow) (3-22%), *Lonicera involucrata* (honeysuckle) (1-10%), *Rosa woodsii* (woods rose) (1-10%), *Salix bebbiana* (Bebb willow) (1-20%). The forb undergrowth can be dense and includes *Cardamine cordifolia* (bittercress) (1-10%), *Mertensia ciliata* (mountain bluebells) (1-20%), *Osmorhiza depauperata* (blunt-fruit sweet-cicely) (1-5%), and *Senecio triangularis* (arrowleaf groundsel) (1-5%). Graminoid cover includes: Calamagrostis canadensis (2-20%), *Equisetum arvense* (field arvense) (1-20%), and *Carex disperma* (soft-leaved sedge) (20

Successional and Ecological Processes: *Populus tremuloides* (quaking aspen) woodlands can be self perpetuating climax plant associations or an early-seral stage of coniferous types (DeByle and Winokur 1985). *Populus tremuloides* (quaking aspen) is a non-obligate riparian species and often occurs in upland communities. Where valley bottoms are moist and stable, *Populus tremuloides* can dominate the riparian area, while also occurring on adjacent mesic hillslopes.

Alnus incana ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After establishment, young stands of *Alnus incana* are continually flooded. As stands mature, the stems can slow flood waters and trap sediment. Fine-textured sediments accumulate on top of the coarser alluvial material and the land surface eventually rises above annual flood levels. Flooding is then less frequent and soils begin to develop (Padgett *et al.* 1989).

Alnus incana is shade-intolerant (Viereck 1970, Chapin *et al*. 1994), and many mature stands in Colorado are restricted to stream bank edges, possibly because these are the only sites where light can penetrate the neighboring overstory canopy. *Alnus incana* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well

Management: Dense stands of *Alnus incana* (thinleaf alder) hinder livestock access into this plant association. *Alnus incana* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species. Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995). With heavy livestock grazing, the shrub layer can become dominated by *Symphoricarpos* spp. (snowberry) (DeByle and Winokur 1985). This is likely to occur in valley bottoms where overgrazing has dried the soil and dropped the water table.

Fire as a management tool may be useful in regenerating old stands of *Populus tremuloides* (Hansen *et al*. 1995). Light fires will stimulate *Populus tremuloides* suckering, but may also kill the canopy trees. Most fires kill *Alnus incana* resulting a sparse herbaceous understory and bank destabilization. It may be necessary to protect these sites from beaver and grazing animals in order to ensure successful regeneration following a fire (Hansen *et al.* 1988, Hansen *et al*. 1995).

Alnus incana sprouts quickly when cut at 4-5 year intervals and can be used for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts (Hansen *et al*. 1995).

Populus tremuloides/Pteridium aquilinum
Quaking aspen/bracken fern

Global Rank: G4
Global Rank Comments:
State Rank: S3S4
State Rank Comments:

General Description and Comments:

Regional Distribution: The Aspen wetland forest is fairly common in the Rocky Mountain region of Colorado and Utah (Bourgeron and Engelking 1994; Johnston 1987).

Distribution in Colorado:

Elevation Range in Colorado: 6890-10170 feet.

Site Geomorphology:

Soils: This Aspen forest prefers northeast, east and south aspects, on poorly drained loam to sandy loam medium-coarse residual shallow soils (Johnston 1987).

Vegetation:

Successional and Ecological Processes:

Management: Graham (1937) notes that if the Bracken fern (*Pteridium aquilinum*) is eaten in large quantities, it is considered slightly poisonous to cattle, horses, and probably sheep.

Pseudotsuga menziesii/Acer glabrum
Douglas-fir / Rocky Mountain Maple Forest

Global Rank: G4
Global Rank Comments: ID, OR, UT, WY
State Rank: S3
State Rank Comments:

General Description and Comments:

Classification Problems:

Regional Distribution:

Distribution in Colorado:

Elevation Range in Colorado:

Site Geomorphology:

Soil:

Vegetation:

Successional and Ecological Processes:

Management:

Pseudotsuga menziesii/Cornus sericea
Douglas fir/red-osier dogwood

Global Rank: G4
Global Rank Comments: This type is well documented and fairly common in Montana.
State Rank: S2
State Rank Comments: In Colorado, this is an uncommon association that naturally occurs in small patches. Less than ten stands are documented. It is threatened by heavy recreational use and improper livestock grazing.

General description and Comments: The *Pseudotsuga menziesii/Cornus sericea* (Douglas-fir/red-osier dogwood) plant association is a limited riparian type in Colorado. It forms small pockets in very narrow, rocky streams and canyons where *Pseudotsuga menziesii* also grows on the adjacent hillslopes.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the San Juan and Rio Grande National Forests (Richard *et al.* 1996, Kittel *et al.* 1999), the San Miguel/Dolores Kittel and Lederer 1993), Gunnison (Kittel *et al*. 1995), and White River Basins (Kittel *et al*. 1994).
Elevation Range in Colorado: 5600-8500 ft (1700-2400 m).

Site Geomorphology: This plant association occurs in narrow valleys with variable stream gradients (5-25%) on narrow floodplains and elevated benches. Stands occur well above, the stream channel bankfull height, 1-10 feet (0.16-3 m). Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3).

Soil: The soils are generally well-drained, well-developed colluvial clay loams to sandy loams. Coarse fragments range from 0 to 25%. The water table is at least one meter below the surface.

Vegetation: *Pseudotsuga menziesii* (Douglas-fir) dominates the overstory with 30-60% cover. Other tree species that may be present include: *Populus angustifolia* (narrowleaf cottonwood) (1-10%), *Populus tremuloides* (quaking aspen) (3-17%), *Abies concolor* (white fir) (20%), *Acer negundo* (boxelder) (10%), and *Picea pungens* (blue spruce) (4-18%). *Cornus sericea* (red-osier dogwood) forms a dense shrub layer with 20-70% cover. Other shrub species that may be present include: *Acer glabrum* (mountain maple) (40-70%), *Quercus gambelii* (Gambel oak) (1-6%), *Alnus incana* (thinleaf alder) (10-32%) *Ribes* (currant) (3-13%) , *Prunus virginiana* (chokecherry) (1-16%). The ground is covered with a thick layer of duff and few herbaceous plants.

Successional and Ecological Processes: *Pseudotsuga menziesii* (Douglas-fir) is a non-obligate riparian species. This plant association is limited to narrow canyon bottoms where upland *Pseudotsuga menziesii* forests on north-facing slopes grade into riparian corridors. Narrow canyons with steep slopes create pockets of moist, cool air by funneling cold-air drainage and providing a microsite for *Pseudotsuga menziesii*. *Cornus sericea* (red-osier dogwood) is more abundant on level sites where water tables are periodically high (Johnston 1987). At lower elevations, Douglas-fir can occur in cool valley bottoms where it cannot survive on the valley slopes. Well drained colluvial soils also favor *Pseudotsuga menziesii* establishment.

Management: This plant association requires minimal management because the steep and rocky terrain provides intrinsic protection. However, *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream" plant (e.g. it is readily eaten and is a preferred browse species) for livestock and wildlife. Browsing of this species can be high if the stands are open enough for animals to walk through (Hansen *et al*. 1995).

Pseudotsuga menziesii (Douglas-fir) regeneration is favored by fire which creates suitable seedbeds and eliminates competition. Mature trees are relatively fire resistant, but seedlings and saplings are vulnerable to surface fires. *Cornus sericea* (red-osier dogwood) can survive all but the most severe fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al.* 1995).

Cornus sericea is a very effective stream bank stabilizer and should be considered for revegetating degraded sites. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on streambanks (Hansen *et al*. 1995).

Salix boothii/Carex utriculata
Booths willow/beaked sedge

Global Rank: G5
Global Rank Comments: This association is a common and abundant type in the northern states.
State Rank: S3
State Rank Comments: This association is known from less than 20 stands, and appears to be restricted to the northern half of the state.

General Description and Comments: The *Salix boothii/Carex utriculata* (Booth willow/beaked sedge) plant association is a tall, 4-12 ft. (1-4 m) closed canopy shrubland. It commonly occurs in the wettest micro-habitats of the floodplain including low floodplains adjacent to beaver ponds and low areas between beaver dams. The ground is very wet and the water table is at or near the soil surface all season long.

Regional Distribution: This plant association occurs in Wyoming, Idaho (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association is generally restricted to northern Colorado. It occurs in the Routt National Forest (Kettler and McMullen 1996), and in the Yampa and White River Basins (Kittel *et al.* 1993, Kittel *et al.* 1994).

Elevation Range in Colorado: 7400-8900 ft (2000-2700 m).

