Survey of Critical Wetlands and Riparian Areas in Mesa County

Colorado Natural Heritage Program
College of Natural Resources, 254 General Services Building
Colorado State University
Fort Collins, Colorado 80523

Knowledge to Go Places

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Prepared for:

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Cover photograph: Rio Grande cottonwood riparian forest (*Populus deltoides* ssp. *wislizenii*/*Rhus trilobata*) along the Colorado River near the Mesa/Garfield county line (CNHP photo).

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EXECUTIVE SUMMARY

Although the rate of wetland loss in Mesa County is difficult to quantify, it is clear that many wetlands, especially on the valley floor, have been lost or profoundly altered from their pre-settlement state. Agriculture, grazing, development, construction of reservoirs, water diversions, and gravel 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.

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. However, the likelihood for human conflicts with biologically important wetlands is minimized if there is the opportunity to proactively plan for managing human activity or managing the species or habitat of interest. The purpose of this project is to provide a data resource for the Colorado Division of Wildlife and the Western Colorado Five Rivers Wetland Focus Area Committee in conducting proactive planning. This document should be considered a tool for managing lands that support rare wetland species and plant associations within Mesa County.

In 2001, the Colorado Natural Heritage Program (CNHP) proposed to the Colorado Department of Natural Resources (CDNR), Colorado Division of Wildlife's (CDOW) Wetlands Program to survey for critical wetlands within Mesa 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 resources. 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 Western Colorado Five Rivers Wetland Focus Area Strategic Plan;
(3) CNHP's Comprehensive Statewide Wetland Classification and Characterization Project;
(4) The Nature Conservancy's Priority Conservation Sites in the Glade Park Priority Area;
(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 Mesa

County, and by performing a qualitative wetland functional assessment to guide future quantitative efforts in assessing the range of variation within a subclass. 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 CNHP's Comprehensive Statewide Wetlands Classification.

Field surveys began in July 2001 and continued through September 2001. Wetlands and riparian areas occurring along the Colorado and Gunnison river corridors 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). Additional analysis within the Colorado and Gunnison River Potential Conservation Areas utilized data from Rocky Mountain Bird Observatory, Bureau of Land Management, and the U.S. Fish and Wildlife Service, Colorado River Fish Recovery Program to identify smaller 'Priority Areas' more conducive to site specific conservation actions. A qualitative functional assessment was conducted at most of the wetland and riparian areas visited. The restoration potential of each site was also noted.

Results of the wetland and riparian survey confirm that Mesa County contains areas with high biological significance and a diverse array of wetlands that support a wide variety of plants, animals, and plant communities. At least 34 major wetland/riparian plant communities, eight plants, nine birds, six fish,three amphibians, and two invertebrates from CNHP's list of rare and imperiled plants, animals, and plant communities are known to occur in, or are associated with, wetlands in Mesa County.

Thirty-two wetland and riparian sites of biodiversity significance are profiled in this report as Potential Conservation Areas (PCAs). These sites represent the best examples of 34 wetland and riparian communities observed on the private and public lands visited. 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 Mesa 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 (reproductive timing) of species, or time constraints. Future surveys will likely 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 Mesa County, and Colorado. Of these sites, several stand out as very significant such as the entire Colorado River corridor which support three endangered fish, the razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*), and Colorado pikeminnow (*Ptychocheilus lucius*), and one globally imperiled (G2) plant community, the Rio Grand cottonwood riparian forest (*Populus deltoides* ssp. *wislizenii*/*Rhus trilobata*). Another significant site is Unaweep Seep, which supports the largest known Colorado population of the globally imperiled (G4T2) Nokomis fritillary butterfly (*Speyeria nokomis nokomis*) and contains one of the largest and most diverse seep wetland complexes observed during this survey.

Of the 32 wetland and riparian PCAs, we identified two as being **irreplaceable** (B1), 12 as being **nearly irreplaceable** (B2), eight of **high biodiversity significance** (B3), seven of **moderate biodiversity significance** (B4), and three of **general biodiversity siginificance** (B5). Two Sites of Local Significance were also identified. Sites of Local Significance do not necessarily contain elements on CNHP's list of rare and imperiled plants, animals, and plant communities but do provide important wetland functions. Overall, the concentration and quality of imperiled elements and habitats attest to the fact that wetland conservation efforts in Mesa County will have both state and global significance.

The results of the survey will be provided to the Colorado Division of Wildlife's Wetlands Program and the Western Colorado Five Rivers Wetland Focus Area Committee and will be available to the public on CNHP's website (http:\\www.cnhp.colostate.edu).

CONSERVATION STRATEGIES

Conservation strategies can be classified as three major types:

(1) **Land protection** can be accomplished through conservation easements, land exchanges, long term leases, purchase of mineral or grazing rights, acquisition, or government regulation;
(2) Management of the land can be influenced so that significant resources are protected;
(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 Mesa 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, are in need of 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 counties' 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 Mesa 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 routinely conducts site specific environmental reviews and should be considered a valuable resource. In addition, one of our key partners, the Colorado Division of Wildlife, should be consulted. To contact 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 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, may ensure that we do not lose species that have not yet been located. Work to protect large blocks of land in each of the major vegetation types in the county, and avoid fragmenting large natural areas unnecessarily with roads, trails, etc. Although large migrating animals like deer and elk are not tracked by 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 Mesa County wetlands. Such an effort could provide a blueprint for wetland conservation in the county. Encourage and support statewide wetland protection efforts such as CDOW's Wetlands Partnership. County governments are encouraged to support research efforts on wetlands to aid in their conservation. Countywide education on the importance of wetlands could be implemented through the county extension service or other local agencies. Encourage communication and cooperation with landowners regarding protection of wetlands in Mesa County. Utilize the expertise and breadth of experience within the Western Colorado Five Rivers 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 Mesa County will be facilitated with the cooperation of many private landowners, businesses, 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 Mesa 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 Mesa County, recognizing that delineation of potential conservation areas does not by itself provide 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 Mesa County's ecosystems are at a large scale (e.g., 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, The Nature Conservancy, 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, controlling weeds, and restoring wildlife habitat.

7. Stay informed and involved in public land management decisions. 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 and state agencies are becoming more and more involved in land exchanges. The Grand Mesa and Uncompahgre National Forests (GMUG) 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 implementation of compatible management designated in Forest Management Plans, Grazing Management Plans, etc.

8. Continue inventories where necessary, including inventories for species that cannot be surveyed adequately in one field season and inventories on lands that CNHP could not access in 2001. 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, 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.

10. Encourage public education functions and publications. One of the greatest tools in conserving land for biodiversity is to explain the value of such areas to the public. As described in this report, Mesa County is rich in animal and plant diversity and houses some of the most unique environments in Colorado. Conveying the value and function of these habitats and the species that inhabit them to the public can generate greater interest in conserving lands. Conducting forums or presentations that highlight the biodiversity of Mesa County should increase awareness of the uniqueness of the habitats within the county. Similarly, providing educational pamphlets or newsletters that explain why these areas are so valuable can increase public interest and support for biodiversity conservation.

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 have been 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 Mesa County is difficult to quantify, it is clear that many wetlands, especially in the Grand Valley, 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 different from those in existence prior to European settlement. For example, the development of an extensive network of canals and irrigation agriculture has created irrigation-induced wetlands where none previously existed. This same activity has altered many natural wetlands by changing hydrological patterns across the landscape. 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.

Because of the profound hydrological alterations within Mesa County, restoring degraded wetlands and riparian areas to pre-settlement conditions is probably not realistic. However, by enacting a watershed level wetland protection and enhancement program, many of the beneficial functions and values performed by wetlands could be enhanced or restored.

Increasingly, local Colorado governments, federal agencies, and non-profit organizations, 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. Rare plants, animals, and plant communities are usually the least understood organisms in a landscape. Some of these organisms are only understood after their rarity is recognized, as in the case of federal threatened and endangered species. However, conservation of these organisms can often be accomplished more quickly and less expensively if there is a clear understanding of their distribution and abundance. Furthermore, the likelihood for human conflicts is minimized if there is the opportunity to proactively plan for managing human activity or managing the species or habitat of interest.

The Survey of Critical Wetlands and Riparian Areas in Mesa County, conducted by the Colorado Natural Heritage Program (CNHP), is a part of ongoing wetland surveys of

Colorado counties by CNHP. To date, similar surveys have been conducted in all or parts of over 13 counties. Currently, CNHP is working on the Comprehensive Statewide Wetland Characterization and Classification Project. This project is compiling data from multiple sources, including CNHP's Riparian Classification, to produce a comprehensive wetland classification for the state of Colorado.

The purpose of this project is to provide a data resource for the Colorado Division of Wildlife and Western Colorado Five Rivers Wetland Focus Area Committee in conducting proactive planning for wetland conservation in Mesa County. This document should be considered a tool for managing lands that support rare wetland species and plant communities within Mesa County, although there are limitations to the information within it. In particular, a majority of the survey work was conducted over one year period. The distribution and abundance of all organisms change with time, and it is anticipate that the conservation areas described in the report will also change with time. Also, all areas of Mesa County were not surveyed, and priority was given to lands along the Colorado River corridor. Due to limitations of time and land access, this report only includes information from readily observed species or from areas that biologists received permission to visit. Finally, this report does not include all wetland species or communities found within Mesa County. This project specifically targeted the organisms that are tracked by CNHP (CNHP has a methodology specific to Natural Heritage Programs and this study was intended to survey for those species believed to be the most rare or the least known), although attention was given to additional wildlife values in the Colorado and Gunnison River Priority Area analysis (see page 57). The primary objective was to identify biologically significant wetlands within Mesa County with an emphasis on the Colorado River corridor. The Survey of Critical Wetlands and Riparian Areas in Mesa County used the methodology that is used throughout Heritage Programs in North, South, and Central America. The primary focus was to identify the locations of the wetland plant and animal populations, and plant communities on 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 from local knowledgeable citizens, National Wetland Inventory maps, and aerial photographs;
- 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 Potential Conservation Area 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.

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 (irreplaceable) to B5 (general or statewide biodiversity 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 CNHP recommends for protection in order to preserve the natural heritage of Mesa 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. *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) 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.

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 other wetland types, 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). 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, CNHP utilized a qualitative, descriptive functional assessment based on the best professional judgment of 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 most of the functions a value rating of "low," "moderate," or "high." Overall Functional Integrity is given as either "At Potential" or "Below Potential." Elemental Cycling is rated as either "Normal" or "Disrupted" depending on unnatural disturbances. 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
- Habitat diversity
- General wildlife habitat
- General fish/aquatic habitat
- Production export/food chain support
- 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. 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 fewer 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 "At Potential" rating, based on the best professional judgment of 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 "Below Potential," 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. 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 floodwaters 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, diversity of vegetation structure, and a sinuous and irregular basin.

Production Export/Food Chain Support
Production export refers to the flushing 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 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 (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	Emphemeral stream courses on the Uncompahgre Plateau
				R2-moderate gradient, low to middle order	Streams in upper elevations on the Uncompahgre Plateau.
				R3-middle elevation, moderate gradient along small/mid-order stream	Big Dominguez Creek
				R4-low elevation canyons or plateaus	Dolores River
				R5-low elev. Floodplains	Colorado River
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.	Fens on Grand Mesa
				S2-subalpine and montane fens on calcareous substrates	None known in Mesa County. High Creek Fen - Park County
				S3-wet meadows at middle elev.	Large hillside seep at Vega Reservoir
				S4-low elevation meadows	Unaweep Seep
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	Lily Lake
				D2-low elevation basins that are permanently or semi-permanently flooded	Depressional wetlands in Colorado River floodplain
				D3-low elevation basin with seasonal flooding	Depressional wetlands in Colorado River floodplain
				D4-low elevation basins that are temporarily flooded	Abandoned beaver ponds
				D5-low elevation basins that are intermittently flooded	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

Mesa County comprises 3,334 square miles, or 2,133,760 acres, of west central Colorado (Figure 1). It is located in the following Nature Conservancy Ecoregions (based on Bailey (1984)): the Utah High Plateaus in the north, the Rocky Mountains in the northeast, and the Colorado Plateau in most of the west and along the Gunnison River valley (Figure 2). Major physiographic features are the Colorado River and its tributaries, including the Gunnison and Dolores rivers; the Uncompahgre Plateau, dissected by Unaweep Canyon; Grand Mesa; the Bookcliffs; and the Grand Valley. Elevations range from about 4,400 ft. to 11,236 ft.

The area lies in a rain shadow caused by mountain ranges to the east, west and north. Precipitation in Grand Junction is about 20 cm per year, but significantly higher at the upper elevations on the mesa tops (Figure 3). Precipitation is highest in August. Grand Junction is frost-free for about 185 days (USDA 1989). Temperatures vary as much as 20 degrees with elevation, with mean lows in January ranging from 0 to 16 degrees F and highs in July from 70 to 95 degrees F. Summer temperatures over 100 degrees F are common. Humidity is generally 22 % in midsummer. Prevailing winds are from the southwest, but are influenced by local topography (USDA 1989).

Mesa County is underlain by geologic formations ranging in age from Precambrian metamorphic and granitic rocks, through Triassic, Jurassic and Cretaceous sedimentary rocks, to the Tertiary basalt of Grand Mesa, and Quaternary alluvial deposits of the valleys (Figure 4). These formations influence the distribution of wetland plant communities through their direct affect on soil development, groundwater movement, and fluvial processes. For example, many seeps and springs in the southern part of the county are associated with the Wingate sandstone and Chinle sandstone contact, where groundwater from the Glen Canyon aquifer often discharges (USGS 1995).

Soils of the area may be alluvial, wind deposited, or weathered in place. Some soils at the lowest elevations may have excess salt or sodium. A special situation in the semi-desert is the presence of cryptobiotic crusts on the soils. This living soil, containing mosses, lichens, algae and bacteria is important for stabilizing the sandy soils and adding to the long-term stability of desert grasslands (USDI 2001). Mountain soils are normally rocky and shallow, except in areas where groundwater discharge or slope wetlands occur. On Grand Mesa, 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 at lower elevations, wetland plant communities occur on alluvial soils. There is minimal soil development around many of the seeps and springs in Mesa County, as many of these wet areas are located on steep hillsides 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 Mesa County Area, Colorado" and "Soil Survey of Uncompahgre National Forest Area, Colorado, Parts of

Mesa, Montrose, Ouray, and San Miguel Counties" which are all published by the USDA Natural Resources Conservation Service (NRCS).

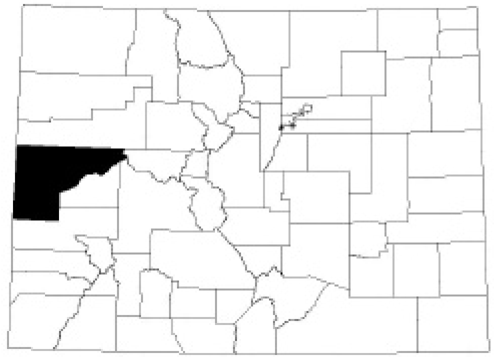

Figure 1. Location of Mesa County in Colorado

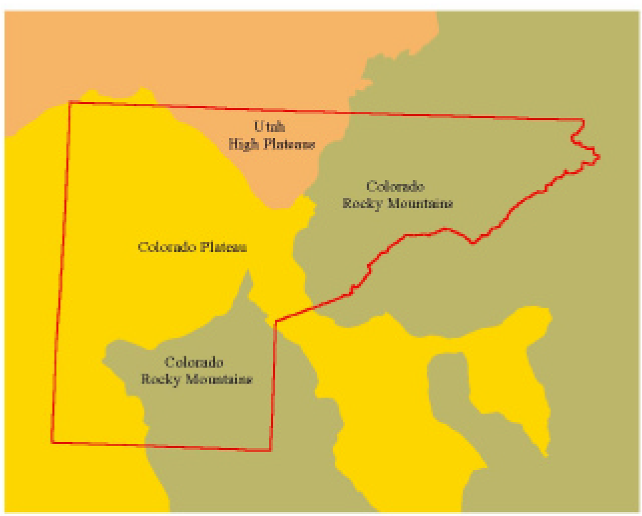

Figure 2. Ecoregions of Mesa County

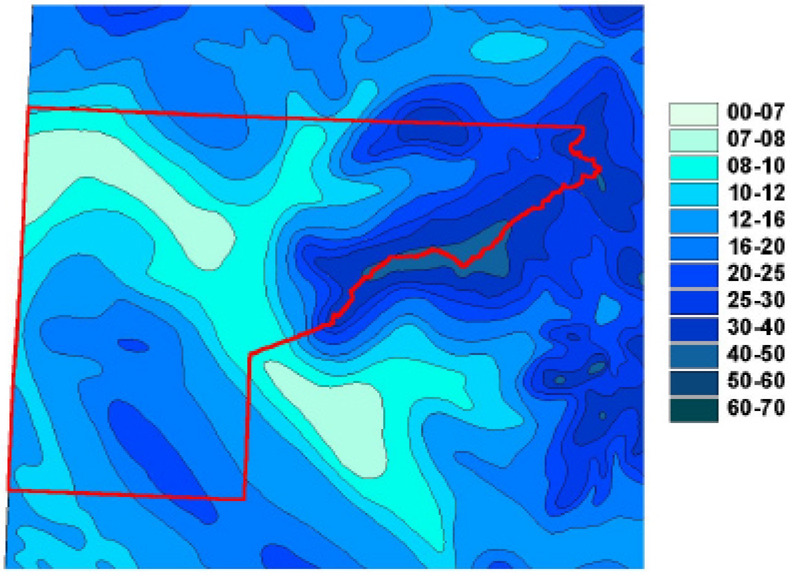

Figure 3. Precipitation (cm) in Mesa County.

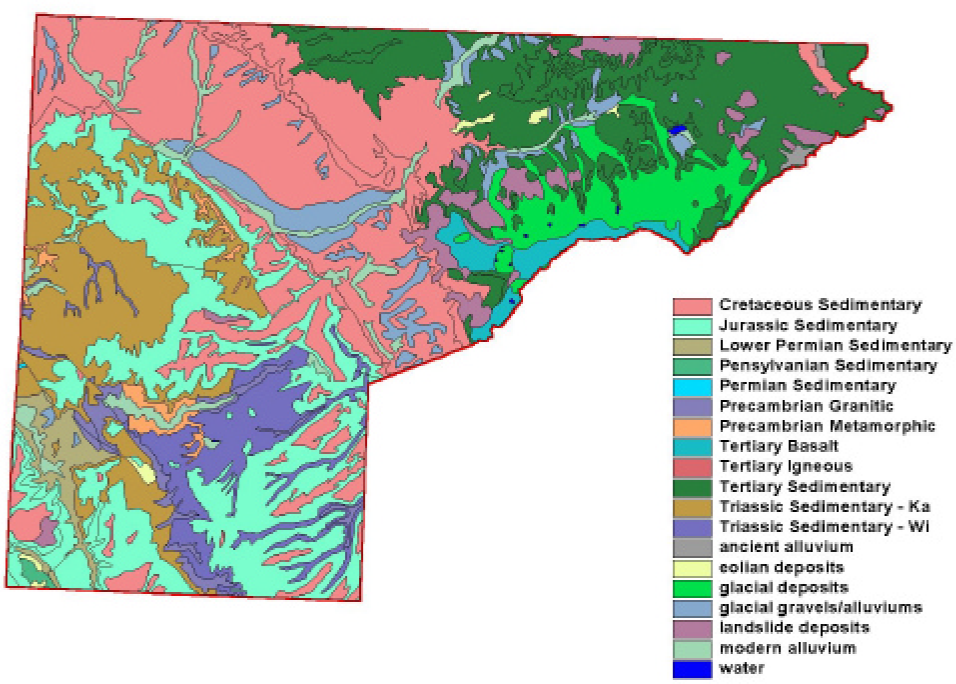

Figure 4. Geological Summary of Mesa County

Ownership is divided between private, municipal, State of Colorado, National Park Service, BLM and US Forest Service lands (Figure 5). Private lands are located primarily along the river corridors, especially the Colorado River, and in Glade Park. 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 throughout the county, but concentrated in the western half. The Grand Mesa and White River National Forests occupy the northeastern part of the county, while the Uncompahgre National Forest occurs on the Uncompahgre Plateau (except for a small parcel in Glade Park which is managed by the Grand Mesa National Forest). The state of Colorado holds land mainly along the Colorado River (Figure 5).

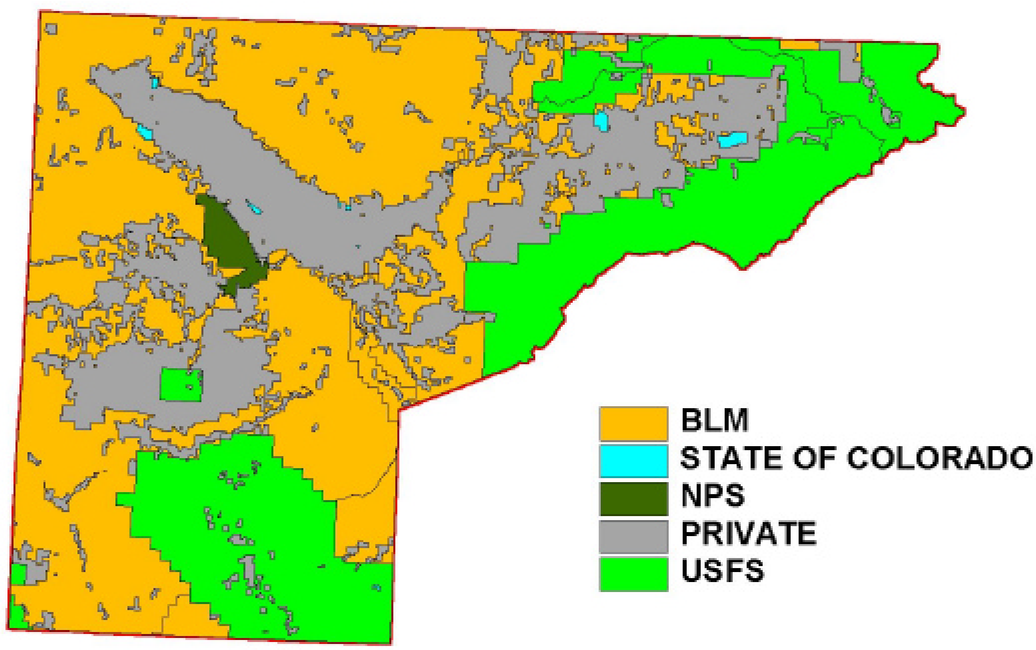

Figure 5. Land ownership in Mesa County

Hydrology

Historically the flow regime of the Colorado and Gunnison rivers consisted of high, turbid spring flows and clearer low flow from late summer through winter (Burdick 1995). The flow of both rivers has been significantly altered due to water development projects (mainstem dams, diversions, and transmountain water diversions) for irrigation and municipal use. Using data from the Natural Resources Conservation Service, which are estimates of what flow would be without regulation (i.e. dams, diversions, etc.), Osmundson (2001) found that mean monthly flows along the Colorado River at Cameo have generally increased during base-flow months (September/October and winter months) and decreased during runoff months (April-July) flow has decreased since the inception of river-flow regulation. For example, during the months of May-July, Osmundson found that flow declined by 17-41%, with the highest declines occurring during the month of June. Although total annual flows may be similar to pre-development records, the timing, duration, and magnitude of flow in the Colorado and Gunnison rivers have been drastically altered (Burdick 1995; Cooper and Severn 1994). Floodplains are not inundated as frequently during spring runoff due to altered flows and channelization structures (e.g. levees, dikes, and/or rip-rap) (Irving and Burdick 1995). Tamarisk has decreased the amount of sediment deposition in floodplains and has stabilized streambanks, which further reduce the connectivity between the river and floodplain areas (Graf 1978, as cited in Irving and Burdick 1995). Cooper and Severn (1994) note that the alteration in the magnitude of maximum annual flows along the Colorado River has decreased overbank flood frequency and duration resulting in reduced salt flushing, sediment deposition, connectivity of wetlands to the river, and cottonwood recruitment. In summary, floodplain dynamics along the major rivers (Colorado and Gunnison) in Mesa County, which are necessary for continued development of wetland habitat, have been greatly altered. As a result of this changes, new wetlands are not being created within the floodplains, non-native species (e.g. tamarisk) have thrived, and aquatic habitat for endangered fish has been reduced.

Groundwater in Mesa County is associated with the four principal regional aquifers of the Colorado Plateau and smaller local aquifers (this discussion on groundwater is almost entirely based on USGS 1995 "Groundwater Atlas of the United State – HA 730-C" see references). Discharge from these aquifers is mainly associated with small seep and spring wetlands, but occasionally supports large slope wetlands, such as the aspen/Rocky Mountain maple (*Populus tremuloides*/*Acer glabrum*) wetland forest near Vega Reservoir. Discharge also provides critical flow to many small streams in Mesa County, and thus is vital to the health of many riparian communities. Springs associated with local aquifers are comparitvely smaller, may have less flow, and have temporally more variable flow (quick to respond to local climatic conditions) than springs associated with regional aquifers which are typically high-flowing and have nearly constant discharge (USDI 2001).

The four regional aquifers are composed of permeable, moderately to well consolidated sedimentary rocks which range in age from Permian to Tertiary and are separated by impermeable confining units. The numerous water-yielding units have been grouped into four principal regional aquifers: (1) Uinta-Animas aquifer; (2) Mesa Verde aquifer; (3) Dakota-Glen Canyon aquifer; and (4) Coconino aquifer. All four aquifers underlie Mesa County but discharge in different geographical locations within the county:

(1) <u>Uinta-Animas aquifer</u> – this aquifer is found in the northeast part of the county and is associated with the Uinta Formation (silty sandstone, siltstone, and marlstone) and Green River Shale Formation (dolomitic marlstone). This aquifer is associated with the numerous seeps and springs that occur in

western Garfield County. Seeps and springs associated with this aquifer in Mesa County are not as widespread as in Garfield, mainly due to the fact that outcrops of the Uinta and Green River Formation are not as common in Mesa County. However, discharge from this aquifer is believed to be the hydrological source for the large aspen/Rocky Mountain maple wetland forest near Vega Reservoir. Recharge occurs in the uplands near the margins of the aquifer while discharge occurs along tributaries to the Colorado River and along the slopes of Grand Mesa, where the Green River Formation underlies thick basalt flows. The lower part of the Green River Formation, which is somewhat impermeable due to less fractures and a high concentration of kerogen (oil shale), and the Wasatch Formation serve as the confining unit between the Uinta-Animas and the underlying Mesa Verde aquifer.

(2) Mesa Verde aquifer – this aquifer is found in essentially the same geographic region as the Uinta-Animas in Mesa County, the northeast portion. The aquifer is found within rocks of the Mesa Verde Group (which locally consists of sandstone with interbedded shale and coal) which are older than those associated with the Uinta-Animas. Thus, the Mesa Verde aquifer is typically found at a lower elevation than the Uinta-Animas. Seeps found along the I-70 corridor in De Beque Canyon and in the Little Book Cliffs area are associated with this aquifer. Locally, recharge occurs on the northern flanks of the West Elk Mountains, areas near Grand Mesa, and along the Roan Plateau. Discharge not only occurs via seeps and springs but also directly into streams. The Mancos Shale Formation serves as the confining unit between the Mesa Verde and the underlying Dakota-Glen Canyon aquifer.

(3) Dakota-Glen Canyon aquifer – this aquifer contains four permeable zones that are referred to as the Dakota aquifer (associated with the Dakota Sandstone), Morrison aquifer (associated with sandstone portions of the Morrison Formation), Entrada aquifer (associated with the Entrada Sandstone), and Glen Canyon aquifer (associated with the Kayenta and Wingate Sandstone). The aquifer underlies both the Uinta-Animas and Mesa Verde aquifers but only surfaces in Mesa County on and around the Uncompahgre Plateau. For example, near the Mesa-Montrose County border along the Dolores River, numerous seeps discharge from the Glen Canyon aquifer at the contact between the Wingate Sandstone and the underlying Chinle Formation (sandstone and shale). The Dakota-Glen Canyon aquifer has been utilized in the Grand Valley as a source of irrigation water for agriculture. Many of these wells, once artesian, now have to be pumped due to overuse and subsequent release of pressure (Chronic 1980). Locally, recharge occurs near the southeastern end of the Uncompahgre Plateau and on the eastern side of the Piceance Basin. From these recharge areas, groundwater then flows toward discharge areas along the Colorado, Dolores, and Gunnison Rivers. The Chinle Formation is the lower confining unit of the Dakota-Glen Canyon aquifer and rests atop of Permian sandstone.

(4) Coconino-DeChelly aquifer – this aquifer is contained in rocks of Early Permian age and underlies most of the southern part of the Colorado Plateau. Rocks associated with this aquifer are only exposed in Mesa County along the Dolores River where a few springs discharge near the base of the canyon slopes. This aquifer may be contributing to base flows in the Dolores River along certain reaches since the river essentially cuts through these rock layers between the Mesa-Montrose county border and the Utah state line. Locally, recharge occurs near the Uncompahgre Plateau while discharge is probably only occurring along the Dolores River.

Local aquifers also support seeps and springs throughout the county. For example, in addition to the regional aquifers, groundwater discharge in the red-rock country west and southwest of Gateway may be associated with localized aquifers which result from perched, impervious, bedding planes found throughout the numerous sandstones in the area (Welsh 1989). These planes were once interdunal valleys and often interdunal wetlands, where accumulations of loess resulted in impervious soil horizons (Welsh 1989). These soil horizons persist within the sandstone as impervious rock layers. As water percolates through the sandstone and encounters these impervious bedding planes, flow occurs down gradient until it discharges where the bedrock is exposed or flows down to another impervious layer at the base of the formation and flows laterally to the margin of the formation along a canyon wall (Welsh 1989). Some of the seeps and springs along Salt Creek and the Dolores River may be associated with such groundwater movement.

Upland Vegetation

Upland vegetation in Mesa County can be classified into six broad types, each containing several plant communities. These types more or less correspond to elevation: from lowest to highest, 1) semi-desert shrublands; 2) sagebrush; 3) pinyon-juniper woodlands; 4) mountain shrublands; 5) aspen forests; 6) coniferous forests. Within each of these zones, the addition of water (streams, rivers, or springs) creates additional vegetation types. The only major types of vegetation in Colorado that are not represented in Mesa County are plains grasslands and alpine tundra.

Semi-desert shrubland is found at the lowest elevations in the county, often on saline or alkaline shale soils. The entire Grand Valley falls within this zone, including the majority of private land in the county. It also represents over 30% of BLM lands. Most of this type is north of the Colorado River or in the Gunnison Valley. Low shrubs of the goosefoot family such as shadscale (*Atriplex confertifolia)*, saltbush (*Atriplex* spp.), and greasewood (*Sarcobatus vermiculatus*), are the dominant life form. These plants are indicators of both climatically dry areas and physiologically dry soils. Within this zone are several characteristic, more or less distinct, plant communities, which can often be correlated with specific differences in soils, slope, aspect, and moisture (Singh and West 1971).

Imperiled plant species found in this zone include Grand buckwheat (*Eriogonum contortum*), tall cryptantha (*Cryptantha elata*), Ferron milkvetch (*Astragalus *musiniensis*), and Uinta Basin hookless cactus (*Sclerocactus glaucus*). Rare animals of the zone include Ord's kangaroo rat (*Dipodomys ordii sanrafaeli*), white-tailed antelope squirrel (*Ammospermophilus leucurus pennipes*), Botta's pocket gopher (*Thomomys bottae howelli*), kit fox (*Vulpes macrotis*), and a variety of birds and lizards.

Semi-desert shrublands have been used primarily as livestock range for about a century. Before irrigation projects were developed, they were unsuited for homesteading, and so remained largely in public ownership. Most of this range was misused for about a half century by overgrazing domestic livestock, prior to the Taylor Grazing Act. Although the range has generally improved in recent years, much of it remains in poor condition. BLM has estimated that the condition of the majority of its land in this zone is fair to poor (USDI 1985). This is most noticeable in the absence of native perennial grasses. Bunch grasses, which are a natural part of this ecosystem, include galleta (*Hilaria jamesii*), Indian ricegrass (*Oryzopsis hymenoides*), needle and thread (*Hesperostipa comata*), and Salina wild rye (*Elymus salina*). Non-native aggressive species such as cheatgrass (*Bromus tectorum*), halogeton (*Halogeton glomeratus*), and Russian thistle (*Salsola australis*) have invaded much of this land. Under proper grazing management, it is possible for recovery to occur. Chances are best when native species are least depleted; the poorer the condition, the slower the recovery (Blaisdell and Holmgren 1984). Remnants of plant communities with a good stand of native bunch grasses have been identified in Lyon et al (1996). Whenever good native grass communities are encountered, they should be valued and protected. They can supply the seed source, and the nucleus for the improvement of adjacent areas.

Present uses, in addition to grazing, include oil and gas development, wildlife habitat, and recreation. This largely uninhabited landscape provides unique areas for camping and solitude. Most people do not perceive this ecosystem to be as aesthetically pleasing as other parts of the county, and it is therefore less heavily used for hiking and camping. It also seems to suffer from a lack of respect and appreciation, and many areas have been heavily altered. Off-road vehicle use is very popular. Unfortunately, the wheels of off road vehicles (ORVs) can destroy vegetation and damage the soil. This can cause accelerated wind and water erosion, or create favorable conditions for the invasion of non-native species. The shale badlands in the salt desert shrub areas yield about 85% of sediments, but only 1% of the water in the Colorado River. There are very few wetlands found in this vegetation type.

Sagebrush in Mesa County is often found on deep, well-drained sandy soils of valley bottoms and mesas, where adjacent steeper slopes are covered with pinyon-juniper woodlands or mountain shrubs. Four species of sagebrush are found here: big sage (*Artemisia tridentata* ssp. *tridentata*); mountain big sage (*A. tridentata* ssp. *vaseyana*); black sage (*A. nova*) and silver sage (*A. cana*). Each has its own ecological requirements, and they rarely mix. The most abundant species in Mesa County is mountain big sage, followed by black sage. The potential natural vegetation of these sites is a mixture of sagebrush (about 10% cover) and native grasses and forbs (USDA 1978). Common associated graminoid species are western wheatgrass (*Pascopyrum smithii*), Indian ricegrass, and muttongrass (*Poa fendleriana*). Forbs include lupine (*Lupinus* spp.), penstemon (*Penstemon* spp.), and Indian paintbrush (*Castilleja* spp.). There may be a scattering of other shrubs such as rabbitbrush (*Chrysothamnus* spp.), winterfat (*Krascheninnikovia lanata*), and four-wing saltbush (*Atriplex canescens*). At higher elevations, sagebrush is mixed with Gambel's oak (*Quercus gambelii*) and snowberry *(Symphoricarpos oreophilus*). Heavy grazing and other disturbances will increase sagebrush cover and decrease perennial bunch grasses. Shrubs such as rabbitbrush and snakeweed will increase, and cheatgrass and other annual non-native aggressive species may invade (USDA 1978). In some cases, removal of herbaceous species has left a "sagebrush desert," with only bare soil under the shrubs. When burned, big sagebrush, mountain big sagebrush, and black sagebrush do not resprout, and are often replaced by pure stands of cheatgrass. This, in turn, makes the area much more susceptible to fire.

Sagebrush areas account for 8% of the BLM lands of the Grand Junction Resource Area. The majority of these areas were judged by BLM to be in poor to fair condition (BLM 1987.) Lyon et al. (1996) indicate that the majority of the sagebrush remaining on private lands in Mesa County is in the Glade Park-Pinyon Mesa area, and in the area west of De Beque. In both locations, grazing and planting of non-native grasses have largely altered the community. According to Tisdale (1969), "The balance between sagebrush and grass has been upset over vast areas. Affected areas now support either dense stands of sagebrush with a scant understory or, where unrestricted grazing has been accompanied by repeated fires, vegetation composed primarily of annual species." Recovery of this vegetation type, once altered, is difficult to achieve. In some cases, restricting grazing for twenty-five years has failed to change the composition back to a more desirable mix of shrubs, grass and forbs (Tisdale 1969). Partial removal of dense shrub cover is usually ineffective, because remaining shrubs will compensate by increasing their canopy cover, and take up all available resources. Complete removal of shrubs usually results in the invasion of non-native aggressive species like cheatgrass. It may be necessary to seed with native grasses, and even then, success is not assured.

A species dependent on the sagebrush zone in Mesa County is the Gunnison Sage Grouse (*Centrocercus minimus gunnisonii*). Its population has declined in recent years, probably because of loss of suitable habitat. In some of its range, pinyon-juniper have invaded the sagebrush flats. The Sage Grouse needs abundant grasses and forbs, in addition to the shrubs. Nearly all manipulations of sagebrush for grazing improvements (e.g., chaining, burning and planting of crested wheat), have been detrimental to the birds (Woods and Braun 1995). Wetlands found in the sagebrush vegetation type are cricital habitat for the Sage Grouse as they use wet meadows and riparian areas for brood-rearing.

Pinyon-Juniper Woodlands are a major vegetation type dominating much of Mesa County. Also known as "pygmy forests," pinyon-juniper woodlands cover the slopes of the Uncompahgre Plateau, Grand Mesa, South Shale Ridge and other areas from 4,600 to 8,900 ft., with their highest development between 5,000 and 7,000 ft. At higher elevations they occur on south and west facing slopes. This type accounts for more than half of the BLM lands in the county. It occupies the zone between sagebrush and mountain shrub, often on rocky hillsides. Trees are typically short and widely spaced, with an understory ranging from almost barren to a diverse mixture of shrubs, forbs and grass. Soils are usually coarse, sandy, and shallow, with low fertility. With increased moisture the canopy can become denser, with a resulting decrease in understory vegetation. It is thought that the pinyon-juniper zone has expanded over the last century, perhaps as a result of grazing (Miller and Wigand 1994). Decreasing the grass cover both reduces competition for the tree seedlings and lowers the frequency of fire. The pinyon-juniper type is widespread throughout the western United States, with different species of pinyon pine and juniper in different areas. The species found in Mesa County are pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*), with Rocky Mountain juniper (*Juniperus scopulorum*) occurring mostly in riparian areas. In most of the region pinyon pine and juniper are co-dominant. However, of the two tree species, pinyon is more tolerant of cold, and juniper more tolerant of drought (Mutel and Emerick 1992). Juniper therefore occurs at lower elevations, where it is often mixed with sagebrush and desert shrubs, while pinyon is found at the higher elevations, where it may occur with ponderosa pine and oak. Sites are usually warm and dry, with a mean annual temperature between 45 and 55 degrees F, annual precipitation between 25 and 50 cm, and at least 80 frost-free days (Mutel and Emerick 1992). Erdman (1970) found that in Mesa Verde, pinyon trees in climax pinyon-juniper woodlands were often over 400 years old, and junipers much older.

The shrub understory depends on site characteristics such as slope, aspect, and disturbance history. Shrubs may include saltbush and other species discussed above under the semi-desert shrub vegetation type at the lower elevations; and mountain mahogany (*Cercocarpus montanus*), Gambel's oak, serviceberry (*Amelanchier utahensis*), snowberry, and other shrubs discussed below under mountain shrublands vegetation type, at the higher elevations.

The herbaceous understory is usually sparse, especially where grazed by cattle. Typical native grasses are Indian rice grass, galleta, mutton grass and bottlebrush squirreltail (*Elymus elymoides*). Cheatgrass is the most frequent non-native invader. Common forbs are golden aster (*Heterotheca villosa*), twin bladderpod (*Physaria acutifolia*), yellow cat's-eye (*Cryptantha flava*), and scarlet globemallow (*Sphaeralcea coccinea*). Many of Mesa County's rare plants are found in this zone: Canyonlands lomatium (*Lomatium latilobum*), Dolores skeleton-plant (*Lygodesmia doloresensis*), Fisher Towers milkvetch (*Astragalus piscator*), Grand Junction milkvetch (*A. linifolius*), San Rafael milkvetch (*A. rafaelensis*), Naturita milkvetch (*A. naturitensis*), and Wetherill milkvetch (*A. wetherillii*), and Jones blue-star (*Amsonia jonesii*).

Mountain shrublands occur between the pinyon-juniper zone and the lower limits of ponderosa pine (*Pinus ponderosa*). Often this zone is not well defined, and there is oak mixed with both pinyon-juniper and ponderosa pine. Mountain shrublands occur on hillsides, upland benches, and well-drained lowlands, with 38 to 68 cm of precipitation per year (Johnston 1987) and are widespread in central and western Colorado and Utah (Knight 1994).

Gambel's oak occurs between 5,100 and 9,200 ft. and is most common between 7,000 and 9,000 ft. It may occur as the dominant species, or associated with ponderosa pine, aspen (*Populus tremuloides*), and other mountain shrubs such as mountain mahogany, serviceberry, and snowberry. It often displays its greatest stature in riparian areas, on slopes and benches above streams, where it often forms a band of thick vegetation just above the riparian zone, where pinyon-juniper occupy the drier slopes above.

Gambel's oak is a clonal species, and may live to be very old. Stands in Utah exceed 4,000 years of age (Mutel and Emerick 1992). It is an important invader after fire. In disturbed ponderosa pine forest, it may prevent the re-establishment of pine. Many of the stands in Mesa County may represent seral stages where the climax community will be pinyon-juniper. Erdman (1970) found that in Mesa Verde, oak and the other mountain shrubs became established in only a few years after a fire, and remained dominant for one hundred years before being replaced by pinyon-juniper.

Another notable shrub community, less common in Colorado, occurs in the region. Along the northwest part of the Uncompahgre Plateau, at about 8,000 ft., are hundreds of acres dominated by greenleaf manzanita (*Arctostaphylos patula*). This shrub is also found as an understory in ponderosa pine forest on the Uncompahgre Plateau, but on the exposed slopes here, it occurs without the trees.

Aspen forests. Aspen, the only upland deciduous forest tree in the region, is the most widespread tree in North America, due to its great genetic variability. Although deciduous, aspen is effectively evergreen, because its bark is able to perform photosynthesis, even at freezing temperatures.

Aspen occurs in Mesa County between elevations of 7,200 and 10,200 ft. At lower elevations it is associated with Gambel's oak and ponderosa pine, where it occurs in mesic sites, often in draws with cool air drainage, on north-facing slopes, in riparian zones, or in areas with snowdrifts or seeps. At upper elevations it may be dominant, or mixed with Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*).

Aspen, like Gambel's oak, is clonal. Although individual stems live for about 100 years, their root systems can live for 1,000 or more years (Peet 1988). They are able to thrive in sunny places with poor soils and are thus adapted for colonizing disturbed or burned sites. The other tree which is a major colonizer after fire in the Rocky Mountains, lodgepole pine (*Pinus contorta*), is conspicuously absent from the county. Aspen is especially plentiful in sites once heavily disturbed by mining, logging, and grazing. After disturbance, colonization can be completed within five to ten years. Maximum density is reached in 25 to 50 years, after which shade tolerant species such as Douglas-fir (*Pseudotsuga menziesii*) and subalpine fir may increase. Whether or not aspen is sometimes the climax, rather than a seral species, is a matter of some debate. Presumed climax forests are characterized by large trees, a lush understory, and soil which is loamy, porous, and moist throughout the season (Mutel and Emerick 1992).

Once established, aspen forests are the most species rich of all the upland vegetation types. This may be due to the increased fertility and moisture holding capacity of the soil with the addition of the deciduous leaf litter (Peet 1988). Aspen leaves decompose readily, since they are low in the tannins and resins which retard decomposition in conifer needles (Mutel and Emerick 1992).

Aspen is most abundant in Mesa County on Uncompahgre Plateau and Grand Mesa National Forest lands. Outside Forest Service lands, the Glade Park-Pinyon Mesa area has the most aspen.

Coniferous Forests. Forested areas dominated by conifers, including ponderosa pine, Douglas-fir, Engelmann spruce and subalpine fir, occur above or intermixed with aspen forests. In Mesa County, they occur on the Uncompahgre Plateau, both north and south of Unaweep Canyon, and on Grand Mesa.

Ponderosa pine tends to occupy lower elevation and drier sites, between 7,000 and 8,500 ft, with coarse, shallow and rocky soils. Ponderosa pines are the largest conifers in the Southern Rocky Mountains. The trees are adapted to withstand drought, with taproots up to 35 ft. and lateral roots as long as 100 ft. (Mutel and Emerick 1992). Their thick, corky bark protects them from the frequent ground fires to which they are adapted. Some of the greenleaf manzanita stands may have once had ponderosa pine as an overstory. In their natural state, Ponderosa pine landscapes are open and park-like, with widely spaced trees and a rich understory of native grasses. Removal of grass by grazing reduces fire frequency. Grazing may also increase tree density by removing competition for seedlings. The result is a more closed canopy, with dense stands of weaker trees. Because these trees do not get adequate sun and nutrients, they are unable to produce enough resins, and are susceptible to beetle infestation (Mutel and Emerick 1992).

Douglas-fir is found in cooler and more mesic sites within the ponderosa pine zone, and extending to somewhat higher elevations. It typically occurs in patches on north-facing slopes, in draws, and in riparian areas. It does not form large stands here as it does farther east in the Central Rocky Mountains. Douglas-fir, like ponderosa pine, has thick bark that has adapted it to survive fire. Mature stands have an open structure, maintained by fire. When dense, it is susceptible to spruce budworm and Douglas-fir bark beetle. Douglas-fir is cold tolerant and can perform photosynthesis even under snow (Mutel and Emerick 1992).

Spruce and fir forests are found at the highest elevations in the National Forest land of Mesa County. They are most highly developed between 9,000 and 10,500 ft. The forest typically has a closed canopy, with a sparse understory of shade tolerant species. Interspersed with the forests, and becoming more common at higher elevations, are subalpine meadows or “parks.” Soils are acidic, and often shallow and infertile, due to leaching and the acidic foliage. There is little bacterial activity at the low temperatures of this zone, and much of the carbon in the ecosystem is locked up in humus. Of the two species, spruce is longer lived and has a higher survival rate, whereas fir is shade tolerant, and is able to become established beneath spruce. Subalpine fir is considered by many to be the climax species. However, Aplet et al. (1988) have found that, in forests studied in Colorado, spruce and fir can co-exist indefinitely. Stand development is dependent on a broad range of disturbances, interacting with the life histories of the two species.

Wetlands are most numerous in Mesa County within this vegetation type.

Wetland and Riparian Vegetation

Wetland and riparian vegetation is the most threatened vegetation type in Mesa County. Riparian areas are found within all of the zones discussed above, at all elevations in the county. At the lowest elevations, along the major rivers, the dominant native vegetation is the Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), skunkbrush (*Rhus trilobata*), and coyote willow *(Salix exigua*). Horsetails (*Equisetum* sp.) and scouring rushes (*Hippochaete* sp.) are fairly common in the understory of these riparian areas. Floodplain wetlands along these low elevation rivers are typically dominated by common reed (*Phragmites australis*), cattail (*Typha latifolia*), bulrush (*Schoenoplectus lacustris* ssp. *acutus*), threesquare bulrush (*S. pungens*), alkali bulrush (*Schoenoplectus maritimus*), and saltgrass (*Distichlis spicata*). Above about 5,500 ft., the Rio Grande cottonwood is replaced by narrowleaf cottonwood (*Populus angustifolia*). The understory slowly makes a transition from that similar to Rio Grande cottonwood stands to one dominated by various willows (*Salix* spp.), red-osier dogwood (*Cornus sericea*), chokecherry (*Prunus virginiana*), and wild rose (*Rosa woodsii*). At higher elevations, narrowleaf cottonwood is replaced by river birch (*Betula occidentalis*), alder (*Alnus incana*), aspen (*Populus tremuloides*), Douglas-fir (*Pseudotsuga menziesii*), and blue spruce (*Picea pungens*).

Seep and spring wetlands also occur within the county. The dominant vegetation in these areas varies depending on elevation, topographic position, and the permanence of groundwater discharge. Higher elevation springs often support similar plant species as those found in other wetlands at that elevation. At lower elevations, vegetation ranges from alkaline tolerant species such as common reed, saltgrass, threesquare bulrush, and Baltic rush (*Juncus balticus*) to unique hanging garden plant communities consisting of Eastwood's monkeyflower *(Mimulus eastwoodiae*) and Mancos columbine (*Aquilegia micrantha*). These hanging gardens are one of the most unique wetland types found in Mesa County and are only found along the Dolores River valley in the county. They harbor three rare plant species: Eastwood's monkeyflower, giant helleborine orchid (*Epipactis gigantea*), and southern maidenhair fern (*Adiantum capillus-veneris*). Other seep wetlands along the Dolores River support dense stands of ditch reedgrass (*Calamagrostis scopulorum*). Another very unique wetland in Mesa County in Unaweep Seep, which supports a high density of populations of rare plants, plant communities, butterflies, and birds.

Much of the riparian zone in the county has been invaded by non-native species, the most damaging of which is tamarisk (*Tamarix ramosissima*), a native of the Middle East, which was probably introduced in the U.S. around the turn of the century. It is salt-tolerant, and has displaced much of the native vegetation along the major rivers, and continues to extend its range upstream along the tributaries. Unfortunately, it has proved almost impossible to eradicate. Other common aggressive non-native species in the lower riparian zone are Russian olive (*Elaeagnus angustifolia*), tumble mustard (*Sisymbrium altissimum*), Canada thistle (*Cirsium canadensis*), Russian knapweed

(*Acroptilon repens*), alfalfa (*Medicago sativa*), and sweet clover (*Melilotus alba*; *M. officinalis*). Low elevation wetlands have been invaded by many non-native species such as reedcanary grass (*Phalaris arundinacea*), barnyard grass (*Echinochloa crus-galli*), and cocklebur (*Xanthium strumarium*). Upstream, red top (*Agrostis gigantea*) and Kentucky bluegrass (*Poa pratensis*) are frequent non-natives.

Disruption of the natural flood regime of the rivers by dams and alteration of the river channel has severely impacted regeneration of cottonwoods. Large cottonwood trees are important for nesting and roosting of Bald Eagles, Great Blue Herons, and other birds. Protection of young cottonwoods, and planting new trees along the Colorado River may be necessary to ensure replacement of older trees for the future.

Smaller streams in the canyons and mountains are essential for wildlife. It has been estimated that riparian areas, which account for only 1% of the landscape, are used by greater than 70% of wildlife species (Knopf 1988). In Colorado, 27% of the breeding bird species depend on riparian habitats for their viability (Pague and Carter 1996.) The denser riparian vegetation provides a protected corridor for migration of deer and elk, as well as cover for smaller animals. Riparian areas generally have a greater diversity of plant species than surrounding uplands. Rare or imperiled plants of Mesa County found in riparian zones are the canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) and the giant helleborine orchid (*Epipactis gigantea*). Along the smaller streams, grazing has altered much natural riparian vegetation. Protection of some riparian areas by fencing out cattle has improved some formerly degraded areas.

Observations on Major Threats to Wetland Biodiversity

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.

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
Colorado River	B1	X	X	X	X		X	X	X
Gateway	B1	X		X	X			X	X
Dolores Canyon South	B2	X		X	X			X	X
Escalante Canyon	B2	X			X			X	X
Fruita and Monument Canyons	B2						X		
Gunnison River	B2	X			X				X
John Brown Canyon	B2							X	
Mee Canyon	B2						X		X
Pinon Mesa Canyon	B2				X		X	X	X
Pinyon Mesa	B2				X				
Salt Creek	B2							X	X
Sewemup Mesa	B2			X			X	X	
Unaweep Seep	B2							X	X

Potential Conservation Area	B –rank	Hydrologic Modification	Residential Development	Oil & Gas Development	Incompatible Grazing	Logging	Recreation	Roads	Non-native Species
Vega Reservoir	B2		X					X	
Big Dominguez Creek	B3						X		
Echo Canyon at No Thoroughfare Canyon	B3						X		
Granite Creek	B3								
Park Creek at Vega Reservoir	B3				X			X	X
Rough Canyon	B3						X		
Suphur Gulch Spring	B3								X
Unaweep Canyon	B3							X	X
West Salt Creek	B3				X		X	X	X
Big Creek	B4	X			X				X
East Salt Creek at Sugarloaf Peak	B4	X							X
Lily Lake	B4				X		X		
Little Dolores River	B4	X							X
Long Canyon	B4						X		
No Thoroughfare Canyon	B4						X		
Skyway Point	B4				X				
Willow Creek	B4				X				
Bangs Canyon	B5				X		X		
West Creek at Fall Creek	B5						X		

Some general threats to biodiversity were not observed specifically at PCAs but rather have an effect on biodiversity on a larger landscape-level scale. These threats are discussed in the following text.

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). The flow of both the Colorado and Gunnison rivers has been significantly altered due to water development projects (mainstem dams, diversions, and transmountain water diversions) for irrigation and municipal use. 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 the Colorado and Gunnison rivers and many large 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. Thus, floodplain dynamics along the rivers and smaller tributaries, which are necessary for continued development of wetland habitat, have been greatly altered in Mesa County. New wetlands are not being created within the floodplains, non-native species (e.g. tamarisk) have thrived on this altered flow-regime, and aquatic habitat for endangered fish has been reduced.

In addition to river impoundment, rivers have also been altered by stream bank stabilization projects (e.g., 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, mature cottonwood/shrubland forests occur on terraces, 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, have 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 Mesa 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 recharge 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. However, irrigation-induced wetlands perform some of the functions performed by natural wetlands. For example, 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 Mesa County, especially in the Grand Valley. 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 stresses.

Gravel Mining
In response to Colorado's rapid growth rate, aggregate mining in Colorado has increased by over 30 percent since 1993 (Macalady 2000). As of 2000, there were 82 active gravel mine permits, totalling approximately 3,216 acres, in Mesa County and there are between

350-400 old and active gravel pits scattered along the Colorado River floodplain through Mesa County (Macalady 2000). Floodplain gravel mines remove riparian vegetation and shallow, bottomland habitat and replace them with deepwater ponds. Many native Colorad River Basin fishes, including three endangered species, utilize flooded bottomland habitats to feed, rest, and grow. The decline of these habitats and increase in deepwater ponds, which allow non-naitve fish populations to thrive, has made native fish recovery efforts difficult (Macalady 2000). The removal of riparian vegetation coupled with the increase in non-native plant species such as tamarisk (*Tamarix ramosissima*) has decreased essential habitat for numerous species, especially avian species (Macalady 2000). Alternative exist to minimize impacts associated with gravel mining such as improved reclamation efforts, targeting terrace deposist, utilizing crushed stone, and recycles material such as asphalt (Macalady 2000).

Oil and Gas Development
Oil and gas development is a major threat to biodiversity in Mesa 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.

Livestock Grazing
Domestic livestock grazing, a traditional industry of Mesa County since the late 1800s, has left a broad and often subtle impact on the landscape. Today, many riparian areas in Mesa County are utilized for rangeland. At most elevations in the county, 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 incise, 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 Mesa County, especially on the Uncompahgre Plateau and Grand Mesa. Different types of recreation (e.g., motorized versus non-motorized activities) typically have different effects on ecosystem processes. ATVs can disrupt migration and breeding patterns, and fragment habitat for native resident species. ATVs have also been 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 Mesa County due to livestock activities, past timber harvests, mining operations, and recreation. 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 communties, 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 some 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

Invasion of non-native and aggressive species, and their replacement of native species, is one of the biggest threats to Mesa County's natural diversity (James 1993; D'Antonio and Vitousek 1992). 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. Most of the major river corridors, and many of their tributaries have been invaded by tamarisk and Russian olive. Disturbed areas are quickly colonized by non-native mustard species, Russian thistle (*Salsola* sp.), Russian knapweed, and halogeton (*Halogeton glomeratus*). In general, lower elevations of the county are more affected by non-native and aggressive plant species than higher elevations and level valley bottoms more than steep slopes.

Non-native, aggressive plant species presently addressed in Mesa County under the Colorado Noxious Weed Act (CRS 35-5.5) are white top (*Cardaria* sp.), Russian knapweed, purple loosestrife (*Lythrum salicaria*), leafy spurge (*Tithymalus* sp.), and scotch thistle (*Onopordum acanthium*) (Leupschen 1995). Some of these are not yet established in the county, and it is proper to remain vigilant to prevent their invasion. A more difficult problem is suppression of already established weeds.

Although complete eradication of non-native aggressive species is not possible, some control efforts can pay off. One important guideline is that when a plant is removed, something will take its place. "Ecological voids do not exist" (Young 1981). Simply killing aggressive species, unless there is a seed source for desirable replacements, will result in more unwanted species, perhaps even more noxious than those removed. Seeding of desirable plant species is usually necessary. When seeding, it is important to consider seedbed characteristics including rock cover, and the potential of the soil to support the planted species. A first step is to assess the current vegetation, in relation to the potential of the site. Former attempts to control halogeton were given up because land managers were unable to come up with a desirable species to replace it, especially on saline or alkaline soils (Young 1981). One approach is to experiment on a small scale to determine the potential success of a weed control/seeding project, using native plant species. Ideally, seed should be harvested locally. A mixture of native grasses and forbs is desirable, so that each species may succeed in the microhabitat for which it is best suited.

Non-native species and native weedy species that are prevalent in Mesa County wetlands:

Canada thistle	*Cirsium arvense*
Hoary cress	*Cardaria draba*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Purple loosestrife	*Lythrum salicaria*
Russian knapweed	*Acroptilon repens*
Russian olive	*Elaeagnus angustifolia*
Tamarisk	*Tamarix ramosissima*
Bull thistle	*Cirsium vulgare*
Cocklebur	*Xanthium strumarium*
Common dandelion	*Taraxacum officinale*
Kochia	*Kochia americana*
Russian thistle	*Salsola australis*
White sweet clover	*Melilotus alba*
Yellow sweet clover	*Melilotus officinalis*
Barnyard grass	*Echinochloa crus-galli*
Kentucky bluegrass	*Poa pratensis*
Siberian elm	*Ulmus pumilus*
Smooth brome	*Bromus inermis*
Rice cutgrass	*Leersia oryzoides*
Rabbitfoot grass	*Polypogon monspeliensis*
Bermuda grass	*Cynodon dactylon*
Horseweed	*Conyza canadensis*

In general, tamarisk, Russian olive, Russian knapweed, barnyard grass, bull thistle, Canada thistle, white and yellow sweet clover, horseweed, cocklebur, and Kentucky bluegrass were the most common weeds found in wetland areas.

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 (e.g., edge of a conifer forest adjacent to a meadow) (Forman and 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 (e.g., large mammals or migratory waterbirds).

THE NATURAL HERITAGE NETWORK AND BIOLOGICAL DIVERSITY

Just as ancient artifacts and historic buildings represent our cultural heritage, a diversity of plant and animal species and their habitats represent our “natural heritage.” Colorado’s natural heritage encompasses a wide variety of ecosystems from tallgrass prairie and shortgrass high plains to alpine cirques and rugged peaks, from canyon lands and sagebrush deserts to dense subalpine spruce-fir forests and wide-open tundra.

These widely diversified habitats are determined by water availability, temperature extremes, altitude, geologic history, and land use history. The species that inhabit each of these ecosystems have adapted to the specific set of conditions found there. Because human influence today touches every part of the Colorado environment, we are responsible for understanding our impacts and carefully planning our actions to ensure our natural heritage persists for future generations.

Some generalist species, like house finches, have flourished over the last century, having adapted to habitats altered by humans. However, many other species are specialized to survive in vulnerable Colorado habitats; among them are Bell’s twinpod (a wildflower), the Arkansas darter (a fish), and the Pawnee montane skipper (a butterfly). These species have special requirements for survival that may be threatened by incompatible land management practices and competition from non-native species. Many of these species have become imperiled not only in Colorado, but also throughout their range of distribution. Some species exist in less than five populations in the entire world. The decline of these specialized species often indicates disruptions that could permanently alter entire ecosystems. Thus, recognition and protection of rare and imperiled species is crucial to preserving Colorado’s diverse natural heritage.

Colorado is inhabited by some 800 vertebrate species and subspecies, and tens of thousands of invertebrate species. In addition, the state has approximately 4,300 species of plants and more than 450 recognized plant communities that represent upland and wetland ecosystems. It is this rich natural heritage that has provided the basis for Colorado’s diverse economy. Some components of this heritage have always been rare, while others have become imperiled with human-induced changes in the landscape. This decline in biological diversity 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 biological diversity has been recognized for decades in the scientific community. However, many conservation efforts made in this country were not based upon preserving biological diversity; 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 biological diversity Dr. Robert Jenkins of The Nature Conservancy pioneered the Natural Heritage Methodology in the early 1970s.

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 their biology and known threats. By ranking the relative rarity or imperilment of a species, the quality of its populations, and the importance of associated conservation sites, the methodology can facilitate the prioritization of conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community realized that plant communities are equally important as individual species, this methodology has 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. The 85 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. Information collected by the Natural Heritage Programs can provide a means to protect species before the need for legal endangerment status arises. It can also enable 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 single-celled organisms such as bacteria and protists through the multicellular kingdoms of plants and animals. 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 between these levels. All levels are necessary for the continued survival of species and plant communities, and many are important for the well being of humans.

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

Genetic Diversity — the genetic variation within a population and among populations of a plant or animal species. The genetic makeup of a species varies 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. Once lost, this unique genetic information cannot be reclaimed.

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

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 restricted to an area. Although the terms plant community and association have been described by numerous ecologists, no general consensus of their meaning has developed. The terms are similar, somewhat overlapping, and are often used more or less interchangeably. The U.S. National Vegetation Classification (USNVC) (Anderson et al. 1998), the accepted national standard for vegetation, defines a community as an "assemblage of species that co-occur in defined areas at certain times and that have the potential to interact with one another" (The Nature Conservancy 1999), and a plant association as a type of plant community with "definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910). The term plant "community " is hereafter used in lieu of "association". Identifying and protecting representative examples of plant communities ensures conservation of multiple number of species, biotic interactions, and ecological process. Using plant communities as a "coarse-filter" enables conservation efforts to work toward protecting a more complete spectrum of biological diversity.

Landscape Diversity — the type, condition, pattern, and connectedness of natural communities. A landscape consisting of a mosaic of natural 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 should 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 closely linked to all levels of this hierarchy. We at the Colorado Natural Heritage Program believe that a healthy natural environment and a healthy human environment go hand in hand, and that recognition of the most imperiled species is an important step in comprehensive conservation planning.

Colorado Natural Heritage Program

To place this document in context, it is useful to understand the history and functions of the Colorado Natural Heritage Program (CNHP).

CNHP is the state's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. After operating in the Colorado Division of Parks and Outdoor Recreation for 14 years, the Program was relocated to the University of Colorado Museum in 1992, and then to the College of Natural Resources at Colorado State University in 1994, where it has operated since.

The multi-disciplinary team of scientists, planners, and information managers at CNHP gathers comprehensive information on the 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.

The Biological and Conservation Data System (BCD) developed by The Nature Conservancy is used by all Natural Heritage Programs to house data about imperiled species. This database includes taxonomic group, global and state rarity rank, federal and state legal status, observation source, observation date, county, township, range, watershed, and other relevant facts and observations. The Colorado Natural Heritage Program also uses the Biodiversity Tracking and Conservation System (BioTiCS) for digitizing and mapping occurrences of rare plants, animals, and plant communities. These rare species and plant communities are referred to as "elements of natural diversity" or simply "elements."

Concentrating on site-specific data for each element enables CNHP to evaluate the significance of each location for the conservation of biological diversity in Colorado and in the nation. By using species imperilment ranks and quality ratings for each location, priorities can be established to guide conservation action. A continually updated locational database and priority-setting system such as that maintained by CNHP provides an effective, proactive land-planning tool.

To assist in biological diversity conservation efforts, CNHP scientists strive to answer questions like the following:

- What species and ecological communities exist in the area of interest?
- Which are at greatest risk of extinction or are otherwise significant from a conservation perspective?
- What are their biological and ecological characteristics, and where are these priority species or communities found?
- What is the species' condition at these locations, and what processes or activities are sustaining or threatening them?
- Where are the most important sites to protect?
- Who owns or manages those places deemed most important to protect, and what is threatening those places?
- What actions are needed for the protection of those sites and the significant elements of biological diversity they contain?

- How can we measure our progress toward conservation goals?

CNHP has effective working relationships with several state and federal agencies, including the Colorado Department of Natural Resources, the Colorado Division of Wildlife, the Bureau of Land Management, and the U.S. Forest Service. Numerous local governments and private entities, such as consulting firms, educators, landowners, county commissioners, and non-profit organizations, also work closely with CNHP. Use of the data by many different individuals and organizations encourages a cooperative and proactive approach to conservation, thereby reducing the potential for conflict.

The Natural Heritage Ranking System

Key to the functioning of Natural Heritage Programs is the concept of setting priorities for gathering information and conducting inventories. The number of possible facts and observations that can be gathered about the natural world is essentially limitless. The financial and human resources available to gather such information are not. Because biological inventories tend to be under-funded, there is a premium on devising systems that are both effective in providing information that meets users' needs and efficient in gathering that information. The cornerstone of Natural Heritage inventories is the use of a ranking system to achieve these twin objectives of effectiveness and efficiency.

Ranking species and ecological assocations according to their imperilment status provides guidance for where Natural Heritage Programs should focus their information-gathering activities. For species deemed secure, only general information needs to be maintained by Natural Heritage Programs. Fortunately, the more common and secure species constitute the majority of most groups of organisms. On the other hand, for those species that are by their nature rare, more detailed information is needed. Because of these species' rarity, gathering comprehensive and detailed population data can be less daunting than gathering similarly comprehensive information on more abundant species.

To determine the status of species within Colorado, CNHP gathers information on plants, animals, and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). This factor is weighted more heavily than other factors because an element found in one place is more imperiled than something found in twenty-one places. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats, and the number of protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State-rank or S-rank) and the element's imperilment over its entire range (its Global-rank or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. For example, the lynx, which is thought to be secure in northern North America but is known from less than five current locations in Colorado, is ranked G5 S1 (globally-secure, but critically imperiled in this state). The Rocky Mountain Columbine, which is known only in Colorado from about 30 locations, is ranked a G3 S3 (vulnerable both in the state and globally, since it only occurs in Colorado and then in small numbers). Further, a tiger beetle that is only known from one location in the world at the Great Sand Dunes National Monument is ranked G1 S1 (critically imperiled both in the state and globally, because it exists in a single location). CNHP actively collects, maps, and electronically processes specific occurrence information for animal and plant species considered extremely imperiled to vulnerable in the state (S1 - S3). Several factors, such as rarity, evolutionary distinctiveness, and endemism (specificity of habitat requirements), contribute to the conservation priority of each species. Certain species 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," for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N," for example S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

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 with an "S" or a "G" respectively, followed by a number or letter. These ranks should not be interpreted as legal designations.

Table 3. Definition of Natural Heritage Imperilment Ranks.

G/S1	Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make 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, or 3,000 to 10,000 individuals).
G/S4	Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery.
G/SX	Presumed extinct globally, or extirpated within the state.
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 usually not verified for an extended period of time.
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 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.

Note: Where two numbers appear in a state or global rank (for example, S2S3), the actual rank of the element is uncertain, but falls within the stated range.

Legal Designations for Rare Species

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 Statutes 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 abbreviations used by CNHP.

Candidate species for listing as endangered or threatened under the Endangered Species Act are indicated with a “C." While obsolete legal status codes (Category 2 and 3) are no longer used, CNHP continues to maintain them in its Biological and Conservation Data system for reference.

Table 4. Federal and State Agency Special Designations for Rare Species.

Federal Status:	
1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)	
LE	Listed Endangered: defined as a species, subspecies, or variety in danger of extinction throughout all or a significant portion of its range.
E (S/A)	Endangered: treated as endangered due to similarity of appearance with listed species.
LT	Listed Threatened: defined as a species, subspecies, or variety likely to become endangered in the foreseeable future throughout all or a significant portion of its range.
P	Proposed: taxa formally proposed for listing as Endangered or Threatened (a proposal has been published in the Federal Register, but not a final rule).
C	Candidate: taxa for which substantial biological information exists on file to support proposals to list them as endangered or threatened, but no proposal has been published yet in the Federal Register.
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: Significant current or predicted downward trends in population numbers or density. 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.
4. State Status:	
The Colorado Division of Wildlife has developed categories of imperilment for non-game species (refer to the Colorado Division of Wildlife's Chapter 10 – Nongame Wildlife of the Wildlife Commission's regulations). The categories being used and the associated CNHP codes are provided below.	
E	Endangered: those species or subspecies of native wildlife whose prospects for survival or recruitment within this state are in jeopardy, as determined by the Commission.
T	Threatened: those species or subspecies of native wildlife which, as determined by the Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct.
SC	Special Concern: those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or are a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

Element Occurrences and their Ranking

Actual locations of elements, whether they are 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. To prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the ecological quality of the occurrences 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:

Size – a measure of the area or abundance of the element's occurrence, relative to other known, and/or presumed viable, examples. Takes into account factors such as area of occupancy, population abundance, population density, population fluctuation, and minimum dynamic area (which is the area needed to ensure survival or re-establishment of an element after natural disturbance).

Condition/Quality – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. This includes factors such as reproduction, age structure, biological composition (such as the presence of non-native versus native species), structure (for example, canopy, understory, and ground cover in a forest community), and biotic interactions (such as levels of competition, predation, and disease).

Landscape Context – an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the element, and connectivity. Dominant environmental regimes and processes include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes, and many kinds of natural disturbances. Connectivity includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological communities and systems, and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

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 not enough information is available to rank an element occurrence, an EO-Rank of E is assigned. EO-Ranks and their definitions are summarized in Table 5.

Table 5. Element Occurrence Ranks and their Definitions.

A	Excellent viability.
B	Good viability
C	Fair viability.
D	Poor viability.
H	Historic: known from historical record, but not verified for an extended period of time.
X	Extirpated (extinct within the state).
E	Extant: the occurrence does exist but not enough information is available to rank.
F	Failed to find: the occurrence could not be relocated.

Potential Conservation Areas and Their Ranking

In order to successfully protect populations or occurrences, it is helpful to delineate Potential Conservation Areas (PCAs). 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. Potential Conservation Areas may include a single occurrence of a rare element, or a suite of rare element occurrences or significant features.

The goal of the PCA process is to identify a land area that can provide the habitat and ecological processes upon which a particular element occurrence, or suite of element occurrences, depends for its continued existence. The best available knowledge about each species' life history is used in conjunction with information about topographic, geomorphic, hydrologic features, vegetative cover; and current and potential land uses. In developing the boundaries of a Potential Conservation Area, CNHP scientists consider a number of factors that include, but are not limited to:

- ecological processes necessary to maintain or improve existing conditions;
- species movement and migration corridors;
- maintenance of surface water quality within the PCA and the surrounding watershed;
- maintenance of the hydrologic integrity of the groundwater;
- land intended to buffer the PCA against future changes in the use of surrounding lands;
- exclusion or control of invasive non-native species;
- land necessary for management or monitoring activities.

The boundaries presented are meant to be used for conservation planning purposes and have no legal status. The proposed boundary does not automatically recommend exclusion of all activity. Rather, the boundaries designate ecologically significant areas in which land managers may wish to consider how specific activities or land use changes within or near the PCA affect the natural heritage resources and sensitive species on which the PCA is based. Please note that these boundaries are based on our best estimate of the primary area supporting the long-term survival of targeted species and plant communities. A thorough analysis of the human context and potential stresses has not been conducted. However, CNHP's conservation planning staff is available to assist with these types of analyses where conservation priority and local interest warrant additional research.

Off-Site Considerations
Frequently, all necessary ecological processes cannot be contained within a PCA of reasonable size. For example, taken to the extreme, the threat of ozone depletion could expand every PCA to include the entire planet. The boundaries described in this report indicate the immediate, and therefore most important, area to be considered for protection. Continued landscape level conservation efforts are necessary as well, which will involve regional efforts in addition to coordination and cooperation with private landowners, neighboring land planners, and state and federal agencies.

Ranking of Potential Conservation Areas
CNHP uses element and element occurrence ranks to assess the overall biological diversity significance of a PCA, which may include one or many element occurrences. Based on these ranks, each PCA is assigned a biological diversity rank (or B-rank). See Table 6 for a summary of these B-ranks.

Table 6. Natural Heritage Program Biological Diversity Ranks and their Definitions.

B1	Outstanding Significance (indispensable): Only known occurrence of an element A-ranked occurrence of a G1 element (or at least C-ranked if best available occurrence) Concentration of A- or B-ranked occurrences of G1 or G2 elements (four or more)
B2	Very High Significance: B- or C-ranked occurrence of a G1 element A- or B-ranked occurrence of a G2 element One of the most outstanding (for example, among the five best) occurrences rangewide (at least A- or B-ranked) of a G3 element. Concentration of A- or B-ranked G3 elements (four or more) Concentration of C-ranked G2 elements (four or more)
B3	High Significance: C-ranked occurrence of a G2 element A- or B-ranked occurrence of a G3 element D-ranked occurrence of a G1 element (if best available occurrence) Up to five of the best occurrences of a G4 or G5 community (at least A- or B-ranked) in an ecoregion (requires consultation with other experts)
B4	Moderate Significance: Other A- or B-ranked occurrences of a G4 or G5 community C-ranked occurrence of a G3 element A- or B-ranked occurrence of a G4 or G5 S1 species (or at least C-ranked if it is the only state, provincial, national, or ecoregional occurrence) Concentration of A- or B-ranked occurrences of G4 or G5 N1-N2, S1-S2 elements (four or more) D-ranked occurrence of a G2 element At least C-ranked occurrence of a disjunct G4 or G5 element Concentration of excellent or good occurrences (A- or B-ranked) of G4 S1 or G5 S1 elements (four or more)
B5	General or State-wide Biological Diversity Significance: good or marginal occurrence of common community types and globally secure S1 or S2 species.

Protection Urgency Ranks

Protection urgency ranks (P-ranks) refer to the timeframe in which it is recommended that conservation protection occur. In most cases, this rank refers to the need for a major change of protective status (for example agency special area designations or ownership). The urgency for protection rating reflects the need to take legal, political, or other administrative measures to protect the area. Table 7 summarizes the P-ranks and their definitions.

Table 7. Natural Heritage Program Protection Urgency Ranks and their Definitions.

P1	Protection actions needed immediately. It is estimated that current stresses may reduce the viability of the elements in the PCA within 1 year.
P2	Protection actions may be needed within 5 years. It is estimated that current stresses may reduce the viability of the elements in the PCA within this approximate timeframe.
P3	Protection actions may be needed, but probably not within the next 5 years. It is estimated that current stresses may reduce the viability of the elements in the PCA if protection action is not taken.
P4	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 protection accorded one or more tracts within 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. Situations that may require a protection action are as follows:

- Forces that threaten the existence of one or more element occurrences at a PCA. For example, development that would destroy, degrade or seriously compromise the long-term viability of an element occurrence; or timber, range, recreational, or hydrologic management that is incompatible with an element occurrence's existence;

- The inability to undertake a management action in the absence of a protection action; for example, obtaining a management agreement;

- In extraordinary circumstances, a prospective change in ownership or management that will make future protection actions more difficult.

Management Urgency Ranks

Management urgency ranks (M-ranks) indicate the timeframe in which it is recommended that a change occur in management of the element or PCA. This rank refers to the need for management in contrast to protection (for example, increased fire frequency, decreased grazing, 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 non-natives, 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. Table 8 summarizes M-ranks and their definitions.

Table 8. Natural Heritage Program Management Urgency Ranks and their Definitions.

M1	Management actions may be required within one year or the element occurrences could be lost or irretrievably degraded.
M2	New management actions may be needed within 5 years to prevent the loss of the element occurrences within the PCA.
M3	New management actions may be needed within 5 years to maintain the current quality of the element occurrences in the PCA.
M4	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 Mesa County. The highest quality occurrences of each wetland type were targeted during the field season. Wetland types were defined using plant communities. CNHP classifies wetland and riparian plant communities, not wetland types. Plant communities reflect the broad nature of wetlands in the study area (e.g., 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 Mesa County.

Collect Available Information

CNHP databases were updated with information regarding the known locations of species and significant plant communities within Mesa 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 U.S. Fish and Wildlife Service and Colorado Division of Wildlife provided data on the fishes of Mesa County. Both general and specific literature sources were incorporated into 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 CNHP's Biological Conservation Database (BCD).

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

The list of plant communities thought to occur in Mesa 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., CNHP Riparian Classification, CNHP wetland surveys, and Colorado State University. The CSWCC incorporates all these data on riparian and other wetlands collected during the past 11 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 Mesa 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 CNHP that were thought to potentially occur in Mesa County and were therefore targeted in 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 (S1-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, e.g., "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 mostly free of visible disturbances such as roads, trails, fences, quarries, etc.

The above information was used to delineate over 67 survey areas that were believed to have high probability of harboring natural heritage resources.

Roadside surveys were useful in further resolving the natural condition of these areas. The condition of wetlands 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 Mesa 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, and 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 qualitative wetland functional evaluation 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 survey area, 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 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 communities in the wetland complex, including the amount of wetland area covered by that community. In almost all cases, plant communities were immediately placed within CNHP's Statewide Wetland Classification. However, on rare occasions a plant community was encountered which could not be easily classified based on the stands that had been previously sampled.
- vegetation data for each major plant community in the wetland were collected using visual ocular estimates of species cover in a representative portion of the plant community.
- sketch of the site layout, with distribution of community types indicated (this was generally done on the 7.5-min. 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 (e.g., horizons, texture, color, cobble size, percent mottling) or from information from the county soil surveys.

Qualitative Functional Assessment

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

Restoration Potential

- cause of disturbances, if any (e.g., 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.

Colorado/Gunnison River Priority Area Analysis

Given that ecological processes driving wetland communities along the Colorado/Gunnison rivers occur over such a large scale, the Potential Conservation Areas identified along these river corridors are very large. The boundaries indicate the area most needed to protect the elements contained within them. However, CNHP realizes that these large-scale boundaries may not be fine enough to direct conservation activities at a scale useful to the Western Colorado Five River Wetland Focus Area Committee. Thus, an additional analysis was performed along the Colorado and Gunnison rivers to identify smaller Priority Areas *within Mesa County*, which would greatly contribute to wetland conservation due to the amount and type of biological value each area has. This analysis used CNHP data, Rocky Mountain Bird Observatory and BLM bird density data, USFWS data on important habitat for endangered fish, Mesa County GIS layers (public lands layer), conservation easement information from various sources, and locations of tamarisk eradication projects from the Tamarisk Coalition, BLM, and the National Park Service.

Specific data collected and put into the GIS layer includes:

(1) CNHP element occurrence locations;

(2) Rocky Mountain Bird Observatory and Bureau of Land Management data on bird density/mile along the Colorado and Gunnison rivers. Most of these data are from the BLM and were collected June and July of 1998 by Coen Dexter. The data were received in a GIS layer from the BLM. An additional field was created in the attribute table grouping the data into four different categories according to # of species/mile: (1) 39-51 species/mile; (2) 28-38 species/mile; (3) 17-27 species/mile; and (4) 6-16 species/mile. Importance of individual species was not considered but should not be overlooked.