Site Geomorphology: This plant association is generally found along wide riparian corridors in areas adjacent to beaver ponds with saturated soils. In the Yampa River Basin, this association occurs on a gently sloping floodplain in soils saturated from irrigation runoff and hillside seepage. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and meandering (Rosgen's Channel Type: C4), and narrow and steep (Rosgen's Channel Type: A4, B3).

Soil: The upper soil layers generally contain a deep organic layer with some minerals, fine sands, loams, and clays. Some mottling is evident. The lower layers are gravel or cobble.

Vegetation: *Salix boothii* (Booth's willow) dominates the canopy of this association with 10-91% cover. Other shrub species that may be present include: *Salix geyeriana* (Geyer willow) (3-40%), *Salix wolfii* (wolf willow) (3-16%), *Salix monticola* (yellow willow) (10%), and *Salix planifolia* (planeleaf willow) (3-30%). *Salix serissima* (autumn willow), a rare disjunct species in Colorado, occurred at one site in the Yampa River Basin.

The saturated soils support a dense graminoid layer dominated by 1-50% cover of *Carex utriculata* (beaked sedge). Other graminoid species that may be present include: *Carex aquatilis* (aquatic sedge) (2-10%), *Carex lanuginosa* (woolly sedge) (1-30%), *Calamagrostis canadensis* (bluejoint reedgrass) (1-13%), *Glyceria grandis* (American mannagrass) (10%), and *Juncus balticus* (wiregrass) (3-10%). Forb cover is minor.

Succession and Ecological Processes: This plant association commonly becomes established following beaver pond siltation. When an area is flooded by beaver activity, *Carex utriculata* (beaked sedge) becomes established and grows successfully even as the site begins to dry. With further drying of the site, *Salix boothii* (Booth's willow) will become established. *Salix boothii* appears to establish on relatively mesic sites with soils that become neither completely saturated nor dry during the growing season. With continued drying, the undergrowth will be replaced with less hydrophytic species. With disturbance, such as excessive grazing, this plant association may be replaced with a *Salix boothii/Poa pratensis* (Booth's willow/Kentucky bluegrass) plant association (Padgett *et al.* 1989).

Management: *Salix boothii* (Booth's willow) is highly palatable to livestock, ungulates and beaver (Kovalchik *et al*. 1988). Wild ungulates (moose, deer) use may be especially heavy in the winter when willow shoots are available above the snow level (Hansen *et al.* 1988). Livestock and wild ungulates may prefer to browse *Salix geyeriana* (Geyer willow), when available, over *Salix boothii*, according to observations in Montana (Hansen *et al.* 1989). The soils of *Salix boothii*/*Carex utriculata* sites are susceptible to trampling and compaction by livestock and heavy machinery because the soils are often wet (Padgett *et al*. 1989).

As with most willow species, *Salix boothii* is an effective stream bank stabilizer and can be successfully planted to rejuvenate degraded riparian areas. Prescribed burning can also be a useful tool for rejuvenating dying and non-regenerating stands of *Salix boothii* since the species rapidly sprouts after fires. Hot, quick fires are most effective because more plants sprout and fewer are killed (Hansen *et al.* 1988).

Salix boothii/mesic forb
Booth willow/mesic forb

Global Rank: G3G4
Global Rank Comments: This association is known from Utah, Idaho, Wyoming and Colorado.
State Rank: S3
State Rank Comments: This association is common in the northern half of Colorado. Over 50 stands are expected to occur in the state. It is threatened by livestock grazing, stream flow alterations, and heavy recreational use.

General Description and Comments: The *Salix boothii*/mesic forb (Booth willow/mesic forb) plant association is a tall (4-5 ft., 1-2 m) shrubland that often forms extensive thickets, or willow carrs, on broad montane floodplains.

Regional Distribution: The *Salix boothii*/mesic forb plant association occurs in Idaho, Wyoming (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Routt National Forest (Kettler and McMullen 1996), the Yampa River valley (Kittel and Lederer 1993), and in the White and Gunnison River Basins (Kittel *et al.* 1994, 1995).

Elevation Range in Colorado: 7400-10300 ft (2000-3000 m).

Site Geomorphology: This plant association occurs on wetter sites within the floodplain environment. It is usually found within 2.5 feet (0.75 m) of the water table, but is occasionally located above the channel on low terraces of straighter sections of river. The ground surface is often uneven and hummocky due to past flooding and beaver activity. A narrow to broad, low gradient floodplain is common along all of the river reaches. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Types:A3), broad and sinuous (Rosgen's Channel Types: B3, C4), narrow and meandering (Rosgen's Channel Types: E4, E6), or recently eroding (Rosgen's Channel Types: F3, F4).

Soil: Soils are highly stratified with alternating layers of sandy loams and clay loams and mottled within the top 4 inches (10 cm). Others are finely textured, dark-colored, highly organic soils with silty clay loam mottling. Lower profiles contain a gravel or cobble layer which may indicate that the soil section is a silted-in beaver pond.

Vegetation: *Salix boothii* forms large stands with a canopy ranging from 20-80% cover. Other shrub species can be as abundant but do not exceed that of *Salix bebbiana* nor are they consistently present. Other shrub species include: *Salix drummondiana* (Drummond willow) (1-80% cover), *Salix geyeriana* (Geyer willow) (1-34% cover), *Salix monticola* (mountain willow) (1-30% cover), *Pentaphylloides floribunda* (shrubby cinquefoil) (3-10% cover), *Betula glandulosa* (bog birch) (10-20%), and *Alnus incana* (thinleaf alder) (1-60%) .

The undergrowth is characterized by a sparse to lush forb layer growing on raised hummocks. No one forb species is dominant, but rather includes several species with a combined cover of 40-60%. Forb species include: *Swertia perennis* (star gentian), *Pedicularis groenlandica* (elephant head), *Polygonum bistortoides* (American bistort), *Heracleum lanatum* (cow parsnip), and *Achellia millefolium* (yarrow). Graminoid cover is typically low (<20%) but can be as high as 80%. Graminoid species include: *Carex aquatilis* (aquatic sedge), *Carex utriculata* (beaked sedge), and *Calamagrostis canadensis* (bluejoint reedgrass).

Succession and Ecological Processes: The *Salix boothii* (Booth willow)/mesic forb plant association appears to be a stable and long-lived community on sites that are neither completely saturated nor dry throughout the growing season (Padgett *et al.* 1989). The undergrowth of *Salix boothii* dominated associations varies according to the substrate and water regime. Wetter stands have an understory of *Carex utriculata* (beaked sedge), while drier stands may have *Calamagrostis canadensis* (bluejoint reedgrass) and various forb species (Hansen *et al.* 1988). It is unclear whether grazing increases the dominance of either mesic forbs or graminoids or if there are subtle environmental differences between sites that contribute to this. With excessive grazing, this community may be replaced by a *Salix boothii/Poa pratensis* (Booth willow/ Kentucky bluegrass) type with native forbs once dominant in the *Salix boothii*/mesic forb plant association growing under the protection of shrub bases (Padgett *et al.* 1989).

Management: *Salix boothii* (Booth willow) is highly palatable to livestock, ungulates and beaver, although dense stands may preclude livestock use (Kovalchik *et al*. 1988). Use by ungulates may be especially heavy in the winter when shoots stick up above the snow level (Hansen *et al.* 1988). Livestock and ungulates may actually prefer to browse *Salix geyeriana* (Geyer willow), when available, over *Salix boothii*, according to observations in Montana (Hansen *et al.* 1989).

As with most willow species, *Salix boothii* is an effective stream bank stabilizer and can be successfully planted to rejuvenate degraded riparian areas. Prescribed burning can also be a useful tool for rejuvenating dying and non-regenerating stands of *Salix boothii* since the species rapidly sprouts after fires. Hot, quick fires are most effective because more plants sprout and fewer are killed (Hansen *et al.* 1988).

***Salix boothii/*mesic graminoid**
Douglas-fir / Rocky Mountain Maple Forest

Global Rank: G3
Global Rank Comments: This riparian community is currently known from major runoff dominated rivers in Colorado, Idaho, Utah, and may also occur in Wyoming and Montana
State Rank: S3
State Rank Comments:

General Description and Comments: Stands occur on moist stream terraces with slopes of 1-8%

Classification Problems: This association is distinguished from the *Salix boothii* / Mesic Forbs Shrubland (CEGL001180) by having a higher cover of graminoid species. Stands with predominantly non-native graminoid species in the undergrowth are considered grazing induced.

Regional Distribution: This association is known over a broad range including Colorado, Utah, Idaho, and possibly Wyoming and Montana. There are at least 21 known occurrences with at least 75 to 100 more expected. Invasion by non-native herbaceous species is cited as the greatest threat to this community. In mid-montane locations with low gradients, impacts from development in the riparian zone may alter this community.

Distribution in Colorado:

Elevation Range in Colorado: 2040-2260 m (6700-7400 feet) in Montana and as high as 2990 m (9800 feet) in Utah. Higher elevation occurrences may occur at lower latitudes.