(3) USFWS data on important bottomland habitat (especially for spawning) for the endangered razorback sucker were extracted form Irving and Burdick (1995) and from a meeting with Bob Burdick of the USFWS, Grand Junction. The Irving and Burdick report inventoried 110 bottomland sites believed to be important for recovery of endangered fishes, along the Colorado River and 48 along the Gunnison River[1]. Of those 158 sites, 54 occur in Mesa County. Irving and Burdick ranked the 158 sites and then produced a table (Table 3 in Irving and Burdick 1995) listing those sites ranked in the Top 13. It should be noted that 26 bottomland sites were ranked in the Top 13 due to the fact that many had the same ranking. Of those 26, only 10 occur in Mesa County. These 10 sites were given higher priority in the analysis used in this report, than those not ranked in the Top 13. They are labeled Top 13 sites hereafter.

(4) USFWS data on important areas for the Colorado pikeminnow were obtained from a meeting with Doug Osmundson[1]. Doug indicated which areas along the Colorado and Gunnison Rivers have had high number of pikeminnow captures in the past.

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[1] Data on important bottomland habitat for the razorback sucker, "High Use" pikeminnow areas, and pikeminnow spawning locations, presented in this report should only be used for prioritization purposes. Any person wishing to restore, enhance, and/or acquire property for the purpose of aiding the conservation of endangered fish should consult with the United States Fish and Wildlife Service, Colorado River Fish Recovery Program and Colorado Division of Wildlife in Grand Junction, CO.

These areas are hereafter referred to as "High Use" areas. Doug also indicated which areas are currently used by the pikeminnow as spawning areas. It should be noted, however, that populations of pikeminnow need an extensive length of river with a variety of habitat types in order to meet the changing needs of different life stages (Osmundson 2001). For example, during the winter pikeminnows typically remain in localized segments of the river, mostly in low-velocity habitats, while in the spring, pikeminnow often seek out warm, off-channel, low to zero velocity parts of the river to avoid high velocities and low water temperatures in the main-channel (Osmundson 2001). Thus, protecting only those areas with "High Use" would not be adequate for the conservation of this species. Habitat types for each life stage must be preserved.

After the above data were gathered and put into a GIS, ArcView was used to overlay all of the data layers to indicate where overlap occurred. In areas along the rivers where three or more data layers overlapped, a Priority Area was digitized. The Priority Areas were then ranked according to a simple scoring method (Table 9). Each site was scored according to the amount and type of overlap amongst data layers. When a Priority Area overlapped multiple river miles, bird density values were averaged. That is, if a Priority Area encompassed three river miles with bird densities of 22, 20, and 24, the average density of 22 species/mile would be used to tabulate the bird density score. Once all the data layer scores were calculated, they were then tabulated to arrive at a Final Score, which was then used to rank the Priority Areas. For example, a site which has two CNHP EORs (score=2), 25 bird species/mile (score=2), bottomland habitat that was not ranked in the Top 13 (score=1), and Colorado pikeminnow habitat considered "high use" which is also a spawning area (score=2) would receive a Final Score of 7. The digitized Priority Areas were then compared to a land status layer to indicate the amount of public vs. private land. The Priority Areas were also compared to the Tamarisk Project layer to indicate which had or are undergoing tamarisk removal projects.

Table 9 Colorado/Gunnison River Priority Areas - Scoring Method

Data Layer	Value	Score
CNHP Element Occurrences (EORs)	Yes No	1 x # of EORS 0
Bird Density	39-51 species/mile 28-38 species/mile 17-27 species/mile 6-16 species/mile	4 3 2 1
Bottomland Habitat (Razorback Sucker)	Yes, Top 13 Site Yes, Not in Top 13 No	2 x # of sites 1 x # of sites 0
Colorado Pikeminnow "High Use"	Yes + spawning area Yes not spawning area No	2 1 0

RESULTS

CNHP ecologists identified 67 wetland/riparian Targeted Inventory Areas (TIAs) that merited on-site investigation (Figure 6). Out of these TIAs, 40% are encompassed within Potential Conservation Areas and 5% are presented as Sites of Local Significance. 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 (16%) were heavily impacted by roads, buildings, non-native species, agriculture, and/or grazing and were dropped from the inventory. Due to time limitations, 34% of the TIAs were not visited; most of these were located on U.S. Forest Service and Bureau of Land Management land. In addition, much of the summer was spent along the Colorado and Gunnison river corridors as part of the "Priority Area Analysis." CNHP ecologists were denied access and/or unable to contact landowners for 3% of the TIAs.

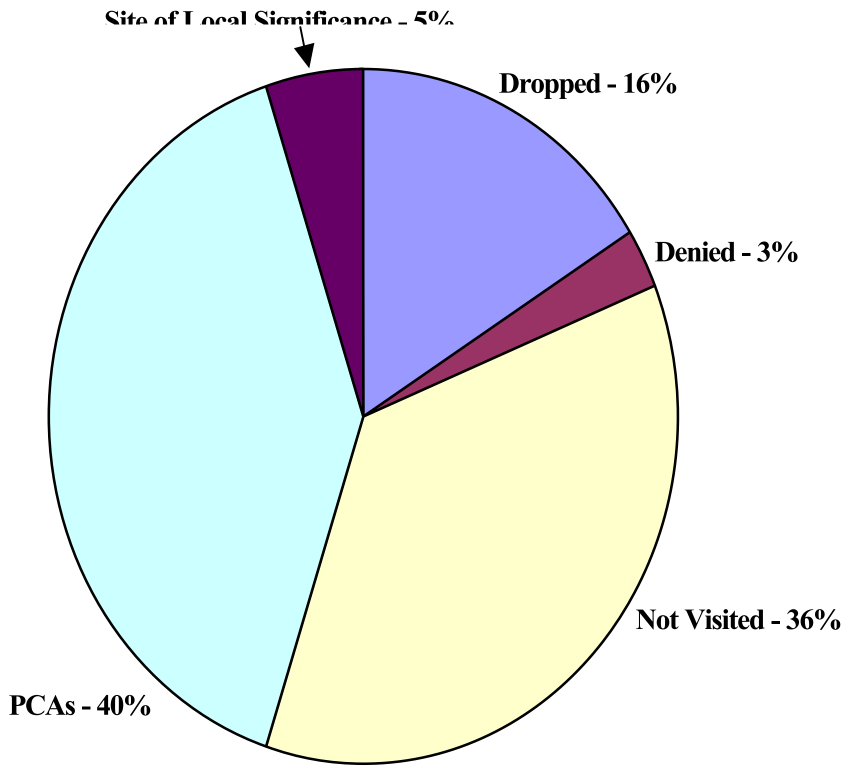


Figure 6. Summary of Targeted Inventory Areas.

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 in the Potential Conservation Areas in this report. This is not a comprehensive list of the elements known to occur in or associated with wetlands in Mesa County, but rather only includes those elements deemed significant enough to be archived in CNHP's Biological Conservation Data System.

Table 10. List of known elements of concern by taxonomic group.
Elements with the highest global significance (G1-G3) are in bold type. Detailed descriptions of the wetland elements listed below can be found in the Natural History section.

Element	Common Name	Global Rank	State Rank	Federal and State Status
Plants				
Adiantum capillus-veneris	Southern maidenhair fern	G5	S2	FS
Centaurium arizonicum	Arizona centaury	G5?	S1	
Comarum palustre	Marsh cinquefoil	G5	S1S2	
Erigeron kachinensis	**Kachina daisy**	**G2**	**S1**	**BLM**
Epipactis gigantea	Giant helleborine	G3	S2	FS
Lygodesmia doloresensis	**Dolores skeletonplant**	**G1Q**	**S1**	**BLM**
Mimulus eastwoodiae	**Eastwood's monkeyflower**	**G3**	**S2**	**BLM**
Platanthera sparsiflora ssp. *ensifolia*	Canyon bog-orchid	G4G5T4?	S3	
Plant Communities				
Abies lasiocarpa-Picea engelmannii/Alnus incana	Montane riparian forest	G5	S5	
Acer negundo-Populus angustifolia/Celtis reticulata	**Narrowleaf cottonwood riparian forest**	**G1Q**	**S1Q**	
Acer negundo/Hippochaete hyemalis	Montane riparian deciduous forest	GU	SU	
Alnus incana-Cornus sericea	**Thinleaf alder-Red-0sier dogwood riparian shrubland**	**G3Q**	**S3**	
Alnus incana/Mesic forb	Thinleaf alder/Mesic forb riparian shrubland	G3G4Q	S3	
***Alnus incana*/Mixed Salix**	**Thinleaf alder-mixed willow species**	**G3**	**S3**	
Alnus incana/Salix drummondiana	**Montane riparian shrubland**	**G3**	**S3**	
Aquilegia micrantha-Mimulus eastwoodiae	**Hanging gardens**	**G2G3**	**S2S3**	
Betula occidentalis/Cornus sericea	**Lower montane riparian shrubland**	**G3?**	**S1S2**	
***Betula occidentalis*/Mesic forb**	**Foothills riparian shrubland**	**G4?**	**S2**	
Carex pellita	**Montane wet meadows**	**G3**	**S3**	
Cornus sericea	Foothills riparian shrubland	G4Q	S3	
Eleocharis palustris	Common spikerush emergent wetlands	G5	S4	
Eleocharis rostellata	**Creeping spikerush emergent wetlands**	**G2G3**	**S2S3**	
Forestiera pubescens	**Foothills riparian shrubland**	**G1G2**	**S1S2**	
Phragmites australis	Western slope marshes	G5	S3	
Picea pungens/Cornus sericea	Blue spruce/Red-osier dogwood	G4	S2	
Populus angustifolia/Betula occidentalis	**Montane riparian forest**	**G3**	**S2**	
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood riparian forest	G4	S3	
Populus angustifolia-Picea pungens/Alnus incana	Montane riparian forest	G4	S4	

Element	Common Name	Global Rank	State Rank	Federal and State Status
Populus angustifolia-Pseudotsuga menziesii	**Douglas-fir/Narrowleaf cottonwood**	**G3**	**S2**	
Populus angustifolia/Salix eriocephala var. ligulifolia-Shepherdia argentea	**Narrowleaf cottonwood riparian forest**	**G1**	**S1**	
Populus angustifolia/Salix exigua	Narrowleaf cottonwood riparian forest	G4	S4	
Populus deltoides ssp. wislizeni/Salix exigua	Rio Grande cottonwood riparian forest	GU	S1S2	
Populus deltoides ssp. wislizeni/Rhus trilobata	**Rio Grande cottonwood riparian forest**	**G2**	**S2**	
Populus tremuloides/Acer glabrum	**Montane riparian forests**	**G2**	**S1S2**	
Salix exigua/Equisetum hyemale	**Lower montane riparian shrubland**	**G2G4?**	**S2S4**	
*Salix exigua/*Mesic graminoid	Coyote willow/Mesic graminoid	G5	S5	
*Salix monticola/*Mesic forb	Montane riparian willow carr	G4	S4	
Sarcobatus vermiculatus/Suaeda torreyana	**Saline bottomland shrublands**	**G2G3**	**S2S3**	
Schoenoplectus acutus	Hardstem bulrush emergent wetland	G5	S4?	
Schoenoplectus maritimus	Alkali bulrush emergent wetland	G4	S2	
Schoenoplectus pungens	Threesquare bulrush marsh	G3G4	S3	
Spartina gracilis	Salt meadows	GU	SU	
Amphibians				
Hyla arenicolor	Canyon treefrog	G5	S2	BLM, SC
Rana pipiens	Northern leopard frog	G5	S3	FS/BLM, SC
Spea intermontana	Great Basin spadefoot	G5	S3	BLM, SC
Birds				
Asio flammeus	Short-eared Owl	G5	S2B, SZN	
Bucephala islandica	Barrow's Goldeneye	G5	S2B, SZN	BLM, SC
Centrocercus minimus	**Gunnison Sage Grouse**	**G1**	**S1**	**BLM, SC**
Egretta thula	Snowy Egret	G5	S2B, SZN	
Empidonax traillii extimus	**Southwest Willow Flycatcher**	**G5T1T2**	**SR**	**FS, LE, E**
Falco peregrinus anatum	**American Peregrine Falcon**	**G4T3**	**S2B, SZN**	**SC**
Grus canadensis tabida	Greater Sandhill Crane	G5T4	S2B, S4N	FS, T
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T
Numenius americanus	Long-billed Curlew	G5	S2B, SZN	FS/BLM, SC
Fish				
Catostomus latipinnis	**Flannelmouth sucker**	**G3G4**	**S3**	**BLM, SC**
Gila cypha	**Humpback chub**	**G1**	**S1**	**LE, T**
Gila elegans	**Bonytail chub**	**G1**	**Sx**	**LE, E**
Gila robusta	**Roundtail chub**	**G3**	**S2**	**BLM, SC**
Ptychocheilus lucius	**Colorado pikeminnow**	**G1**	**S1**	**LE, T**
Xyrauchen texanus	**Razorback sucker**	**G1**	**S1**	**LE, E**
Oncorhynchus clarki pleuriticus	**Colorado River cutthroat trout**	**G4T3**	**S3**	**FS/BLM, SC**
Invertebrates				
Ochlodes yuma	Yuma skipper	G5	S2S3	
Speyeria nokomis nokomis	**Nokomis fritillary**	**G3T1**	**S1**	**BLM**

Sites of Biodiversity Significance

The 27 most important wetland sites in Mesa 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. Three Sites of Local Significance are also profiled. These sites were chosen based on the local importance of their ecological functions within Mesa County. These Sites of Local Significance did not receive B-ranks.

The PCAs are organized in ascending order according to their B-Rank (e.g. B1 to B5). Sites of Local Significance are profiled after the PCAs. Priority Areas, intended to assist the Lower Colorado River Focus Area Committee in site-specific conservation, are listed in the Colorado and Gunnison River Potential Conservation Areas.

Each Potential Conservation Area (PCA) is described in a standard site profile report that reflects data fields in 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 *Natural Heritage Ranking System* section for more details.

Protection Urgency Rank: P#
A summary of major land ownership issues that may affect the long-term viability of the site and the element(s).

Management Urgency Rank: M#
A summary of major management issues that may affect the long-term viability of the site and the element(s).

Location: General location.

Legal Description: USGS 7.5-minute Quadrangle name(s) and Township Range Section(s).

Size: Expressed in acres.

Elevation: Expressed in feet.

General Description: A brief narrative of the topography, hydrology, vegetation, and current use of the potential conservation area.

Biodiversity Rank Comments: 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 3 for explanations of ranks and Table 4 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 Rank Comments: Discussion of major land ownership issues that may affect the long-term viability of the site and the element(s).

Management Rank Comments: Discussion of major 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* (USDA 1994).

Wetland Functional Assessment: A summary of the functions and the proposed HGM classification, Cowardin system, and the plant community derived from CNHP's Statewide Wetland Classification for the wetlands occurring within each Potential Conservation Area. (Note: Some of the sites profiled in this report were not visited by the author but rather by previous CNHP ecologists. For these sites, a 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 is detailed in the site profile.)

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

Table 11 displays all 32 PCAs and the two Sites of Local Significance in the Mesa 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 (e.g., U.S. Forest Service and BLM) was not conducted.

Table 11. Potential Conservation Areas identified in Mesa County, arranged by biodiversity rank (B-rank).

Potential Conservation Areas
B1
Colorado River
Gateway
B2
Dolores Canyon South
Escalante Canyon
Fruita and Monument Canyons
Gunnison River
John Brown Canyon
Mee Canyon
Pinon Mesa Canyons
Pinyon Mesa
Salt Creek
Sewemup Mesa
Unaweep Seep
Vega Reservoir
B3
Big Dominguez Creek
Echo Canyon at No Thoroughfare Canyon
Granite Creek
Park Creek at Vega Reservoir
Rough Canyon
Suphur Gulch Spring
Unaweep Canyon
West Salt Creek
B4
Big Creek
East Salt Creek at Sugarloaf Peak
Lily Lake
Long Canyon
No Thoroughfare Canyon
Skyway Point
Willow Creek
B5
Bangs Canyon
Lower Little Dolores River
West Creek at Fall Creek
Sites of Local Significance
Highline Lake
Jerry Creek Reservoirs

Figure 7. Map of PCAs and Sites of Local Significance in the Mesa County study area.

Called mesa all pcas.

Colorado River Potential Conservation Area

Biodiversity Rank: B1. Irreplaceable. Multiple occurrences of globally critically imperiled (G1) fish.

Protection Urgency Rank: P2. Protection actions may be needed within five years. It is estimated that stresses may reduce the viability of the elements within this timeframe. A large portion of this site is privately owned and has no protection.

Management Urgency Rank: M2. New management actions may be needed within five years to prevent the loss of the element occurrences. Restoration of riparian vegetation and aquatic habitat needs to occur.

Location: This site extends from Rifle to the Colorado-Utah state line.

U.S.G.S. 7.5-min. quadrangle: Anvil Points, Rifle, Silt, Red Pinnacle, Grand Valley, Rulison, North Mamm Peak, Wagon Trail Ridge, De Beque, Bitter Creek Well, Ruby Canyon, Mack, Fruita, Cameo, Mesa, Westwater, Colorado National Monument, Palisade, Clifton, and Grand Junction.

Legal Description:
T1N R1W, sec. 31;
T1N R2W sec. 17-21, 26-29, 33-36;
T1N R3W sec 6-18;
T1S R1E sec. 12-14, 16, 19-24, 27-30;
T1S R1W sec. 5-10, 15-17, 22-24;
T1S R2E sec. 1-5, 7-10, 17-19;
T6S R92W sec. 7-11, 15, 16;
T6S R93W sec. 10-20;
T6S R94W sec. 13, 14, 22-24, 26-31, 33, 34;
T6S R95W sec. 25, 32-36;
T7S R95W sec. 1-8, 18;
T7S R96W sec. 12-14, 23-27, 32-34;
T8S R96W sec. 4-8, 18;
T8S R97W sec. 12-14, 22, 24, 26-28, 32-34;
T9S R97W sec. 4, 5, 7-9, 17-19, 29-31;
T9S R98W sec. 25, 36;
T10S R97W sec. 6, 7, 18, 19;
T10S R98W sec. 12-14, 22-24, 26, 27, 33-35;
T10S R103W sec. 4-8, 15-22, 30;
T10S R104W sec. 13, 23-28, 32-35;
T11S R98W sec. 2, 3, 8-11;
T11S R101W sec. 14, 15;
T11S R104W sec. 3-9.

Elevation: 4,440 to 5,689 ft.   Size: Approximately 44,054 acres.

General Description: This site includes the stretch of the Colorado River that extends from Rifle to the Utah border. The Colorado River riparian corridor is the most heavily developed area in Mesa County. The floodplains near the river were historically dominated by stands of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) with an understory of skunkbrush *(Rhus trilobata*). However, development of the floodplain, agriculture, and most notably, the invasion of non-native species such as tamarisk (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), and Russian knapweed (*Acroptilon repens*) have greatly reduced the amount of native riparian vegetation within this PCA. Along the immediate banks of the river and around wetlands in the floodplain, coyote willow (*Salix exigua*), cocklebur (*Xanthium strumarium*), barnyard grass (*Echinochloa crus-galli*), reedcanary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), cattail (*Typha latifolia*), hardstem bulrush (*Schoenoplectus acutus*), threesquare bulrush (*S. pungens*), alkali bulrush (*Schoenoplectus maritimus*), and redroot flatsedge (*Cyperus erythrorhizos*) are typically dominant.

This site provides critically important habitat for endangered fish such as the razorback sucker (*Xyrauchen texanus*), Colorado pikeminnow (*Ptychocheilus lucius*), and humpback chub (*Gila cypha*). The river reach from New Castle into De Beque Canyon supports populations of roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomas latipinnis*), and mountain whitefish (*Prosopium williamsoni*). In addition, a recovery program for razorback suckers (*Xyrauchen texanus*) stocked a total of 29,377 juvenile and adult razorback suckers 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 and 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 have the potential to support nesting Bald Eagles, and in time eagles could repopulate this PCA as populations continue to expand after the DDT induced declines of the 1970s and 80s. Reestablishment of the Bald Eagles is dependant on the current quality of the area is maintained or improved upon.

This 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* ssp. *wislizeni*), skunkbrush (*Rhus trilobata*), tamarisk (*Tamarix ramosissima*), and Russian olive (*Elaeagnus angustifolia*). Small patches of the globally imperiled (G2S2) Rio Grande cottonwood riparian forest (*Populus deltoides* ssp. *wislizeni/Rhus trilobata*) dot the islands and portions of the floodplain. Sporadic marshes dominated by cattail (*Typha* sp.) and hardstem bulrush (*Schoenoplectus acutus*) and alkaline meadows dominated by Baltic rush (*Juncus balticus*), common threesquare, and saltgrass (*Distichlis spicata*) are scattered throughout the floodplain. Most patches of the Rio Grande cottonwood forest are only in fair condition due to the influx of non-native shrubs such as tamarisk and Russian olive and improper grazing. Although small, the most intact stands of this community in Mesa County occur on an island within the Bureau of Reclamation's De Beque Wildlife Area and on private land in the Cameo area.

The narrow De Beque Canyon portion of the river is historical habitat for at least two of the river’s endangered fish. However, recent surveys conducted by Colorado Division of Wildlife (CDOW) and United States Fish and Wildlife Service (USFWS) did not locate any Colorado pikeminnow (Osmundson 2001). A proposed fish ladder would enable the natural migration of the fish to take place. If it is built, the fish could be returned to the canyon within a few years. Other species of concern in De Beque Canyon include Peregrine Falcons, Bald Eagles, Great Blue Herons, and the northern leopard frog (*Rana pipiens*). Although isolated patches of Rio Grande cottonwood forest in fair to good condition remain, much of the understory vegetation has been replaced by tamarisk.

The Grand Valley portion of the river is highly developed and heavily used for agriculture. Nonetheless, it is the most important stretch of the river in Mesa County for the endangered fish due to the amount of historical and current backwater areas, sloughs, and ponds which provide critical habitat for these fish. Most of the cottonwood galleries have been heavily infested with tamarisk, Russian olive, and Russian knapweed but still provide valuable wildlife habitat and perform importance ecological functions in an otherwise arid, urbanizing landscape.

The stretch of river through Horsethief and Ruby Canyon does not contain extensive stands of riparian vegetation but does contain important areas for the endangered fishes.

Difficulties encountered in the recovery efforts for the razorback sucker and Colorado pikeminnow are not unrelated to other conservation issues in the area. Natural flows of the river have been altered by upstream water diversions, dams, and levees, resulting in a lack of floodplain dynamics that are critical to wetland habitat creation, regeneration of cottonwoods, and maintenance of aquatic habitat for native fishes. Floods, which created the areas that the fish historically used for spawning, and which are also necessary for the normal regeneration of cottonwood and willow, are no longer viable options because of the water development in the area and develoment within the floodplain. The lack of natural flooding has increased tamarisk invasion, which, in turn, reduces flows via very high transpiration rates and increased sedimentaion (Nature Conservancy 1998). Decreased flows and the absence of flushing results in a concentration of elements such as selenium, which move up the food chain, affecting the survival of the fish.

The area near Grand Junction is an important area for open space and recreation. Grand Junction’s Riverfront Project includes a system of trails and protected areas and the Western Colorado Botanic Garden. State protected areas include the Walker State Wildlife Area, and Connected Lakes Park. The U. S. Fish and Wildlife Service’s Colorado River Recovery Program uses the area as an experimental spawning ground for endangered fish.

Biodiversity Rank Justification: The site includes multiple occurrences of three of the endangered fish of the Colorado River, the razorback sucker, Colorado pikeminnow, and humpback chub. Razorbacks are considered globally critically imperiled (G1). The USFWS and Colorado Division of Wildlife list the razorback sucker as endangered. Fewer than seventy specimens of razorback sucker have been collected since 1979, and these have all been adult fish, which may live for thirty years (Woodling 1985). This suggests that reproductive failure is the cause of their decline. Lack of recruitment of young into the population has been attributed to predation by non-native species including catfish and carp. Dams may block access to spawning habitats, change suitable juvenile habitat, block upstream migration, and lower water temperatures. There are confirmed spawning areas in Mesa County at Clifton, and the Colorado River between Grand Junction and Clifton is one of the main concentration areas of the fish. Backwaters, eddies, and impoundments are critical habitat for the fish. The fish are often associated with sand, mud and rock substrates in areas with sparse aquatic vegetation and moderate to warm temperatures (Sigler and Miller 1963). The Colorado River has been stocked with razorback suckers along the Rifle stretch.

Colorado pikeminnow are considered globally critically imperiled (G1). The USFWS and Colorado Division of Wildlife list the Colorado pikeminnow as endangered. The Colorado pikeminnow was once an important commercial fish throughout the Colorado River drainage in mainstream channels, including the Green, Yampa, White, Colorado, Gunnison, Dolores, and Animas rivers. Its current distribution is restricted to the lower reaches of the these rivers, except the Dolores and Animas (Woodling 1985.) The decline of the fish is not fully understood. It is thought that dams have restricted spawning migrations, and that lowered water temperatures resulting from cold-water releases prevent the development of fertilized eggs. Biotic interactions with other introduced fish species may also have impacted their decline (Woodling 1985). Young pikeminnows prefer small, quiet backwaters. Adults use various habitats, including deep, turbid, strongly flowing water, eddies, runs, flooded bottoms, or backwaters (especially during high flow). Lowlands inundated during spring high flow appear to be important habitats (Tyus and McAda 1984). Efforts for the recovery of the pikeminnow include reintroduction and the construction of fish ladders to facilitate their natural migration (R. Anderson, CDOW, personal communication.).

Humpback chub are considered globally critically imperiled (G1). The USFWS and Colorado Division of Wildlife list the humpback chub as endangered. The humpback chub was historically widely distributed throughout the Colorado River Basin to which it is endemic. Its habitat has been altered by the construction of dams, and today it is found in widely separated river areas in the upper and lower Colorado Basin. The species is also threatened by hybridization with the roundtail chub (*Gila robusta*). Reduced river flows allow the round tail chub to successfully inhabit some deep water areas during low water periods where humpback chubs were previously isolated, resulting in competition and hybridization. Intermediates between the species occur in altered river systems, but not in unaltered rivers, emphasizing the importance of natural riverine environments for the recovery of the species (Tyus and Karp 1989).

This site supports multiple occurrences of the globally imperiled (G2) Rio Grande cottonwood/skunkbrush (*Populus deltoides* ssp. *wislizeni*/*Rhus trilobata*) riparian forest. This community 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 of cottonwoods is poor at all sites, and tamarisk is invading stands of this type on many of the aforementioned rivers.

Historically, only two to three pairs of Bald Eagles nested in Colorado, but the nesting paris have increased steadily since the 1980 to 38 confirmed nests in 1995 (Winternitz 1998). There were active nests along the Colorado River in the mid-1990's but they have not been successful since the early 1980s (Lyon et. al 2001). However, recently an active and successful nest was discovered on one of the large islands near Rhone (Soker, D. USFWS, personal communication, 2001). Colorado is a very popular wintering area for Bald Eagles. The annual midwinter count shows a stable population of 600 to 800 eagles. 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 species which is vulnerable through its range (G4T3).

The site also contains a nesting site for Great and Snowy Egrets. A portion of this site has also been designated an Important Bird Area (Grand Valley Riparian Corridor) by the Audubon Society due to the fact that nearly 300 bird species have used the lowland riparian vegetation in the Grand Valley over the last 15 years. This includes nearly 70 breeding species and over 70 wintering species (National Audubon Society 2000).

Table 12. Natural Heritage element occurrences at Colorado River PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	E
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila elegans	Bonytail chub	G1	Sx	LE, E	H
Gila robusta	Roundtail chub	G3	S2	SC	B
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Catostomus latipinnis	Flannelmouth sucker	G3G4	S3	BLM, SC	A
Prosopium williamsoni	Mountain whitefish	G5	S3		C
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	D
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	H
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	H
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	H
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	H
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	H
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT, T	H
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S2B, SZN	SC	B
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S2B, SZN	SC	C

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S2B, SZN	SC	D
Grus canadensis tabida	Greater Sandhill Crane	G5T4	S2B, S4N	FS, SC	C
Amphibians					
Rana pipiens	Northern leopard frog	G5	S3	FS/BLM, SC	B
Rana pipiens	Northern leopard frog	G5	S3	FS/BLM, SC	E
Spea intermontana	Great Basin spadefoot	G5	S3	BLM, SC	B
Spea intermontana	Great Basin spadefoot	G5	S3	BLM, SC	H
Plant Communities					
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		B
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		BC
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		BC
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		D
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		D
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		E
Plants					
Centaurium arizonicum	Arizona centaury	G5?	S1		D

*EO=Element Occurrence. Multiple listings represent separate locations.

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 areas where old oxbows, sloughs, and ponds could provide a source of recruitment for native wetland and riparian plant species and provide critical fish habitat. 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 along the Colorado River and its tributaries 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.

Protection Comments: There is mixed ownership: state, federal, city, county, and private. There are many ongoing efforts by federal, state and local entities to protect and restore elements of this site. Efforts are underway to acquire properties or easements, which will enable the development of a continuous greenbelt and trail system from Fruita to Palisade. This use would be consistent with protecting the natural values of the river corridor, whereas further industrial and commercial development, such as gravel mining, will negatively impact riparian and wetland habitat. Most of the PCA along the Rifle Stretch is privately owned except for a few patches of BLM land. The aesthetic qualities of the area may encourage increased development as human population expands in the Rifle area. Because the land along the Colorado River here is privately owned, realization of this threat is highly probable. The majority of the site within De Beque Canyon is owned and managed by the BLM with no formal protection. Small parts of the site are managed by the Bureau of Reclamation and Colorado State Parks (Island Acres State Recreation Area). In Ruby Canyon, the BLM land on the south side of the river has been designated as part of the Colorado Canyons National Conservation Area. Most of Ruby Canyon is under BLM ownership, with a few very small parcels of private land. The state and federal government under the Endangered Species Act provide protection for the Peregrine Falcon, Bald Eagle, razorback sucker, Colorado pikeminnow, and humpback chub.

Management Comments: Removal of tamarisk and restoration of native vegetation should be a priority. Tamarisk removal is underway along portions of the Colorado River. Revegetation projects should use only native plants.

The BLM estimates that the Ruby Canyon section of the river receives 7000 visitor days of use per year. BLM management plans for Ruby Canyon emphasize recreation. The plan calls for managing wildlife habitat primarily for endangered and riparian species, with a focus on improving the chance of survival, and increasing the area of cottonwood stands. Woody riparian habitat is to be maintained "to favor the tallest plant species native to each site, while promoting diversity in plant heights and species" (USDI 1987). In order to accomplish this, tamarisk control will be necessary. Habitat for Peregrine Falcons and Bald Eagles is actively managed and protected from surface-disturbing activities. A further management objective is to provide suitable habitat for the four endemic Colorado River fish in cooperation with the CDOW and USFWS. Surface disturbance is to be prohibited in riparian areas. ORV use is limited to existing roads on the north side of the river. The south side is closed to vehicles because of the wilderness recommendation (USDI 1987). Consideration should be given to restricting motorized watercraft in the canyon.

In De Beque Canyon, as with other areas along the river, the riparian community has been altered due to the absence of natural flooding. Management for the protection and increase of cottonwood stands, as called for by the BLM management plan for the Ruby Canyon area is also appropriate here.

Threats along the Rifle Stretch and Grand Valley include invasion of aggressive non-native species, 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 or alter the timing of grazing in the riparian zone might aid in sustaining the globally rare Rio Grande cottonwood/skunkbush community and the native fish populations. Monitoring these communities would assist in understanding how release from grazing pressures influences regeneration of native plants.

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: Soils are derived from alluvium and vary in texture depending on geomorphic position. Organic matter accumulation is minimal except around wetlands and near the banks of sloughs where small O- and thick A-horizons may form.

The substratum along the Rifle Stretch consists of unconsolidated surficial deposits of Quaternary gravel and alluvium in the valley bottom. The soils within floodplain consist of a mosaic of Torrifluvents, Halaquepts, and Wann series. The Torrifluvents 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 are 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 generally gravelly. Halaquepts are commonly gleyed from the surface down (Soil Conservation Service 1985).

Soils within De Beque Canyon are not mapped by the Natural Resources Conservation Service (NRCS), but given the narrow nature of the canyon and subsequent lack of extensive floodplains, most soils likely consist of various textures of alluvium. Backwater areas and soils under cottonwood canopies likely have organic rich A-horizons.

Soils along the river within the Grand Valley are not mapped by the NRCS, but given what is mapped along the river in Ruby Canyon and along the Gunnison River, a likely common soil type in the area may be the Youngston Series. The Youngston is classified as a Fine-loamy, mixed, (calcareous), mesic Typic Torrifluvents. The Youngston consists of deep, well-drained soils that have been formed in alluvium on floodplains and alluvial fans (USDA 1978). It is mapped as occurring along the Gunnison River and in Ruby Canyon.

Restoration Potential: Restoration is a daunting task along the Colorado River in Mesa County. River hydrology has been drastically altered and is the most significant disturbance affecting this site. Non-native species are very prevalent. Tamarisk removal should be one of the top restoration priorities along the river corridor. However, removing dense stands of tamarisk and subsequently planting cottonwoods and willows without restoring the historical flooding regime will require extensive follow-up management (Smith and Devitt 1996 *as cited in* The Nature Conservancy 1998). Restoring natural river flows is unlikely, but there are actions that can be taken to restore some fluvial processes into areas where they have been removed. For example, some recent discussions focus on allowing the Colorado River to flow through gravel pit areas during high flows (J. Toolen, CDOW, personal communication 2001). This would allow for sediment deposition, flushing/depositing organic matter from/to the floodplain, and the creation of wetland and aquatic habitat for endangered fish. However, there is some concern that exposing these gravel ponds to the Colorado River may increase the competition between native and non-native fishes by allowing game fish, which are often stocked in the gravel ponds, to enter the river. Also, the National Park Service recently filed for reserve water rights on behalf of the Black Canyon of the Gunnison National Park. If these water rights are secured, instream flow in the Gunnison River may increase thereby increasing flow in the Colorado River downstream of the confluence. The key will be the timing and duration of increased flows.

There has been much alteration of plant communities within the floodplain of the Colorado River that stem from altered hydrology and past land use. Current land use patterns allow for overuse of the Rifle Stretch 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. There are numerous hay meadows, gravel pits, and roads that could be restored to natural vegetation patterns. Cottonwoods and willow pole cuttings could be planted once tamarisk has been removed. Depending on groundwater depth, the plantings may require irrigation until their root systems have reached the groundwater table. However, depending on soil types and the amount of irrigation water applied, irrigation may only wet the top 35-70 ft^3 of the vertical soil profile, which may not allow tree roots to grow deep enough to access the groundwater table (Briggs 1996). Carothers et. al (1990, as cited in Briggs 1996) suggest that plantings be given an overabundance of irrigation water to ensure the entire soil profile down to the water table is wetted. Because tamarisk is known to release excessive amounts of salt to soils and that many areas have accumulated salts due to a lack of flooding, some areas may have to be treated for excess salts prior to revegetation efforts (Sala 1996). Various methods exist to accomplish this, such as flooding the area with water that has a lower soluble salt content than the soil. This should be conducted in the winter months when plant uptake is minimal. Another treatment option is to amend the soils with gypsum to neutralize the affects of sodium.

Working toward a restoration of natural river flows by eliminating channel diversion structures and riprap hindering natural meanders would benefit recovery of all the native fish found here, which require low winter flow, high spring flow, cool to warm river temperatures, and flooding. These fish also require large stream areas that incorporate diverse habitats including pools, riffles, runs, backwaters, adequate substrate and current diversity.

Wetland Functional Assessment for the Colorado River PCA:
Proposed HGM Class: Riverine Subclass: R5
Cowardin System: Palustrine.
CNHP's Wetland Classification: *Populus deltoides ssp. wislizeni/Rhus trilobata,* plus numerous emergent wetlands in the floodplain.

Table 13. Wetland functional assessment for the riverine wetland at the Colorado River site.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland is functioning below potential as hydrological alterations and dominance of non-native species have altered natural functions.
Hydrological Functions		
Flood Attenuation and Storage	Moderate to High	The floodplain along the Rifle Stretch 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. However, the floodplain between Palisade and Fruita has been developed for urban development and agriculture. Numerous levees exist throughout this area. Given the large area of the site, it is still capable of performing this function, but its capacity to do so has been drastically decreased.
Sediment/Shoreline Stabilization	High	Most banks of the Colorado are vegetated with shrubs, trees, and herbaceous species, however some areas have been heavily impacted by overgrazing, urban development, and altered hydrology.
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	Disrupted	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 (prevalence of Russian knapweed) 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). Altered hydrology has also disrupted nutrient cycles by eliminating normal flushing cycles and lack of deposition of organic material from floodwaters.
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. However, urban development, gravel

		mining, and agriculture have decreased habitat diversity in many areas. Altered hydrological patterns limits habitat creation from fluvial processes.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Oxbows and sloughs provide open water for waterbirds. However, urban development, gravel mining, and agriculture have eliminated much wildlife habitat.
General Fish/Aquatic Habitat	High	The river supports populations of three endangered fish including the razorback sucker, Colorado pikeminnow, and humpback chub. However, altered hydrology, gravel mining, and the presence of non-native fish have negatively affected the populations of these species.
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. This function is being negatively affected by the dominance of non-native species such as tamarisk, Russian olive, and Russian knapweed and lack of historical flooding regime.
Uniqueness	High	The wetland supports three endangered fishes and a globally imperiled plant community and represents an important portion of the Colorado River, where large cottonwood forests occupy an extensive floodplain.

Figure 8. Colorado River Potential Conservation Area.

Colorado River Potential Conservation Area Priority Areas

The table below lists the Priority Areas identified within the Colorado River Potential Conservation Area in Mesa County using the methods described on page 58. A total of 21 Priority Areas were identified within the PCA. The sites are listed in descending order of their Final Score.

Table 14. Colorado River Potential Conservation Area Priority Areas. Note: River miles are relative to the confluence of the Colorado and Green Rivers (moving upstream). Site names are mostly derived from Irving and Burdick 1995).