Site Geomorphology:

Soil:

Vegetation: Community structure consists of a shrub layer dominated by *Salix boothii, Salix drummondiana*, and/or *Salix monticola*. While *Salix geyeriana* may codominate in some stands, *Salix lucida ssp. lasiandra (= Salix lasiandra), Salix exigua*, or *Salix brachycarpa* may be present, but are never abundant. Total graminoid cover ranges from 10-55% and exceeds that of total forb cover. No single species is particularly dominant over the others, and no one species is present in every stand. The sparse to dense understory of graminoids commonly includes *Carex lanuginosa, Carex microptera, Juncus balticus, Glyceria striata, Agrostis stolonifera*, and *Deschampsia cespitosa*. Minor understory components may include *Poa pratensis, Poa palustris, Calamagrostis canadensis*, and *Carex rostrata*.

Successional and Ecological Processes:

Management:

Salix brachycarpa/mesic forb
Shortfruit willow/mesic forb

Global Rank: G4

Global Rank Comments: This association has not been documented outside Colorado, however it is expected to occur in other Rocky Mountain states.
State Rank: S4
State Rank Comments: This association is common in the subalpine and alpine areas throughout Colorado.

General Description and Comments: Typically, the *Salix brachycarpa*/mesic forb (shortfruit willow/mesic forb) plant association occurs on well-drained slopes in subalpine valleys. This association is often considered part of a *Salix planifolia-Salix brachycarpa* (planeleaf willow-shortfruit willow) mixed type. However, *Salix brachycarpa* occurs on slightly drier sites and is often adjacent to wetter, pure stands of *Salix planifolia*. The two species intermix at the ecotone between the wetter and drier sites.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 1997, Baker 1989, Johnston 1987).

Distribution in Colorado: This plant association occurs in subalpine areas of the San Juan Mountains, the San Miguel/Dolores, Gunnison, Colorado and White River Basins, the Routt National Forest, and Rio Grande/Closed Basin (Baker 1989, Hess and Wasser 1982, Komarkova 1986, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Kettler and McMullen 1996, Richard *et al*. 1996, Kittel *et al*. 1999).

Elevation Range in Colorado: 8600-11,200 ft. (2600-3400 m).

Site Geomorphology: The *Salix brachycarpa*/mesic forb (shortfruit willow/mesic forb) plant association occurs along the drier fringes of broad, glaciated basins and along broad, straight streams in the subalpine zone. This association occupies elevated hummocks and drier side slopes, often surrounding wetter, low areas vegetated with *Salix planifolia* (planeleaf willow) associations. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and shallow (Rosgen's Channel Type: B1-B3) or narrow, deep and sinuous (Rosgen's Channel Type: E4). **Soil:** Soil textures range from silty clay loams to fine sandy loams with some mottling. There is often an upper or buried fibric or hemic layer. Soils in the Colorado River Basin classify as typic Cryaquolls and Cryorthents.

Vegetation: *Salix brachycarpa* (shortfruit willow) occurs in almost pure stands with 10-98% cover on hummocks and well-drained slopes adjacent to the valley floor. *Salix planifolia* (planeleaf willow) dominated associations occur within the same riparian/wetland mosaic in lower, poorly-drained areas and intermix with the *Salix brachycarpa* association at their ecotone. *Salix planifolia* may occur within the *Salix brachycarpa* association with 2-30% cover. Other shrubs that may be present include: *Salix wolfii* (Wolf willow) (3-70% cover) and *Betula glandulosa* (bog birch) (3-8%) in high, subalpine stands and *Salix monticola* (mountain willow) (3-50% cover), *Salix drummondiana* (Drummond willow) (3-23%), and *Salix boothii* (Booth willow) (27-41%) in lower, transitional montane stands.

The herbaceous undergrowth is dominated by forb cover, which exceeds total graminoid cover, although no one forb species is dominant nor present in every stand. Forb species include: *Senecio triangularis* (arrowleaf groundsel) (1-20%), *Mertensia ciliata* (mountain bluebells) (1-16%), *Cardamine cordifolia* (bittercress) (1-14%), *Caltha leptosepala* (marsh marigold) (2-30%), *Thalictrum* spp. (meadowrue) (2-3%), *Pseudocymopterus montanus* (mountain parsley) (1-30%), *Fragaria virginiana* (mountain strawberry) (1-20%), *Oxypolis fendleri* (cowbane) (1-13%), and *Ligusticum* spp. (ligusticum) (1-20%). Graminoid species that may be present include:

Deschampsia cespitosa (tufted hairgrass) (1-26%), *Carex aquatilis* (aquatic sedge) (10-22%), and *Calamagrostis canadensis* (bluejoint reedgrass) (1-13%). Lichen and moss-covered boulders are often present.

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

This plant association appears to be stable, but little is known about its successional trends. It is sometimes heavily grazed by sheep, which may alter the species composition.

Management: Management information for this plant association is not available.

Salix drummondiana/Care utriculata
Drummond willow/beaked sedge

Global Rank: G4
Global Rank Comments: This association is found abundantly in the Northern Rocky Mountains of Montana and Idaho, and in eastern Washington. It may also occur in northern Utah and western Wyoming, but has not been confirmed from these states. This association (or the environments it represents) is very common, perhaps one of the most common, *Salix spp.*-dominated riparian/wetland types of the Northwest and Intermountain West. Even were it to be most narrowly defined, say by the dominance of *Salix drummondiana* and *Carex utriculata* alone (other species a minor component) or by these species having very high cover values, say in excess of 50%, then this type would still be abundant.
State Rank: S3
State Rank Comments:

General Description and Comments:

Classification Problems: This type is substantiated by 43 plots in Montana and 20 plots in Washington.

Regional Distribution:

Distribution in Colorado:

Elevation Range in Colorado:

Site Geomorphology:

Soil:

Vegetation: In addition, surrounding states have a number of well-documented, highly similar tall *Salix* spp.-dominated associations in which *Salix drummondiana* can be both a dominant/codominant and highly constant, including *Salix drummondiana - Salix boothii / Carex rostrata - Carex aquatilis* Shrubland (no ELCODE), *Salix boothii / Carex utriculata* Shrubland (CEGL001178), *Salix geyeriana / Carex utriculata* Shrubland (CEGL001207), and *Salix lutea / Carex utriculata* Shrubland (CEGL001220). *Salix drummondiana* can also be a major component in short willow communities, e.g., *Salix candida / Carex rostrata* Shrubland (CEGL001188) and *Salix wolfii / Carex utriculata* Shrubland (CEGL001237). Other *Salix* spp.-dominated associations have appreciable coverages of *Carex utriculata*, raising the issue of what coverages of *Carex utriculata* will be accorded indicator status. Another significant hurdle in establishing confidence in this type is what, if any, *Carex* spp. will be accepted as ecological equivalents (as used by Hansen et al. 1995). In addition *Salix drummondiana* is easily confused with *Salix sitchensis* making community identification difficult. There is a monumental amount of crosswalk work to accomplish before this type can be unequivocally classified across its considerable geographic range. Similar, if not identical, types under different names have been described throughout the Northwest and Intermountain West. However, a type of this exact name (accepting *Carex utriculata* as synonymous with *Carex rostrata*) was first described for Montana; its identifying series or alliance level features are *Salix* spp. having at least 10% canopy cover and *Salix drummondiana* having greater canopy cover than the combined cover of *Salix geyeriana* and *Salix boothii* and less cover than *Salix lutea*.

Successional and Ecological Processes:

Management: The most significant threat to this community is livestock overuse, which can lead to the reduced vigor, highlining, clubbing, or death of willows. The principal graminoids, *Carex utriculata* and *Carex aquatilis*, are not particularly palatable, but on narrow riparian or small wetland sites within extensive rangeland, these and other sedge species are heavily utilized, particularly where stocking rates are high. Vegetation trampling, hummocking and a shift to weedy species (or their introduction) occurs as a result and can result in an irremediable type conversion.

Salix drummondiana (Drummond willow) is highly palatable to livestock and wildlife (Kovalchik 1987). Season-long grazing can reduce native forb cover and increase the abundance of non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop). Continued heavy grazing and browsing may weaken the root systems of *Salix drummondiana* (Drummond willow) (Padgett *et al.* 1989).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Prescribed burning in this association is an effective method of rejuvenating decadent stands of the associated willow species. The willows will vigorously sprout following fire, especially in wetter stands. Quick, hot fires produce more sprouts than slower fires (Hansen *et al*. 1995).

Salix drummondiana is useful for revegetating stream banks. The best results come from transplanting nursery grown cuttings. Cuttings should be taken in the spring from dormant 2-4 year-old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen *et al*. 1995).