Site Name (approximate river miles)	Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score	Public Lands?	Tamarisk Eradication Projects?	Land Status
Hot Spot Junction (173.7 - 176.6)	36	Yes - 3	No	3	Yes	**13**	Partial	Yes	CO State Parks, City of Grand Junction, Mesa County, Bureau of Reclamation, and private
Walter Walker SWA (164.4 - 166.0)	32	Yes -2	No	5	Yes	**12**	Partial	Yes	CDOW, Mesa County, and private
Connected Lakes Area (167.5 - 170.3)	44	No	Yes - 2	3	Yes (spawning area)	**11**	Partial	Yes	CO State Parks, City of Grand Junction, Mesa County, Audubon Society, Bureau of Reclamation, and private
Black Rocks (136.6 - 137.1)	14	No	Yes - 1	6	Yes	**10**	Yes	Yes	BLM
De Beque I-70 Slough (209.4 - 211.4)	42	Yes - 2	No	2	No	**10**	Partial	No	CDOT, BLM, and private
Island Complex near Rhone (158.7 - 162.7)	31	Yes - 1	No	1	Yes (spawning area)	**8**	No	No	Private and small amount of Mesa County

Site Name (approximate river miles)	Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score	Public Lands?	Tamarisk Eradication Projects?	Land Status
Clifton Water Treatment Plant Area (179.0 - 181.1)	41	Yes - 1	No	0	Yes	**7**	No	No	Private
Skipper's Island (154.2 - 155.7)	44	No - 1	No	1	Yes	**7**	Partial	No	Private and BLM
Clifton Pond (177.5 - 178.2)	46	No	No	2	No	**6**	Partial	No	Mesa County, private
No Name 2 (202.2 - 204.2)	25	Yes - 1	No	2	No	**6**	Partial	No	Private and BLM
Bishop SWA (183.0 - 184.2)	27	Yes - 1	Yes - 1	0	Yes	**6**	Partial	Yes	Private (small amount has a conservation easement) CDOW
No Name 1 (206.2 - 207.5)	26	Yes - 1	No	1	No	**5**	No	No	Private
Crow Bottom (143.9 - 146.5)	23	No	Yes - 1	2	No	**5**	Partial	No	BLM and private
Vulture Bottom (139.7 - 142.1)	16	No	Yes - 1	3	No	**5**	Partial	Yes	BLM and private
Island Acres (191.1 - 192.1)	17	No	Yes - 1	2	No	**5**	Partial	No	CO State Parks, Bureau of Reclamation, and private
Fruita 340 Bridge Area (157.5 - 159.1)	22	No	Yes - 2	0	Yes	**4**	No	No	Private
Watson Island (170.9 - 172.0)	22	No	Yes - 1	1	No	**4**	Partial	Yes	City of Grand Junction Parks Dept. and private
Cameo (190.0 - 191.0)	25	No	Yes - 1	1	No	**4**	Partial	No	Private and Bureau of Reclamation

Site Name (approximate river miles)	Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score	Public Lands?	Tamarisk Eradication Projects?	Land Status
No Name 5 (204.8 - 206.6)	15	Yes - 1	No	1	No	**3**	No	No	Private
No Name 3 (137.2 - 138.0)	13	No	Yes - 1	1	No	**3**	Partial	No	BLM and private
Long Point Bottom (197.8 - 198.9)	12	No	Yes - 1	1	No	**3**	Yes	No	BLM and small amount of private

Figure 9. Priority Areas within the Colorado River Potential Conservation Area

Name: co_gunn_river_pcas_priority.jpg

Descriptions of Priority Areas:

Hot Spot Junction within the Colorado River Potential Conservation Area

Final Score: 13

Public Lands? Partially

Restoration Occurring? Yes. The BOR is implementing restoration of some areas by planting and protecting (from beaver) cottonwood trees.

Land Status: CO State Parks, City of Grand Junction, Mesa County, Bureau of Reclamation, and private. The south side of the river is BOR and private land, while the north side is a mix of private, BOR, CO State Parks, and Mesa County property.

Location: Hot Spot Junction is located approximately 3.75 miles upstream of Grand Junction (Broadway Bridge) and just north of Central Orchard Mesa. T1S R1E Sec. 19-22, 29, 30.

River miles: 173.7-176.6

Size: Approximately 867 acres.

General Description: This site is so named due to the concentration of fish activity in the area. Numerous backwater areas and ponds provide habitat for the Colorado pikeminnow and razorback sucker. The area routinely produces high capture numbers for the Colorado pikeminnow. A large portion of the bottomland area on the south side of the river is contained within the Bureau of Reclamation's (BOR) Orchard Mesa Wildlife Area. This location contains scattered groves of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), old sloughs, and irrigated wetlands. Species such as alkali bulrush (*Schoenoplectus maritimus*), common reed (*Phragmites australis*), saltgrass (*Distichlis spicata*), and foxtail barley (*Hordeum jubatum*) are common in these irrigated wetlands. Tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) are prevalent throughout the area. On the north side of the river, much of the site is under state ownership (Colorado River State Park) and contained within the BOR's Colorado River Wildlife Area. Numerous gravel ponds exist on this side of the river. The BOR is planting cottonwoods in this area.

Table 15. Ranking Factors for Hot Spot Junction

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottonland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
36	Yes - 3	No	3	Yes	**13**

As mentioned above, the site is an important area for the Colorado pikeminnow. The site contains three bottomland habitat areas that are all ranked in the Top 13: Humphrey's (ranked #9), Griffith's (ranked #9), and Hot Spot Junction (ranked # 12) and thus is also an important area for the razorback sucker. An average of 36 bird species have been documented here. This area is part of the Audubon Society's Grand Valley Riparian Corridor Important Bird Area due to the fact that nearly 300 bird species have used the lowland riparian vegetation in the Grand Valley over the last 15 years, including nearly 70 breeding species and over 70 wintering species (National Audubon Society 2000).

Table 16. Natural Heritage element occurrences at Hot Spot Junction.

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**Federal and State Status**	**EO* Rank**
Fish					
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	C
Gila robusta	Roundtail chub	G3	S2	SC	H
Plant Communities					
Populus deltoides ssp. *wislizeni*/*Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C

*EO=Element Occurrence

Walter Walker SWA within the Colorado River Potential Conservation Area

Final Score: 12

Public Lands? Partially

Restoration Occurring? Yes. The Colorado Division of Wildlife (CDOW) is also planning to breach the levee in two additional locations. CDOW currently sprays for Russian knapweed and Canada thistle and plans on addressing tamarisk in the future.

Land Status: CDOW, Mesa County, and private. Most of the north side of the river (most of the site) is owned by CDOW while private parcels exists on the south side. The USFWS, Colorado River Fish Recovery Program has a property upstream of this site acquired via fee or easement.

Location: The Walter Walker SWA is approximately 4.5 miles downstream of Grand Junction (Broadway Bridge). T1N R2W sec. 35 and 36; T11S R101W sec. 14 and 15.
River miles: 164.4-166.0

Size: Approximately 480 acres.

General Description: Before 1984, most of this area consisted of large gravel pits but they were filled in during the 1984 flood along the Colorado River. Old sloughs, which are remnants of where the river flowed through the site during the 1984 flood, exist throughout the area. Some deeper sloughs are dominated by cattail (*Typha latifolia*) and hardstem bulrush (*Schoenoplectus acutus*), plus many other emergent species. There used to be a levee that rimmed the entire site, which separated it from the river. The 1984 flood blew most of the levee out and currently only a portion of it still exists on the southeast and south side of the site. The river, during high water (~ every 3-4 years), can enter the site via the 'Texas crossing', a low spot in the levee. There are plans to lower this area even more to allow floodwaters to enter the site annually. The Colorado Division of Wildlife (CDOW) is also planning to breach the levee in two additional locations. CDOW currently sprays for Russian knapweed and Canada thistle and plans on addressing tamarisk in the future.

Most of the cottonwood stands established during the flood of 1984. The understory in these areas is sparse. Tamarisk is prevalent throughout the site but has not infested these cottonwood stands.

Table 17. Ranking Factors for Walter Walker SWA

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
32	Yes -2	No	5	Yes	**12**

An average of 32 bird species/mile have been documented in this area. This area supports the highest concentration of winter waterfowl use in western Colorado (C.

Dexter, RMBO and BLM, personal communication). Approximately 7,000 Mallards, 5,000 Canada Geese, and numerous other species including Double-Crested Cormorants, herons, and shorebirds use this area. This site contains two areas identified as important Bottomland Habitat by the USFWS, both in the Top 13: the Walter Walker SWA site (ranked # 1) and the Panorama site (ranked # 6). This site also has the highest use (along with Hot Spot Junction) by Colorado pikeminnow in the County (based on capture records). Thus, this is a very important area for protecting and restoring bottomland habitat for the razorback sucker and Colorado pikeminnow.

Table 18. Natural Heritage element occurrences at Walter Walker SWA.

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**Federal and State Status**	**EO* Rank**
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	E
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	C
Gila robusta	Roundtail chub	G3	S2	SC	H
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4T?Q	S1B, S3N	LT, T	D
Amphibians					
Coluber constrictor mormon	Western yellowbelly racer	G5T5	S3		E

*EO=Element Occurrence

Connected Lakes Area within the Colorado River Potential Conservation Area

Final Score: 11

Public Lands? Partial.

Restoration Occurring? Yes. Removal of tamarisk has occurred at the Audubon Society's Ela Sanctuary.

Land Status: CO State Parks, City of Grand Junction, Mesa County, Audubon Society, Bureau of Reclamation, and private. Much of the northern portion of this site is included in the Colorado State Park system or owned by the City of Grand Junction. The southern portion has scattered parcels of City of Grand Junction and Bureau of Reclamation property, but most of it is private. The USFWS, Colorado River Fish Recovery Program has property within this site acquired via fee or easement.

Location: This site contains Connected Lakes State Park and surrounding lands just outside (west) of Grand Junction. T1S R1W sec. 8-10 and 15-17.
River miles: 167.5-170.3

Size: Approximately 962 acres.

General Description: There is a mostly intact Rio Grande cottonwood/skunkbush stand within the State Park boundaries. Although tamarisk and Russian olive are abundant, this particular stand has a relatively high amount of skunkbush compared to other stands in the Grand Valley. However, numerous roads, trails, and gravel ponds fragment the stand. Many cottonwood stands, especially those near the Audubon property, were established during the 1984 flood. The Redlands Power Canal traverses the southwest side of this site. Sand bars along the river at the north end of the park are dominated by coyote willow (*Salix exigua*). The major native grasses are saltgrass (*Distichlis spicata*), sand dropseed (*Sporobolus cryptandrus*), and alkali sacaton (*Sporobolus airoides*). Other common native species in the area are four-wing saltbush (*Atriplex canescens*), rabbitbrush (*Chrysothamnus nauseosus and C. linifolius*), greasewood (*Sarcobatus vermiculatus*), cattail (*Typha latifolia*), and bulrushes (*Schoenoplectus pungens* and *S. validus*).

Much of the area has been disturbed, and most treeless areas are dominated by non-native species. The most abundant non-native species are: Russian knapweed (*Acroptilon repens*), cheatgrass (*Bromus tectorum*), reed canary grass (*Phalaris arundinacea*), tamarisk (*Tamarix ramosissima*), Russian olive (*Eleagnus angustifolia*), ironweed (*Kochia scoparia*), Siberian elm (*Ulmus pumila*), red goosefoot (*Chenopodium rubrum*), and Canada thistle (*Cirsium arvense*).

One plant of state significance was found on the shore of Duke Lake. It has been identified as Arizona centaury (*Centaurium arizonicum*), previously unknown from Colorado, but was recently found here and in Delta County along the Gunnison River. The Duke Lake population was small, consisting of only a few plants. It seems to be fairly well protected, as it is separated from the trails nearby by some dense vegetation, but could be impacted by people fishing along the bank.

Several northern leopard frogs (*Rana pipiens*), a species of special concern, were observed in Endangered Fishes Lake. Northern leopard frogs have recently been Watchlisted by CNHP (occurrences are maintained in manual files but no longer in our central database, BCD). Bullfrogs (*Rana catesbiana*), a non-native species, were found in the Colorado River near the confluence of the Redlands Canal and in Connected Lake. This species is known to displace native frog species. The northern leopard frogs in Endangered Species Lake may be protected by their isolation from the river and other lakes.

Table 19. Ranking Factors for Connected Lakes Area

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
44	No	Yes - 2	3	Yes (spawning area)	**11**

One of the most important characteristics of this site is that it contains one of two spawning areas for the Colorado pikeminnow in Mesa County (D. Osmundson, USFWS, personal communication). The area occurs just downstream from the Broadway Bridge. Another important attribute is that, along with Skipper's Island, this site has the second highest concentration of bird species (44 species) among all the Priority Areas. This area is part of the Audubon Society's Grand Valley Riparian Corridor Important Bird Area due to the fact that nearly 300 bird species have used the lowland riparian vegetation in the Grand Valley over the last 15 years, including nearly 70 breeding species and over 70 wintering species (National Audubon Society 2000). This site contains two Bottomland Habitat areas both of which are not in the Top 13. They are the Connected Lakes site (ranked # 20) and Blue Heron Pond (no rank).

Table 20. Natural Heritage element occurrences at Connected Lakes Area.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Reptiles					
Elaphe guttata	Corn snake	G5	S3		E
Plants					
Centaurium arizonicum	Arizona centaury	G5?	S1		D
Plant Communities					
Populus deltoides ssp. *wislizeni*/*Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C

*EO=Element Occurrence

Black Rocks within the Colorado River Potential Conservation Area

Final Score: 10

Pbulic Lands? Yes

Restoration Occurring? Yes. The BLM has a tamarisk eradication project occurring in this area.

Land Status: BLM. The entire area is under managed by the BLM.

Location**:** Black Rocks is located in Ruby Canyon, approximately 3 miles upstream from the Colorado-Utah state line. T10S R104W sec. 28 and 33.
River miles: 136.6-137.1

Size: Approximately 230 acres.

General Description: This site is a very important area for fishes. Humpback chub, roundtail chub, and Colorado pikeminnow all use this area.

Table 21. Ranking Factors for Black Rocks

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
14	No	Yes - 1	6	Yes	**10**

There is one bottomland habitat area (ranked as #21) contained within this site. The average number of bird species found here is relatively low (14) compared to other portions of the river.

Table 22. Natural Heritage element occurrences at Black Rocks.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, T	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, T	H
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	C
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila elegans	Bonytail chub	G1	SX	LE, E	H
Birds					
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S3B, SZN	SC	E

*EO=Element Occurrence

De Beque I-70 Slough within the Colorado River Potential Conservation Area

Final Score: 10

Public Lands? Partial.

Restoration Occurring? No

Land Status: CDOT, BLM, and private. Approximately 3/4 of the site is private property while the remaining 1/4 is BLM and a small State parcel (northern half of the western part of the site).

Location**:** This area is just upstream from the town of De Beque where I-70 crosses the river. T8S R97W sec. 22, 23, 26, 27.
River miles: 209.4-211.4

Size: Approximately 315 acres.

General Description: This area supports mature stands of Rio Grande cottonwood. Although the understory is dominated by tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeganus angustifolia*), skunkbrush (*Rhus trilobata*) is abundant. The riverbanks are lined with coyote willow (*Salix exigua*), common spikerush (*Eleocharis palustris*), reed canarygrass (*Phalaris arundinacea*), and common reed (*Phragmites australis*). Cottonwood regeneration is occurring on coyotes although in heavy competition with tamarisk seedlings. Habitat diversity is fairly high in this area, with sloughs, backwater areas, and floodplain wetlands scattered throughout the site.

Table 23. Ranking Factors for De Beque I-70 Slough

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
42	Yes - 2	No	2	No	**10**

The site contains two bottomland habitat areas in the Top 13: De Beque I-70 Slough (ranked #4) and Stoddard Property (ranked #7), thus the area contains important bottomland habitat for the razorback sucker. This area also has a very high concentration of bird use, with an average of 42 species documented in the area.

Table 24. Natural Heritage element occurrences at De Beque I-70 Slough.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Plant Communities					
Populus deltoides ssp. *wislizeni*/*Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C

*EO=Element Occurrence

Island Complex near Rhone within the Colorado River Potential Conservation Area

Final Score: 8

Public Lands? No.

Restoration Occurring? No

Land Status: Private and small amount of Mesa County. Except for a small Mesa County parcel, the entire site is private land. The USFWS, Colorado River Fish Recovery Program has property within this site acquired via fee or easement.

Location**:** This site is just downstream from Walter Walker SWA. T1N R2W Sec. 26-28 and 33-35.

River miles: 158.7-162.7

Size: Approximately 750 acres.

General Description: Sloughs and side channels provide important habitat for the fish in this area. Cottonwood stands are heavily invaded by tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeganus angustifolia*).

Table 25. Ranking Factors for Island Complex near Rhone

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
31	Yes - 1	No	1	Yes (spawning area)	**8**

The site contains one of two spawning areas for the Colorado pikeminnow in Mesa County (the other being within the Connected Lakes Area site) (D. Osmundson, USFWS, personal communication). The site contains a bottomland habitat area in the Top 13: Dupont Island Complex (ranked #11). The average number of bird species/mile is 31. Recently, an active and successful nest was discovered on one of the large islands (Soker, D. USFWS, personal communication, 2001).

Table 26. Natural Heritage element occurrences at Island Complex near Rhone.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Gila robusta	Roundtail chub	G2G3	S2	BLM, SC	H

*EO=Element Occurrence

Clifton Water Treatment Plant Area within the Colorado River Potential Conservation Area

Final Score: 7

Public Lands? No

Restoration Occurring? No

Land Status: Private. The USFWS, Colorado River Fish Recovery Program has property near the upstream end of this site acquired via fee or easement.

Location**:** Southeast of the town of Clifton in the Oldham Bottoms area. T1S R1E sec. 7 and 18; T1S R2E sec. 12 and 13.

River miles: 179.0-181.1

Size: Approximately 430 acres.

General Description: This site mainly consists of scattered cottonwood stands with a thick understory of tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeganus angustifolia*) and hay fields. There are old sloughs in the area, which may have been converted for irrigation use. The Clifton Water Treatment Plant is also nearby.

Table 27. Ranking Factors for Clifton Water Treatment Plant Area

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
41	Yes - 1	No	0	Yes	**7**

The site contains a Top 13 bottomland habitat area: Clifton Water Treatment Plant (ranked #13) and evidence of high use by Colorado pikeminnow. The site also supports the fifth highest density of bird species/mile (41) along the Colorado River in Mesa County. No CNHP element occurrences are found here.

Skipper's Island within the Colorado River Potential Conservation Area

Final Score: 7

Public Lands? Partial.

Restoration Occurring? No

Land Status: Private and BLM. Most of the site is private land except for a small parcel on the southern side of the river and 3/4 of the westernmost island, which are BLM parcels.

Location**:** Located just west of the town of Fruita. T1N R3W sec. 13 and 14.
River miles: 154.2-155.7

Size: Approximately 337 acres.

General Description: Large stands of Rio Grande cottonwood with a moderate amount of skunkbrush (*Rhus trilobata*) cover most of the island. Although tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeganus angustifolia*) are prevalent in the understory, the diversity of habitat types and vegetation structure (sloughs, streambank vegetation, canopy diversity) support many bird species. A Great Blue Heron rookery used to be located here and Black-crowned Night Heron nests have been recorded in this area.

Table 28. Ranking Factors for Skipper's Island

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
44	No	Yes - 1	1	Yes	**7**

The most important attribute of this site is the number of bird species it supports. Along with the Connected Lakes Area, this site has the second highest concentration of bird species/mile (44 species) among all the Priority Areas. The site also contains a bottomland habitat area: Horsethief SWA (ranked #18) and evidence of high use by Colorado pikeminnow.

Table 29. Natural Heritage element occurrences at Skipper's Island.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT	H

*EO=Element Occurrence

A pair of Bald Eagles were active at the western most site in 1991 and 1992 and at the eastern most site in 1993, 1994, and 1995. Nesting attempts failed in all years.

Clifton Pond within the Colorado River Potential Conservation Area

Final Score: 6

Public Lands? Partial.

Restoration Occurring? No

Land Status: Mesa County, private. Approximately half the site is Mesa County property (mainly the central part) while the remaining portion is private.

Location**:** Located due south of the town of Clifton. T1S R1E sec.14 and 23.
River miles: 177.5-178.2

Size: Approximately 135 acres.

General Description: This small site encompasses the Clifton Slough, an area that used to be used heavily by razorback sucker. The slough is surrounded by development and is heavily infested with tamarisk. A gravel pond now separates the slough from the river, thus much riparian vegetation has been removed from the area. Abundant urban debris (cars, various pieces of metal, etc.) litters the slough.

Table 30. Ranking Factors for Clifton Pond

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
46	No	No	2	No	**6**

This site has the highest number of bird species/mile documented along the Colorado River in Mesa County at 46. Atlhough it contains the third highest rated bottomland habitat area in the county: the Clifton Pond (Clifton Slough) ranked #3, the USFWS feels that this area has a minimal chance of ever being connected to the river, thus the bottomland habitat area was not considered in the analysis (Soker, D., USFWS, personal communication 2002).

Table 31. Natural Heritage element occurrences at Clifton Pond.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H
Gila robusta	Roundtail chub	G2G3	S2	BLM, SC	H

*EO=Element Occurrence

No Name 2 within the Colorado River Potential Conservation Area

Final Score: 6

Public Lands? Partial.

Restoration Occurring? No

Land Status: Colorado Department of Transportation (CDOT), Private and BLM. Most of the site is private property. However, there are some BLM and CDOT parcels in the area.

Location: Located approximately 3.5 miles downstream of the town of De Beque at the head to De Beque Canyon. T9S R97W sec. 8, 17, 18.
River miles: 202.2-204.2

Size: Approximately 560 acres.

General Description: This site contains a diversity of wetland types including marshes, sloughs, and mature cottonwood stands. A few locations have a thick understory of skunkbrush (*Rhus trilobata*) and some silverberry (*Shepherdia argentea*) while tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeganus angustifolia*) dominate most the understory. There is an Osprey nest and Great Blue Heron rookery in the area.

Table 32. Ranking Factors for No Name 2.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
25	Yes - 1	No	2	No	**6**

An average of 25 bird species have been documented in the area. The site contains a Top 13 bottomland habitat area: No Name (ranked # 11).

Table 33. Natural Heritage element occurrences at No Name 2.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Gila robusta	Roundtail chub	G3	S2	BLM, SC	H
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT	H

*EO=Element Occurrence

Although CNHP does not have current information on the Bald Eagle occurrence, approximately 6-12 birds used the area in the winter in 1996 and the site was considered one of the best roosting areas in Colorado.

Bishop SWA within the Colorado River Potential Conservation Area

Final Score: 6

Public Lands? Partial.

Restoration Occurring? Yes. The BOR is currently creating shallow water wetlands on the property by piping in irrigation water behind shallow levees. Cottonwoods will be planted in the area.

Land Status: Private land (small amount has a conservation easement) and CDOW. Most of the center portion of the site was recently purchased by the Colorado Division of Wildlife and is now the Bishop SWA. The remaining portion of the site is private. A small parcel of private land is under a conservation easement.

Location**:** Located southwest of the town of Palisade, just below East Orchard Mesa. T1S R2E sec. 3 and 4.

River miles: 183.0-184.2

Size: Approximately 273 acres.

General Description: The cottonwood gallery in this area has some skunkbush but tamarisk and Russian olive mostly dominate the understory. Alkali bulrush (*Schoenoplectus maritimus*), threesquare bulrush (*S. pungens*), hardstem bulrush (*S. acutus*), foxtail barley (*Hordeum jubatum*), rabbitfoot grass (*Polypogon monspeliensis*), barnyard grass (*Echinochloa crus-galli*), cocklebur (*Xanthium strumarium*), coyote willow (*Salix exigua*), reedcanary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), common spikerush (*Eleocharis palustris*), and scouring rush (*Hippochaete laevigata*), and cottonwood seedlings dominate the river banks. The large slough contained within the SWA is dominated by cattails.

Table 34. Ranking Factors for Bishop SWA.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
27	Yes - 1	Yes - 1	0	Yes	**6**

The site contains two bottomland habitat areas: No Name (ranked #12) and Palisade (ranked #16). There is evidence that the area also has high Colorado pikeminnow use. The average number of bird species/mile is 27. This area is part of the Audubon Society's Grand Valley Riparian Corridor Important Bird Area due to the fact that nearly 300 bird species have used the lowland riparian vegetation in the Grand Valley over the last 15 years, including nearly 70 breeding species and over 70 wintering species (National Audubon Society 2000). No CNHP element occurrences are documented.

No Name 1 within the Colorado River Potential Conservation Area

Final Score: 5 **Public Lands?** No **Restoration Occurring?** No **Land Status:** Private.

Location**:** Located approximately 1 mile downstream of the town of De Beque. T8S R97W sec. 32 and 33; T9S R97W sec. 4 and 5.
River miles: 206.2-207.5

Size: Approximately 309 acres.

General Description: Cottonwood groves occur in this site but the understory in mainly composed of tamarisk and Russian olive. Coyotes are vegetated with coyote willow (*Salix exigua*) and tamarisk seedlings. Numerous sloughs are scattered throughout the area. These are dominated by cattails, reed canarygrass (*Phalaris arundinacea*), and common reed (*Phragmites australis*). Beaver have also been active in the area, expanding open water wetlands along some of the sloughs.

Table 35. Ranking Factors for No Name 1.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
26	Yes - 1	No	1	No	**5**

This site contains a Top 13 bottomland habitat area: No Name (ranked #9) but does not have evidence of high Colorado pikeminnow use. An average of 26 bird species have been documented here including a nesting pair of willow flycatchers.

Table 36. Natural Heritage element occurrences at No Name 1.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT	D

*EO=Element Occurrence

In 1998, six Bald Eagles were known to roost in this area.

Crow Bottom within the Colorado River Potential Conservation Area

Final Score: 5

Public Lands? Partial

Restoration Occurring? No

Land Status: BLM and private. Most of the river and immediate floodplain is private land while BLM lands compose the remaining portion of the site.

Location: Located approximately 10.5 miles downstream of the town of Fruita, where Salt Creek flows into the Colorado River. T10S R103W sec. 8, 16, 17.
River miles: 143.9-146.5

Size: Approximately 453 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 37. Ranking Factors for Crow Bottom.

Average Bird Density/River Mile	Top 13 Bottomland Site?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
23	No	Yes - 1	2	No	**5**

This site contains one bottomland habitat area, Crow Bottom (ranked #26) and does not have evidence of high Colorado pikeminnow use. Average number of bird species/mile is 23.

Table 38. Natural Heritage element occurrences at Crow Bottom.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, T	H
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT	H

*EO=Element Occurrence

Seven to eight adult Bald Eagles used this area as a winter roost.

Vulture Bottom within the Colorado River Potential Conservation Area

Final Score: 5

Public Lands? Partial

Restoration Occurring? Yes. The BLM currently is implementing tamarisk eradication efforts at this site.

Land Status: BLM and private. The upper (upstream) half of the site is private land while the lower is BLM land.

Location**:** Located approximately 14 miles downstream of the town of Fruita in Ruby Canyon. T10S R103W sec. 18 and 19; T10S R104W sec. 23 and 24.
River miles: 139.7-142.1

Size: Approximately 356 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 39. Ranking Factors for Vulture Bottom.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
16	No	Yes - 1	3	No	**5**

This site contains one bottomland habitat area, Vulture Bottom (ranked #26) and does not have evidence of high Colorado pikeminnow use. The average number of bird species/mile is low at 16.

Table 40. Natural Heritage element occurrences at Vulture Bottom.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, T	H
Gila cypha	Humpback chub	G1	S1	LE, T	H
Birds					
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S3B, SZN	SC	C

*EO=Element Occurrence

Island Acres within the Colorado River Potential Conservation Area

Final Score: 5

Public Lands? Partial.

Restoration Occurring? No

Land Status: CO State Parks, Bureau of Reclamation, and private. Almost the entire site is owned by the Colorado Dept. of Natural Resources (State Parks). Small parcels of private and BOR land also occur in the site.

Location: Located at Island Acres State Park. T10S R98W sec. 23, 26, 27.
River miles: 139.7-142.1

Size: Approximately 132 acres.

General Description: Much of the area has mowed turf grasses and planted, non-native trees. There are some patches of greasewood (*Sarcobatus vermiculatus*), skunkbrush (*Rhus trilobata*), and sagebrush (*Artemisia tridentata*) at the east end of the park. Other native species that are well represented are coyote willow (*Salix exigua*) along the Colorado River, cattails (*Typha latifolia*) and bulrushes (*Schoenoplectus* spp.) around the lakes, and rabbitbrushes (*Chrysothamnus nauseosus* and *C. linifolius*) along the north service road. There is a large patch of poison ivy (*Toxicodendron rydbergii*) in a shady area between the campground and the river. Much of the area is used for recreation as Island Acres State Park is encompassed in this site. Tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeganus angustifolia*) are prevalent in the area.

Table 41. Ranking Factors for Island Acres.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
17	No	Yes - 1	2	No	**5**

The site contains a bottomland habitat area: Island Acres (ranked #27). There is no evidence of high Colorado pikeminnow use. The average number of bird species/mile is 17. This area is part of the Audubon Society's Grand Valley Riparian Corridor Important Bird Area due to the fact that nearly 300 bird species have used the lowland riparian vegetation in the Grand Valley over the last 15 years, including nearly 70 breeding species and over 70 wintering species (National Audubon Society 2000).

Table 42. Natural Heritage element occurrences at Island Acres.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Amphibians					
Spea intermontana	Great Basin spadefoot	G5	S3	BLM, SC	B
Birds					
Dendroica graciae	Grace's Warbler	G5	S3b, SZN		C

*EO=Element Occurrence

Fruita 340 Bridge Area within the Colorado River Potential Conservation Area

Final Score: 4 **Public Lands?** No **Restoration Occurring?** No **Land Status:** Private.

Location**:** Located just south of the town of Fruita. T1N R2W sec. 19, 20, 28, 29.
River miles: 157.5-159.1

Size: Approximately 286 acres.

General Description: This area has cottonwood stands with an understory dominated by tamarisk and Russian olive. There are two gravel ponds in the lower end of the site.

Table 43. Ranking Factors for Fruita 340 Bridge Area.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
22	No	Yes - 2	0	Yes	**4**

The site contains two bottomland habitat areas: Fruita 340 Bridge (ranked #19) and Paul Smith's (ranked #19). There is also evidence of high Colorado pikeminnow use. The average number of bird species/mile is 22. No CNHP element occurrences are documented.

Watson Island within the Colorado River Potential Conservation Area

Final Score: 4

Public Lands? Partial.

Restoration Occurring? Yes. The Tamarisk Coalition has a tamarisk eradication project in this area.

Land Status: City of Grand Junction Parks Dept. and private. Except for the portion of the island owned by the City of Grand Junction, the site is private land.

Location**:** Located in Grand Junction. T1S R1W sec. 23.
River miles: 170.9-172.0

Size: Approximately 114 acres.

General Description: This area has cottonwood stands with an understory dominated by tamarisk (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), Russian knapweed (*Acroptilon repens*), and many other non-native species. The northern portion of Watson Island is developed as a trail system by the City of Grand Junction. There is a slough in the area dominated by reed canarygrass and cattails.

Table 44. Ranking Factors for Watson Island.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
22	No	Yes - 1	1	No	**4**

The site contains a bottomland habitat area: Watson Island (ranked #18). There is no evidence of high Colorado pikeminnow use. The average number of bird species/mile is 22. This area is part of the Audubon Society's Grand Valley Riparian Corridor Important Bird Area due to the fact that nearly 300 bird species have used the lowland riparian vegetation in the Grand Valley over the last 15 years, including nearly 70 breeding species and over 70 wintering species (National Audubon Society 2000).

Table 45. Natural Heritage element occurrences at Watson Island.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Birds					
Egretta thula	Snowy Egret	G5	S2B, SZN		H

*EO=Element Occurrence

Cameo within the Colorado River Potential Conservation Area

Final Score: 4

Public Lands? Partial. There have been initial discussions with the private landowner regarding potential ways to protect the stand of Rio Grande cottonwood/skunkbush.

Restoration Occurring? No

Land Status: Private and Bureau of Reclamation. Except for a 40-acre parcel owned by the BOR, the site is under private ownership.

<u>Location</u>**:** Located just downstream of Island Acres State Park. T10S R98W sec. 26, 27, 34.

River miles: 190.-191.0

<u>Size:</u> Approximately 129 acres.

<u>General Description</u>: This site contains a small, but intact stand of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and skunkbrush (*Rhus trilobata*). Seepwillow (*Baccharis salicina*) is also fairly prevalent in the area. Tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) are present, but the abundance of skunkbush is only matched by a few other locations observed in Mesa County during the 2001 field survey.

Table 46. Ranking Factors for Cameo.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
25	No	Yes - 1	1	No	**4**

The site contains a bottomland habitat area: Cameo (ranked #23). There is no evidence of high Colorado pikeminnow use. The average number of bird species/mile is 25.

Table 47. Natural Heritage element occurrences at Cameo.

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	EO* Rank
Plant Communities					
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		E

*EO=Element Occurrence

No Name 5 within the Colorado River Potential Conservation Area

Final Score: 3 **Public Lands?** No **Restoration Occurring?** No **Land Status:** Private.

Location: Located approximately 2.5 miles downstream from the town of De Beque. T9S R97W sec. 4, 5, 8, 9.
River miles: 204.8-206.6

Size: Approximately 298 acres.

General Description: There are scattered stands of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and skunkbrush (*Rhus trilobata*) in the area. Tamarisk, Russian olive, and Siberian elm (*Ulmus pumila*) are also prevalent. Old oxbows, which appear to be seasonally connected to the river via sloughs, occur in the area.

Table 48. Ranking Factors for No Name 5.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
15	Yes - 1	No	1	No	**3**

The site contains a Top 13 bottomland habitat area: Etter's (ranked #9). There is no evidence of high Colorado pikeminnow use. The average number of bird species/mile is 15.

Table 49. Natural Heritage element occurrences at No Name 5.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Xyrauchen texanus	Razorback sucker	G1	S1	LE, E	H

*EO=Element Occurrence

No Name 3 within the Colorado River Potential Conservation Area

Final Score: 3

Public Lands? Partial

Restoration Occurring? No

Land Status: BLM and private. The site is almost all BLM property, but a small portion of private land occurs in the northeast corner of the site.

Location**:** Located in Ruby Canyon approximately 1 mile downstream of the mouth of Mee Canyon. T10S R104W Sec. 26 and 27.
River miles: 137.2-138.0

Size: Approximately 107 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 50. Ranking Factors for No Name 3.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
13	No	Yes - 1	1	No	**3**

This site contains one bottomland habitat area, No Name (ranked #26) and does not have evidence of high Colorado pikeminnow use. Average number of bird species/mile is low at 13.

Table 51. Natural Heritage element occurrences at No Name 3.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Birds					
Haliaeetus leucocephalus	Bald Eagle	G4	S1B, S3N	LT	H

*EO=Element Occurrence

In 1995, a pair Bald Eagles produced one young, while in 1994 two young were produced. CNHP does not have current information regarding this nest.

Long Point Bottom within the Colorado River Potential Conservation Area

Final Score: 3

Public Lands? Yes

Restoration Occurring? No

Land Status: BLM and small amount of private. The site is almost entirely BLM. A small private parcel exists in the northern end of the site.

Location**:** Located in De Beque Canyon approximately 4.5 miles upstream from the confluence of Plateau Creek and the Colorado River. T9S R97W Section 31; T9S R98W Section 36.

River miles: 197.8-198.9

Size: Approximately 164 acres.

General Description: There is a mostly intact stand of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and skunkbrush (*Rhus trilobata*) in this area. The abundance of tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) is minimal except at the downstream end of the large island. Boxelder (*Acer negundo*) and common reed (*Phragmites australis*) are also present in the area. Coyote willow (*Salix exigua*) and scouring rush (*Hippochaete* sp.) are dominant along the riverbanks. Dense stands of wetland vegetation dominate a side channel between the island and the western riverbank.

Table 52. Ranking Factors for Long Point Bottom.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
12	No	Yes - 1	1	No	**3**

This site contains one bottomland habitat area, Long Point Bottom (ranked #23) and does not have evidence of high Colorado pikeminnow use. The average number of bird species/mile is low at 12.

Table 53. Natural Heritage element occurrences at Long Point Bottom.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Populus deltoides ssp. *wislizeni*/*Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		B

*EO=Element Occurrence

Gateway

Biodiversity Rank: B1. Irreplaceable. Good to excellent occurrences of a critically imperiled (G1) plant.

Protection Urgency rank: P2. Protection actions may be needed within five years. It is estimated that stresses may reduce the viability of the elements within this approximate timeframe. BLM and private. There is currently no special protection for the area.

Management Urgency rank: M2. New management actions may be needed within five years to prevent the loss of the element occurrences. The area is heavily grazed. Riparian areas could be enchanced by tamarisk removal.

Location: This site occurs along the Dolores River north of the town of Gateway.

U.S.G.S. 7.5-min. quadrangle: Dolores Point North and Gateway.
Legal Description: T15S R104W sec. 5-9, 15-23, 26-29, 32-35;
T51N R19W sec. 7-10, 15-17.

Elevation: 4,500 - 6,800 ft. Size: Approximately 10,148 acres.

General Description: At the foot of the monolithic Palisade, the Dolores River emerges from its narrow canyon and develops a wide floodplain. The riparian areas are dominated by scattered Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), coyote willow (*Salix exigua*), tamarisk (*Tamarix ramosissima*), big sagebrush (*Artemisia tridentata*), skunkbrush (*Rhus trilobata*), and wild privet (*Forestiera pubescens*). The largest cottonwood gallery along the Dolores River in Mesa County occurs just north of Gateway. Tamarisk is fairly prevalent in the stand. The wild privet stand occurs on a sandy bench above the river and forms an impenetrable thicket. Coyote willow and skunkbush also occur in the stand. There is very little herbaceous understory in this stand. Gentle slopes with pinyon (*Pinus edulis*), juniper (*Sabina osteosperma*) and blackbrush (*Coleogyne ramosissima*) lead up to vertical Wingate sandstone cliffs, where Peregrine Falcons are known to nest. County roads lead northwest from Gateway to follow the river on both the east and west. Along these roads, in the alluvial soils deposited by the river, are found two of the rarest plants in Colorado, the Dolores skeletonplant (*Lygodesmia doloresensis*) and the Fisher Towers milkvetch (*Astragalus piscator*). They grow among the common desert shrub species shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), prickly pear cactus (*Opuntia polyacantha*), and Indian rice grass (*Oryzopsis hymenoides*).

There is a large diversion dam a few miles north of Gateway. Hay meadows dot the floodplain on a few benches. The entire stretch of river through this site is heavily infested with tamarisk and Russian knapweed (*Acroptilon repens*) and is heavily grazed by domestic livestock.

Roundtail chub and flannelmouth sucker are found in this stretch of the Dolores River (Bureau of Land Management, 1990). However, records of these fish are not in CNHP's database.

Biodiversity Rank Justification: This site supports multiple occurrences of the globally critically imperiled (G1) Dolores skeletonplant. The Dolores skeletonplant is known only from Mesa County. It occurs on the reddish alluvial soils on both sides of the Dolores River between Gateway and the Utah border. It has also been reported from the Dolores Canyon south of Gateway, John Brown Canyon, Bar X Wash and Rabbit Valley. The globally imperiled (G2G3) Fisher Tower milkvetch is also found at this site. The Fisher Tower milkvetch was first described from Grand and San Juan counties in Utah in 1986. It has been found in three counties in eastern Utah, and in Mesa County. In Colorado it is known only from the Dolores River Canyon north of Gateway. It grows on alluvial soils derived from the Cutler sandstone. The site also supports state critically imperiled (S1S2) and state imperiled (S2) plants: Osterhout cryptantha and Utah penstemon, respecitvely.

The globally critically imperiled (G1G2) wild privet community occurs along the riparian area of the Dolores River. The wild privet community occurs in Colorado and is expected to occur in New Mexico and Arizona. In Colorado, this community is known only to occur along the Dolores and San Miguel Rivers. It is threatened by inappropriate stream flow alterations. Two additional pinyon pine communities occur in the uplands.

Records of breeding Peregrine Falcons and Black-throated Sparrows have also been documented in this site. There is also a record of the state imperiled longnose leopard lizard.

Table 54. Natural Heritage element occurrences at the Gateway PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Lygodesmia doloresensis	**Dolores skeletonplant**	**G1Q**	**S1**	**BLM**	**B**
Lygodesmia doloresensis	**Dolores skeletonplant**	**G1Q**	**S1**	**BLM**	**B**
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	E
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	C
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	C
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	C
Astragalus piscator	Fisher Towers milkvetch	G2G3	S1		AB
Astragalus piscator	Fisher Towers milkvetch	G2G3	S1		B
Astragalus piscator	Fisher Towers milkvetch	G2G3	S1		E
Cryptantha osterhoutii	Osterhout cryptantha	G3	S1S2		B
Penstemon utahensis	Utah penstemon	G4	S2		E
Plant Communities					
Pinus edulis/Coleogyne ramosissima	Pinyon pine/blackbrush	G3	S3		E

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Pinus edulis/Cowania mexicana	Pinyon pine/cliffrose	G5	S3?		B
Forestiera pubescens	Foothills riparian shrubland	G1G2	S1		C
Birds					
Falco peregrinus anatum	American Peregrine Falcon	G4T4	S2B, SZ	SC	E
Amphispiza bilineata	Black-throated Sparrow	G5	S3B, SZ		E
Reptiles					
Gambelia wislizeni	Longnose leopard lizard	G5	S1	BLM, SC	E

*EO=Element Occurrence.

Boundary Justification: The boundary is drawn to include the Dolores River floodplain and slopes below the steep cliffs, which rise on both sides of the river. The area contains extensive habitat, which is suitable for the Dolores skeletonplant and the Fisher Towers milkvetch, although the occurrences are patchy. 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 riparian elements. It should be noted that the hydrological processes necessary to the riparian elements are not fully contained by the site boundaries. Given that the elements are dependent on natural hydrological processes associated with the Dolores 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.

Protection Comments: The PCA is owned by BLM and private landowners. There is currently no special protection for the area. Although most of the occurrences of the Dolores skeletonplant and the Fisher Towers milkvetch are on BLM land, the area is a patchwork of private and public land. The extremely limited range of these species makes protection of their habitat crucial. Efforts should be made to educate and work with the private landowners for the plants' protection. The Dolores River has been recommended for status as a Wild and Scenic River. The site has been designated by BLM as open to oil and gas leasing with a no surface occupancy stipulation.

Management Comments: The area is heavily grazed. It is not known how much impact this has on the plants. The predominance of the Dolores skeletonplant in clumps of prickly pear cactus suggests that they may be vulnerable to trampling by cattle. Small wire cage exclosures were installed by the BLM in 1989 to study the effects of grazing, but these have not been recently checked and may no longer be in place. A follow-up of that study or new exclosures and a monitoring plan are needed. A similar study should be conducted for Fisher Tower milkvetch. After such studies are completed, a management plan should be developed. Riparian areas could be improved by tamarisk removal.

Soils Description: Soils are derived from alluvium and vary in texture depending on geomorphic position. Organic matter accumulation is minimal except near the banks of sloughs and/or backwaters where small O- and thick A-horizons may form.

Much of the floodplain is mapped as the Glenberg series, Coarse-loamy, mixed (calcareous), mesic, Ustic Torrifluvents (USDA 1978). These soils mainly occur on secondary floodplain terraces along the Dolores River.

Restoration Potential: Tamarisk removal and control of Russian knapweed is needed at this site. However, removing dense stands of tamarisk and subsequently planting cottonwoods and willows without restoring the historical flooding regime will require extensive follow-up management (Smith and Devitt 1996 *as cited in* The Nature Conservancy 1998). Upstream, the regulation of water discharge from McPhee Reservoir has reduced the capacity for the Dolores River to seasonally flood, scour, and transport/deposit sediments along its course. Efforts to work with upstream water users, especially those who use water from McPhee Reservoir, to reestablish spring flooding would greatly assist in cottonwood regeneration along the Dolores River. The timing, quantity, and duration of these spring floods should attempt to mimic seasonal flooding patterns prior to the construction of McPhee dam. Otherwise, cottonwood and willow plantings may require irrigation until their root systems have reached the groundwater table. Depending on groundwater depth, the plantings may require irrigation until their root systems have reached the groundwater table. However, depending on soil types and the amount of irrigation water applied, irrigation may only wet the top 35-70 ft^3 of the vertical soil profile, which may not allow tree roots to grow deep enough to access the groundwater table (Briggs 1996). Carothers et. al (1990, as cited in Briggs 1996) suggest that plantings be given an overabundance of irrigation water to ensure the entire soil profile down to the water table is wetted. Because tamarisk is known to release excessive amounts of salt to soils and that many areas have accumulated salts due to a lack of flooding, some areas may have to be treated for excess salts prior to revegetation efforts (Sala 1996). Various methods exist to accomplish this, such as flooding the area with water that has a lower soluble salt content than the soil. This should be conducted in the winter months when plant uptake is minimal. Another treatment option is to amend the soils with gypsum to neutralize the affects of sodium.

Wetland Functional Assessment for the Gateway PCA:
Proposed HGM Class: Riverine Subclass: R4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Forestiera pubescens*

Table 55. Wetland functional assessment for the riverine wetland at the Gateway site.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland is functioning below potential mainly due to the dominance of non-native species. Altered hydrology from upstream water diversions/reservoirs is also contributing to altered natural functions.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The floodplain along this stretch of the Dolores River is large and extensive and is vegetated with a moderate density of shrubs and trees, although some areas are sparse due to excessive grazing and hay fields. Upstream water projects, mainly McPhee Reservoir, have altered hydrological patterns and thus have forced the river to incise portions of its channel.
Sediment/Shoreline Stabilization	Moderate	Most of the river banks are vegetated with shrubs, trees, and herbaceous species, however some areas have been heavily impacted by overgrazing, altered hydrology, and subsequent channel incision which decreases the ability to perform this function.
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	Disrupted	The presence of aerated water (the river) and a few 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 (prevalence of Russian knapweed) 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). Altered hydrology has also disrupted nutrient cycles by eliminating normal flushing cycles and lack of deposition of organic material from floodwaters.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of excess nutrients and sediment (e.g. from upstream and local livestock and agricultural activity) is likely being performed considering the large area in which such transformations could occur prior to reaching the river. Although excess salts in the soil (derived from tamarisk and lack of historical flooding) may be disrupting nutrient cycling processes. Toxicants and sediments from nearby roads are likely also intercepted in the floodplain prior to reaching the river.
Biological Functions		
Habitat Diversity	Moderate	Scrub-shrub and forested wetlands exist in the area. Hay meadows and the prevalence of non-native species have decreased habitat diversity in many areas. Altered

		hydrological patterns limit habitat creation from fluvial processes.
General Wildlife Habitat	Moderate	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Hay meadows and non-native species have eliminated some wildlife habitat.
General Fish/Aquatic Habitat	Moderate	Roundtail chub and flannelmouth sucker are found in this stretch of the Dolores River (Bureau of Land Management, 1990). Upstream water diversions and McPhee Reservoir have altered hydrological patterns, which have likely reduced high quality fish habitat.
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. Although some areas lack a diversity of structural vegetation classes (e.g. herbaceous layer is minimal), because the area is so large food chain support is high. This function is negatively affected by the dominance of non-native species such as tamarisk, Russian olive, and Russian knapweed and lack of historical flooding regime.
Uniqueness	Moderate	The entire stretch of the Dolores River through Mesa County serves as an important corridor for wildlife. The surrounding landscape is arid and has abundant topographic relief, thus the presence of open water and lush riparian vegetation provides important habitat.

Figure 10. Gateway Potential Conservation Area.

Dolores Canyon South Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. A good occurrence of a critically imperiled plant, and multiple unranked occurrences of plants imperiled and vulnerable through their range (G2 & G3, respectively).

Protection Rank: P4. No protection actions are needed in the foreseeable future. The area has no special designation at this time.

Management Rank:M2. New management actions may be needed within five years to prevent the loss of the element occurrences. Non-native species need to be controlled and hydrological alteration may need to be addressed.

Location: Dolores Canyon South encompasses the Dolores River valley south of Gateway to the Mesa/Montrose County line.

U.S.G.S. 7.5-min. quadrangle: Gateway and Juanita Arch.
Legal Description: T51N R19W sec. 22, 23, 26, 27, 34-36.
T50N R19W sec. 1-3, 11-14, 23-25, 36;
T50N R18W sec. 7, 18, 19, 30-32;
T49N R18W sec. 5, 6, 8, 9, 17, 20.

Elevation: 4600-4700 ft. Size: Approximately 8,298 acres.

General Description: This spectacular red sandstone canyon south of Gateway is one of the most scenic areas in Mesa County. The Dolores River winds between sheer cliffs, reflecting the red rocks above. The riverbank is dominated by tamarisk (*Tamarix ramosissima*) and coyote willow (*Salix exigua*) while Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), boxelder (*Acer negundo*) and Siberian elm (*Ulmus pumila*) are found less frequently. Herbaceous species lining the riverbank include common reed (*Phragmites australis*), saltgrass (*Distichlis spicata*), sedges (*Carex* spp.), rushes (*Juncus* spp.), and bulrush (*Schoenoplectus acutus*). The secondary floodplain terrace is dominated by a dense stand of wild privet (*Forestiera pubescens*), sagebrush (*Artemisia tridentata*), and rabbitbrush (*Chrysothamnus* sp.). Gambel's oak (*Quercus gambelii*), Utah juniper (*Juniperus osteosperma*), Mormon tea (*Ephedra* sp.), and sagebrush (*Artemisia* sp.) cover nearby slopes, reaching up to cliffs with inaccessible ledges. Much of the area is dominated by aggressive non-natives such as tamarisk, Russian knapweed (*Acroptilon repens*), white sweetclover (*Melilotus alba*), and alfalfa (*Medicago sativa*). Upstream hydrologic diversions have altered the hydrologic regime. Dense stands of tamarisk along riverbanks which were historically dominated by herbaceous species or sporadic cottonwoods may also be disrupting typical flooding patterns by slowing water velocity and subsequently increasing sediment deposition (Nature Conservancy 1998). This can cause the river channel to narrow and incise leaving many historical wetlands too high above the water table for wetland vegetation to survive.

The Dolores skeletonplant (*Lygodesmia doloresensis*) was found along the highway in 1979 and 1985. At that time it was noted that the population might not be viable, as it appeared to be preferentially grazed by domestic livestock and wildlife. Recent searches have failed to relocate it. However, since the entire range of the species is extremely limited, it would be worthwhile to continue the effort.

Roundtail chub and flannelmouth sucker are found in this stretch of the Dolores River (Bureau of Land Management, 1990). However, records of these fish are not in CNHP's database.

Biodiversity Rank Justification: This site supports populations of the globally critically imperiled (G1Q) Dolores skeletonplant. The Dolores skeletonplant is known only from Mesa County. It occurs on the reddish alluvial soils on both sides of the Dolores River between Gateway and the Utah border. It has also been reported from the Dolores Canyon north of Gateway, John Brown Canyon, Bar X Wash and Rabbit Valley. The globally critically imperiled (G1G2) foothills riparian shrubland (*Forestiera pubescens*) plant community is also found at this site. This community occurs in Colorado and is expected to occur in New Mexico and Arizona. In Colorado, this community is known only to occur along the Dolores and San Miguel Rivers. It is threatened by inappropriate stream flow alterations. Records of breeding Peregrine Falcons, listed as Endangered by the U.S. Fish and Wildlife Service, have also been documented in this site. Records of the Canyon tree frog are also reported for this site. The site also supports the state imperiled (S2) canyon tree frog, a wetland dependent species. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone.

Table 56. Natural Heritage element occurrences at Dolores Canyon South PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Astragalus linifolius	Grand Junction milkvetch	G3Q	S3	BLM	E
Astragalus naturitensis	Naturita milkvetch	G2	S2S3		E
Lygodesmia doloresensis	**Dolores skeletonplant**	**G1Q**	**S1**	**BLM**	**B**
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	C
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	H
Lygodesmia doloresensis	Dolores skeletonplant	G1Q	S1	BLM	H
Pediomelum aromaticum	Paradox breadroot	G3	S2		C
Plant Communities					
Forestiera pubescens	**Foothills riparian shrubland**	**G1G2**	**S1S2**		**B**

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Birds					
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S3B, SZN	SC	C
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S3B, SZN	SC	B
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	SC	H

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary is drawn to include the Dolores River floodplain and slopes below the steep cliffs, which rise on both sides of the river. 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 riparian elements. It should be noted that the hydrological processes necessary to the riparian elements are not fully contained by the site boundaries. Given that the elements are dependent on natural hydrological processes associated with the Dolores River, any upstream activities such as water diversions, impoundments, and development could potentially be detrimental to the elements. The area contains extensive habitat, which is suitable for the Dolores skeleton plant although the occurrences are patchy. This boundary indicates the minimum area that should be considered for any conservation management plan.

Protection Comments: This PCA is a mixture of BLM and private lands. The area has no special designation at this time. No protection needs are known. BLM has designated the area as open to oil and gas leasing with a no surface occupancy stipulation.

Management Comments: Management needs to include the eradication of tamarisk. Continued searching for the Dolores skeletonplant is recommended, and if located, fencing the site to protect from grazing by wildlife should be considered.

Soils Description: Soils are derived from alluvium and vary in texture depending on geomorphic position. Organic matter accumulation is minimal except near the banks of sloughs and/or backwaters where small O- and thick A-horizons may form.

Much of the floodplain is mapped as the Glenberg series, Coarse-loamy, mixed (calcareous), mesic, Ustic Torrifluvents (USDA 1978). These soils mainly occur on secondary floodplain terraces along the Dolores River.

Restoration Potential: Tamarisk removal and control of Russian knapweed is needed at this site. However, removing dense stands of tamarisk and subsequently planting cottonwoods and willows without restoring the historical flooding regime will require extensive follow-up management (Smith and Devitt 1996 *as cited in* The Nature Conservancy 1998). Upstream, the regulation of water discharge from McPhee Reservoir has reduced the capacity for the Dolores River to seasonally flood, scour, and transport/deposit sediments along its course. Efforts to work with upstream water users, especially those who use water from McPhee Reservoir, to reestablish spring flooding would greatly assist in cottonwood regeneration along the Dolores River. The timing, quantity, and duration of these spring floods should attempt to mimic seasonal flooding patterns prior to the construction of McPhee dam. Otherwise, cottonwood and willow plantings may require irrigation until their root systems have reached the groundwater table. Depending on groundwater depth, the plantings may require irrigation until their root systems have reached the groundwater table. However, depending on soil types and the amount of irrigation water applied, irrigation may only wet the top 35-70 ft^3 of the vertical soil profile, which may not allow tree roots to grow deep enough to access the groundwater table (Briggs 1996). Carothers et. al (1990, as cited in Briggs 1996) suggest that plantings be given an overabundance of irrigation water to ensure the entire soil profile down to the water table is wetted. Because tamarisk is known to release excessive amounts of salt to soils and that many areas have accumulated salts due to a lack of flooding, some areas may have to be treated for excess salts prior to revegetation efforts (Sala 1996). Various methods exist to accomplish this, such as flooding the area with water that has a lower soluble salt content than the soil. This should be conducted in the winter months when plant uptake is minimal. Another treatment option is to amend the soils with gypsum to neutralize the affects of sodium.

Wetland Functional Assessment for the Dolores Canyon South PCA:
Proposed HGM Class: Riverine Subclass: R4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Forestiera pubescens*

Table 57. Wetland functional assessment for the riverine wetland at the Dolores Canyon South site.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland is functioning below potential mainly due to the dominance of non-native species. Altered hydrology from upstream water diversions/reservoirs is also contributing to altered natural functions.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The floodplain along this stretch of the Dolores River is vegetated with a high density of non-native shrubs (tamarisk), although some areas are sparse due to the presence of hay fields. Upstream water projects, mainly McPhee Reservoir, have altered hydrological patterns and thus have forced the river to incise portions of its channel.
Sediment/Shoreline Stabilization	Moderate	Most of the river banks are vegetated with shrubs, trees, and herbaceous species, however some areas have been heavily impacted by overgrazing, altered hydrology, and subsequent channel incision which decreases the ability to perform this function.
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	Disrupted	The presence of aerated water (the river) and a few 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 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). Altered hydrology has also disrupted nutrient cycles by eliminating normal flushing cycles and lack of deposition of organic material from floodwaters.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of excess nutrients and sediment (e.g. from upstream and local livestock and agricultural activity) is likely being performed, although excess salts in the soil (derived from tamarisk and lack of historical flooding) may be disrupting nutrient cycling processes. 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	Moderate	Scrub-shrub wetlands exist in the area. Small emergent wetlands line the riverbank. Hay meadows and the prevalence of non-native species have decreased habitat diversity in many areas. Altered hydrological patterns limit habitat creation from fluvial processes.

General Wildlife Habitat	Moderate	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Hay meadows and non-native species have eliminated some wildlife habitat.
General Fish/Aquatic Habitat	Moderate	Roundtail chub and flannelmouth sucker are found in this stretch of the Dolores River (Bureau of Land Management, 1990). Upstream water diversions and McPhee Reservoir have altered hydrological patterns, which have likely reduced high quality fish habitat.
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. Although some areas lack a diversity of structural vegetation classes (e.g. herbaceous layer is minimal and monotonous tamarisk stands), because the area is so large food chain support is high. This function is negatively affected by the dominance of non-native species such as tamarisk and Russian knapweed and lack of the historical flooding regime.
Uniqueness	Moderate	The entire stretch of the Dolores River through Mesa County serves as an important corridor for wildlife. The surrounding landscape is arid and has abundant topographic relief, thus the presence of open water and lush riparian vegetation provides important habitat.

Figure 11. Dolores Canyon South Potential Conservation Area.

Escalante Canyon Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. A fair occurrence of a critically imperiled (G1) plant community and numerous good occurrences of globally imperiled (G2) plants and plant communities.

Protection Rank: P3. Protection actions may be needed, but probably not within the next five years. It is estimated that stresses may reduce the viability of the elements if protection action is not taken. Mostly USFS and BLM, with smaller private and CDOW parcels. No formal protection is given to the area.

Management Rank: M2. New management actions may be needed within five years to prevent the loss of the element occurrences. Livestock grazing and hay meadows have impacted water quality and abundance of non-native species.

Location: Escalante Creek is located on the eastern slope of the Uncompahgre Plateau. The town of Escalante sits near the mouth of the canyon. The site occurs in Mesa, Montrose, and Delta counties.

U.S.G.S. 7.5-min. quadrangle: Good Point, Escalante Forks, Kelso Point, Snipe Mountain, and Starvation Point.

Legal Description: T49N R14W sec. 2, 3, 9, 10, 16, 17, 20, 30;
T49N R15W sec. 5, 6, 7;
T49N R16W sec. 1, 2, 12, 16;
T50 N R14W sec. 13-24, 26, 27, 34, 35;
T50N R15W sec. 7-13, 19-24, 27-33, 35, 36;
T50N R16W sec. 13, 14, 25, 26 35, 36;
T51N R13W sec. 10, 11, 14-16, 20-22, 28-32;
T51N R14W sec. 1-12, 23-25, 32-36;
T15S R98W sec. 35, 36;
T15 S R97W sec. 17-20, 29-32, 35, 36.

Elevation: 5000-7800 ft. Size: Approximately 38,830 acres

General Description: Escalante Canyon boasts a rich riparian area, with great diversity due to its wide elevation range. At its highest elevations, the creek is lined with river birch (*Betula occidentalis*), mountain willow (*Salix monticola*) and various forbs. As the creeks begins to enter its canyon, Douglas-fir (*Pseudotsuga menziesii*) and narrowleaf cottonwood (*Populus angustifolia*) trees, with a thick understory of red-osier dogwood (*Cornus sericea*), thinleaf alder (*Alnus incana*), and mixed willow species (*Salix* spp.) dominate the riparian area. Near the lower end of the creek, Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), narrowleaf cottonwood, skunkbrush (*Rhus trilobata*), coyote willow (*Salix exigua*), seepwillow (*Baccharis salicina*), spearleaf rabbitbrush (*Chrysothamnus linifolius*), tamarisk (*Tamarix ramosissima*), silverberry (*Shepherdia argentea*), sagebrush (*Artemisia tridentata*), and common reed (*Phragmites australis*) are common along the riverbank. Stands of beaked spikerush (*Eleocharis rostellata*) and cordgrass (*Spartina gracilis*), an uncommon plant community on the West Slope, are also found in the lower part of the drainage. Seeps at the base of the vertical Wingate sandstone cliffs support unusual hanging garden communities (*Aquilegia micrantha-Mimulus eastwoodiae*), which include the rare giant helleborine orchid (*Epipactis gigantea*). North-facing slopes above the creek are covered with firs, while the warmer, drier, south-facing slopes are dominated by pinyon-juniper. Benches and dry washes with soils derived from the Morrison formation support one of the world's best populations of the Grand Junction milkvetch (*Astragalus linifolius*) which is vulnerable through its range (G3).

The lower end of the drainage has an abundance of non-native aggressive species such as tamarisk, Russian knapweed (*Acroptilon repens*), yellow sweetclover (*Melilotus officinalis*), redtop (*Agrostis gigantea*), and alfalfa (*Medicago sativa*). Numerous hay meadows exist in this reach and are likely the source of many non-native species. Hay meadows further upstream at Escalante Forks are also contributing to these problems. However, most of the site is in good condition. Hydrological processes appear to be intact, although some water is being diverted for hay production. On July 10, 2001, a large flood occurred in Escalante Creek. Much of the herbaceous understory had been scoured out and most of the coyote willow was matted down.

Biodiversity Rank Justification: This site supports a fair occurrence of the globally critically imperiled (G1) narrowleaf cottonwood riparian forest (*Populus angustifolia/Salix eriocephala* var. *ligulifolia-Shepherdia argentea*). This community is known only from a few fragmented stands in southwestern Colorado. No large, unaltered stands are left. Remaining stands are highly threatened by improper livestock grazing, heavy recreational use, stream flow alterations, and improvements and maintenance of roads and railroads. . Historically, this community was more widespread and common in broad river valleys (Baker 1986). The site also supports three good examples of globally imperiled (G2) plant communities, eight examples of plant communities vulnerable through their range (G3), and a unique stand of cordgrass (*Spartina gracilis*), an uncommon plant community on the West Slope. Populations of the globally imperiled (G2) good-neighbor bladderpod (*Lesquerella vicina*), the Grand Junction milkvetch (*Astragalus linifolius*), Eastwood monkeyflower (*Mimulus eastwoodiae*), and the Uinta Basin hookless cactus (*Sclerocactus glaucus*) which are vulnerable through their range (G3) (the latter is listed as Threatened by the U.S. Fish and Wildlife Service) are all found at this site. The state imperiled (S2) giant helleborine orchid (*Epipactis gigantea*) is all found at this site.

Table 58. Natural Heritage element occurrences at Escalante Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Lesquerella vicina	**Good-neighbor bladderpod**	**G2**	**S2**	**BLM**	**B**
Astragalus linifolius	Grand Junction milkvetch	G3Q	S3	BLM	B
Astragalus linifolius	Grand Junction	G3Q	S3	BLM	B

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
	milkvetch				
Astragalus linifolius	Grand Junction milkvetch	G3Q	S3	BLM	B
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	A
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	C
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	C
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	C
Mimulus eastwoodiae	Eastwood monkeyflower	G3	S2	BLM	A
Epipactis gigantea	Giant helleborine	G3	S2	FS	A
Epipactis gigantea	Giant helleborine	G3	S2	FS	A
Epipactis gigantea	Giant helleborine	G3	S2	FS	B
Epipactis gigantea	Giant helleborine	G3	S2	FS	E
Platanthera sparsiflora ssp. *ensifolia*	Canyon bog-orchid	G4G5T4?	S3		A
Plant Communities					
Populus angustifolia/Salix eriocephala* var. *ligulifolia-Shepherdia argentea	**Narrowleaf cottonwood riparian forest**	**G1**	**S1**		**C**
Juniperus osteosperma/Hesperostipa comata	Utah juniper shrublands	G2	S2?		B
Populus deltoides ssp. wislizeni/Rhus trilobata	Rio Grande cottonwood riparian forest	G2	S2		B
Populus deltoides ssp. wislizeni/Rhus trilobata	Rio Grande cottonwood riparian forest	G2	S2		B
Aquilegia micrantha-Mimulus eastwoodiae	Hanging gardens	G2G3	S2S3		A
Eleocharis rostellata	Beaked spikerush emergent wetland	G2G3	S2S3		B
Populus angustifolia- Pseudotsuga menziesii	Narrowleaf cottonwood/ Douglas-fir	G3	S2		A
Alnus incana-Mixed *Salix* species	Thinleaf alder-mixed willow species	G3	S3		B
Betula occidentalis/Mesic forb	Foothills riparian shrubland	G3	S2		AB
Betula occidentalis/Mesic forb	Foothills riparian shrubland	G3	S2		B
Salix monticola/Mesic forb	Montane riparian willow carr	G3	S3		C
Salix monticola/Mesic forb	Montane riparian willow carr	G3	S3		CD
Spartina gracilis	Western slope salt meadows	G4	S2		B
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood/Red-osier dogwood	G4	S3		A

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: The PCA is mostly USFS and BLM lands, with smaller private and CDOW parcels. Future alteration of the private land in this scenic area could be a threat.

Management Comments: Livestock grazing and hay meadows have impacted water quality and abundance of non-native species at the lower end of the canyon in Delta County. The upper parts of the canyon within Mesa County are in better condition, although hay meadows at Escalante Forks are diverting water and may be contributing to water quality and non-native species issues.

Soils Description: Soils along Escalante Creek are derived from alluvium and are not mapped in the County soil survey.

Restoration Potential: Eradication of tamarisk and Russian knapweed should be a priority in the lower reach of the drainage. Hydrological processes are mostly intact, thus making restoration efforts much easier. Monitoring of non-native, aggressive species should be continually conducted, especially in the lower end of the site.

Wetland Functional Assessment for the Escalante Canyon PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Betula occidentalis/*Mesic forb, *Salix monticola/*Mesic forb, *Populus angustifolia/Cornus sericea*, *Alnus incana*-Mixed *Salix* species, *Populus angustifolia- Pseudotsuga menziesii*, *Populus angustifolia/Salix eriocephala* var. *ligulifolia-Shepherdia argentea*, and *Populus deltoides* ssp. *wislizeni/Rhus trilobata*.

Table 59. Wetland functional assessment for the Escalante Canyon PCA.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	Dense riparian vegetation could moderate floodwater velocity but the canyon is fairly narrow, thus there is minimal floodplain for floodwater attenuation/storage. Large floods such as the one on July 10, 2001 have too much velocity to be attenuated by this wetland.
Sediment/Shoreline Stabilization	Moderate	Stream banks are vegetated with shrubs, trees, and herbaceous species. However, the recent flood removed much herbaceous vegetation from the lower reach. Upper reaches likely provide excellent stabilization functions, but lower reaches may have less capacity due to the erosive nature of floods in the lower reach.
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	Normal	The presence of aerated water (the river), a few areas of saturated soil (backwater areas) and a diversity of litter types provide a gradient for various nutrient transformations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of excess nutrients and sediment (e.g. from hay productions) is likely being performed, especially in the upper reaches. The lower reach has less capacity to perform this function as flooding in this area often results in excessive erosion.
Biological Functions		
Habitat Diversity	High	Emergent, scrub-shrub, and forested wetlands exist along the drainage. An intact hydrological regime will maintain habitat diversity.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Structural diversity of the vegetation is high and thus excellent habitat for birds.
General Fish/Aquatic Habitat	High	Fish habitat is excellent given the diversity of pools, riffles, dense overhanging vegetation, and abundance of invertebrates.
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.

		Dense streamside vegetation supports healthy invertebrate populations.
Uniqueness	Moderate	Escalante Creek supports a rich diversity of riparian plant communities and plant species.

Figure 12. Escalante Canyon Potential Conservation Area.

Fruita and Monument Canyons Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. Two good occurrences of a globally critically imperiled (G1) plant, and multiple occurrences of plants vulnerable through their range (G3).

Protection Rank: P5. Land protection is complete. The area is well protected as part of Colorado National Monument.

Management Rank: M4. Current management seems to favor the persistence of the elements but management actions may be needed in the future to maintain the current quality of the element occurrences. Hikers to Balance Rock may impact the Canyonlands lomatium (*Lomatium latilobum*) population.

Location: This site is located within the Colorado National Monument.

U.S.G.S. 7.5 min. quadrangle: Colorado National Monument
Legal Description: T1N R2W sec. 29-33;
T11S R101W sec. 17-20, 29, 30;
T11S R102W sec. 13.

Elevation: 4600-5820 ft. Size: Approximately 3,900 acres.

General Description: This spectacular site includes the west entrance to Colorado National Monument, and the north end of the park. A paved road leads from Fruita to the canyon rims. Included in the site are such well-known formations as Balance Rock and Independence Monument. One of only three known Colorado locations for the Canyonlands lomatium (*Lomatium latilobum*) is found at the base of Balance Rock in seasonally wet gullies in the Chinle sandstone. The same habitat supports the Osterhout cryptantha (*Cryptantha osterhoutii*). Seasonal pools along the drainages support populations of the canyon treefrog (*Hyla arenicolor*). There are few non-native species in the park, and thus excellent examples of common communities occur in this site. These communities include various combinations of Utah juniper (*Juniperus osteosperma*), pinyon pine (*Pinus edulis*), mountain mahogany (*Cercocarpus montanus*), Mormon tea (*Ephedra* sp.), and Utah serviceberry (*Amelanchier utahensis*).

Biodiversity Rank Justification: This site supports two occurrences of the globally critically imperiled (G1) Canyonlands lomatium. This species is a regional endemic, that occurs in pinyon-juniper and desert shrub communities between 4800 and 6855 ft. elevation (Atwood 1991; Welsh 1987) and is arguably the most biologically important rare plant in Mesa County, and one of the rarest plants in Colorado. It is known only from thirteen locations in Grand and San Juan Counties in Utah, and three locations in Mesa County (Franklin 1995). The site also supports the state imperiled (S2) canyon tree frog, a wetland dependent species. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone.

Table 60. Natural Heritage element occurrences at Fruita and Monument Canyons PCA.
Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Lomatium latilobum	**Canyonlands Lomatium**	**G1**	**S1**	**BLM**	**B**
Lomatium latilobum	**Canyonlands Lomatium**	**G1**	**S1**	**BLM**	**B**
Cryptantha longiflora	Long-flower cat's eye	G3	S2		H
Cryptantha osterhoutii	Osterhout cryptantha	G3	S1S2		E
Cryptantha osterhoutii	Osterhout cryptantha	G3	S1S2		E
Cryptantha osterhoutii	Osterhout cryptantha	G3	S1S2		H
Cryptantha osterhoutii	Osterhout cryptantha	G3	S1S2		H
Cryptantha osterhoutii	Osterhout cryptantha	G3	S1S2		H
Pediomelum aromaticum	Paradox breadroot	G3	S2		E
Allium nevadense	Nevada onion	G4	S1		H
Allium nevadense	Nevada onion	G4	S1		H
Eriogonum palmerianum	Palmer buckwheat	G4	S1		H
Centaurium exaltum	Great Basin centaury	G5	S1		E
Centaurium exaltum	Great Basin centaury	G5	S1		E
Sporobolus flexuosus	Mesa dropseed	G5	S1S2		E
Birds					
Falco peregrinus anatum	American peregrine falcon	G4T4	S2B, SZ	SC	A
Mammals					
Plecotus townsendii pallescens	Townsend's big-eared bat	G4T4	S3		H
Reptiles					
Gambelia wislizeni	Longnose leopard lizard	G5	S1	BLM, SC	H
Gambelia wislizeni	Longnose leopard lizard	G5	S1	BLM, SC	H
Lampropeltis triangulum taylori	Utah milk snake	G5T4	S2		H
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	SC	H
Hyla arenicolor	Canyon treefrog	G5	S2	SC	H
Hyla arenicolor	Canyon treefrog	G5	S2	SC	H
Speas intermontana	Great Basin spadefoot toad	G5	S2	SC	H

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: Boundaries are drawn to include the cluster of element occurrences in the northwestern part of Colorado National Monument. The site boundaries also incorporate upstream drainages which are critical to maintaining natural hydrological processes that provide breeding spots for the canyon tree frog and Great Basin spadefoot toad.

Protection Comments: This PCA is owned and managed by the National Park Service (Colorado National Monument). The area is well protected as part of Colorado National Monument.

Management Comments: Hikers to Balance Rock may impact the Canyonlands lomatium population. Well-signed established trails away from the plants would protect them from trampling and erosion, which were identified as the major threats to the plants in Arches National Park (Floyd and Hanna 1994).

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Monitor and eradicate any tamarisk (*Tamarix ramosissima*) that establishes.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001. Thus, a functional assessment could not be conducted. However, given that most of the drainages flow intermittently, it is hypothesized that most wetland functions will be performed a low levels, although they would be functioning at their potential. Vegetation growth is minimal along the drainages, but periodic episodes of flowing water and seasonal pools provide important food chain support and seasonal habitat for species such as the canyon tree frog.

Figure 13 Fruita and Monument Canyons Potential Conservation Area.

Gunnison River Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. This site supports multiple occurrences of three endangered fish, one endangered plant, and numerous plant communities imperiled (G2) and vulnerable through their range (G3).

Protection Rank: P4. No protection actions are needed in the foreseeable future. The site consists of BLM and private lands.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management may be needed in the future to maintain the current quality of the element occurrences. A BLM "no surface occupancy" stipulation for oil and gas leasing in the Gunnison River corridor is in place, and the corridor has been identified as unsuitable for public utilities.

Location: Located along the Gunnison River in Mesa, Montrose, and Delta counties.

U.S.G.S. 7.5-min. quadrangle: Grand Junction, Island Mesa, Whitewater, Triangle Mesa, Dominguez, Good Point, Point Creek, Roubideau, Delta, North Delta, Orchard City, and Lazear.
Legal Description: T1S R1W sec. 22, 23, 26, 27, 34-36;
T1S R1E sec. 31;
T2S R1E sec. 4-6, 8-10, 14-17, 23, 26, 35, 36;
T3S R2E sec. 29, 33-36;
T4S R3E sec. 7, 8, 17-20, 26-35;
T12S R99W sec. 19, 28-30, 33;
T12S R100W sec. 13-15, 24;
T13S R99W sec. 4, 9, 10, 15, 16, 21, 22, 26, 27, 34, 35;
T14S R94W sec. 31, 36;
T14S R98W sec. 6-11, 14-18, 20-23, 26, 27, 34, 35;
T14S R99W sec. 1, 2, 12;
T15S R94W sec. 1-11;
T15S R95W sec. 1, 2, 3-5, 7, 8, 10-12, 18;
T15S R96W sec. 10-22, 30;
T15S R97W sec. 7-10, 15-18, 22-26;
T15S R98W sec. 2, 3, 11-13.

Elevation: 4500-5100 ft. Size: Approximately 30,531 acres

General Description: The Gunnison River drains all of Delta County, as well as a large part of Gunnison and Montrose counties. The section of the river below the confluence with the Uncompahgre River in Delta has been designated as critical habitat for the endangered Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*). Other fish that have been found in the Gunnison River include the roundtail chub (*Gila robusta*) and the endangered humpback chub (*Gila cypha*). The fish have been much studied, and tremendous effort has been put into their recovery. A fish ladder was constructed at Redlands, near the confluence with the Colorado, to allow upstream migration of fish from the Colorado River, and genetic mixing with the Gunnison River population. Non-native fishes have increased with lowered water levels and threaten the survival of native fish. Of twenty-one species of fish collected in the warm water reaches of the Gunnison river, seven were native and fourteen were non-native. However, the native fish comprised 79% of the total fish collected (Burdick 1995). In a two year study, densities of native fish were higher in a high-water year, while non-natives were more dense in a low water year. Increasing spring flows in the river is essential to restore natural floodplain functions, provide habitat for native fish, and control non-native fish.

Natural riparian plant communities of the Gunnison are dominated by Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*) and coyote willow (*Salix exigua*). Other native species that are common along the river include skunkbrush (*Rhus trilobata*), big sagebrush (*Artemisia tridentata*), greasewood (*Sarcobatus vermiculatus*), rubber rabbitbrush (*Chrysothamnus nauseosus*), spearleaf rabbitbrush (*Chrysothamnus linifolius*), bulrushes (*Schoenoplectus* spp.), cattails (*Typha* sp.), spikerush (*Eleocharis* sp.), Baltic rush (*Juncus balticus*), wild licorice (*Glycyrrhiza lepidota*), saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*) and sand dropseed (*Sporobolus cryptandrus*). Much of the river has been highly altered, and cottonwood regeneration is not occurring as it should. Because of diversions for irrigation, much of the floodplain which once periodically flooded is no longer inundated during the spring runoff. Areas that were once covered with dense cottonwood forest have been invaded by non-native species such as tamarisk (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), Siberian elm (*Ulmus pumila*), Russian knapweed (*Acroptilon repens*), cheatgrass (*Bromus tectorum*), and reed canarygrass (*Phalaris arundinacea*). When the water table is lowered, tamarisk and Russian olive gain an advantage over native species. Remaining cottonwood groves often have an understory of Russian knapweed and other non-native species. An area a couple miles downstream from Delta had a mature, open cottonwood forest, with concentric bands of younger trees and willows which were established as the river meandered and built up new gravel bars. Undisturbed cottonwood groves are essential for the nesting sites of the Great Blue Heron. Rookeries observed along the Gunnison were in mature cottonwoods just downstream of Confluence Park and Escalante Creek.

Biodiversity Rank Justification: The site includes multiple occurrences of three of the endangered fish of the Colorado River, the razorback sucker, Colorado pikeminnow, and humpback chub. Razorbacks are considered globally critically imperiled (G1). The razorback sucker is listed as endangered by the USFWS and Colorado Division of Wildlife. The razorback sucker is extremely rare in Colorado. Fewer than seventy specimens have been collected since 1979, and these have all been adult fish, which may live for thirty years (Woodling 1985). This suggests that reproductive failure is the cause of their decline. Lack of recruitment of young into the population has been attributed to predation by non-native species including catfish and carp. Dams may block access to spawning habitats, change suitable juvenile habitat, block upstream migration, and lower water temperatures. There are confirmed spawning areas in Mesa County at Clifton, and the Colorado River between Grand Junction and Clifton is one of the main concentration areas of the fish. Habitats for the fish include backwaters, eddies, and impoundments. The fish are often associated with sand, mud and rock substrates in areas with sparse aquatic vegetation and moderate to warm temperatures (Sigler and Miller 1963). Colorado pikeminnow are considered globally critically imperiled (G1). The Colorado pikeminnow is listed as endangered by the USFWS and Colorado Division of Wildlife. The Colorado pikeminnow was once an important food and commercial fish, living throughout the Colorado River drainage in mainstream channels, including the Green, Yampa, White, Colorado, Gunnison, Dolores, and Animas rivers. Its current distribution is restricted to the lower reaches of the these rivers, except the Dolores and Animas (Woodling 1985.) The decline of the fish is not fully understood. It is thought that dams have restricted spawning migrations, and that lowered water temperatures resulting from cold water releases prevent the development of fertilized eggs. Biotic interactions with other introduced fish species may also have impacted their decline (Woodling 1985). The young pikeminnows prefer small, quiet backwaters. Adults use various habitats, including deep, turbid, strongly flowing water, eddies, runs, flooded bottoms, or backwaters (especially during high flow). Lowlands inundated during spring high flow appear to be important habitats (Tyus and McAda 1984). Efforts for the recovery of the pikeminnow include reintroduction and the construction of fish ladders to facilitate their natural migration (R. Anderson, CDOW, personal communication.). Humpback chub are considered globally critically imperiled (G1). The Humpback chub is listed as endangered by the USFWS and Colorado Division of Wildlife. The humpback chub was historically widely distributed throughout the Colorado River Basin to which it is endemic. Its habitat has been altered by the construction of dams, and today it is found in widely separated river areas in the upper and lower Colorado Basin. Not only is the species rare, but it is threatened by hybridization with the roundtail chub (*Gila robusta*). Reduced river flows allow the round tail chub to successfully inhabit some deepwater areas during low water periods where humpback chubs were previously isolated, resulting in competition and hybridization. Intermediates between the species occur in altered river systems, but not in unaltered rivers, emphasizing the importance of natural riverine environments for the recovery of the species (Tyus and Karp 1989).