Salix drummondiana/mesic forb
Drummond willow/mesic forb

Global Rank: G4
Global Rank Comments: This is a common and abundant association, although it commonly forms fairly small and often narrow riparian habitats.
State Rank: S4
State Rank Comments: In Colorado, over 40 stands have been documented and an additional 10-20 are expected to occur. However, it is currently threatened by improper livestock grazing, stream flow alterations and heavy recreational use.

General Description and Comments: The *Salix drummondiana*/mesic forb (Drummond willow/mesic forb) plant association most commonly occurs on relatively steep streams and rarely forms more than a narrow, 5-25 feet (1.5-7.5 m) wide, band along stream banks. The closed to partially open canopy of *Salix drummondiana* and a thick carpet of many forb species characterize this plant association.

Classification Problems: Without catkins (the flowering stalk), *Salix drummondiana* (Drummond willow) can be difficult to distinguish from the similar looking *Salix geyeriana* (Geyer willow). Both species are tall, greater than 5 feet (2 meters), montane willows with strongly pruinose (a waxy covering that rubs off, similar to the coating on a plum) current-year twigs. Luckily, the two species can be distinguished using only vegetative characters. *Salix geyeriana* (Geyer willow) leaves never more than 0.5 inches (13 mm) wide and *Salix drummondiana* (Drummond willow) leaves are, on average, over 0.5 inches (13 mm) wide (on non-sucker shoots) (Welsh *et al*. 1987).

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997). It is expected to occur in Wyoming (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989) and Nevada (Manning and Padgett 1995).

Distribution in Colorado: This plant association occurs throughout the West Slope and in montane regions along the Front Range (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Richard *et al.* 1996, Rondeau *et al.* 1997, Cooper and Cottrell 1990, Phillips 1977).

Elevation Range in Colorado: 7500-11,300 ft (2400-3500 m).

Site Geomorphology: This plant association occurs in a variety of habitats. All streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). It occurs in narrow, V-shaped valleys as a dense, narrow band along high gradient (1-41%) streams (Rosgen's Channel Type: A1-A3) and as large willow carrs in broad valleys, 150-1000 feet wide (50-300 m), along low gradient (1-3%), moderately sinuous streams (Rosgen's Channel Type: B1-B4). It is also located along broad, highly sinuous streams (Rosgen's Channel Type: C3-C5) and broad, actively downcutting channels (Rosgen's Channel Type: F6). This association also occur near seeps.

Soil: Soils range from deep sandy loams and sandy clay loams with no coarse fragments to shallow silty clay loams and sandy clay loams over coarse, angular cobbles. Soils in the Colorado River Basin classify as typic and oxyaquic Cryorthents, pachic and typic Cryofluvents, histic and typic Cryaquents, and pachic and typic Cryoborolls.

Vegetation: The *Salix drummondiana/*Mesic Forbs (Drummond willow/Mesic Forbs) association covers a wide elevational range and consequently has a wide diversity of species. *Salix drummondiana* (Drummond willow) forms an open to closed, narrow canopy of tall shrubs lining the stream bank with 20-98% cover. Several other shrub species may be present some with equal cover but none that exceed that of Salix drummondiana. Other shrub species that may be present at upper elevations include: *Salix brachycarpa* (barrenground) (1-3%) and *Salix planifolia* (planeleaf willow) (2-37%). At lower elevations, other shrub that may be present include: *Lonicera involucrata* (honeysuckle) (1-30%), *Alnus incana* (thinleaf alder) (1-21%) (if the alder is equal to Drummond willow see the *Alnus incana-Salix drummondiana* plant association), *Salix monticola* (Rocky Mountain willow) (1-40%), *Salix bebbiana* (Bebb willow) (1-21%), and *Salix eriocephala* var. *ligulifolia* (strap leaf willow) (10-13%).

Mature trees may be present, not forming a true overhead canopy, but a few individuals scattered about the shrubland or their canopy leaning over from an adjacent forested association. Tree species that may be present include: *Picea engelmannii* (Engelmann spruce) (1-30%), *Abies lasiocarpa* (subalpine fir) (1-10%), *Populus angustifolia* (narrowleaf cottonwood) (1-20%), and *Populus tremuloides* (quaking aspen) (1-75%) (stands with a real canopy of aspen are included in this association, and likely that a *Populus tremuloides/Salix drummondiana* type may be split out at later date).

The herbaceous undergrowth in some stands is sparse due to heavy shade and shallow soils. Other stands have a rich diversity of forbs and graminoids in the undergrowth. In general, total forb cover exceeds that of graminoid cover, and no single species is dominant. Forb species include: *Mertensia ciliata* (mountain bluebell) (1-44%), *Heracleum lanatum* (cow parsnip) (1-40%), *Cardamine cordifolia* (bittercress) (1-30%), *Oxypolis fendleri* (cowbane) (11-23%), *Hydrophyllum fendleri* (waterleaf) (1-17%), *Saxifraga odontoloma* (brook saxifrage) (1-34%), and *Delphinium barbeyi* (delphinium) (1-30%). Graminoid species include: *Carex utriculata* (beaked sedge) (1-29%), *Equisetum arvense* (field horsetail) (1-19%), *Calamagrostis canadensis* (bluejoint reedgrass) (1-20%).

Successional and Ecological Processes: The *Salix drummondiana*/mesic forb (Drummond willow/mesic forb) plant association is often an early colonizer of first-order, boulder-strewn, steep streams. This association could be an early-seral stage of the *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) plant associations which also occurs along steep streams and alternates with the willow carrs. In wider valleys, the *Salix drummondiana*/mesic forb (Drummond willow) plant association occurs as a broad willow carr on well-developed soils near seeps or downstream from beaver dams. It appears to be a stable community in these environments.

Management: *Salix drummondiana* (Drummond willow) is highly palatable to livestock and wildlife (Kovalchik 1987). Season-long grazing can reduce native forb cover and increase the abundance of non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis* *stolonifera* (redtop). Continued heavy grazing and browsing may weaken the root systems of *Salix drummondiana* (Drummond willow) (Padgett *et al.* 1989).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Prescribed burning in this association is an effective method of rejuvenating decadent stands of the associated willow species. The willows will vigorously sprout following fire, especially in wetter stands. Quick, hot fires produce more sprouts than slower fires (Hansen *et al*. 1995).

Salix drummondiana is useful for revegetating stream banks. The best results come from transplanting nursery grown cuttings. Cuttings should be taken in the spring from dormant 2-4 year-old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen *et al*. 1995).

Salix monticola/Carex utriculata
Mountain willow/beaked sedge

Global Rank: G3
Global Rank Comments: This association is know only from Colorado.
State Rank: S3
State Rank Comments: In Colorado, this association is known from thirteen location, and an addition ten to twenty are expected to occur. This association is threatened by improper livestock grazing, inappropriate stream flow alterations, and heavy recreational use.

General Description and Comments: The *Salix monticola/Carex utriculata* (yellow willow/beaked sedge) plant association is a tall, (5-8 ft., 1.5-2.5 m), deciduous shrubland with an open canopy of willows and a thick understory of grasses and sedges. It occurs on open floodplains and often forms a continuous willow canopy across the valley floor. The undergrowth is dominated by patches of *Carex utriculata* (beaked sedge). *Carex aquatilis* (water sedge) and *Calamagrostis canadensis* (bluejoint reedgrass) are often also present, but *Carex utriculata* is either the clear dominant or is most consistently present throughout the stand. This distinguishes this association from the *Salix monticola/Carex aquatilis* (yellow willow/aquatic sedge) and *Salix monticola/Calamagrostis canadensis*

Classification Problems: *Salix monticola* appears to be the center of its distribution in Colorado, where it frequently forms large thickets with few other willow species present. Literature from Utah, Wyoming, Montana, Idaho, Nevada and Oregon indicate that *Salix monticola* looses importance north and west of Colorado, where *Salix monticola* mixes with other *Salix* species.

For example, in central and eastern Utah, *Salix monticola* dominated stands are infrequent and due to structural and ecological similarities are included in *Salix boothii* (Booth willow) associations (Padgett *et al.* 1989), and in Idaho, *Salix monticola* also has a limited distribution and largely associates with other *Salix* (willow) species (Brunsfeld and Johnson 1985).

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Colorado (Kittel *et al.* 1994), the Gunnison (Kittel *et al.* 1995) and South Platte River Basins (Cooper and Cottrel 1990), and the San Juan National Forest (Richard *et al*. 1996).

Elevation Range in Colorado: 8300-10,240 ft. (2500-3100 m).

Site Geomorphology: This plant association commonly occurs near beaver ponds. Willows establish on hummocks of higher ground and *Carex utriculata* establishes at the pond margins. This association also occurs along wet stream banks and terraces of low gradient (<3%), broad valley bottoms. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream reaches can be moderately wide with a gentle gradient (Rosgen's Channel Type: B3), wide and meandering (Rosgen's Channel Type: C3), or altered by beaver activity, creating multiple channels (Rosgen's Channel Type: D6),. One stand occurs on a severely eroding gulch (Rosgen's Channel Type: G6).