This site supports an occurrence of the globally imperiled (G2S2) Rio Grande cottonwood/skunkbrush riparian forest. This community 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. Occurrences of two globally imperiled (G2) plant communities and one plant community vulnerable through its range are also found here.

Numerous populations of the Uinta Basin hookless cactus (*Sclerocactus glaucus*), which is listed as Threatened by the U.S. Fish and Wildlife Service, occur within the site. It is the only plant in Mesa County to have federal protection under the Endangered Species Act. It is found on gravelly alluvial soils or in clay, between 4500 and 6000 ft.

Table 61. Natural Heritage element occurrences at Gunnison River PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	D
Xyrauchen texanus	**Razorback sucker**	**G1**	**S1**	**LE, E**	**C**
Gila cypha	Humpback chub	G1	S1	LE, E	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Gila robusta	Roundtail chub	G3	S2	SC	H
Plants					
Sclerocactus glaucus	**Uinta Basin hookless cactus**	**G3**	**S3**	**LT**	**A**
Sclerocactus glaucus	**Uinta Basin hookless cactus**	**G3**	**S3**	**LT**	**B**
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	C
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	C
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	D
Sclerocactus glaucus	Uinta Basin hookless cactus	G3	S3	LT	D
Plant Communities					
Populus deltoides* ssp. *wislizeni/Rhus trilobata	**Rio Grande cottonwood riparian forest**	**G2**	**S2**		**B**
Carex pellita	Montane wet meadows	G3	S3		C
Atriplex confertifolia/Hilaria jamesii	Cold desert shrublands	G3	S2		C

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The site boundary encompasses the mainstem of the Gunnison River and its floodplain. 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 many 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 areas where old oxbows, sloughs, and ponds could provide a source of recruitment for native wetland and riparian plant species and provide critical fish habitat. It should be noted that the hydrological processes necessary to the elements are not fully contained by the site boundaries. Given that many of the elements are dependent on natural hydrological processes associated with the Gunnison 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.

Protection Comments: The PCA consists of BLM and private lands. The Colorado pikeminnow, razorback sucker, humpback chub, and the Uinta Basin hookless cactus are protected under the endangered species act. Present management of the riparian area should be adequate to protect the canyon treefrog and Utah milk snake.

Management Comments: BLM's management plan calls specifically for protection of the Uinta Basin hookless cactus and "known habitat sites of sensitive plant and animal species from surface-disturbing activities." A "no surface occupancy" stipulation for oil and gas leasing in the Gunnison River corridor is in place, and the corridor has been identified as unsuitable for public utilities. In addition, the plan prohibits surface disturbance within 100 ft. of perennial streams. Woody riparian habitat is to be maintained "to favor the tallest plant species native to each site while promoting diversity in plant heights and species" (USDI 1987). This may require active management, including protection of existing cottonwoods and removal of tamarisk and other non-native aggressive species.

Soils Description: Soils are derived from alluvium and vary in texture depending on geomorphic position. Organic matter accumulation is minimal except around wetlands and near the banks of sloughs where small O- and thick A-horizons may form.

Soils along the Gunnison River are mapped mostly as the Youngston and Glenberg Series. The Youngston is classified as a Fine-loamy, mixed, (calcareous), mesic Typic Torrifluvents. The Youngston consists of deep, well-drained soils that have formed in alluvium on floodplains and alluvial fans (USDA 1978). The Glenberg series is classified as a Coarse-loamy, mixed (calcareous), mesic, Ustic Torrifluvents (USDA 1978). These soils mainly occur on secondary floodplain terraces and thus are more common upstream of the Mesa/Delta county line since the river is restricted in a narrow canyon downstream to Grand Junction and secondary floodplain terraces are not common.

Restoration Potential: Restoration is a daunting task along the Gunnison River. River hydrology has been drastically altered and is the most significant disturbance affecting this site. Non-native species are very prevalent. Tamarisk removal should be one of the top restoration priorities along the river corridor. However, removing dense stands of tamarisk and subsequently planting cottonwoods and willows without restoring the historical flooding regime will require extensive follow-up management (Smith and Devitt 1996). Restoring natural river flows is unlikely, but there are actions that can be taken to restore some fluvial processes into areas where they have been removed. For example, the National Park Service recently filed for reserve water rights on behalf of the Black Canyon of the Gunnison National Park. If these water rights are secured, instream flow in the Gunnison River may increase thereby increasing flow in the Colorado River downstream of the confluence. The key will be the timing and duration of increased flows.

There has been alteration of plant communities within the floodplain of the Gunnison River that stems from altered hydrology and past land use. 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. There are numerous hay meadows, gravel pits, and roads that could be restored to natural vegetation patterns. Cottonwoods and willow pole cuttings could be planted once tamarisk has been removed. The plantings may require irrigation until their root systems have reached the groundwater table. Depending on groundwater depth, the plantings may require irrigation until their root systems have reached the groundwater table. However, depending on soil types and the amount of irrigation water applied, irrigation may only wet the top 35-70 ft^3 of the vertical soil profile, which may not allow tree roots to grow deep enough to access the groundwater table (Briggs 1996). Carothers et. al (1990, as cited in Briggs 1996) suggest that plantings be given an overabundance of irrigation water to ensure the entire soil profile down to the water table is wetted. Because tamarisk is known to release excessive amounts of salt to soils and that many areas have accumulated salts due to a lack of flooding, some areas may have to be treated for excess salts prior to revegetation efforts (Sala 1996). Various methods exist to accomplish this, such as flooding the area with water that has a lower soluble salt content than the soil. This should be conducted in the winter months when plant uptake is minimal. Another treatment option is to amend the soils with gypsum to neutralize the affects of sodium.

Working toward a restoration of natural river flows by eliminating channel diversion structures and riprap hindering natural meanders would benefit recovery all the native fish found here, which require low winter flow, high spring flow, cool to warm river temperatures, and flooding. These fish also require large stream areas that incorporate diverse habitats including pools, riffles, runs, backwaters, adequate substrate and current diversity.

Wetland Functional Assessment for the Gunnison River PCA:
Proposed HGM Class: Riverine Subclass: R5
Cowardin System: Palustrine
CNHP's Wetland Classification: *Populus deltoides ssp. wislizeni/Rhus trilobata,* plus emergent wetlands in the floodplain.

Table 62. Wetland functional assessment for the riverine wetland at the Gunnison River site.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland is functioning below potential as hydrological alterations and dominance of non-native species have altered natural functions.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The floodplain in Delta County 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. However, the floodplain in Mesa County is narrow and constricted. Altered hydrology limits the potential of this site to perform this function.
Sediment/Shoreline Stabilization	High	Most banks are vegetated with shrubs, trees, and herbaceous species, however some areas have been heavily impacted by overgrazing, urban development, and altered hydrology.
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	Disrupted	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 (prevalence of Russian knapweed) 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). Altered hydrology has disrupted nutrient cycles by eliminating normal flushing cycles and lack of deposition of organic material from floodwaters.
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. However, urban development, gravel mining, and agriculture have decreased habitat diversity in many areas. Altered hydrology limits habitat creation from fluvial processes.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as

		eagles, hawks, and falcons. Oxbows and sloughs provide open water for waterbirds. However, urban development, gravel mining, and agriculture have decreased wildlife habitat.
General Fish/Aquatic Habitat	High	The river supports populations of three endangered species including the razorback sucker, Colorado pikeminnow, and humpback chub. However, altered hydrology and the presence of non-native fish have negatively affected the populations of these species.
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. This function is negatively affected by the abundance of non-native species such as tamarisk, Russian olive, and Russian knapweed and the lack of a historical flooding regime.
Uniqueness	High	The wetland supports three endangered fishes and a globally imperiled plant community.

Figure 14. Gunnison River Potential Conservation Area.

Gunnison River Potential Conservation Area Priority Areas

The table below lists the Priority Areas identified within the Gunnison River Potential Conservation Area in Mesa County using the methods described on page 58. A total of four Priority Areas were identified within the PCA. The sites are listed in descending order of their Final Score.

Table 63. Gunnison River Potential Conservation Area Priority Areas. Note: River miles are relative to the confluence of the Gunnison and Colorado rivers (moving upstream). Site names are mostly derived from Irving and Burdick 1995).

Site Name (approximate river miles)	Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score	Public Lands?	Tamarisk Eradication Projects?	Land Status
Redlands Dam (2.2-3.0)	28	No	Yes - 1	1	Yes	**6**	Partial	No	City of Grand Junction, BLM, and private
Sand Flat (27.3-28.7)	12	No	Yes - 3	1	No	**5**	Partial	No	BLM and private
No Name 4 (21.3-21.8)	10	No	Yes - 1	2	No	**4**	Yes	No	BLM
Whitewater (13.3-16.0)	24	No	Yes - 1	1	No	**4**	No	No	Private

Figure 15. Priority Areas within the Gunnison River Potential Conservation Area.

This is the same map as found on page 84 please insert again.

Name: co_gunn_river_pcas_priority.jpg

Descriptions of Priority Areas:

Redlands Dam

Final Score: 6

Public Lands? Partially

Restoration Occurring? No

Land Status: City of Grand Junction, BLM, and private

Location: This area is located approximately 1.5 miles south of Grand Junction. The upstream end of this area starts at the Redlands Dam. T1S R1W sec. 26, 27, 34, and 35.
River miles: 2.2-3.0

Size: Approximately 227 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 64. Ranking Factors for Redlands Dam.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
28	No	Yes - 1	1	Yes	**6**

An average of 28 bird species/mile have been documented in this area. This site contains one bottomland habitat site, the Redlands (ranked #26) and has evidence of high use by Colorado pikeminnow.

Table 65. Natural Heritage element occurrences at Redlands Dam.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H

*EO=Element Occurrence

Sand Flat

Final Score: 5 **Public Lands?** Partially **Restoration Occurring?** No **Land Status:** BLM and private

Location: The Sand Flat priority area is located approximately 1 mile south of the Mesa/Delta county line. T3S R2E sec. 29, 30, and 32; T14S R98W sec. 6-8; T14S R99W 1 and 12.

River miles: 27.3-28.7

Size: Approximately 680 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 66. Ranking Factors for Sand Flat.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
12	No	Yes - 3	1	No	**5**

An average of 12 bird species/mile have been documented in this area. This site contains three bottomland habitat sites, the Dads Flat (ranked #23), Tunnel Point (ranked #21), and Sand Flats (ranked #23) and does not have evidence of high use by pikeminnow.

Table 67. Natural Heritage element occurrences at Sand Flat.

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H

*EO=Element Occurrence

No Name 4

Final Score: 4	
Public Lands? Yes	
Restoration Occurring? No	
Land Status: BLM	

Location: The No Name 4 priority area is located approximately 1 mile south of the Mesa/Delta county line. T13S R99W sec. 22 and 27.
River miles: 21.3-21.8

Size: Approximately 85 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 68. Ranking Factors for No Name 4.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
10	No	Yes - 1	2	No	**4**

An average of 10 bird species/mile have been documented in this area. This site contains one bottomland habitat site, the No Name (ranked #26) and does not have evidence of high use by pikeminnow.

Table 69. Natural Heritage element occurrences at No Name 4.

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	EO* Rank
Fish					
Ptychocheilus lucius	Colorado pikeminnow	G1	S1	LE, E	H
Plant Communities					
Carex pellita	Montane wet meadows	G3	S3		C

*EO=Element Occurrence

Whitewater

Final Score: 4

Public Lands? No

Restoration Occurring? No

Land Status: Private

Location: The Whitewater priority area is located at the town of Whitewater. T2S R1E sec. 14 and 15; T12S R99W sec. 28.
River miles: 13.3-16.0

Size: Approximately 196 acres.

General Description: This area not visited by CNHP during the 2001 field season.

Table 70. Ranking Factors for No Name 4.

Average Bird Density/River Mile	Top 13 Bottomland Site?/How Many?	Bottomland Site Not Ranked in Top 13?/How Many?	# Of CNHP EORs	Pikeminnow High Use Area	Final Score
24	No	Yes - 1	1	No	**4**

An average of 24 bird species/mile have been documented in this area. This site contains one bottomland habitat site, the Whitewater Building Materials (ranked #23) and does not have evidence of high use by pikeminnow.

Table 71. Natural Heritage element occurrences at Whitewater.

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	EO* Rank
Reptiles					
Gambelia wislizeni	Longnose leopard lizard	G5	S1	BLM, SC	H

*EO=Element Occurrence

John Brown Canyon Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. An unranked occurrence of a globally critically imperiled (G1) plant.

Protection Rank: P4. No protection actions are needed in the foreseeable future. The site has no formal protection, although no protection needs are known.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. The Dolores skeletonplant population should be monitored.

Location: John Brown Canyon is located southwest of Gateway.

U.S.G.S. 7.5 min. quadrangle: Gateway.
Legal Description: T50N R19W sec. 4-7;
T50 N R20W sec. 1, 12;
T51N R19W sec. 21, 22, 27-34;
T51N R20W sec. 25, 36.

Elevation: 4600-4800 ft. Size: Approximately 4,515 acres.

General Description: John Brown Creek, a tributary of the Dolores River, forms a narrow canyon southwest of Gateway. Riparian vegetation along the creek includes Rio Grande cottonwood (*Populus deltoides* ssp. *wislizeni*), narrowleaf cottonwood (*Populus angustifolia*), and their hybrid, *Populus acuminata*, as well as box elder (*Acer negundo*) and willows (*Salix* spp.). A large flood occurred on July 10, 2001, scouring out most of the herbaceous vegetation in the canyon. The Dolores skeletonplant was found along the stream near its mouth. Rocky pools in the creek support the canyon tree frog (*Hyla arenicolor*) and northern leopard frog (*Rana pipiens*). The mesa top is forested with aspen (*Populus tremuloides*), Gambel's oak (*Quercus gambelii*) and ponderosa pine (*Pinus ponderosa*). A gravel road runs along the canyon bottom for several miles before it climbs to the mesa top. It is quite heavily used by logging trucks, and receives fairly heavy recreational traffic.

Biodiversity Rank Justification: This site supports an occurrence of the globally critically imperiled (G1) Dolores skeletonplant. The Dolores skeletonplant is known only from Mesa County. It occurs on the reddish alluvial soils on both sides of the Dolores River between Gateway and the Utah border. It has also been reported from the Dolores Canyon from the Mesa County line to the Utah border, John Brown Canyon, Bar X Wash and Rabbit Valley. The site also supports the state imperiled Utah penstemon. A fair occurrence of the globally imperiled (G2S2) Rio Grande cottonwood/skunkbrush riparian forest occurs at this site. This community 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 state imperiled (S2) canyon tree frog (*Hyla arenicolor*) inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone.

Table 72. Natural Heritage element occurrences at John Brown Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Lygodesmia doloresensis	**Dolores skeletonplant**	**G1Q**	**S1**	**BLM**	**E**
Penstemon utahensis	Utah penstemon	G4	S2		E
Plant Communities					
Populus deltoides ssp. *wislizeni/Rhus trilobata*	Rio Grande cottonwood riparian forest	G2	S2		C
Mammals					
Plecotus townsendii pallescens	Townsend's big-eared bat	G4T4	S2	FS/BLM	E
Reptiles					
Tantilla hobartsmithi	Southwestern blackhead snake	G5	S1		E
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	SC	H
Hyla arenicolor	Canyon treefrog	G5	S2	SC	H

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary is drawn to include the floodplain and extensive habitat suitable for the Dolores skeletonplant. 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 riparian elements.

Protection Comments: The Bureau of Land Management (BLM) manages the site. The site has no formal protection. No protection needs are known.

Management Comments: The Dolores skeletonplant population should be monitored.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Monitor and eradicate any tamarisk (*Tamarix ramosissima*) present in the area.

Wetland Functional Assessment for the John Brown Canyon PCA:
Proposed HGM Class: Riverine   Subclass: R4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Populus deltoides* ssp. *wislizeni/Rhus trilobata*.

Table 73. Wetland functional assessment for the riverine wetland at the John Brown Canyon site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar local HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	Low	The canyon is fairly narrow, thus there is minimal floodplain for floodwater attenuation/storage. Large floods such as the one on July 10, 2001 have too much velocity to be attenuated by this wetland.
Sediment/Shoreline Stabilization	Low	Stream banks are vegetated with shrubs, trees, and only sporadically with herbaceous species. The recent flood removed most herbaceous vegetation. This area has low capacity to perform this function due to the erosive nature of flooding in this narrow canyon.
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	Normal	Although intermittent, the presence of aerated water (the river), a few areas of saturated soil (small seasonal pools) and a diversity of litter types provide a gradient for various nutrient transformations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low	This area has minimal capacity to perform this function as flooding in this area often results in excessive erosion.
Biological Functions		
Habitat Diversity	Moderate	Scrub-shrub, forested wetlands plus small seasonal pools exist along the drainage. An intact hydrological regime will maintain habitat diversity.
General Wildlife Habitat	Moderate	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. However, structural diversity of the vegetation is low.
General Fish/Aquatic Habitat	Low	This is an intermittent stream and thus does not support fish populations. However, small pools support amphibians
Production Export/Food Chain Support	Moderate	An intermittent water source and allochthonous organic substrates provide various sources of carbon (both dissolved and particulate) and nutrients for downstream ecosystems, although only seasonally. Seasonal pools support invertebrate populations.
Uniqueness	Low	Other canyons in the immediate area support similar riparian vegetation.

Figure 16 John Brown Canyon Potential Conservation Area.

Mee Canyon Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. A good occurrence of a globally imperiled (G2G3) plant community.

Protection Rank: P5. Land protection is complete and no protection actions are needed. The area is a part of the Black Ridge BLM Wilderness Area.

Management Rank: M3. New management actions may be needed withint five years to maintain the current quality of the element occurrences. Heavy traffic could damage the riparian areas, and particularly the giant helleborine orchid.

Location: Mee Canyon is located approximately 8 miles southwest of Fruita.

U.S.G.S. 7.5-min. quadrangle: Battleship Rock and Ruby Canyon.
Legal Description: T10S R104W sec. 35, 36;
T10S R103W sec. 30, 31;
T11S R103W sec. 2-6, 9-11, 14-16, 23.

Elevation: 5100-6000 ft. Size: Approximately 4,001 acres.

General Description: This scenic sandstone canyon contains an enormous, 300 foot deep cavern cut by a meander of a small stream which drains to the Colorado River. The canyon is rimmed with red Entrada sandstone, and has steep sides of the Kayenta and Wingate formations. The bottom is ungrazed, and difficulty of access to the upper reaches has probably protected it from human impacts. The narrow riparian area in the canyon bottom has scattered box elders (*Acer negundo*) that are regenerating. The stream bank has a dense growth of scouring rushes (*Hippochaete* sp.), with hundreds of giant helleborine orchids (*Epipactis gigantea*) growing among them. Other riparian species include Baltic rush (*Juncus balticus*), skunkbrush (*Rhus trilobata*), coyote willow (*Salix exigua*), mountain willow (*S. monticola*), and cattails (*Typha* sp.). Not far from the cavern is a grotto with seeping walls covered by mosses and yellow Mancos columbine (*Aquilegia micrantha*). Dry slopes on the side of the canyon have scattered Utah juniper (*Juniperus osteosperma*), Fremont barberry (*Mahonia fremontii*), and cliffrose (*Cowania* mexicana). The mesa at the head of the canyon supports an excellent example of the Utah juniper/Salina wild rye (*Juniperus osteosperma/Elymus salinus*) community. Other species on the mesa include black sage (*Artemisia novum*), Indian ricegrass (*Achnatherum hymenoides*) and needle and thread grass (*Hesperostipa* sp.). Raptors nest in the Wingate sandstone cliffs, and the canyon tree frog (*Hyla arenicolor*) was found in the stream.

Biodiversity Rank Justification: The site supports a good example of the globally imperiled hanging garden community (*Aquilegia micrantha-Mimulus eastwoodiae*). This community is found in sandstone alcoves where seeping water supports hanging gardens comprised of Mancos columbine and sometimes the globally vulnerable (G3) Eastwood's monkeyflower (*Mimulus eastwoodiae*). Other rare species, such as the giant helleborine orchid which is vulnerable through its range (G3) and the demonstrably globally secure (G5S2) Venus' hair fern (*Adiantum capillus-veneris*) are sometimes found growing in these hanging gardens. The giant helleborine orchid grows along streambanks and near springs and seeps in the pinyon-juniper zone. Although the species is widespread in the southwestern region, its specific habitat requirements limit its numbers. The state imperiled (S2) canyon tree frog also occurs here. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone. Three good examples of upland and riparian plant communities also occur here.

Table 74. Natural Heritage element occurrences at Mee Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Epipactis gigantea	Giant helleborine	G3	S2	FS	A
Plant Communities					
Aquilegia micrantha-Mimulus eastwoodiae	**Hanging gardens**	**G2G3**	**S2S3**		**B**
Juniperus osteosperma/Elymus salinus	Utah juniper/Salina wildrye	GU	SU		B
Acer negundo/Hippochaete hyemalis	Box elder/Scouring rush	GU	SU		B
Salix exigua/Equisetum hyemale	Coyote willow/horsetail	G4?	S2S4		B
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	BLM, SC	E

*EO=Element Occurrence

Boundary Justification The boundary encompasses the entire canyon, and the juniper/Salina wild rye community on the mesa above. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: The area is a part of the Black Ridge BLM Wilderness Area. The site would also make an excellent Research Natural Area. It is notable that the wilderness EIS makes no mention of rare plants (USDI 1989).

Management Comments: Although visitor use is not yet high, hiking use would probably increase with publicity. Heavy traffic could damage the riparian areas, and particularly the giant helleborine orchid.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: The BLM currently is eradicating tamarisk (*Tamarix ramosissima*) within this canyon.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 17. Mee Canyon Potential Conservation Area.

Pinon Mesa Canyons Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. Multiple excellent and good occurrences of plant communities vulnerable through their range (G3).

Protection Rank: P3. Protection actions may be needed, but probably not within the next five years. It is estimated that stresses may reduce the viability of the elements if protection actin is not taken. This site is currently under public (Bureau of Land Management) and private ownership with no formal designation.

Management Rank: M3. New management actions may be needed within five years to maintain the current quality of the element occurrences. Action will likely need to be taken within five years to prevent spread of non-native aggressive species.

Location: This site includes numerous streams which drain north off of Pinyon Mesa, which occupies the high country between Glade Park and Unaweep Canyon.

U.S.G.S. 7.5-min. quadrangle: Bieser Creek.
Legal Description: T13S R103W sec. 19-22, 27-34;
T13S R104W sec. 24-26; 35, 36.

Elevation: 7200-8440 ft. Size: Approximately 3,074 acres.

General Description: The Pinon Mesa Canyons site encompasses five canyons and their side canyons, which drain north off Pinyon Mesa. The site is mostly underlain by Precambrian igneous rock in the canyons and the Triassic Chinle Formation on steep canyon slopes. The site includes a mosaic landscape of riparian areas, and gentle to precipitous canyon slopes with a variety of intact plant communities. At the canyon rims, on moderately sloping uplands there are nearly pure patches of greenleaf manzanita (*Arctostaphylos patula*), a plant community that rarely occurs in Colorado, this being the eastern edge of its range. At the edges of nearly monotypic greenleaf manzanita patches, one can observe Gambel's oak (*Quercus gambelii*), pinyon pine (*Pinus edulis*), ponderosa pine (*Pinus ponderosa*), or mountain big sagebrush (*Artemisia tridentata*). Pinyon pine may also be scattered in greenleaf manzanita stands. On deeper soils along gently sloping canyon rims, there are patches of grasslands dominated in places by non-native pasture grasses, but sometimes consisting of nearly pure needle and thread grass (*Hesperostipa comata*). Other shrubs that may occur, and even co-dominate, include serviceberry (*Amelanchier utahensis*) and squaw apple (*Peraphyllum ramosissimum*). At the bottom of these V-shaped canyons lie narrow riparian zones with predominantly shrubby vegetation. Shrubs such as river birch (*Betula occidentalis*), red-osier dogwood (*Cornus sericea*), thin leaf alder (*Alnus incana*), and mountain willow (*Salix monticola*) occur immediately adjacent to the creek, with a band of wild cherry (*Prunus virginiana*) and occasionally oaks just above the riparian zone. Parts of this site remain in excellent condition, while other areas are more or less impacted by human activities including livestock grazing and recreation. The site is not impacted by housing development at this time, however it is somewhat fragmented by roads. Recreational impacts are concentrated along public access roads and include litter and off road vehicle tracks. Non-native species are far more common along roads than elsewhere in the site. While there is some grazing in the canyons, parts of them are steep and inaccessible, and therefore less impacted.

Biodiversity Rank Justification: This site supports multiple occurrences of upland and riparian plant communities vulnerable through their range (G3). The river birch/red-osier dogwood shrubland, which is vulnerable through its range, is known from streams at low elevations (4730-6020 ft.), on loam or clay soils throughout the western U.S. The **:** The river birch/mesic forbs plant community, which is vulnerable through its range (G3), is a tall (5-8 ft., 1.5-2.5 m), narrow band of shrubs lining a stream channel. This community is well documented in the western states but fewer than thirty stands are documented in Colorado, and while more are estimated to occur, this community is highly threatened by development, road building, and recreation. The Colorado blue spruce/red-osier dogwood montane riparian forest plant community, which is vulnerable through its range (G3), is a cool, moist riparian woodland occurring in deep narrow canyons. This plant community is known from Wyoming to Arizona but fewer than twenty stands are documented in Colorado. This community is highly threatened by road improvements and maintenance, improper grazing, heavy recreational use, and development.

Table 75. Natural Heritage element occurrences at Pinon Mesa Canyons PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Betula occidentalis/Cornus sericea	**River birch/Red-osier dogwood shrubland**	**G3?**	**S1S2**		**B**
Betula occidentalis/Cornus sericea	**River birch/Red-osier dogwood shrubland**	**G3?**	**S1S2**		**B**
Betula occidentalis/Cornus sericea	River birch/Red-osier dogwood shrubland	G3?	S1S2		C
Arctostaphylos patula/Ceanothus velutinus-Ceanothus prostratus	**Montane shrublands**	**G3**	**S2**		**B**
Betula occidentalis/Mesic forb	River birch/Mesic forb	G3	S2		C
Pinus edulis/Cercocarpus ledifolius	**Mesic western slope pinyon-juniper woodlands**	**G3**	**S3**		**A**
Quercus gambelii/Cercocarpus montanus	**Gambel's oak/mountain mahogany**	**G3**	**S3**		**B**
Alnus incana/Cornus sericea	Thinleaf alder/red-osier dogwood	G3Q	S3		B
Picea pungens/ Cornus sericea	Montane riparian forest	G4	S2		A
Quercus gambelii/Poa agassizensis	Gambel's oak/prairie bluegrass	GU	SU		B
Quercus gambelii/Poa agassizensis	Gambel's oak/prairie bluegrass	GU	SU		C
Quercus gambelii/Symphoricarpos oreophilus	Gambel's oak/snowberry	G5	S3S4		A
Artemisia tridentata/Hesperostipa comata	Big sagebrush/Needle and thread	G5	S4		B
Pinus edulis/Cercocarpus montanus	Pinyon pine/Mountain	G5	S4		B

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
	mahogany				
Populus tremuloides/Symphoricarpos oreophilus	Aspen/Snowberry	G5	S5		A

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: This site is currently under Bureau of Land Management and private ownership with no formal designation. It is potentially threatened by roads, recreational use and development, although the time frame of the threat is unknown.

Management Comments: The current ranch manager practices rotational grazing and has rested the pastures within this site. While current and past land uses have preserved the site in its present state, no management is directed towards preserving the known and suspected natural heritage elements at this site. Action will likely need to be taken within five years to prevent spread of non-native aggressive species.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 18. Pinon Mesa Canyons Potential Conservation Area.

Pinyon Mesa Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. An excellent occurrence of a globally imperiled (G2) plant community and globally imperiled (G2) bird. Wetlands within the site provide critical brood habitat for the Sage Grouse.

Protection Rank: P3. Protection actions may be needed, but probably not within five years. It is estimated that stresses may reduce the viability of the elements if protection action is not taken. Public lands have no formal protective status, however there is a conservation easement on a portion of the site that is private.

Management Rank: M2. New management actions may be needed within five years to prevent the loss of the element occurrences. Some habitat improvement for Sage Grouse should be undertaken on both BLM and private lands.

Location: Pinyon Mesa occupies the high country between Glade Park and Unaweep Canyon.

U.S.G.S. 7.5-min. quadrangle: Bieser Creek, Fish Creek, Payne Wash, and Two V Basin.
Legal Description: T13S R102W sec. 28-32;
T 13S R103W sec. 20-36;
T14S R102W sec. 5-8, 19;
T14S R103W sec. 1-5, 8-12, 13-16, 18, 21-24, 26-28.

Elevation: 7600 to 9500 ft. Size: Approximately 19,377 acres.

General Description: The Pinyon Mesa site includes two of the known leks (mating display grounds) of the Gunnison Sage Grouse. The area is a mosaic of sagebrush (*Artemisia* sp.), Gambel's oak (*Quercus gambelii*), aspen (*Populus tremuloides*), greenleaf manzanita (*Arctostaphylos patula*), and pinyon-juniper communities. In addition to these dominant species, the area has a diverse mixture of shrub species, including mountain mahogany (*Cercocarpus* sp.), serviceberry (*Amelanchie*r sp.), squaw-apple (*Peraphyllum ramosissimum*), bitterbrush (*Purshia tridentata*) and snowberry (*Symphoricarpos* sp.). Understory grasses and forbs, which are important to Sage Grouse, tend to be sparse, as the area has been heavily grazed for many years. There has been a loss of good habitat for the Sage Grouse as a result of invasion of sagebrush areas by pinyon-juniper, as well as the removal of the grass/forb component (Woods and Braun 1995). Many primitive roads and trails and a county road are present. Several springs and numerous natural and stock ponds exist within the site. The wetlands associated with these springs and ponds are cricital habitat for the Sage Grouse as they use wet meadows and riparian areas for brood-rearing. Non-native species in the area include Kentucky bluegrass (*Poa pratensis*), salsify (*Tragopogon dubius*) and dandelion (*Taraxacum officinale*).

Biodiversity Rank Justification: This site supports two Gunnison Sage Grouse leks. Recently described as a new species (Braun and Young 1995) the Gunnison Sage Grouse (globally critically imperiled G4T1) is known from only three locations: one site in Utah, the Gunnison, Colorado area, and Glade Park-Pinyon Mesa, in Mesa County. The small grouse depend on a sagebrush habitat, preferring patchy shrublands with abundant grasses and forbs. They annually gather at leks to display and mate. These are often located in small clearings. Sage Grouse use wet meadows and riparian areas for brood-rearing. There are now estimated to be fewer than 100 birds on Pinyon Mesa. Historic overgrazing has reduced suitable habitat, and changes in grazing management may be critical to the species' survival. High quality examples of three upland plant communities were documented within the site.

Table 76. Natural Heritage element occurrences at the Pinyon Mesa PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Hesperostipa comata	**Needle and thread grassland**	**G2**	**S2**		**B**
Hesperostipa comata	**Needle and thread grassland**	**G2**	**S2**		**B**
Arctostaphylos patula	Greenleaf manzanita shrublands	GU	SU		B
Artemisia cana-Symphoricarpos oreophilus	Silver sage/snowberry	GU	S?		B
Birds					
Centrocercus minimus gunnisonii	**Gunnison Sage Grouse**	**G4T1**	**S1**	**BLM, SC**	**E**
Centrocercus minimus gunnisonii	**Gunnison Sage Grouse**	**G4T1**	**S1**	**BLM, SC**	**E**

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The Gunnison Sage Grouse leks of the area are included within the boundary. In addition, an area of approximately 2.5 mile radius surrounding each lek is included provided that there is some suitable habitat. Some adjoining potential habitat on the north end of the mesa is also included.

Protection Comments: The PCA is mostly private land, although a small portion is BLM land. The public lands have no formal protective status. There is a conservation easement on a small portion of the site, however most of the PCA is in private ownership with several ranches on which no formal protection is provided. Private land in the site is critical for the Sage Grouse and needs to be protected.

Management Comments: The decline in the Gunnison Sage Grouse is thought to be a response to the degraded sage community (Woods and Braun 1995). Some habitat improvement for Sage Grouse should be undertaken on both BLM and private lands. The grouse is being intensively studied by CDOW. Nearby Forest Service lands that were known to be occupied are not now inhabited.

Soils Description: Soils types are variable given the large area of which this site encompasses and the diverse geomorphic features found in this PCA.

Restoration Potential: Ensuring springs and natural ponds remain hydrologically intact will help maintain wet meadow habitat vital for the Sage Grouse.

Wetland Functional Assessment for the Pinyon Mesa PCA: CNHP wetland ecologists did not visit the springs and natural ponds contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 19. Pinyon Mesa Potential Conservation Area.

Salt Creek Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. A good occurrence of a globally imperiled (G1G2) riparian plant community.

Protection Rank: P4. No protection actions are needed in the foreseeable future. Salt Creek is a BLM Wilderness Study Area.

Management Rank: M4. Current management actions seem to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. The inaccessibility of the seeps likely limits impact from humans and grazers.

Location: Salt Creek is located along County Rd. Z6 between Sinbad Valley and the Dolores River.

U.S.G.S. 7.5-min. quadrangle: Juanita Arch.
Legal Description: T49N R19W sec. 1-4, 9-11;
T50N R18W sec. 30, 31;
T50N R19W sec. 25, 26, 33-36.

Elevation: 4700-7300 ft. Size: Approximately 4,468 acres.

General Description: Salt Creek drains east out of Sinbad Valley, although most flow is derived from numerous springs that discharge within the canyon between Sinbad Valley and the Dolores River. Riparian vegetation along Salt Creek is sparse and consists of scattered cottonwoods (*Populus* sp.), coyote willow (*Salix exigua*), skunkbrush (*Rhus trilobata*), and tamarisk (*Tamarix ramosissima*). A spring discharges from a south-facing rock face near the base of a hill near the head of the canyon. The spring feeds into a small, inundated marsh dominated by alkali bulrush (*Schoenoplectus maritimus*) and alkali muhly (*Muhlenbergia asperifolia*) with tamarisk abundant on slightly higher ground. Other species present in the area include seablite (*Suaeda* spp.), greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnus nauseosus*), threesquare bulrush (*Schoenoplectus pungens*), saltgrass (*Distichlis spicata*), common reed (*Phragmites australis*), white sweetclover (*Melilotus alba*), and rabbitfoot grass (*Polypogon monspeliensis*). The spring discharges to Salt Creek and the downstream end of the wetland is impounded by an old depositional bar of Salt Creek.

Another seep occurs along a tributary of Salt Creek on a west-facing slope surrounded by pinyon-juniper. The seep is dominated by common reed and ditch reedgrass (*Calamagrostis scopulorum*), except in the wettest patches which are dominated by beaked spikerush (*Eleocharis rostellata*). Ditch reedgrass is a montane species, but is a principal component of hanging gardens in southern Utah and southwest Colorado (Welsh 1993). Water seeps down the hillside and infiltrates into the colluvium resurfacing sporadically along the slope until finally draining into the stream channel below. Additional seeps and springs occur along a few of the tributaries to Salt Creek.

Most support dense vegetative growth dominated by common reed, ditch grass, and willow. Cottonwood and wild privet (*Forestiera pubescens*) dominate along a few of the stream channels. Unidentified tadpoles and aquatic insects including water striders (family Gerridae) and predaceous diving beetle larvae (family Dytiscidae) were located in scattered pools along one of the tributaries.

Adult dragonflies were also abundant throughout the site. Evidence of huge floods remains in many of the canyons as herbaceous vegetation lying flat and debris suspended in shrubs.

The associated uplands are pinyon-juniper woodlands with big sagebrush (*Artemisia tridentata*) on terraces. A small patch of the aggressive non-native Russian knapweed (*Acroptilon repens*) occurs on a bench just above Salt Creek. Tamarisk (*Tamarix ramosissima*) grows at the mouth of the tributary and along Salt Creek but has not spread upstream along the tributaries .

Biodiversity Rank Justification:
This site supports an good and fair occurrence of the globally imperiled (G1G2) foothills riparian shrubland (*Forestiera pubescens*). This plant community is a medium tall (3-5 ft., 1-1.5 m) shrubland, often occurring as dense thickets. It grows at the interface between the riparian area and the adjacent upland in desert areas of the southwest. In Colorado, this community is known only from the Dolores and San Miguel Rivers. The globally rare (G2G3) beaked spikerush (*Eleocharis rostellata*) emergent wetland is an uncommon plant community and is found in wetlands with permanent flowing water including calcareous wet meadows, seeps, stream margins, and near mineral springs. This occurrence is very small and thus considered a fair (C) occurrence. The common reed community (*Phragmites australis*) was once thought to be widespread throughout western Colorado. Now, it occurs only in small, isolated patches where water has become impounded, such as adjacent to raised railroad beds, irrigation ditches, oxbow lakes, and other low-lying swampy areas. It is threatened by stream flow alterations, road building and maintenance. This species has strong rhizomes that allow it to out compete all but the most non-native aggressive species. Although this grass is a common weedy invader of wetlands in the eastern U.S, it is considered a native to western Colorado. The globally apparently secure (G4) alkali bulrush (*Schoenoplectus maritimus*) communities are abundant in Montana and not well documented in Colorado. This plant community occurs in wet swales and along narrow channels, spring-fed creeks, and back-water eddies of larger rivers.

Table 77. Natural Heritage element occurrences at Salt Creek PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Forestiera pubescens	**Foothills riparian shrubland**	**G1G2**	**S1**		**C**
Forestiera pubescens	**Foothills riparian shrubland**	**G1G2**	**S1**		**C**
Eleocharis rostellata	Beaked spikerush emergent wetland	G2G3	S2S3		C
Phragmites australis	Common reed wetland	G4	S3		B
Phragmites australis	Common reed wetland	G4	S3		B
Schoenoplectus maritimus	Alkali bulrush wetland	G4	S2		C

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary encompasses the entire canyon, and the juniper/Salina wild rye community on the mesa above. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: Salt Creek is a BLM Wilderness Study Area. Except for a small parcel at the upstream end of the site, the entire area is BLM land.

Management Comments: The inaccessibility of the seeps likely limits impact from humans and grazers.

Soils Description: Soils along drainages are derived from alluvium and vary in texture depending on geomorphic position. Soils near springs have a greater accumulation of organic matter and were found to be highly reduced in some areas.

Restoration Potential: Most of the site is functioning as expected. The BLM currently has a tamarisk eradication project at this site. Eradication of Russian knapweed should also be initiated. It is important to ensure that the recharge area for these seeps (area north/northwest of Salt Creek) remains hydrologically intact (no withdrawals/diversions) to ensure maintenance of the seeps.