Soils: Soils are clay loam, sandy clay loam and heavy silty clay textures and occasional mottling. Some profiles have a buried organic layer. Others have up to 40% organic matter in the top 20 inches (50 cm). In the Colorado River Basin, soils classify as oxyaquic Ustorthents, typic Cryaquents, oxyaquic Cryofluvents, cumulic and histic Cryaquolls, and pachic Cryoborolls.

Vegetation: This association is characterized by a thick, closed willow canopy dominated by 10-80% cover of *Salix monticola* (yellow willow). In this association, *Salix monticola* is the "matrix" shrub, the species with the highest abundance, even though other willow species may have a higher combined canopy cover. Other shrub species that may be present include: Salix geyeriana (Geyer willow) (4-40%), *Salix brachycarpa* (barrenground willow) (2-28%), *Salix drummondiana* (Drummond willow) (1-20%) and *Salix eriocephala* var. *ligulifolia* (strap leaf willow) (1-11%), and *Salix boothii* (Booth willow) (1%).

Carex utriculata (beaked sedge) is the most abundant graminoid with 1-44% cover. Other graminoid cover is minor, and includes Carex aquatilis (aquatic sedge) (1-11%), Poa pratensis (Kentucky bluegrass) (1-24%), and Deschampsia cespitosa (tufted hairgrass) (1-4%). Total forb cover is generally <10% cover. Forb species include: *Cardamine cordifolia* (bittercress) (1-10%), *Mertensia ciliata* (chiming bells) (1-3%), and *Heracleum maximum* (cow parsnip) (1-3%).

Successional and Ecological Processes: This plant association requires a high water table and saturated soils for much of the growing season and may be an early successional stage of the *Salix monticola/Carex aquatilis* and the *Salix monticola/ Calamagrostis canadensis* associations (Cooper and Cottrellf 1996).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) are common dominant undergrowth of several *Salix* plant associations. These three graminoids indicate different micro-environments, generally separating out along a moisture gradient related to the depth of the water table, and can represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (Cooper 1986).

Changes in the physical environment, brought on by flooding or other disturbance, can initiate successional shifts in species composition. Sediment deposition on the floodplain raises the surface higher above the water table (Cooper 1986). As aggradation, or build up, of the floodplain proceeds, the site becomes drier and the dominant graminoid understory changes. Thus *Carex aquatilis* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

Management: *Salix monticola* (yellow willow) appears to be less tolerant of browsing pressure than other tall montane willow species. It responds to heavy browsing pressure in the same way that *Salix geyeriana* (Geyer willow) does, it forms the classic "mushroom" shape with over browsing by deer and cattle (Hansen *et al.* 1995). *Carex* (sedge) species can be heavily grazed by livestock in narrow riparian areas in mid-elevation rangelands. Improper grazing by livestock in this plant association can dry sites, increase non-native cover, and reduce the vigor of willow root structure. The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. In order to maintain productivity and vigor of the plants and prevent damage to the soils, livestock grazing should be deferred until soils dry (Hansen *et al*. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995, Kovalchik and Elmore 1992) .

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water table across the floodplain and provided year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

According to Hansen *et al*. (1995), burning of this plant association temporarily increases the productivity of *Carex aquatilis* (aquatic sedge). However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after in order to prevent livestock from consuming young, palatable regrowth. Prescribed burning is also an effective method of rejuvenating decadent stands of willows. The willow species in this plant association vigorously sprout following quick, hot fires. Slow burning fires can actually damage the plants. (Hansen *et al*. 1995).

Salix monticola (yellow willow), *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) are effective stream bank stabilizers. *Carex utriculata* and *Carex aquatilis* hold stream banks with their dense network of rhizomatous roots. *Salix monticola* can probably be grown and transplanted from nursery cuttings in the same manner as *Salix geyeriana.* Cuttings should be taken in the spring from dormant, 2-4 year old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen *et al*. 1995).

Salix monticola/mesic forb
Mountain willow/mesic forbs

Global Rank: G3
Global Rank Comments: This association is known only from Colorado.
State Rank: S3
State Rank Comments: In Colorado, over thirty stands have been documented. Many stands of this association may represent grazing induced shifts from other *Salix monticola* dominated plant associations. Stands with a complete native herbaceous understory intact are threatened by improper livestock grazing, inappropriate stream flow alterations, and heavy recreational use.

General Description and Comments: The *Salix monticola/*mesic forb (yellow willow/mesic forb) plant association is a tall (5-8 ft., 1.5-2.5 m), deciduous shrubland with a fairly open canopy and an herbaceous layer dominated by a variety of forbs and grasses. While no single herbaceous species is a clear dominant, total forb cover is generally greater than 30% and exceeds total graminoid cover.

Classification Problems: *Salix monticola* appears to be the center of its distribution in Colorado, where it frequently forms large thickets with few other willow species present. Literature from Utah, Wyoming, Montana, Idaho, Nevada and Oregon indicate that *Salix monticola* looses importance north and west of Colorado, where *Salix monticola* mixes with other *Salix* species. For example, in central and eastern Utah, *Salix monticola* dominated stands are infrequent and due to structural and ecological similarities are included in *Salix boothii* (Booth willow) associations (Padgett *et al.* 1989), and in Idaho, *Salix monticola* also has a limited distribution and largely associates with other *Salix* (willow) species (Brunsfeld and Johnson 1985).

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is a major type in the upper montane areas of the San Miguel/Dolores (Kittel and Lederer 1993), Colorado, White (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995), South Platte (Copper and Cottrell 1990, Kittel *et al*. 1997), North Platte and Rio Grande/Closed Basin (Kittel *et al*.1999), as well as the western half of the San Juan National Forest (Richard *et al.* 1996).

Elevation Range in Colorado: 6600-10,700 ft. (2000-3260 m).

Site Geomorphology: The *Salix monticola*/mesic forb (yellow willow/mesic forb) plant association occurs along broad, swift-moving streams and active floodplains in narrow to moderately wide valleys (20-250 m). The ground surface is usually undulating, from past flooding or beaver activity. Stands form narrow bands at the stream edge, ranging from 1-6 ft.(0.1-2 m) above the channel elevation. In wider valley bottoms, stands occur further from the bank, but never more than 2.5 ft. (0.75 m) above the annual high water mark. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Most stands occur adjacent to fairly straight, wide, and shallow channels ranging from bedrock to silty-bottomed reaches (Rosgen's Channel Type: B1-B6). A few stands occur on meandering, cobble-bottomed reaches (Rosgen's Channel Type: C3) or streams braided by beaver activity (Rosgen's Channel Type: D6).

Soil: Soils are fine textured sandy clays to silty and sandy clay loams. Mottling and gleyed layers are common within 5 inches (12 cm) of the ground surface indicating elevated water tables for part of the year. Coarse material varies from 0 to 80% in the upper horizons. In the Colorado River Basin, the soils classify as Cryofluvents and Cryorthents

Vegetation: *Salix monticola* (yellow willow) forms a dense to open canopy with 20-100% cover and if not the clear dominant, then it is the matrix willow. The matrix species is the willow with the highest abundance, even though other willow species may have a higher combined canopy cover. Other shrub species that may be present include: *Salix drummondiana* (Drummond willow) (1-70%), *Ribes inerme* (1-70%), *Salix planifolia* (planeleaf willow) (1-30%), *Alnus incana* (thinleaf alder) (1-20%), *Salix bebbiana* (Bebb willow (1-20%), *Salix geyeriana* (Geyer willow) (1-80%), *Lonicera involucrata* (bush honeysuckle) (1-20%), *Salix brachycarpa* (short fruit willow) (1-20%), *Salix wolfii* (Wolf willow) (1-30%), and *Salix eriocephala* (yellow willow) (1-20%).

Total forb cover ranges from 10-70%. No one forb species is particularly more abundant than any other, nor is any species consistently present in all stands. Forb species that may be present include: *Heracleum lanatum* (cow parsnip) (1-73%), *Rudbeckia laciniata* (cone flower) (1-28%), *Mertensia ciliata* (chiming bells) (1-20%), and *Fragaria virginiana* (wild strawberry) (1-10%). Graminoid cover ranges from zero to 50%, and ingeneral never exceeds the total forb cover. Graminoid species that may be present include: *Calamagrostis canadensis* (bluejoint reedgrass) (1-30%) and *Carex utriculata* (beaked sedge) (1-4%). Generally, forbs are dominant under shrubs on hummocks and ridges while graminoids dominate the undergrowth in low-lying, wetter swales. In the San Juan National Forest, stands of this association show a significant shift in forb species at lower elevations with *Rudbeckia laciniata* (cone flower) more dominant and the average cover of exotic species higher. This may indicate heavy grazing pressure in the past. Exotic graminoid and forb species include: *Poa pratensis* (Kentucky bluegrass) (1-50%), *Trifolium repens* (sweet clover) (1-22%), and *Taraxacum officinale* (dandelion) (1-12%).