Wetland Functional Assessment for the Salt Creek PCA:
Proposed HGM Class: Slope   Subclass: S4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Eleocharis rostellata*, *Phragmites australis*, and *Schoenoplectus maritimus*

Table 78. Wetland functional assessment for the slope wetlands at the Salt Creek site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
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	Low	Collectively, the organic rich soils near the seeps/springs restrict water movement and thus provide storage of discharging groundwater, however the total capacity is low.
Biogeochemical Functions		
Elemental Cycling	Normal	Saturated soils, a carbon source, and lack of soil disturbance maintain vital nutrient cycling processes.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low	There is little potential for these areas to remove sediments/ nutrients/toxicants as there are no upstream sources of 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 of the seeps and springs are vegetated with herbaceous species, however numerous shrubs and trees are found near the lateral fringe and at the toe-slope of some.
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. Structural diversity is not high since most seeps/springs are dominated by herbaceous vegetation.
General Fish/Aquatic Habitat	N/A	Although some seeps and springs have a small spring-brook associated with them, these small streams do 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 Salt Creek. Moist soil and permanent flowing water help support insect populations (aquatic insects, butterflies, dragonflies, damselflies, etc.).
Uniqueness	Moderate	Due to the exposure of the Wingate sandstone in this canyon, the density of seeps/springs is relatively high compared to other canyons in the study area. Other canyons in the Little Book Cliffs may have a high density of springs but they support different vegetation than found here.

Figure 20. Salt Creek Potential Conservation Area.

Sewemup Mesa Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. This site contains a good occurrence of a globally imperiled (G2) plant species and an excellent occurrence of a globally imperiled (G2G3) plant community.

Protection Rank: P4. No protection actions are needed in the foreseeable future. The area is currently a BLM Wilderness Study Area (WSA). It is open to mineral exploration and development until designated by Congress as wilderness, but is closed to oil and gas leasing.

Management Rank: M4. Current management actions seem to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Although not currently threatened, management may be needed in the future to maintain the current quality of element occurrences.

Location:. Sewemup Mesa is located 5.75 air miles northeast of Paradox, Colorado in northwestern Montrose County.

U.S.G.S. 7.5-min. quadrangle: Juanita Arch, Roc Creek and Red Canyon.
Legal Description: T48N R18W sec. 5, 6.
T48N R19W sec. 1-3, 12;
T49N R18W sec. 5-8, 17-21, 28-34;
T49N R19W sec. 1-3, 10-15, 22-27, 35, 36;
T50N R18W sec. 31;
T50N R19W sec. 35, 36;

Elevation: 4600-7465 ft. Size: 18,420 acres

General Description: Sewemup Mesa is a large mesa west of the Dolores River Canyon. A series of parallel drainages coming off the mesa end at the cliffs above the Dolores River, where they form seasonal waterfalls or seep into the ground to emerge again in box canyons and alcoves to sustain hanging garden seep communities. One of these hanging gardens supports one of only two populations of the Kachina daisy (*Erigeron kachinensis*) in Colorado. Rare hanging garden communities dominated by Mancos columbine (*Aquilegia micrantha*) and Eastwood's monkeyflower (*Mimulus eastwoodiae*) are also found at some of these seeps, which are located on the steep sandstone cliffs surrounding the mesa at the contact between the Wingate and Chinle formations. State imperiled (S2 and S2S3) species such as maidenhair fern (*Adiantum capillus-veneris*) and giant helleborine orchids (*Epipactis gigantea*) are also found in these seeps. Ditch reedgrass (*Calamagrostis scopulorum*) and common reed (*Phragmites australis*) are other common species found growing in these seeps. Uplands on Sewemup Mesa have pinyon-juniper woodlands, with some excellent patches of native bunchgrasses. Typical grasses here are needle-and-thread (*Hesperostipa comata*), blue grama (*Bouteloua gracilis*), alkali sacaton (*Sporobolus airoides*), galleta (*Hilaria jamesii*), Indian ricegrass (*Achnatherum hymenoides*), and sand dropseed (*Sporobolus cryptandrus*). Common shrub species of the mesa include snakeweed (*Gutierrezia sarothrae*), Mormon tea (*Ephedra* sp.), yucca (*Yucca harrimaniae*), four-wing saltbush (*Atriplex canescens*), single leaf ash (*Fraxinus anomala*), antelope bitterbrush (*Purshia tridentata*), cliff rose (*P. stansburiana*), serviceberry (*Amelanchier utahensis*), and mountain mahogany (*Cercocarpus montanus*). Soil crusts of mosses, lichens and micro-organisms are well developed on the red sandy soils.

Biodiversity Rank Justification: This site supports one of only two currently known locations in Colorado of the globally imperiled (G2) Kachina daisy (*Erigeron kachinensis*). This species occurs in hanging gardens seeps in southern Utah and southwest Colorado. The site also supports a good example of the globally imperiled (G2G3) hanging garden plant community (*Aquilegia micrantha-Mimulus eastwoodiae*). This community is found in sandstone alcoves where seeping water supports hanging gardens comprised of Mancos columbine and sometimes the Eastwood's monkeyflower (*Mimulus eastwoodiae*) which is vulnerable through its range (G3S2). Other rare species, such as the giant helleborine orchid, which is vulnerable through its range (G3) and the globally demonstrably secure (G5S2) Venus' hair fern (*Adiantum capillus-veneris*) are sometimes found growing in these hanging gardens. Locally, these hanging gardens are found near the base of the Wingate formation, above the contact with the Chinle formation. The giant helleborine orchid grows along streambanks and near springs and seeps in the pinyon-juniper zone. Although the species is widespread in the southwestern region, its specific habitat requirements limit its numbers. A good example of the globally imperiled (G2?) xeric western slope pinyon-juniper woodland (*Pinus edulis/Hesperostipa comata*) is also found at this site. This woodland community is known from southwestern Colorado and likely occurs into eastern Utah. Stands occur on a variety of sites from flat or gentle lower slopes, benches, mesa tops to moderately steep slopes on montane alluvial fans. Parent materials are frequently sandstone and shale.

The Peregrine Falcon, a state species of special concern, is also found at this site. Since 1947, its eggshell thickness was reduced 15 to 20 percent, probably due to the introduction of chemicals such as DDT in the food chain. In recent years, the species has been recovering, and in 1995, was proposed for removal from the endangered species list. The cliffs around Sewemup Mesa provide habitat for nests and foraging.

Table 79. Natural Heritage element occurrences at Sewemup Mesa PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Erigeron kachinensis	**Kachina daisy**	**G2**	**S1**	**BLM**	**B**
Mimulus eastwoodiae	Eastwood monkey-flower	G3	S2		A
Mimulus eastwoodiae	Eastwood monkey-flower	G3	S2		E
Epipactis gigantea	Giant helleborine orchid	G3	S2	FS	B
Epipactis gigantea	Giant helleborine orchid	G3	S2	FS	C
Epipactis gigantea	Giant helleborine orchid	G3	S2	FS	E
Epipactis gigantea	Giant helleborine orchid	G3	S2	FS	E
Sporobolus flexuosus	Mesa dropseed	G5	S1S2		E
Adiantum capillus-veneris	Southern maidenhair fern	G5	S2		B

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Pellaea atropurpurea	Purple cliff brake	G5	S2S3		D
Plant Communities					
Pinus edulis/Hesperostipa comata	Xeric western slope pinyon-juniper woodlands	G2?	S2		B
Aquilegia micrantha/Mimulus eastwoodiae	**Hanging gardens**	**G2G3**	**S2S3**		**A**
Birds					
Falco peregrinus anatum	American Peregrine Falcon	G4T4	S2B, SZ	SC	C

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary is drawn to include the flat top of Sewemup Mesa and surrounding cliffsides above the Dolores River where the Kachina daisy and hanging gardens (and rare plants associated with them) are located. Cliffs and canyons currently unoccupied by these elements are also included as they may provide sites for the plants to become established in the future. Recharge areas for the hanging gardens are encompassed in the site boundaries and thus will maintain necessary groundwater flow to sustain the seeps.

Protection Comments: The PCA is located primarily on BLM land with no special protection. Much of the site is remote and undisturbed, and has been considered for wilderness designation. However, the part of the PCA with the greatest biological significance is adjacent to the highway, and would not be included in such designation. Continued existence of Peregrine Falcons in Colorado is dependent upon protection of traditional nesting sites, identification and protection of critical habitat both for the breeding areas and for wintering, foraging, and roosting areas. Some additional relief to the Peregrine's plight in Colorado can be provided by keeping the remaining nest sites free from human intrusions during nesting season and by ensuring that land use changes protect habitat that supports the Peregrine's prey species.

Management Comments: The one site of the Kachina daisy is a popular roadside stop with a developed spring. Nevertheless, the plants have remained undisturbed for many years. The site is easily accessible for periodic monitoring of the Kachina daisy population, and could be a valuable location for further research on the taxonomy and ecology of this extremely rare species. Monitoring would also alert managers to changes in the size and quality of the population that would warrant management action. Access to the mesa is difficult, so plant communities have been little disturbed.

Soils Description: Soils below the hanging gardens are typically saturated and have organic matter accumulation.

Restoration Potential: Eradicate/control any non-native aggressive species that are present and/or establish at this site.

Wetland Functional Assessment for the Sewemup Mesa PCA:
Proposed HGM Class: Slope Subclass: S4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Aquilegia micrantha/Mimulus eastwoodiae*

Table 80. Wetland functional assessment for the slope wetlands at the Sewemup Mesa site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
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	There are many seeps and springs throughout the site.
Dynamic Surface Water Storage	Low	Collectively, the organic rich soils near the seeps/springs restrict water movement and thus provides storage of discharging groundwater, however the total amount is low.
Biogeochemical Functions		
Elemental Cycling	Normal	Saturated soils, a carbon source, and lack of soil disturbance maintain vital nutrient cycling processes.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low	There is little potential for these areas to remove sediments/ nutrients/toxicants as there are no upstream sources of excess inputs as most of the seeps and springs occur on hillsides or at the base of large cliffs.
Biological Functions		
Habitat Diversity	Low	The seeps and springs are 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. Structural diversity is not high since seeps/springs are dominated by herbaceous vegetation.
General Fish/Aquatic Habitat	N/A	These seeps do not have a springbrook associated with them.
Production Export/Food Chain Support	Low	Since there is no springbrook associated with the springs there little opportunity for production export. Moist soil and permanent flowing water help support insect populations (aquatic insects, butterflies, dragonflies, damselflies, etc.).
Uniqueness	High	Due to the exposure of the Wingate sandstone in this canyon, the density of seeps/springs is relatively high compared to other canyons in the study area. Other canyons in the Little Book Cliffs may have a high density of springs but they support different vegetation than found here. Also the population of the Kachina daisy is very rare.

Figure 21. Sewemup Mesa Potential Conservation Area.

Unaweep Seep Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. An excellent occurrence of a plant community vulnerable through it range (G3), and the best known occurrence of a globally imperiled (G4T2) butterfly subspecies in Colorado.

Protection Rank: P2. Protection actions may be needed within five years. It is estimated that stresses may reduce the viability of the elements if protection action is not taken. Much of the habitat of the Nokomis fritillary butterfly is on private land with no special protection.

Management Rank: M2. New management actions may be needed within five years to prevent the loss of the element occurrences. The area is grazed in early spring and fall, and seems to recover well during the summer. Research by CNHP in 1996 suggests that Nokomis fritillary populations are declining.

Location: This site is located in Unaweep Canyon, approximately 8 miles east of Gateway along Hwy. 141.

U.S.G.S. 7.5 minute quadrangles: Fish Creek, Two V Basin, Snyder Flats, Casto Reservoir, Pine Mountain, and Gateway.
Legal Description: T14S R102W sec. 20, 29-33;
T14S R103W sec. 25-28, 33-36;
T15S R102W sec. 2-27;
T15S R103W sec. 1-4, 9-16.

Elevation: 6600-9000 ft. Size: Approximately 19,921 acres.

General Description: This site contains one of the largest seep wetland complexes observed during this survey. The hillside wetland at Vega Reservoir is larger, but lacks the diversity of wetland types found at Unaweep Seep. No other wetland observed during this survey matches the diversity of species and wetland habitat at Unaweep Seep. A 1983-84 study of the Bureau of Land Management Grand Junction Resource Area found that Unaweep Seep had the richest plant, bird, and small mammal life in the Resource Area (BLM 1999). The Audubon Society has declared this area an Important Bird Area in Colorado (National Audubon Society 2000). The site includes the Unaweep Seep state designated Natural Area an unusual hillside wetland ecosystem of marshes, wet meadows, and seeps. Dense stands of coyote willow (*Salix exigua*) occupy the seep's uppermost source area. Most of the seep is dominated by beaked spikerush (*Eleocharis rostellata*) with sporadic stands of river birch (*Betula occidentalis*) occurring on the lateral fringe of the seep. A large population of the giant helleborine orchid (*Epipactis gigantea*) occurs on the lower part of the slope amid spikerushes and underneath the canopy of the river birches. Near the toeslope, wet meadows and marshes support dense stands of hardstem bulrush (*Schoenoplectus acutus*) common reed (*Phragmites australis*), and creeping spikerush (*Eleocharis palustris*). Other species found in the wetland complex include red-osier dogwood (*Cornus sericea*), river hawthorn (*Crataegus rivularis*), poison ivy (*Toxicodendron rydbergii*), horsemint (*Monarda fistulosa*), Joe Pye weed (*Eupatorium maculatum*), cattail (*Typha latifolia*), fowl mannagrass (*Glyceria striata*), beggar's tick (*Bidens frondosa*), Nebraska sedge (*Carex nebrascensis*), woolly sedge (*C. pellita*), beaked sedge (*C. utriculata*), wild mint (*Mentha arvense*), self-heal (*Prunella vulgaris*), canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*), scouring rush (*Hippochaete* sp.), horsetail (*Equisetum arvense*), and watercress (*Nasturtium officinale*). Non-native species in the seep include reed canarygrass (*Phalaris arundinacea*), Kentucky bluegrass (*Poa pratensis*), redtop (*Agrostis gigantea*), timothy (*Phleum pratense*), white sweetclover (*Melilotus alba*), and barnyard grass (*Echinochloa crus-galli*). Most of these species are not affecting ecosystem function or displacing native vegetation. However, a population of Himalayan blackberry (*Rubus discolor*) was recently found at this site. In the Northwest USA, this species is an aggressive non-native plant where it commonly displaces native species, especially along wetland margins. The population at this site should be intensively monitored to ensure it does not displace native species. Numerous other seeps and springs exist throughout the site. At the base of the seeps, West Creek supports a lush growth of narrowleaf cottonwood (*Populus angustifolia*), box elder (*Acer negundo*), coyote willow, and other riparian species. North Fork Creek enters the canyon at the western end of the site. The adjacent slopes are covered with pinyon-juniper and Gambel's oak (*Quercus gambelii*).

The seeps and springs found at this site are not affected by flooding and fluctuation in surface water flow; however, the hydrology of the area is not completely understood. The geology of the area is complicated and is not agreed upon. Researchers have suggested that the seep may be located in a pre-Wisconsin glacier terminal moraine or that the seep is associated with alluvial material deposited in a V-shaped valley that was cut then filled by the Gunnison or the Gunnison-Colorado River (BLM 1999). A fault defining the eastern boundary of a graben exists near the seep. This fault complicates conclusions about local hydrology (BLM 1999).

In addition to those species tracked by CNHP, other species of interest found at Unaweep Seep include: (1) 11 species on the BLM sensitive list including northern leopard frog (*Rana pipiens*), Bald Eagle (*Haliaeetus leucocephalus*), Cooper's Hawk (*Accipiter cooperii*), Golden Eagle (*Aquila chrysaetos*), Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (whether the willow flycatcher at Unaweep Seep is the southwestern race is still being determined), white-throated woodrat (*Neotoma albigula brevicauda*), Nokomis fritillary (*Speyeria nokomis nokomis*), Great purple hairstreak (*Atlides halesus*), California sister (*Adelpha bredowii*), canyon bog orchid, and the giant helleborine; (2) over 67 species of butterflies (close to half of those ever recorded in Mesa County), including notably disjuncts such as Canyonlands satyr (*Cyllopsis pertepida*) and California sister (*Adelpha bredowii*), species on the periphery of their range such as the Hackberry Emperor Butterfly (*Asterocampa celtis*) plus the Colorado State insect: Colorado Hairstreak (*Hypauotis crysalus*); (3) dense population (pounds per acre) of montane shrews and western jumping mice; and (4) plant species more typical of the eastern tallgrass prairie such as Joe Pye weed (rare on west slope), switchgrass

(*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and panic mannagrass (*Dichanthelium acuminatum fasciculatum*) (BLM 1999).

Biodiversity Rank Justification: This site supports the largest known Colorado population of the globally imperiled (G4T2) Nokomis fritillary butterfly (*Speyeria nokomis nokomis*). Although there is a larger population in Utah, there appears to be a genetic difference between the two. The butterfly larvae feed specifically on bog violets (*Viola nephrophylla*) growing in open areas. The violets were found to grow in a very narrow range of moisture, usually on toe slopes at the base of seeps or on hummocks, where their roots can reach open water. Nectar plants, such as Joe Pye weed and bull thistle (*Cirsium vulgare*), used by the adult butterflies, are also found here. The Yuma skipper (*Ochlodes yuma*), which is vulnerable in Colorado (S2S3) has also been documented from this site. This skipper is found in freshwater marshes, stream courses, ponds, and seeps/springs. It is common in its limited habitat in California, Nevada, Utah, Colorado, northern New Mexico, and Arizona. Western Colorado represents the eastern periphery of this species range. It uses common reed (*Phragmites australis*) as its host plant.

The site supports the globally critically imperiled (G1Q) boxelder-narrowleaf cottonwood riparian forest (*Acer negundo-Populus angustifolia/Celtis reticulata*) which occurs in dense patches around several small channels fed by the seep. Currently, this community is known from only one stand in Colorado. Additional surveys should be conducted in western Colorado, southern Utah, northern Arizona, and northwest New Mexico to identify its distribution. The site also supports the globally imperiled (G2G3) beaked spikerush emergent wetland community (*Eleocharis rostellata*), and numerous wetland and riparian plant communities, which are vulnerable in Colorado (S3). These wetland plant communities support the richest diversity of plant and bird life of any other BLM parcel in the Grand Junction Resource Area (BLM 1999).

The giant helleborine (*Epipactis gigantea*) which is vulnerable throught its range is abundant at this site. This orchid grows along streambanks and near springs and seeps in the pinyon-juniper zone. Although the species is widespread in the southwestern region, its specific habitat requirements limit its numbers.

The western yellowbelly racer (*Coluber constrictor mormon*), which is vulnerable in Colorado (S2S3), is found in a wide variety of habitats: meadow, prairies; open chaparral, pinyon-juniper woodland; and riparian woodland. In western Colorado, it occurs below about 5500 ft., in agricultural areas, lowland riparian habitats, and occasionally in semi-desert shrublands.

Table 81. Natural Heritage element occurrences at Unaweep Seep PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Epipactis gigantea	Giant helleborine	G3	S2	FS	A
Epipactis gigantea	Giant helleborine	G3	S2	FS	B
Platanthera sparsiflora var.	Canyon bog orchid	G4G5T3	S2		B

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
ensifolia					
Plant Communities					
Acer negundo-Populus angustifolia/Celtis reticulata	**Boxelder-Narrowleaf cottonwood riparian forest**	**G1Q**	**S1**		**A**
Eleocharis rostellata	Beaked spikerush emergent wetland	G2G3	S2S3		A
Schoenoplectus acutus	Hardstem bulrush emergent wetland	G5	S3?		A
Alnus incana/Mesic forb	Thinleaf alder/mesic forb riparian shrubland	G3G4Q	S3		A
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood/red-osier dogwood riparian forest	G4	S3		AB
Salix exigua/Mesic graminoid	Coyote willow/mesic graminoid riparian shrubland	G5	S5		A
Reptiles					
Coluber constrictor mormon	Western yellowbelly racer	G5T5	S2S3		H
Invertebrates					
Speyeria nokomis nokomis	**Nokomis fritillary**	**G4T2**	**S1**		**A**
Ochlodes yuma	Yuma skipper	G5	S2S3		E

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: Boundaries are drawn to include all colonies which are part of the "Unaweep Canyon population" of the Nokomis fritillary. Also included is the intervening riparian habitat which is necessary to maintain dispersal between colonies, as well as the potential spring recharge zones which must be maintained to preserve hydrological integrity of the seep/spring wetland complexes.

Protection Comments: This PCA consists of BLM and private lands. Much of the habitat of the Nokomis fritillary butterfly is on private land with no special protection. BLM has purchased the private land of the main seep, known locally as Swamp Hill. Other private land in the area should be a high priority for conservation easements or other protection. The site includes 36 acres that are designated as a state Natural Area for protection of the seeps and the butterfly population, and is a BLM Research Natural Area. However, this represents only a small portion of the butterfly habitat.

Management Comments: The area is grazed from April to mid-May and December to mid-January. Impacts from grazing appear to be limited to soil disturbance. Hoof action along the steep slope has created water pockets and terraces which may negatively affect hydrology by accelerating erosion and dewatering of portions of the wetland. Plant species composition does not appear to be affected by the current grazing regime. Research by CNHP in 1996 suggests that Nokomis fritillary populations are declining. The Management Plan states that "rare species will be monitored by maintaining a log on which to register reports as to the continued presences of the species" and that "butterfly density and diversity will be monitored following the Xerces Society's count protocol" (BLM 1999). Research efforts that would help in determining management needs include continued monitoring of Nokomis fritillary populations and bog violets, determining effects of grazing, and determining the extent of the recharge zone necessary to sustain the hydrology of the seeps.

Soils Description: Soils are highly variable at this site. Soils along West Creek are derived from alluvium and vary in texture according to geomorphic position. Many areas in the seep have deep organic soil horizons (peat). Most of these soils are sapric material, and ranged in depth from a few inches to over 2 ft. in some locations of the main hillside seep. This obviously indicates that the main seep has had persistent flow for hundreds, likely thousands of years. Given the aridity and low elevation of this site, the amount of peat accumulation at Unaweep Seep is very unique.

Restoration Potential: Due to its aggressive nature, the Himalayan blackberry (*Rubus discolor*) population should be eradicated. The population at Unaweep Seep is one of few, if not the only record of this species in Colorado. Eradicating areas infested with mature plants of Himalayan blackberry may be most effective via mechanical removal or burning (Nature Conservancy 1989). Subsequent treatment with herbicides should be conducted cautiously because: (1) Himalayan blackberry often grows in riparian areas and the herbicide may be distributed downstream by running water, and (2) some herbicides promote vegetative growth from lateral roots (Nature Conservancy 1989). Planting native shrubs or trees which are fast-growing may prevent Himalayan blackberry re-establishment, since this species is usually intolerant of shade (Nature Conservancy 1989).

Wetland Functional Assessment for the Unaweep Seep PCA:
Proposed HGM Class: Slope Subclass: S4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Eleocharis rostellata* and *Schoenoplectus acutus*

Table 82. Wetland functional assessment for the slope wetlands at the Unaweep Seep site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
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	The main hillside spring system is very large and coupled with the buildup of organic soil horizons, the soils restrict water movement providing storage of discharging groundwater.
Biogeochemical Functions		
Elemental Cycling	Normal	Saturated soils and a large carbon source maintain vital nutrient cycling processes. The diversity of litter types associated with the high diversity of plant species provide a gradient for various nutrient transformations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low	There is little potential for these areas to remove sediments/ nutrients/toxicants as there are no upstream sources of these excess inputs as the seeps and springs occur on hillsides.
Biological Functions		
Habitat Diversity	Moderate	Most of the seeps and springs are vegetated with herbaceous species, however numerous shrubs and trees are found near the lateral fringe and at the toe-slope.
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. The site has the richest density of bird species of all BLM parcels in the Grand Junction Resource Area and nearly half of all the butterfly species known to occur in Mesa County. Distinctive populations of small mammals including a high density (pounds/acre) of montane shrews and western jumping mice and the northwest-most record in Colorado of brush mice are found at this site.
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 West Creek. Moist soil and permanent flowing water help support insect populations (over 67 species of butterflies occur here, plus numerous species of damselflies and dragonflies were observed).

Uniqueness	High	The most diverse seep wetland observed in Mesa County. Supports the largest known Colorado population of the globally imperiled Nokomis fritillary.

Wetland Functional Assessment for the Unaweep Seep PCA:
Proposed HGM Class: Riverine   Subclass: R3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Alnus incana/*Mesic forb, *Populus angustifolia/Cornus sericea, Salix exigua/*Mesic graminoid

Table 83. Wetland functional assessment for the riverine wetland at the Unaweep Seep site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	There is a high density of shrubs and trees but a confined floodplain.
Sediment/Shoreline Stabilization	High	There is a dense growth of herbaceous and woody species along the streambank.
Groundwater Discharge/ Recharge	N/A	This wetland floods via overbank flooding.
Dynamic Surface Storage	N/A	This wetland floods via overbank flooding.
Biogeochemical Functions		
Elemental Cycling	Normal	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 may be some imported material from upstream hay meadows, rangeland and adjacent road. Dense vegetation along the streambanks also contribute to this function.
Biological Functions		
Habitat Diversity	High	There are forested, scrub-shrub, emergent, and open water wetland habitats along West Creek.
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 site has the richest density of bird species of all BLM parcels in the Grand Junction Resource Area and nearly half of all the butterfly species known to occur in Mesa County. Distinctive populations of small mammals including a high density (pounds/acre) of montane shrews and western jumping mice and the northwest-most record in Colorado of brush mice are found at this site.
General Fish/Aquatic Habitat	High	There is a diversity of pools, riffles, and woody debris along this stretch of the creek. However, data on fish populations was not collected.
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 aquatic habitat provide a variety of habitats for invertebrate populations.
Uniqueness	High	Very diverse riparian area. Bog violets found along the streambank support the largest known Colorado population of the globally imperiled Nokomis fritillary.

Figure 22. Unaweep Seep Potential Conservation Area.

Vega Reservoir Potential Conservation Area

Biodiversity Rank: B2. Nearly irreplaceable. The site supports an excellent occurrence of a globally imperiled (G2) plant community.

Protection Rank: P2. Protection actions may be needed within five years. It is estimated that stresses may reduce the viability of the elements within this approximate timeframe. There is abundant housing development in the area. Most of the site occurs on private land.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Surrounding development may impact hydrology.

Location: This site is located south of Vega Reservoir within Vega Reservoir State Recreation Area.

U.S.G.S. 7.5 minute quadrangles: Vega Reservoir
Legal Description: T10S R93W sec. 4-9, 16-18.

Elevation: 8000-9600 ft. Size: Approximately 1,891 acres.

General Description: This site consists of a north-facing hillside where groundwater seepage supports an extensive, unique, deciduous forest dominated by aspen (*Populus tremuloides*), Rocky mountain maple (*Acer glabrum*), chokecherry (*Prunus virginiana*), and Utah serviceberry (*Amelanchier utahensis*). Understory species are typical of riparian and moist forests and include baneberry (*Actaea rubra* ssp. *arguta*), black twinberry (*Lonicera involucrata*), monkshood (*Aconitum columbianum*), roughfruit fairybells (*Prosartes trachycarpa*), black-eyed Susan (*Rudbeckia occidentalis*), geranium (*Geranium richardsonii*), false-Solomon's seal (*Maianthemum stellatum*), sweet cicely (*Osmorhiza depauperata*), cow parsnip (*Heracleum sphondylium* ssp. *montanum*), groundsel (*Senecio serra*), yarrow (*Achillea lanulosa*), fringed brom (*Bromus ciliatus*), blue wildrye (*Elymus glaucus*), and Kentucky bluegrass (*Poa pratensis*). There is a low abundance of non-native species in the stand.

This forest is very unique in that no conifers are growing throughout the stand and thus does not appear to be in a successional stage. Soils have a deep A-horizon and are very dark (7.5 YR 2.5/1) down to a depth of at least 19 inches. Thus, abundant litter and periodic soil saturation have allowed for organic matter accumulation. The underlying bedrock is thought to be the Green River Shale formation, which may explain the source of the groundwater discharge, as the Green River shale is known to harbor an aquifer in the Parachute Creek Member of this formation (mainly dolomitic marlstone) and is the principal aquifer associated with seeps and springs in western Garfield County (Martinson 1980).

Vega Reservoir sits below the hillside and sporadic homes occur on the eastern edge of the hill.

Biodiversity Rank Justification: This site supports the globally imperiled (G2) aspen/Rocky Mountain maple montane riparian forest (*Populus tremuloides/Acer glabrum*). This forest community 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. This community is only known from Colorado and occurs in scattered locations on the West Slope.

Table 84. Natural Heritage element occurrences at Vega Reservoir PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Populus tremuloides/Acer glabrum	**Aspen/Rocky Mountain maple montane riparian forest**	**G2**	**S1S2**		**A**

*EO=Element Occurrence

Boundary Justification: The boundary encompasses the portion of the hillside believed to be associated with groundwater recharge in the area. However, a better understanding of hydrological processes is needed to ensure that recharge areas are protected and groundwater discharge, which is supporting this unique forest, is maintained.

Protection Comments: There is abundant housing development in the area. Considering that much of the site occurs on private land, the threat of additional development is high.

Management Comments: The surrounding development may impact the local hydrological regime. There is a need to work with developers to ensure additional development does not disrupt hydrologically processes. Otherwise, this site is in excellent condition.

Soils Description: The following soil description was taken from the interior of the aspen/Rocky Mountain maple stand:

A1 0-5 inches, 7.5 YR 2.5/1, coarse/medium crumb structure, diffuse boundary
A2 5-19 inches, 7.5 YR 2.5/1, very coarse/coarse crumb structure.

The soil pit was not dug below 19 inches, thus the entire soil profile is not represented. The soil was moist but not saturated.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment for the Vega Reservoir PCA:
Proposed HGM Class: Slope Subclass: S3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Populus tremuloides/Acer glabrum*

Table 85. Wetland functional assessment for the slope wetlands at the Vega Reservoir site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
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	Seepage occurs over an extensive area.
Dynamic Surface Water Storage	Moderate	The hillside spring system is very large and may be providing storage of discharging groundwater, however saturation of soils is seasonal.
Biogeochemical Functions		
Elemental Cycling	Normal	Saturated soils and a large carbon source maintain vital nutrient cycling processes. The diversity of litter types (woody, herbaceous, etc.) associated with the high diversity of plant species provide a gradient for various nutrient transformations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Adjacent housing development may release nutrients and toxicants into the groundwater. The organic rich soil and vegetation could help alleviate these inputs. Sediment input may occur only during precipitation runoff as no permanent stream courses were observed in the area.
Biological Functions		
Habitat Diversity	Low	The entire hillside consists of a large, deciduous, forested wetland.
General Wildlife Habitat	High	Food and cover for a diversity of bird, mammal, and invertebrate species is provided by a high diversity of plant species.
General Fish/Aquatic Habitat	N/A	No permanent stream courses were observed in the area.
Production Export/Food Chain Support	Moderate	Organic matter production is high at this site, however the lack of permanent flowing water limits export. Plant diversity likely supports a diverse invertebrate population.
Uniqueness	Moderate	The largest seep wetland observed in Mesa County.

Figure 23. Vega Reservoir Potential Conservation Area.

Big Dominguez Creek Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. An excellent occurrence of a community vulnerable through its range (G3), and multiple fair to good occurrences of plants vulnerable through their range (G3).

Protection Rank: P3. Protection actions may be needed, but probably not within the next five years. It is estimated that stresses may reduce the viability of the elements if protection action is not taken. BLM and Uncompahgre National Forest. The site has been proposed for wilderness designation, and is presently a BLM Wilderness Study Area.

Management Rank: M3. New management actions may be needed withint five years to maintain the current quality of the element occurrences. Wilderness designation, and a proposed bridge across the Gunnison River providing easier public access could bring about increased human activity.

Location: Big Dominguez Creek is located on the eastern slope of the Uncompahgre Plateau and is the first major drainage south of Unaweep Canyon.

U.S.G.S. 7.5-min. quadrangle: Keith Creek and Triangle Mesa.
Legal Description: T14S R98W sec. 18;
T14S R99W sec. 23-28, 32-36;
T15S R99W sec. 3-8, 18;
T15S R100W sec. 12-19, 21-23, 30, 31;
T15S R101W sec. 24 and 25;
T51N R16W sec. 11-13

Elevation: 4800 - 9000 ft. Size: Approximately 7,114 acres.

General Description: Dominguez Creek supports some of the best riparian vegetation observed during this survey. Compared to other drainages of similar elevations in Mesa County, few compare to the diversity of plant species, vigorous growth of vegetation, low abundance of non-native aggressive species, and diversity of vegetation structure as found in Big Dominguez Creek. In a stretch of about sixteen air miles from Carson Hole on the Uncompahgre Plateau to the Gunnison River, this beautiful stream descends from 9000 to 4800 ft., from coniferous forests to desert shrubs and cactus. Near the headwaters, mountain willow (*Salix monticola*) is common along the stream banks. Downstream, in the area of Big Dominguez Campground, the rushing stream forms small waterfalls and trout-filled plunge pools in the Precambrian rock. Riparian vegetation along this middle reach is very lush and diverse. Woolly sedge (*Carex pellita*), cloaked bulrush (*Scirpus pallidus*), Baltic rush (*Juncus balticus*), redtop (*Agrostis gigantea*), fowl mannagrass (*Glyceria striata*), horsetail (*Equisetum arvense*), scouring rush (*Hippochaete laevigata*), wild licorice (*Glycyrrhiza lepidota*), false-Solomon's seal (*Maianthemum stellata*), and canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) line the banks, while blue spruce (*Picea pungens*) and narrowleaf cottonwood (*Populus *angustifolia*) tower above thickets of river birch (*Betula occidentalis*), thinleaf alder (*Alnus incana*), coyote willow (*Salix exigua*), and red-osier dogwood (*Cornus sericea*). Approximately one to two miles downstream of the campground, beaver ponds have formed an extensive wetland complex consisting of open still water, scrub-shrub, and emergent wetlands. Above the creek, on the canyonsides, the bright green of pinyon-juniper contrast with red sandstone cliffs. Farther downstream, plains cottonwood (*Populus deltoides* ssp. *wislizeni*) replaces the narrowleaf, as the canyon bottom winds below sheer Wingate sandstone cliffs.

Biodiversity Rank Justification: This site supports an excellent example of the narrowleaf cottonwood/red-osier dogwood riparian forest (*Populus angustifolia*/*Cornus sericea*) which is vulnerable through its range (G3). Many stands of this community occur in Colorado, but they are highly threatened by improper livestock grazing, development, highway corridors, and stream flow alterations. Although no large, pristine stands remain in Colorado, this stand is one of the few in excellent condition. Two additional plant communities which are vulnerable through their range (G3) and two plant communities apparently globally secure (G4).

Three plants which are vulnerable through their range (G3) also occur within the site. The Grand Junction milkvetch (*Astragalus linifolius*) is confined to the eastern base of the Uncompahgre Plateau in Mesa, Montrose and Delta Counties. The canyon bog orchid grows in wet areas and along streams, while the Uinta Basin hookless cactus (*Sclerocactus glaucus*) is found on drier alluvial soils.

The state imperiled (S2) canyon tree frog is also found here. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone.

Table 86. Natural Heritage element occurrences at Big Dominguez Creek PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Astragalus linifolius	**Grand Junction milkvetch**	**G3Q**	**S3**	**BLM**	**B**
Astragalus linifolius	**Grand Junction milkvetch**	**G3Q**	**S3**	**BLM**	**C**
Sclerocactus glaucus	**Uinta Basin hookless cactus**	**G3**	**S3**	**LT**	**B**
Sclerocactus glaucus	**Uinta Basin hookless cactus**	**G3**	**S3**	**LT**	**C**
Sclerocactus glaucus	**Uinta Basin hookless cactus**	**G3**	**S3**	**LT**	**E**
Platanthera sparsiflora var. ensifolia	Canyon bog orchid	G4G5T4	S3		A
Plant Communities					
Alnus incana-Cornus sericea	**Thinleaf alder-red osier dogwood riparian shrubland**	**G3Q**	**S3**		**B**
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood/Red-osier dogwood	G4	S3		A
Salix monticola/Mesic forb	Montane riparian willow carr	G3	S3		C
Betula occidentalis/Mesic	Foothills riparian shrubland	G4?	S2		A

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
forb					
Picea pungens/Cornus sericea	Blue spruce/Red-osier dogwood	G4	S2		B
Birds					
Falco peregrinus anatum	American Peregrine Falcon	G4T3	S3B, SZN	SC	C
Vireo vicinior	Gray Vireo	G4	S2B, SZN		H
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	SC	E

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: This PCA is owned and managed by the BLM and Uncompahgre National Forest. The site has been proposed for wilderness designation, and is presently a BLM Wilderness Study Area. Mineral exploration and development are allowed until the area is designated wilderness by Congress. This high quality riparian area deserves special designation to ensure proper management of ecosystem values.

Management Comments: Wilderness designation, and a proposed bridge across the Gunnison River providing easier public access could bring about increased human activity. Trampling by fishermen could endanger the canyon bog orchid. A designated trail away from the stream with access points to the creek might help to reduce trampling on the stream bank where the plants are concentrated. The local avifauna could be significantly impacted by the increasing popularity of this canyon.

Soils Description: Soils along Big Dominguez creek are alluvium and generally not mapped on the County soil survey. The Glenberg series, Coarse-loamy, mixed (calcareous), mesic, Ustic Torrifluvents is shown to occur on floodplain terraces within the site (USDA 1978).

Restoration Potential: The site has experienced past grazing but the area appears to have recovered nicely. Monitoring of non-native, aggressive species should be continually conducted, especially in the lower end of the site where tamarisk could invade.

Wetland Functional Assessment for the Big Dominguez Creek PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Alnus incana-Cornus sericea*, *Betula occidentalis/*Mesic forb, *Populus angustifolia/Cornus sericea*, *Picea pungens/Cornus sericea*, and *Salix monticola/*Mesic forb.

Table 87. Wetland functional assessment for the Big Dominguez Creek PCA.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	Dense riparian vegetation could moderate flood water velocity but the canyon is fairly narrow, thus there is minimal floodplain for floodwater attenuation/storage. The large beaver pond, however, does provide storage.
Sediment/Shoreline Stabilization	High	Stream banks are densely vegetated with shrubs, trees, and herbaceous species.
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	Normal	The presence of aerated water (the river) and a few areas of saturated soil (beaver ponds, backwater areas) provide a gradient for various nutrient transformations.
Removal of Imported Nutrients, Toxicants, and Sediments.	High	Removal of excess nutrients and sediment (e.g. from upstream and local livestock activity) is likely being performed considering the dense streamside vegetation.
Biological Functions		
Habitat Diversity	High	Emergent, scrub-shrub, forested, and open water wetlands exist in the area. An intact hydrological regime will maintain habitat diversity.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Structural diversity of the vegetation is high and thus excellent habitat for birds. Open water areas could provide habitat for waterbirds.
General Fish/Aquatic Habitat	High	Fish habitat is excellent given the diversity of pools, riffles, dense overhanging vegetation, and abundance of invertebrates.
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. Dense streamside vegetation and the beaver pond likely support healthy invertebrate populations.
Uniqueness	High	Compared to other drainages of similar elevation, Big Dominguez Creek riparian/wetland communities were the most intact and highest quality observed during this survey.

Figure 24. Big Dominguez Potential Conservation Area.

Echo Canyon at No Thoroughfare Canyon Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. An excellent occurrence of a plant vulnerable through its range (G3).

Protection Rank: P4. No protection actions are needed in the foreseeable future. No special protection is currently provided except for the small portion included in the Colorado National Monument. Part of the BLM land in this site has been leased to the county, and is of interest to the City of Grand Junction as a city park.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. The area is used for hiking and mountain biking. Existing trails do not seem to impact the Grand Junction milkvetch or giant helleborine.

Location: This site is located south of Grand Junction near the eastern edge of the Colorado National Monument.

U.S.G.S. 7.5-min. quadrangle: Grand Junction.
Legal Description: T1S R1W sec. 32;
T12S R100W sec. 7, 18.