Successional and Ecological Processes: *Salix monticola* (yellow willow) dominated plant associations appear to be long lived and stable. They occur on mesic sites that support a diversity of graminoids and forbs. *Salix monticola* appears to grow only where the water table does not drop below 3 feet (1 m) of the surface. It appears to be limited to cold, wet environments in broad valley bottoms at high elevations. Due to the colder environments, organic matter builds up in the soils, and it is likely that succession to other associations is slow (Padgett *et al.* 1989). The presence of dying conifer trees in these associations may indicate an increase in the water table.

The *Salix monticola/*mesic forb (yellow willow/mesic forb) plant association occurs on mesic sites and supports a rich diversity of forbs. On broad, hummocky floodplains stands can form extensive willow carrs. Sites with a higher abundance of exotic forbs and graminoids may be grazing-induced. At higher elevations, this association grades into the *Salix planifolia*/mesic forb (planeleaf willow) association. Stands with abundant *Salix planifolia* present may indicate a transition between higher sites dominated by *Salix planifolia* and the wider, lower montane areas where *Salix monticola* becomes more abundant.

Management: Stands with an abundance on non-native and increaser herbaceous species in the undergrowth are likely grazing induced shifts form either the native forb component of the Salix monticola/Mesic forb plant association, or a shift from another Salix monticola dominated plant association. Improper livestock grazing can dry sites, increase non-native cover, and reduce the vigor of willow root structure. Rest periods from grazing are recommended in order to provide time for plant regrowth. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995, Kovalchik and Elmore 1992).

Disturbed stands or stands with a history of improper grazing may respond to rest and rotation periods. These stands may have potential for higher graminoid biomass including species such as *Carex aquatilis* (water sedge) and *Calamagrostis canadensis* (bluejoint reedgrass).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel down cutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water table across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995).

Prescribed burning in this plant association is also an effective method of rejuvenating decadent stands of willows. The willow species in this plant association vigorously sprout following quick, hot fires. Slow burning fires can actually damage the plants (Hansen *et al*. 1995).

Salix monticola (yellow willow) is an effective stream bank stabilizer. It can probably be grown and transplanted from nursery cuttings in the same manner as *Salix geyeriana.* Cuttings should be taken in the spring from dormant, 2-4 year-old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen *et al*. 1995).

Salix planifolia/Caltha leptosepala
Planeleaf willow/marsh marigold

Global Rank: G4
Global Rank Comments: This is a common and widespread plant association known from throughout ht Rocky Mountains.
State Rank: S4
State Rank Comments: This is a common and widespread plant association in subalpine habitats in Colorado.

General Description and Comments: The *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) plant association is a common and abundant upper montane and subalpine community occurring on very wet to saturated soils. This association is characterized by low-stature shrubs, less than 2 feet (0.5 m) tall, and a thick carpet of forbs in the undergrowth. There may be scattered patches of other willows present.

Regional Distribution: This plant association occurs in Wyoming (Johnston 1987) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This is a major subalpine wetland plant association that occurs throughout the Rocky Mountains of Colorado. It has been documented from the San Juan, Gunnison, Routt, Roosevelt, Arapaho and Pike National Forests (Richard *et al.* 1996, Johnston 1987, Kettler and McMullen 1996). It has also been documented from the San Miguel/Dolores, Gunnison, Colorado, Arkansas and South Platte River Basins (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996).

Elevation Range in Colorado: 9200-12,100 ft. (2800-3700 m).

Site Geomorphology: This plant association typically occurs in wide, glaciated valleys adjacent to streams. It occurs in swales, depressions and on slopes where snow melt runoff saturates soils for much of the growing season. The ground may be flat or uneven with raised hummocks. Stream gradients range from <1% in broad floodplains to 14% in steep snowmelt basins. Stream channels vary. Channels may be steep and narrow, first-order streams in snow melt basins (Rosgen's Channel Type: A3), relatively wide and straight (Rosgen's Channel Type: B3, B4), narrow, relatively deep, and meandering in broad, glaciated valleys (Rosgen's Channel Type: E3, E4) or braided, multiple channels below beaver dams (Rosgen's Channel Type: D6).

Soil: Soil textures are highly variable. Mineral soils vary along a moisture gradient. Wet sites have soil textures of silty clays and silt loams, while slightly drier sites have loamy sands and sandy loams overlying gravely alluvium. Some stands occur on well-drained, mineral soils with well-oxygenated water and no mottled or gleyed layers. Other sites have a shallow organic layer overlying a gravel or cobble layer within 10-20 inches (20-50 cm) of the surface. The water table at these sites is usually near the surface throughout the growing season and may be perched by a clay horizon. Still other stands occur on deep, dark clay loams with high organic content or a fibric or hemic layer on top. Soils in the Colorado River Basin classify as oxyaquic Cryumbrepts, typic Cryoborolls, Cryochrepts, typic Cryorthents, and typic Cryaquents.

Vegetation: *Salix planifolia* (planeleaf willow) forms nearly pure stands with 30-100% cover. Other willows that may be present at lower elevations include: *Salix geyeriana* (Geyer willow) (2-20%) and *Salix monticola* (mountain willow) (1-40%). At higher elevations, other shrubs that may be present include *Salix brachycarpa* (shortfruit willow) (1-30%) on drier sites, *Betula glandulosa* (glandular birch) (1-16%) and *Salix wolfii* (Wolf willow) (1-10%) on wetter sites. *Picea engelmannii* (Engelmann spruce) is occasionally scattered throughout the stand with 1-10% cover.

Typically, the willow canopy is nearly closed and an herbaceous undergrowth occurs only in openings between willow patches. The undergrowth is characterized by an abundance of forbs with few graminoids. Forb species include 1-43% cover of *Caltha leptosepala* (marsh marigold), *Cardamine cordifolia* (heartleaf bittercress) (1-58%), *Senecio triangularis* (arrowleaf groundsel) (1-30%), *Mertensia ciliata* (mountain bluebells) (1-20%), *Pedicularis groenlandica* (elephant-head) (1-11%), and *Sedum rhodanthum* (pink stonecrop) (1-11%). Graminoid species that may be present include: *Calamagrostis canadensis* (bluejoint reedgrass) (1-36%) and *Carex aquatilis* (water sedge) (1-40%).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Salix planifolia also grows at elevations below the subalpine, and becomes a much taller willow due to a longer growing season. The two ecotypes were once thought to be two varieties of the species (Weber 1990). In montane elevations, *Salix planifolia* is often a co-dominant in *Salix monticola* plant associations. While *Salix planifolia* is not rhizomatous, it can be stimulated by browsing and has been shown to produce ten times more shoot biomass and twice as much root biomass as *Salix monticola* (Cottrell 1995). This may explain why *Salix planifolia* is so abundant in the upper reaches of most mountain watersheds in Colorado.

The *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) plant association occurs in wet swales that are saturated throughout most or all of the growing season. It is a long-lived, stable association that changes with fluctuations in the water table and degree of soil saturation. Cooper and Cottrell (1990) state that this type may be successional to another, presumably drier, *Salix planifolia* type.

Management: *Salix planifolia* (planeleaf willow) is highly palatable to wildlife and livestock. Low-stature *Salix planifolia* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season. However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed downcutting and increased evapotranspiration. This will dry the site and allow *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Kittel *et al.* 1994).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel downcutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Salix planifolia is valuable for revegetating and stabilizing disturbed stream banks. *Salix planifolia* can be grown from nursery cuttings and then transplanted. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Once transplanted, roots and shoots should appear within 10-15 days if conditions are right (Hansen *et al*. 1995).

Salix planifolia/Carex aquatilis
Planeleaf willow/water sedge

Global Rank: G4

Global Rank Comments: This is a common association of subalpine habitats throughout the Rocky Mountains.
State Rank: S4
State Rank Comments: This is a common subalpine plant association. It is threatened by improper livestock grazing and heavy recreational use.

General Description and Comments: The *Salix planifolia/Carex aquatilis* (planeleaf willow/water sedge) plant association is a low-stature willow shrubland that grows in wet to saturated soils above 9000 feet (2800 m). It is a common plant association of subalpine glacial valleys. *Salix planifolia* occasionally mixes with *Salix brachycarpa* (shortfruit willow) or *Salix wolfii* (Wolf willow) at higher elevations and grades into taller willow carrs with *Salix monticola* (mountain willow) at lower elevations.

Regional Distribution: This plant association occurs in Wyoming (Girard *et al.* 1995, Youngblood *et al.* 1985), Idaho (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989), and Colorado (Baker 1989, Cooper and Cottrell 1990, Hess 1981, Hess and Wasser 1982, Johnston 1987, Komarkova 1986, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is a common type and occurs throughout the Rocky Mountains of Colorado (Baker 1989, Cooper and Cottrell 1990, Hess 1981, Hess and Wasser 1982, Johnston 1987, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Kittel *et al*. 1996, Komarkova 1986).

Elevation Range in Colorado: 9000-11,200 ft. (2800-3400 m).

Site Geomorphology: This plant association occurs in wide, wet valleys on snow-melt fed swales. It also occurs in narrow valleys with sinuous streams and wet floodplains associated with beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and moderately sinuous (Rosgen's Channel Type: B3), narrow and sinuous (Rosgen's Channel Type: E4), or highly braided by beaver activity (Rosgen's Channel Type: D4).

Soil: Soils have an organic peat top layer over mineral silty clays, heavy silty clay loams, silty loams, sandy loams, or loamy sands. Mottling is often evident. Soils in the Colorado River Basin classify as Histisols, Cryaquolls, Hemists, and Borohemists.

Vegetation: This plant association is characterized by 11-91% cover of low-stature (.5-1.5 m) *Salix planifolia* (planeleaf willow). Other willows that may be present include: *Salix monticola* (mountain willow) (1-38%), *Salix wolfii* (Wolf willow) (1-40%), *Salix boothii* (Booth willow) (1-21%), *Salix geyeriana* (Geyer willow) (1-10%), and *Salix drummondiana* (Drummond willow) (5-20%). One stand in the Colorado River Basin had 80% cover of *Salix brachycarpa* with 90% *Salix planifolia*. The *Salix brachycarpa* (shortfruit willow) was more or less restricted to the better-drained and drier slopes along the outer edges of the wetter, *Salix planifolia* (planeleaf willow) dominated swale.

The herbaceous undergrowth is dominated by 1-84% *Carex aquatilis* (water sedge). Other graminoid species that may be present include: *Carex utriculata* (beaked sedge) (1-50%), *Calamagrostis canadensis* (bluejoint reedgrass) (1-40%), and *Deschampsia cespitosa* (tufted hairgrass) (1-20%). Total forb cover is typically less than 20%. Species that may be present include: *Caltha leptosepala* (marsh marigold) (1-70%), *Cardamine cordifolia* (heartleaf bittercress) (1-13%), *Pedicularis groenlandica* (elephant-head) (1-20%), and *Conioselinum scopulorum* (hemlock parsley) (1-13%).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow)*, Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Salix planifolia also grows at elevations below the subalpine, and becomes a much taller willow due to a longer growing season. The two ecotypes were once thought to be two varieties of the species (Weber 1990). In montane elevations, *Salix planifolia* is often a co-dominant in *Salix monticola* plant associations. While *Salix planifolia* is not rhizomatous, it can be stimulated by browsing and has been shown to produce ten times more shoot biomass and twice as much root biomass as *Salix monticola* (Cottrell 1995). This may explain why *Salix planifolia* is so abundant in the upper reaches of most mountain watersheds in Colorado.

Carex utriculata (beaked sedge)*, Carex aquatilis* (aquatic sedge)*,* and *Calamagrostis canadensis* (bluejoint reedgrass) are common dominant undergrowth of several *Salix* plant associations. These three graminoids indicate different micro-environments, generally separating out along a moisture gradient related to the depth of the water table, and can represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (Cooper 1986).

Changes in the physical environment, brought on by flooding or other disturbance, can initiate successional shifts in species composition. Sediment deposition on the floodplain raises the surface higher above the water table (Cooper 1986). As aggradation, or build up, of the floodplain proceeds, the site becomes drier and the dominant graminoid understory changes. Thus *Carex aquatilis* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

The *Salix planifolia/Carex aquatilis* (planeleaf willow/water sedge) plant association occurs in wet swales that are saturated throughout the growing season. The dense canopy layers and thick undergrowth indicate stable conditions. Both *Carex aquatilis* (water sedge) and *Caltha leptosepala* (marsh marigold) can tolerate saturated soils, and occasionally they co-dominate the undergrowth (Padgett *et al.* 1989).

Management: *Salix planifolia* (planeleaf willow) is highly palatable to wildlife and livestock. In general, graminoid and forb production is moderate in this plant association. Forage value for *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) is variable depending on the season, previous grazing use, and the size of the rangelands. In narrow riparian areas within extensive rangelands, the undergrowth of this association may be heavily grazed (Hansen *et al*. 1995).

Low-stature *Salix planifolia* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season (Girard *et al.* 1995). However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed downcutting and increased evapotranspiration. This allows *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Hansen *et al*. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association can be important for maintaining the high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel downcutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex aquatilis* and *Carex utriculata*. Grazing should be eliminated from the burned sites for 2-3 years following a fire in order to prevent livestock from browsing young, palatable regrowth (Hansen *et al*. 1995).

Salix planifolia and *Carex* (sedge) species are valuable for revegetating and stabilizing stream banks. *Salix planifolia* can be grown from nursery cuttings and then transplanted. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear within 10-15 days after planting if conditions are right. *Carex aquatilis* and *Carex utriculata* are effective due to their dense network of rhizomatous roots (Hansen *et al*. 1995).

Salix wolfii/Carex aquatilis
Wolf willow/water sedge

Global Rank: G4
Global Rank Comments: This association is well documented in the western states.
State Rank: S3
State Rank Comments: In Colorado, this association rarely forms extensive stands, but occurs throughout its subalpine habitats.

General Description and Comments: The *Salix wolfii/Carex utriculata* (Wolf willow/beaked sedge) plant association is an uncommon community of very wet subalpine sites in western Colorado. In Colorado, *Salix wolfii* grows in small patches and does not form large, expansive willow carrs like *Salix planifolia. Salix wolfii* often forms a mosaic with stands of *Salix planifolia*, *Salix brachycarpa* (shortfruit willow) and open *Carex* spp. (sedge) meadows.

Regional Distribution: The *Salix wolfii/Carex aquatilis* (Wolf willow/water sedge) plant association occurs in Utah, southeastern Idaho (Padgett *et al.* 1989), Montana (Hansen *et al*. 1995), Wyoming (Youngblood *et al.* 1985, Girard *et al*. 1995), and Colorado (Baker 1989, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs on the Colorado West Slope in the San Juan and Routt National Forests, the San Miguel/Dolores, Gunnison and Colorado River Basins and on the East Slope in the Arkansas River Basin (Richard *et al.* 1996, Kettler and McMullen 1996, Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Baker 1989, Johnston 1987).

Elevation Range in Colorado: 8400-11,400 ft. (2600-3500 m).

Site Geomorphology: The *Salix wolfii/Carex aquatilis* (Wolf willow/water sedge) plant association occurs in moderately narrow to wide valleys and glacial basins. It occurs on saturated peat wetlands and floodplains with lateral seepage of ground water. Stream reaches can be moderately steep (gradient of 3-7%). Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are deep, narrow, and sinuous (Rosgen's Channel Type: E4, E6), shallow, broad, and gently meandering (Rosgen's Channel Type: B2-B3), and highly divided by beaver activity (Rosgen's Channel Type: D4).

Soil: Soils vary from highly organic or peat to mineral-based. Soils textures include heavy silty clay loams, silty loams, and sandy clay loams with mottling. Some stands occur on deep sandy clays, often with a high organic content, and others occur on shallow silty clays over gravels and rocks. Stands in the Colorado River Basin occur on silty clay over deep peat and classify as hydric Borofibrists.

Vegetation: The shrub layer is dominated by 10-70% cover of *Salix wolfii* (Wolf willow). Other willow species that may be present include: *Salix planifolia* (planeleaf willow) (1-28%), *Salix boothii* (Booth willow) (11-29%), *Salix monticola* (yellow willow) (10-13%), and *Salix brachycarpa* (shortfruit willow) (2-20%). *Betula glandulosa* (glandular birch) may also be present with 10-20% cover. The herbaceous graminoid cover is generally dense and rich, dominated by 10-80% cover of *Carex aquatilis* (water sedge). Other graminoid species that may be present include: *Carex utriculata* (beaked sedge) (1-19%) and *Deschampsia cespitosa* (tufted hairgrass) (1-7%). Forb cover varies from sparse (<10%) to very dense (70%) and is generally diverse. Forb species that may be present include: *Caltha leptosepala* (marsh marigold), *Ligusticum tenufolium* (small ligusticum) and *Thalictrum alpinum* (arctic meadowrue).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Stands of *Salix wolfii* are less frequently encountered, and are usually limited in size. *Salix wolfii* dominated stands are more common on the western slope (David Cooper, *personal communication*). Of the twenty-eight *Salix wolfii* stands documented by the Colorado Natural

Heritage Program, twenty-six are located on the west slope (Colorado Natural Heritage Program 1997). According to Phillips (1977), *Salix wolfii* grows on deep, undecomposed peat, while *Salix planifolia* tends to grow on more decomposed (humified) organic soils.

Further north in Montana, *Salix planifolia* stands are observed on wetter and finer-textured soils than sites containing *Salix wolfii* dominated communities (Hansen *et al.* 1988).

The dense shrub canopy and thick undergrowth of the *Salix wolfii/Carex aquatilis* (Wolf willow/water sedge) plant association indicate stable conditions. *Carex aquatilis* is well-suited to wet, organic soils and succession will occur slowly under these conditions (Hansen *et al.* 1988). If the water table is lowered, other herbaceous species may become dominant in the undergrowth and eventually give way to non-native graminoid species such as *Poa pratensis* (Kentucky bluegrass) (Hansen *et al*. 1995).

Carex utriculata (beaked sedge), *Carex aquatilis* (water sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) are dominant understory species of several *Salix* plant associations. These graminoids indicate different microenvironments within the *Salix* communities (Padgett *et al*. 1989) and may represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata, Carex aquatilis, and *Calamagrostis canadensis* separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Carex aquatilis* occurs on intermediate sites. *Calamagrostis canadensis* dominates the driest sites with the lowest water tables and often colonizes clumps of *Carex utriculata* and *Carex aquatilis* (Cooper 1986).

Floodplain aggradation, or build up, can result in a change in species composition over time. Late spring snow melt and long periods of summer rain cause upper elevation streams to overflow their banks. Sediments are deposited on the floodplain, raising the surface higher above the water table (Cooper 1986). As aggradation of the floodplain proceeds and the site becomes less saturated, the dominant graminoid understory can change from *Carex utriculata* to *Carex aquatilis* to *Calamagrostis canadensis*.

Distance from the stream channel can differentiate the graminoids spatially. *Carex utriculata* commonly occurs at the stream channel edge where the water table is close to the ground surface. *Carex utriculata* is usually found in standing water. Further away from the channel are mesic meadows of *Carex aquatilis* and slightly drier meadows of *Calamagrostis canadensis*.

Management: *Salix wolfii* is moderately palatable to livestock. Forage value for *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) is variable depending on the season, previous grazing use, and the size of the rangelands. In narrow riparian areas within extensive rangelands, the undergrowth of this association may be heavily grazed (Hansen *et al*. 1995).

Low-stature *Salix wolfii* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season (Girard *et al.* 1995). However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed downcutting and increased evapotranspiration. This allows *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Hansen *et al*. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel downcutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Prescribed burning can aid in rejuvenating decadent stands of *Salix wolfii*. Quick, hot fires result in more sprouts, while slow fires damage the willows and result in fewer sprouts. Burning also temporarily increases the productivity of *Carex aquatilis* and *Carex utriculata*. Grazing should be eliminated from the burned sites for 2-3 years following a fire in order to prevent livestock from browsing young, palatable regrowth (Hansen *et al*. 1995).

Salix wolfii and *Carex* (sedge) species are valuable for revegetating and stabilizing stream banks. *Salix wolfii* can be grown from nursery cuttings and then transplanted, but success is inconsistent. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear within 10-15 days after planting if conditions are right. *Carex aquatilis* and *Carex utriculata* are very effective due to their dense network of rhizomatous roots (Hansen *et al*. 1995)

Salix wolfii/mesic forb
Wolf willow/mesic forb

Global Rank: G3
Global Rank Comments: This is a wide spread association, although never very abundant where it occurs.
State Rank: S3
State Rank Comments: This association is known from less than 20 locations. More stands are expected to occur. It is threatened by improper livestock grazing and heavy recreational use.

General Description and Comments: The *Salix wolfii*/mesic forb (Wolf willow/mesic forb) plant association occurs at mid- to upper montane and lower subalpine elevations. It frequently covers wide, open, gently sloping areas near first- and second-order streams. It can be recognized by the generally dense layer of low-growing, silvery *Salix wolfii* dominating the overstory with a variety of mesic forbs and some graminoids in the undergrowth.

Regional Distribution: This plant association occurs in Utah, Idaho, western Wyoming (Padgett *et al.* 1989, Youngblood *et al.* 1985, Johnston 1987) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs on the West Slope in the Yampa, White and Colorado River Basins and in the San Juan and Routt National Forests (Sanderson and Kettler

1996, Kittel and Lederer 1993, Kittel *et al*. 1994, Richard *et al*. 1996, Kettler and McMullen 1996).

Elevation Range in Colorado: 7900-11,000 ft. (2400-3400 m).

Site Geomorphology: This plant association occurs in wide mountain valleys. It occurs along first- or second-order streams on well-drained slopes and hummocks on the valley floor. The water table is usually within the top meter of soil and groundwater slowly seeps to the surface. Stream channels are narrow, relatively deep and sinuous (Rosgen's Channel Type: E4).

Soil: The soils may be saturated in the spring and early summer, but dry somewhat during the summer as the water table drops. Soil textures often have a high organic content and are silty clays, silty clay loams, silty loams, or deep sandy clays, clay loams, and sandy clay loams over gravels and rocks. Some stands have a loamy horizon underlain by a clay horizon. One profile in the Colorado River Basin classifies as a dystric Cryochrept.

Vegetation: *Salix wolfii* (Wolf willow) dominates the shrub layer with 10-90% cover. Other willow species that may be present include: *Salix planifolia* (planeleaf willow) (1-80%), *Salix boothii* (Booth willow) (3-70%), and *Salix geyeriana* (Geyer willow) (3-20%). Total forb cover exceeds that of total graminoid cover. No single forb species is particulariy more abundant than any other, and no one species is present in every stand. Forb species that may be present include: *Caltha leptosepala* (marsh marigold) (1-60%), *Mertensia ciliata* (mountain bluebell) (1-10%), *Senecio triangularis* (arrowleaf groundsel) (1-3%), *Ligusticum porteri* (Southern ligusticum) (3-10%), *Fragaria virginiana* (mountain strawberry) (1-12%), *Cardamine cordifolia* (heartleaf bittercress) (1-10%), *Geum macrophyllum* (large-leaved avens) (1-3%), and *Heracleum maximum* (cow parsnip) (1-3%).

Graminoid species present are diverse, yet generally have a low cover relative to the amount of total forb cover. Graminoid species that may be present include *Deschampsia cespitosa* (tufted hairgrass) (1-40%), *Calamagrostis canadensis* (bluejoint reedgrass) (1-10%), and various *Carex* species (sedge) (1-10%).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest microhabitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Stands of *Salix wolfii* are less frequently encountered, and are usually limited in size. *Salix wolfii* dominated stands are more common on the western slope (David Cooper, *personal communication*). Of the twenty-eight *Salix wolfii* stands documented by the Colorado Natural Heritage Program, twenty-six are located on the west slope (Colorado Natural Heritage Program 1997). According to Phillips (1977), *Salix wolfii* grows on deep, undecomposed peat, while *Salix planifolia* tends to grow on more decomposed (humified) organic soils.

Further north in Montana, *Salix planifolia* stands are observed on wetter and finer-textured soils than sites containing *Salix wolfii* dominated communities (Hansen *et al.* 1988).

Kettler and McMullen (1996) suggest that the *Salix wolfii*/mesic forb association may be a grazing-induced phase of the *Salix wolfii/Carex aquatilis* (Wolf willow/water sedge) association. Many stands in the Routt National Forest are heavily grazed and contain a high number of exotic and increaser species such as *Taraxacum officinale* (dandelion) and *Fragaria virginiana* (mountain strawberry). Other stands in Colorado, however, do not indicate an increase in non-native species. Padgett *et al.* (1989) consider this association to be a stable community based on its well-developed soil morphology and lush undergrowth, and that succession from a *Carex aquatilis* (water sedge) understory to mesic forbs would be slow to occur.

Management: *Salix wolfii* (Wolf willow) is moderately palatable to livestock. Low-stature *Salix wolfii* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season (Girard *et al.* 1995). However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed downcutting and increased evapotranspiration. This allows *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Hansen *et al*. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen *et al*. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel downcutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Prescribed burning can aid in rejuvenating decadent stands of *Salix wolfii*. Quick, hot fires result in more sprouts, while slow fires damage the willows and result in fewer sprouts (Hansen *et al*. 1995).

Salix wolfii is valuable for revegetating and stabilizing disturbed stream banks, but success in transplanting cuttings is inconsistent. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right. *Calamagrostis canadensis* is valuable due to its propagation from rhizomes (Hansen *et al*. 1995).

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