Elevation: 4600-5680 ft. Size: Approximately 408 acres.

General Description: Echo Canyon, a tributary of No Thoroughfare Canyon, is a secluded area between Little Park Road and Colorado National Monument. It contains a perennial stream, bordered by willows (*Salix* spp.) and horsetails (*Equisetum* spp.), with occasional cottonwoods (*Populus* spp.). Hundreds of giant helleborine orchids (*Epipactis gigantea*) line the banks. Quiet pools are breeding grounds for the canyon tree frog (*Hyla arenicolor*) and Great Basin spadefoot toad (*Spea intermontana*). Partway up the canyon, a fault creates a steep drop, over which the stream cascades during spring runoff. Above the falls, the geology and soils change, and support the Grand Junction milkvetch (*Astragalus linifolius*). The long-nosed leopard lizard (*Gambelia wislizeni*) is found in the pinyon-juniper and sagebrush community above the stream.

Biodiversity Rank Justification: The site supports an excellent occurrence of the Grand Junction milkvetch which is vulnerable through its range (G3). It grows with pinyon-juniper, on dry clay slopes and gullies of the Morrison formation, between 4800 and 6200 ft. The giant helleborine which is vulnerable through its range (G3) is also found at this site. Although the species is widespread in the southwestern region, its specific habitat requirements limit its numbers.

The state imperiled (S2) canyon tree frog is also found here. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone. The state imperiled (S2) Great Basin spadefoot toad is found in a wide variety of habitats, from low elevation shrublands to spruce-fir forests, and from British Columbia to Northwestern Arizona. In Colorado, it frequents pinyon- juniper woodlands, sagebrush and semi-desert shrublands, usually in or near dry rocky slopes or canyons (Hammerson 1982). The Great Basin spadefoot may dig a burrow in loose soil, or use ready-made burrows of small mammals. It breeds in temporary or permanent water, including rain pools and flooded areas along streams.

Table 88. Natural Heritage element occurrences at Echo Canyon at No Thoroughfare Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Astragalus linifolius	**Grand Junction milkvetch**	**G3Q**	**S3**	**BLM**	**A**
Epipactis gigantea	Giant helleborine	G3	S2	FS	B
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	BLM, SC	E
Spea intermontana	Great Basin spadefoot toad	G5	S2	BLM, SC	E
Reptiles					
Gambelia wislizeni	Longnose leopard lizard	G5	S2		E

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to include all element occurrences and a buffer zone of approximately 1000 ft. to protect the elements from direct and indirect impacts such as trampling. The site boundaries also protect most upstream drainages which are critical in order to maintain natural hydrological processes that support the giant helleborine orchid and provide breeding spots for the canyon tree frog and Great Basin spadefoot toad.

Protection Comments: This PCA consists of BLM, private, and National Park Service lands. No special protection is currently provided except for the small portion included in the Colorado National Monument. Part of the BLM land in this site has been leased to the county, and is of interest to the City of Grand Junction for a city park. BLM has recommended that if the city acquires the property it adopt a management plan aimed at mountain bike trails modeled after one already in place by the BLM in Bangs Canyon (Daily Sentinel, July 9, 1996). At present, BLM is formulating the management plan for this property (J. Stevens, City of Grand Junction Parks and Recreation, personal communication). No special protection is needed if management concerns are addressed.

Management Comments: The area is used for hiking and mountain biking. Existing trails do not seem to impact the Grand Junction milkvetch or giant helleborine. However, any additional trails that are developed should be located away from the element occurrences.

Soils: Soils along drainages are derived from alluvium.

Restoration Potential: Monitor and eradicate any tamarisk (*Tamarix ramosissima*) that establishes.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted. However, given that most of the drainages only flow intermittently, most wetland functions will be performed a low levels, although they would be functioning at their potential. Vegetation growth is minimal along the drainages, but periodic episodes of flowing water and seasonal pools provide important food chain support and seasonal habitat for species such as the canyon tree frog and Great Basin spadefoot toad.

Figure 25. Echo Canyon at No Thoroughfare Canyon Potential Conservation Area.

Granite Creek Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. Excellent and good occurrences of plant communities vulnerable throught their range (G3).

Protection Rank:P2. Protection actions may be needed within five years. It is estimated that stresses may reduce the viability of the elements within this approximate timeframe. Most of the lower elevation land is owned by the Bureau of Land Management. It carries no special status; however, a "no surface occupancy" stipulation applies to oil and gas leasing in Granite Canyon, to protect scenic and natural values (USDI 1987). Upper portion is mainly private land.

Management Rank: M5. No management needs are known or anticipated.

Location: This site is located on the western margin of Pinyon Mesa.

U.S.G.S. 7.5-min. quadrangle: Steamboat Mesa, Two V Basin
Legal Description: T14S R103W sec. 6, 7, 18;
T14S R104W sec. 10-21.

Elevation: 6000-8800 ft. Size: Approximately 2,050 acres

General Description: Granite Creek drains the higher elevations of Pinyon Mesa and is a very steep, V-shaped canyon with a narrow riparian zone. At the higher elevations, aspen (*Populus tremuloides*) and Douglas-fir (*Pseudotsuga menziesii*) grow on the steep slopes. Lower, pinyon-juniper stands dominate the slopes with some sagebrush (*Artemisia* sp.) terraces above the creek and Gambel's oak (*Quercus gambelii*) stands directly adjacent to the riparian area. There is a range of riparian communities. At the upper elevations, the riparian zone is densely covered with shrubs, including mountain willow (*Salix monticola*) and red-osier dogwood (*Cornus sericea*). Farther downstream, cottonwood (*Populus* sp.), river birch (*Betula occidentalis*), and thinleaf alder (*Alnus incana*) dominate. The site has been used for livestock grazing and there is evidence of an old settlement in the upper canyon. In the lower canyon, a 4-wheel drive road parallels the creek.

Biodiversity Rank Justification: The site contains six of plant communities vulnerable to apparently secure through their range (G3 and G4, respectively) in fair to good condition (C to B-ranked). The mountain willow/mesic forb riparian willow carr (*Salix monticola*/Mesic forb) is vulnerable through it range (G3). Mountain willow dominated stands are not common in Utah (Padgett et al. 1989) and are reported as limited in distribution in Idaho (Brunsfeld and Johnson 1985). However, this community is considered a major vegetation type in central Colorado (Kittel et al. 1995). The river birch/Red-osier dogwood riparian shrubland (*Betula occidentalis-Cornus sericea*), which is vulnerable through its range (G3), is considered a major type in Utah and occurs mostly in the central part of the state (Padgett et al. 1989) but is uncommon in Colorado. The narrowleaf cottonwood/river birch riparian forest (*Populus angustifolia/Betula* *occidentalis*), which is vulnerable through its range, has only recently been documented in Colorado but is considered a major type in the Wasatch Mountains of Utah (Padgett et al. 1989). The apparently globally secure (G4) narrowleaf cottonwood/red-osier dogwood (*Populus angustifolia/Cornus sericea*) is considered a major type in Utah (Padgett et al. 1989), and also occurs in Montana (Hansen et al. 1989) and Colorado. Most occurrences of this community in Colorado are degraded and high quality stands are rare (Kittel et al. 1995). The global distribution of the Gambel's oak/mountain lover shrubland (*Quercus gambelii/Paxistima myrsinites*) is currently unknown (GU), however it appears to occur only on the Colorado Plateau. The apparently globally secure (G4) pinyon pine/cliffrose shrubland (*Pinus edulis/Cowania mexicana*) is a widespread community that occurs in New Mexico, Utah, Arizona, and Colorado.

Table 89. Natural Heritage element occurrences at Granite Creek PCA.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4?	S3		E
Plant Communities					
Populus angustifolia/Betula occidentalis	**Narrowleaf cottonwood/River birch**	**G3**	**S2**		**B**
Betula occidentalis/Cornus sericea	River birch/Red-osier dogwood	G3?	S1S2		C
Salix monticola/Mesic forb	Mountain willow/mesic forb	G4	S3		AB
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood/Red-osier dogwood	G4	S3		BC
Pinus edulis/Cowania mexicana	Pinyon pine/cliffrose	G4?	S3?		B
Quercus gambelii/Paxistima myrsinites	Gambel's oak/mountain lover	GU	SU		B

*EO=Element Occurrence

Boundary Justification: The current boundary protects the occurrences from direct impact, and encompasses most of the slopes of the canyon and major tributaries. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: Most of the lower elevation land is owned by the Bureau of Land Management and carries no special status; however, a "no surface occupancy" stipulation applies to oil and gas leasing in Granite Canyon, to protect scenic and natural values (USDI 1987). The land at the higher elevations is currently held by a private ranch. Historically, the site has been used for cattle and sheep ranching with cattle ranching being the current use. No formal protection is provided, although the adjacent part of the ranch at the headwaters is under a conservation easement. Although present management does not threaten the elements, a change in ownership could change management of the site.

Management Comments: No serious management needs are known or anticipated at this site.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Monitor and eradicate any tamarisk (*Tamarix ramosissima*) that establishes.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 26. Granite Creek Potential Conservation Area.

Park Creek at Vega Reservoir Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. A good occurrence of a riparian plant community vulnerable through its range (G3).

Protection Rank: P4. No protection actions are needed in the foreseeable future. Near the downstream end of the site, private land is prevalent, but the remaining portion of the site is on USFS land.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Ensure that non-native species, sediments, and toxicants derived from the FS. Rd. 262 do not affect the riparian plant communities.

Location: Park Creek is located southwest of Vega Reservoir.

U.S.G.S. 7.5-min. quadrangle: Vega Reservoir
Legal Description: T10S R93W sec. 7, 16-18, 20, 21, 28, 29, 32, and 33.

Elevation: 5100-6000 ft. Size: Approximately 4,001 acres.

General Description: Park Creek has a narrow creek bottom and is surrounded by conifer dominated hillsides. At upper elevations, the riparian zone is dominated by subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), thinleaf alder (*Alnus incana*). Further downstream, thinleaf alder becomes more dominant along with Drummonds willow (*Salix drummondiana*), red-osier dogwood (*Cornus sericea*), narrowleaf cottonwood (*Populus angustifolia*), and aspen (*P. tremuloides*). Structural and species diversity along the creek is high. A large hillside seep occurs on a west-facing slope along the middle portion of the drainage. The seep is dominated by red-osier dogwood, fowl mannagrass (*Glyceria striata*), monkeyflower (*Mimulus guttatus*), brookgrass (*Catabrosa aquatica*), woolly sedge (*Carex pellita*), small-winged sedge (*C. microptera*), and horsetail (*Equisetum arvense*).

Biodiversity Rank Justification: This site supports a good occurrence of a montane riparian shrubland (*Alnus incana-Salix drummondiana*) which is vulnerable through its range (G3). This plant community has only been documented from Colorado and is a small, but widespread plant community. It is highly threatened by improper livestock grazing and stream impoundments. The community is generally found along steep-gradient streams with stable, shaded stream banks. The site also supports good occurrence of two common riparian plant communities.

Table 90. Natural Heritage element occurrences at Park Creek at Vega Reservoir PCA.
Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Alnus incana-Salix drummondiana	**Montane riparian shrubland**	**G3**	**S3**		**B**
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood riparian forest	G4	S3		B
Abies lasiocarpa-Picea engelmannii/Alnus incana	Montane riparian forests	G5	S5		A

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: Near the downstream end of the site, private land is prevalent, but the remaining portion of the site is on USFS land.

Management Comments: Management concerns include ensuring that non-native species, sediments, and toxicants derived from the FS. Rd. 262 do not affect the riparian plant communities. Another management issue is monitoring of livestock grazing in the area to assess any damages that may occur to the riparian zone from such activities.

Soils Description: Soils along drainages are derived from alluvium and vary in texture depending on geomorphic position.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment for the Park Creek at Vega Reservoir PCA:
Proposed HGM Class: Riverine   Subclass: R3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Alnus incana-Salix drummondiana; Populus angustifolia/Cornus sericea;* and *Abies lasiocarpa-Picea engelmannii/Alnus incana*.

Table 91. Wetland functional assessment for the riverine wetland at the Park Creek at Vega Reservoir site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	There is a high density of shrubs and trees but a somewhat confined floodplain.
Sediment/Shoreline Stabilization	High	There is a dense growth of herbaceous and woody species along the streambank.
Groundwater Discharge/ Recharge	N/A	This wetland floods via overbank flooding.
Dynamic Surface Storage	N/A	This wetland floods via overbank flooding.
Biogeochemical Functions		
Elemental Cycling	Normal	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 some imported material from the adjacent road. Dense vegetation along the streambanks and saturated soils aid in removing nutrients/toxicants.
Biological Functions		
Habitat Diversity	High	There are forested, scrub-shrub, emergent, and open water wetland habitats along Park Creek.
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.
General Fish/Aquatic Habitat	High	There is a diversity of pools, riffles, and woody debris along this stretch of the creek. However, data on fish populations was not collected.
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 aquatic habitat provide a variety of habitats for invertebrate populations.
Uniqueness	Low	Very diverse riparian area, but similar riparian areas are likely found in the area.

Figure 27. Park Creek at Vega Reservoir Potential Conservation Area.

Rough Canyon Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. A good occurrence of a plant vulnerable through its range (G3).

Protection Rank: P3. Protection actions may be needed within five years. It is estimated that stresses may reduce the viability of the elements within this approximate timeframe. Part of the area is within a BLM Research Natural Area and Area of Critical Environmental Concern; the same area has been designated a State Natural Area.

Management Rank: M3. New management actions may be needed within five years to maintain the current quality of the element occurrences. The area is a popular recreation site, with a large parking area and a designated slickrock trail.

Location: Rough Canyon drains down the eastern edge of the Uncompahgre Plateau and is approximately 4.5 miles west of Whitewater.

U.S.G.S. 7.5-min. quadrangle: Island Mesa and Glade Park.
Legal Description: T12S R100W sec. 19-22, 27-33;
T12S R101W sec. 25, 36.
T13S R100W sec. 5, 6;
T13S R101W sec. 1.

Elevation: 5200-8440 ft. Size: Approximately 3,995 acres.

General Description: Rough Canyon comprises one of several parallel drainages on the Uncompahgre Plateau, leading east to the Gunnison River. The canyon cuts across the flank of a large faulted monocline, and has been recognized by the Colorado Natural Areas Program for its structurally complex and informative geology. Upper elevations of the site are in the Morrison formation, which is the preferred substrate of the Grand Junction milkvetch (*Astragalus linifolius*). The canyon rim is Entrada slickrock, and is the route of a popular bicycle trail. The red rock is dotted with small pockets of soil supporting Utah juniper (*Juniperus osteosperma*), pinyon pine (*Pinus edulis*), blackbrush (*Coleogyne ramosissima*), and yucca (*Yucca harrimaniae*). Downstream in the steep sided canyon, a series of deep pools are home to the canyon tree frog (*Hyla arenicolor*).

Biodiversity Rank Justification: This site supports a population of the Grand Junction milkvetch (*Astragalus linifolius*), which is vulnerable throught it range (G3) and whose globally distribution is confined to the eastern base of the Uncompahgre Plateau in Mesa, Montrose and Delta counties. The long-flower cat's eye (*Cryptantha longiflora*) also vulnerable through its range (G3) is also found here. This plant endemic to region and grows on sandy or clay soils in the desert shrub zone. The state imperiled (S2) canyon tree frog also occurs here. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone.

Table 92. Natural Heritage element occurrences at Rough Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Astragalus linifolius	**Grand Junction milkvetch**	**G3Q**	**S3**	**BLM**	**AB**
Cryptantha longiflora	Long-flower cat's eye	G3	S2		E
Plant Communities					
Pinus edulis/Coleogyne ramosissima	Pinyon pine/blackbrush	G3	S3		E
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	BLM, SC	E

*EO=Element Occurrence

Boundary Justification: The boundary includes the present BLM Area of Critical and Environmental Concern, the state designated Natural Area, and the element occurrences. The site boundaries also incorporate upstream drainages which are critical to maintaining natural hydrological processes that provide breeding spots for the canyon tree frog.

Protection Comments: Part of the area is within a BLM Research Natural Area and Area of Critical Environmental Concern; the same area has been designated a State Natural Area. However, the best populations of the Grand Junction milkvetch are not included within those boundaries. The area with special status should be enlarged.

Management Comments: The area is a popular recreation site, with a large parking area and a designated slickrock trail. However, there is evidence of off-trail ORV use, and damage to cryptogrammic crusts. Taxonomic decisions are needed on the status of *Astragalus linifolius*.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 28. Rough Canyon Potential Conservation Area.

Sulphur Gulch Potential Conservation Area

Biodiversity Rank: B3. High Significance. Good occurrence of a globally vulnerable (G3G4 S3) wetland plant community and fair occurrences of two rare plants.

Protection Urgency rank: P1. Protection actions needed within one year. A proposed dam and reservoir would inundate the wetland community and rare plant occurrence. The land is owned by the Bureau of Land Management.

Management Urgency rank: M4. Current management appears adequate. Area is grazed by cattle and possibly wild horses.

Location: This site is approximately four miles southwest of the town of DeBeque and about one mile upstream from the Sulphur Gulch/Colorado River confluence.

U.S.G.S. 7.5-min. quadrangle: Wagontrack Ridge.
Legal Description: T9S R98W sec. 13, 18.

Elevation: 4,920 - 5,160 ft. Size: Approximately 247 acres.

General Description: Sulphur Gulch is a steep sided canyon carved within the Utah juniper (*Juniperus osteosperma*) and big sagebrush (*Artemisia tridentata tridentata*) dominated uplands. The canyon slopes also support scattered ponderosa pine (*Pinus ponderosa*). Within the gulch a spring supports a marsh community of threesquare bulrush (*Schoenoplectus pungens*) (G3G4 S3). The wetland is large relative to others found at similarly low elevations in Mesa County. A thick crust of alkaline salts coats the soils in the vicinity of the springs and seeps. In addition to threesquare bulrush, the sandy alkaline floodplain soils support saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), seepwillow (*Baccharis salicina*), and greasewood (*Sarcobatus vermiculatus*). Tadpoles were observed within the channel and adult damselflies and dragonflies were abundant.

The uplands and alkaline floodplain also support two rare plants: the federally listed threatened Uinta Basin hookless cactus (*Sclerocactus glaucus*) and the BLM sensitive species Debeque milkvetch (*Astragalus debequaeus*). The nearby BLM designated Pyramid Rocky ACEC (Area of Critical Environmental Concern) and state designated Natural Area contains populations of these two rare species as well.

Biodiversity Rank Justification: This site supports a good occurrence of a globally vulnerable threesquare bulrush wetland community (*Schoenoplectus pungens*) (G3G4 S3). Additionally, this site supports fair occurrences of two rare plants: Debeque milkvetch (*Astragalus debequaeus*) (G2 S2) and Uinta Basin hookless cactus (*Sclerocactus glaucus*) (G3 S3).

The threesquare bulrush (*Schoenoplectus pungens*) plant association forms small low stature (1-3 ft) marshes in low-lying swales, abandoned channels, and overflow channels where the soils remain saturated. This association is characterized by pure stands of threesquare bulrush and occasionally with a few other graminoid species.

Table 93. Natural Heritage element occurrences at the Sulphur Gulch PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Astragalus debequaeus	Debeque milkvetch	G2	S2	BLM	C
Sclerocactus glaucus	Uinta Basin	G3	S3	LT	C
Sclerocactus glaucus	Uinta Basin	G3	S3	LT	D
Plant Communities					
Schoenoplectus pungens	**Threesquare bulrush marsh**	**G3G4**	**S3**		**B**

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary is drawn to include the spring-fed wetland community and a portion of the gulch both upstream and downstream from the spring. The boundary represents a preliminary estimate of the area needed to maintain local hydrological conditions. However, the spring is likely associated with a regional or large-scale aquifer. The site boundary likely does not account for all those areas in which recharge to the aquifer occurs. Also included within the boundary are occurrences of two rare plants. This boundary indicates the minimum area that should be considered for any conservation management plan.

Protection Comments: The PCA is owned by BLM. There is currently a reservoir proposed for Sulphur Gulch. Construction of the dam and filling of the reservoir would inundate the spring and wetland community as well as rare plants occurring on alkaline soils within the gulch.

Management Comments: The area is moderately grazed. Few scattered tamarisk are present within the gulch – control is recommended.

Soils Description: Soils are derived from alluvium and vary in texture depending on geomorphic position. The soils have a coating of alkaline salts.

Restoration Potential: Tamarisk removal is recommended at this site. The tamarisk are not well established or abundant.

Wetland Functional Assessment for the Sulphur Gulch PCA:
Proposed HGM Class: Slope   Subclass: S4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Schoenoplectus pungens*

Table 94. Wetland functional assessment for the slope wetland at the Sulphur Gulch site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland is functioning at potential. There are no apparent hydrological alterations.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The floodplain likely undergoes seasonal flooding and aids in flood attenuation.
Sediment/Shoreline Stabilization	High	The banks are vegetated with shrubs and herbaceous species.
Groundwater Discharge/ Recharge	Yes	Spring present.
Dynamic Surface Water Storage	N/A	This wetland floods via overbank flow.
Biogeochemical Functions		
Elemental Cycling	Normal	Minimal hoof action and presence of a few tamarisk may alter natural elemental cycling; however, processes appear to be intact.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Livestock and wild horses may be contributing excess nutrients to the wetland. Saturated soil conditions may allow for nutrient transformations, such as loss of nitrogen via denitrification.
Biological Functions		
Habitat Diversity	Low	Herbaceous wetlands and open water (limited to channel flow) occur here.
General Wildlife Habitat	Moderate	This area provides browse and water for native wildlife.
General Fish/Aquatic Habitat	Moderate	This reach is not fish habitat due to the intermittent nature of the stream both upstream and downstream of the spring. Tadpoles and aquatic insects including damselflies and dragonflies were present.
Production Export/Food Chain Support	Low	There is no surface outflow from the gulch, except during precipitation events, indicating little opportunity for production export.
Uniqueness	High	One of the largest known wetlands (not associated with the Colorado River) occurring at low elevation within Mesa County.

Figure 29. Sulphur Gulch Potential Conservation Area.

Unaweep Canyon Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. A good occurrence of a plant community vulnerable throught its range (G3).

Protection Rank: P4. No protection actions are needed in the foreseeable future. BLM and private, with no formal protection.

Management Rank: M5. No management needs are known or anticipated.

Location: This site is located along East Creek between Whitewater and Unaweep Divide along CO Hwy. 141.

U.S.G.S. 7.5-min. quadrangle: Island Mesa, Jack's Canyon, Snyder Flats and Whitewater.
Legal Description: T12S R99W sec. 28, 32, 33;
T133S R1E sec. 4-8, 17-20, 30, 31;
T13S R100W sec. 25, 36;
T14S R99W sec. 6
T14S R100W sec. 1, 2, 8-12, 14-17, 19-21, 29, 30;
T14S R101W sec. 25, 26, 35, 36.

Elevation: 6520-7800 ft. Size: Approximately 9,184 acres.

General Description: This large site encompasses the eastern part of Unaweep Canyon, the "Canyon with two mouths." Near the divide between East and West Creeks, dark gray Precambrian cliffs with diagonal slashes of quartz intrusions comprise the valley walls. High on the cliff faces, red alum-root (*Heuchera rubescens*), a tiny rare saxifrage, clings to small crevices. Rare bat species and raptors use the cliffs for their homes. Pools in the perennial stream are home to red spotted toads (*Bufo punctatus*) and canyon tree frogs (*Hyla arenicolor*). Farther downstream, the granite gives way to younger sandstones and shales. The banks of East Creek have scattered cottonwoods (*Populus* sp.), coyote willow (*Salix exigua*), and scouring rushes (*Hippochaete* sp.), while the uplands have pinyon-juniper woodlands with mountain mahogany (*Cercocarpus montanus*) and Indian rice grass (*Achnatherum hymenoides*). Tamarisk (*Tamarix ramosissima*) is prevalent near the mouth of the canyon. A large flood occurred on July 10, 2001, scouring out most of the herbaceous vegetation in the canyon. Several side canyons, draining the Uncompahgre Plateau, enter the main canyon. In at least one of these, Nancy Hanks Gulch, widely spaced pinyon-juniper are accompanied by curl-leaf mountain mahogany (*Cercocarpus ledifolius*), comprising a plant community vulnerable through its range (G3). Along the North Fork East Creek, thinleaf alder (*Alnus incana*), red-osier dogwood (*Cornus sericea*), river birch (*Betula occidentalis*), and blue spruce (*Picea pungens*) dominate the riparian area.

Biodiversity Rank Justification: This site supports a good examples of mesic western slope pinyon-juniper woodlands (*Pinus edulis/Cercocarpus ledifolius*) and thinleaf alder-red-osier dogwood riparian shrubland (*Alnus incana-Cornus sericea*), which are both vulnerable through their range (G3). The thinleaf alder/red-osier dogwood plant community is a narrow thicket of medium to tall shrubs lining the stream bank. It is an uncommon community restricted to small tributaries and narrow, constricted reaches of larger rivers. Due to heavy shading, there is usually a limited herbaceous understory. This plant community is widespread throughout the Rocky Mountains. However, all of the occurrences are small and threatened by improper grazing and stream impoundments. The state imperiled (S2) canyon tree frog is also found here. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone. Peregrine Falcons are also known to use this area.

Table 95. Natural Heritage element occurrences at Unaweep Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Pinus edulis/Cercocarpus ledifolius	**Mesic western slope pinyon-juniper woodlands**	**G3**	**S3**		**B**
Alnus incana-Cornus sericea	Thinleaf alder-red osier dogwood riparian shrubland	G3Q	S3		B
Plants					
Heuchera rubescens	Red alum-root	G4	S1		B
Mammals					
Plecotus townsendii pallescens	Townsend's big-eared bat	G4T4	S3		H
Plecotus townsendii pallescens	Townsend's big-eared bat	G4T4	S3		H
Plecotus townsendii pallescens	Townsend's big-eared bat	G4T4	S3		H
Amphibians					
Hyla arenicolor	Canyon treefrog	G5	S2	BLM, SC	E
Birds					
Falco peregrinus anatum	American peregrine falcon	G4T4	S2B, SZ	SC	E
Falco peregrinus anatum	American peregrine falcon	G4T4	S2B, SZ	SC	E
Reptiles					
Elaphe guttata	Corn snake	G5	S3S4		E

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: This PCA consists of BLM and private lands, with no formal protection. Most of the site is BLM land. The cliff-dwelling species are probably secure because of their inaccessibility.

Management Comments: Other than the presence of tamarisk in the lower reach, there are no known threats at this time.

Soils Description: Soils along the drainage are derived from alluvium.

Restoration Potential: The BLM is currently conducting a tamarisk eradication project near the mouth of the canyon.

Wetland Functional Assessment for the Unaweep Canyon PCA:
Proposed HGM Class: Riverine   Subclass: R4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Populus deltoides ssp. wislizeni/Salix exigua* (this plant community was present at this site, but did not rank high enough to be entered into CNHP's Biological Conservation Database as an element occurrence.)

Table 96. Wetland functional assessment for the riverine wetland at the Unaweep Canyon site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar local HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	Low	The canyon is constrained and incised in some areas, thus there is minimal floodplain for floodwater attenuation/storage in some parts of the canyon.
Sediment/Shoreline Stabilization	Moderate	Stream banks are vegetated with shrubs, trees, and sporadically with herbaceous species. Scouring rushes are dense in some areas, however the recent flood removed a lot of herbaceous vegetation.
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	Normal	Although intermittent, the presence of aerated water (the river), a few areas of saturated soil (small seasonal pools) and a diversity of litter types provide a gradient for various nutrient transformations. The abundance of tamarisk near the mouth of the canyon may be altering nutrient cycles due to the excessive salts tamarisk contributes to the soil (Sala 1996).
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Moderate cover of shrubs and herbaceous vegetation likely removes excess inputs from upstream hay meadows and the nearby road.
Biological Functions		
Habitat Diversity	Moderate	Scrub-shrub, forested wetlands plus small seasonal pools exist along the drainage. An intact hydrological regime will maintain habitat diversity.
General Wildlife Habitat	Moderate	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. However, structural diversity of the vegetation is low.
General Fish/Aquatic Habitat	Moderate	There is adequate fish habitat along the creek, although flow is highly variable according to local precipitation events. However, data on fish populations was not collected.
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. Seasonal pools support invertebrate and amphibian populations.
Uniqueness	Low	Other canyons in the immediate area support similar riparian vegetation.

Figure 30. Unaweep Canyon Potential Conservation Area.

West Salt Creek Potential Conservation Area

Biodiversity Rank: B3. High biodiversity significance. This site contains a fair occurrence of a globally imperiled (G2) plant community.

Protection Rank:P4. No protection are needed in the foreseeable future. The site consists of BLM land with no special protection status.

Management Rank:M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. BLM has taken steps to reduce off-road vehicle use, but livestock grazing seems to have changed the vegetation composition of the area.

Location: This site is located along County Rd. 4, west of Highline State Recreation Area, in the northwest corner of Mesa County.

U.S.G.S. 7.5-min. quadrangle: Snyder Flats.
Legal Description: T8S R104W sec. 33, 34;
T9S R104W sec. 2, 3.

Elevation: 4600-4900 ft. Size: Approximately 881 acres

General Description: This site has one of the largest expanses of mat saltbush (*Atriplex corrugata*) and barren shale known in Mesa County. The greasewood/seablite community (*Sarcobatus vermiculatus/Suaeda torreyana*) is heavily invaded by cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola australis*), and halogeton (*Halogeton glomeratus*), but has enough of the seablite to indicate that it would be the dominant native understory species. The Gardner saltbush/Salina wildrye (*Atriplex gardneri/Elymus salinus*) community occurs on higher ground, and is the site of the tall cryptantha (*Oreocarya elata*). The three communities form a mosaic pattern on the landscape. This site is typical of the condition of the salt desert shrublands in the county.

Biodiversity Rank Justification: The site supports a fair example of the globally imperiled (G2?) Gardner's mat saltbush shrublands (*Atriplex gardneri/Elymus salinus*). Fair examples of the saline bottomland shrublands (*Sarcobatus vermiculatus/Suaeda torreyana*) and tall cryptantha, which are vulnerable through their range, also occur at this site.

Table 97. Natural Heritage element occurrences at West Salt Creek PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Atriplex gardneri/Elymus salinus	**Gardner's mat saltbush shrublands**	**G2?**	**S2?**		**C**
Sarcobatus vermiculatus/Suaeda torreyana	Saline bottomland shrublands	G2G3	S2S3		C

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Atriplex corrugata/Shale barren	Alkali mat saltbush shrublands	G5	S2?		B
Plants					
Oreocarya elata	Tall cryptantha	G3	S2		C
Oreocarya elata	Tall cryptantha	G3	S2		H

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary is drawn to enclose a mosaic of three desert shrub communities which are typical of the area, as well as the occurrences of tall cryptantha. It should be noted that recharge areas, which are critical to the maintenance groundwater flow supporting the saline bottomland shrublands, are not encompassed in the site boundaries. The origin and direction of groundwater flow needs to be determined.

Protection Comments: This PCA consists of BLM land with no special protection status.

Management Comments: BLM has taken steps to reduce off-road vehicle use, but livestock grazing seems to have changed the vegetation composition of the area. An exclosure to test natural recovery would be of interest. Need to control non-native species in order to maintain native plant communities.

Soils Description: Soils are mapped as the Bankard series, a Sandy-mixed, mesic, Ustic Torrifluvents (USDA 1978). Bankard soils are deep, well-drained and were formed in sandy alluvium on floodplains (USDA 1978).

Restoration Potential: Unknown.

Wetland Functional Assessment: CNHP wetland ecologists did not visit this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 31. West Salt Creek Potential Conservation Area.

Big Creek Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. Two good occurrences of apparently globally secure (G4) riparian plant communities.

Protection Rank: P4. No protection actions are needed in the foreseeable future. Most of the site is private, although no immediate threats are foreseen.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Affect of altered hydrology and grazing should be monitored.

Location: Big Creek is located south of Collbran.

U.S.G.S. 7.5-min. quadrangle: Collbran and Grand Mesa.
Legal Description: T10S R94W sec. 31;
T10S R95W sec. 10, 11, 13, 14, 23-26, 35, 36;
T11S R94W sec. 1, 2, 4-6, 8, 9.

Elevation: 6500-9600 ft. Size: Approximately 4,536 acres.

General Description: Big Creek is a steep drainage beginning atop of Grand Mesa and draining north into Plateau Creek near Collbran. The floodplain is confined and narrow. Riparian vegetation is dense and consists of narrowleaf cottonwood (*Populus angustifolia*), blue spruce (*Picea pungens*), thinleaf alder (*Alnus incana*), and red-osier dogwood (*Cornus sericea*) along most of the creek. Gambel's oak (*Quercus gambelii*) and serviceberry (*Amelanchier utahensis*) dominate upland slopes. Ditches and canals transporting water from nearby reservoirs have altered the creek's hydrology. Areas downstream of these intakes have high stream flow throughout the summer. Water quality also appears to be affected by these intakes as indicated by clear stream water above the intakes and cloudy, murky water below. Head gates of several ditches also remove water from Big Creek. There are a few non-native species present, especially near the ditches and head gates, but overall the riparian area is in good condition.

Biodiversity Rank Justification: This site supports two good occurrences of apparently globally secure (G4) riparian plant communities. The narrowleaf cottonwood riparian forest (*Populus angustifolia/Cornus sericea*) plant community is found along moderate-size rivers in the montane zone and is a widespread plant community in Nevada, Idaho, Wyoming, New Mexico, and Colorado. 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. The montane riparian forest (*Populus angustifolia-Picea pungens/Alnus incana*) is an abundant (>100 stands) community in Colorado and is likely to occur in other Rocky Mountain states. This is a common community of montane valleys. However, only a handful of good condition stands are known, and it is highly threatened by improper livestock grazing, heavy recreational use, and stream flow alterations.

Table 98. Natural Heritage element occurrences at Big Creek PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Populus angustifolia/Cornus sericea	Narrowleaf cottonwood riparian forest	G4	S3		B
Populus angustifolia-Picea pungens/Alnus incana	Montane riparian forest	G4	S4		B

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: Most of the site is private. USFS and BLM land also occur within the site. No immediate threats are foreseen.

Management Comments: Livestock grazing appears to be occurring in early summer but impacts are currently minimal. The effects of altered hydrology should be monitored. The combined effect of water intakes and outlets needs to be studied to determine the affects on the riparian corridor.

Soils Description: Soils along the drainage are derived from alluvium. Soil development in minimal due to the steep, confined nature of the stream channel.

Restoration Potential: Removing water intakes would restore natural hydrological patterns.

Wetland Functional Assessment for the Big Creek PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Populus angustifolia/Cornus sericea,. Populus angustifolia-Picea pungens/Alnus incana*.

Table 99. Wetland functional assessment for the Big Creek PCA.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification. Although areas downstream of ditches and intakes may not be functioning naturally due to altered hydrology.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	Dense riparian vegetation could moderate flood water velocity but the canyon is fairly narrow, thus there is minimal floodplain for floodwater attenuation/storage. Areas with altered hydrological patterns may not be functioning at potential.
Sediment/Shoreline Stabilization	Moderate	Stream banks are densely vegetated with shrubs and trees but abundance of herbaceous species is low.
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	Normal	The presence of aerated water (the river) and a few areas of saturated soil (backwater areas) provide a gradient for various nutrient transformations. There is abundant litter input and water quality appears to support healthy microbial and invertebrate populations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of excess nutrients and sediment (e.g. from upstream and local livestock activity) is unlikely in many reaches due to the steep, confined nature of the channel and lack of upstream inputs. However, downstream of water intakes some areas may be removing excess inputs.
Biological Functions		
Habitat Diversity	Moderate	Scrub-shrub and forested wetlands exist in the area. An intact hydrological regime will maintain habitat diversity.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Structural diversity and density of the vegetation is high and thus excellent habitat for birds.
General Fish/Aquatic Habitat	High	Fish habitat is excellent given the diversity of pools, riffles, dense overhanging vegetation, and abundance of invertebrates. Disrupted water quality may affect areas downstream of intakes.
Production Export/Food Chain Support	High	A permanent water source and allochthonous organic substrates provide various sources of carbon and nutrients for downstream ecosystems. Dense streamside vegetation and pools likely support healthy invertebrate populations.
Uniqueness	Low	Other canyons in the immediate area support similar riparian vegetation.

Figure 32. Big Creek Potential Conservation Area.

East Salt Creek at Sugarloaf Peak Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. This site supports a good example of an apparently globally secure (G4) plant community.

Protection Rank: P4. No protection actions are needed in the foreseeable future. Approximately half (lower reach) of the site is private. USFS and BLM lands comprise the remaining half.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Affect of water diversions on hydrology should be monitored. Abundance of hay grasses should be addressed.

Location: East Salt Creek is located approximately 2.5 miles southeast of Vega Reservoir.

U.S.G.S. 7.5-min. quadrangle: Vega Reservoir.
Legal Description: T10S R93W sec. 19, 30;
T10S R94W sec. 1, 2, 10-15, 23-26.

Elevation: 7200-9600 ft. Size: Approximately 4,049 acres.

General Description: East Salt Creek drains north off the Grand Mesa in a medium wide valley. Riparian vegetation consists of scattered shrubs such as river birch (*Betula occidentalis*) and a dense understory of herbaceous species. There is a high cover of non-native hay grasses such as timothy (*Phleum pratense*) and redtop (*Agrostis gigantea*). An agricultural water diversion alters natural hydrology. Beaver ponds are scattered along the creek.

Biodiversity Rank Justification: This site supports a good occurrence of the apparently globally secure (G4) foothills riparian shrubland (*Betula occidentalis*/Mesic forb). This plant community 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. This community is well documented in the western states. In Colorado, fewer than thirty stands are documented, and while more are estimated to occur, this community is highly threatened by development, road building, and recreation.

Table 100. Natural Heritage element occurrences at East Salt Creek at Sugarloaf Peak PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
***Betula occidentalis*/Mesic forb**	**Foothills riparian shrubland**	**G4?**	**S2**		**B**

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: Approximately half (lower reach) of the site is privately owned. USFS and BLM lands comprise the remaining half. No immediate threats are foreseen.

Management Comments: The affect of water diversions on hydrology should be monitored and the abundance of hay grasses should be addressed.

Soils Description: Soils along the drainage are derived from alluvium. Soils near beaver ponds and along streambanks are more developed.

Restoration Potential: Removing water diversions would restore natural hydrological patterns. Control of non-native hay grasses would encourage growth of native species.

Wetland Functional Assessment for the East Salt Creek at Sugarloaf Peak PCA:
Proposed HGM Class: Riverine Subclass: R3
Cowardin System: Palustrine
CNHP's Wetland Classification: *Betula occidentalis*/Mesic forb.

Table 101. Wetland functional assessment for the East Salt Creek at Sugarloaf Peak PCA.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	High	Dense riparian vegetation and beaver ponds moderate flood water velocity.
Sediment/Shoreline Stabilization	Moderate	Stream banks are densely vegetated.
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	Normal	The presence of aerated water (the river) and a few areas of saturated soil (beaver ponds, backwater areas) provide a gradient for various nutrient transformations. There is an abundance of litter input and water quality appears to support healthy macroinvertebrate and microbial populations.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of excess nutrients and sediment (e.g. from upstream and local livestock activity/hay meadows) is likely being performed considering the dense streamside vegetation.
Biological Functions		
Habitat Diversity	High	Scrub-shrub, emergent, forested, and open water wetlands exist in the area. An intact hydrological regime will maintain habitat diversity.
General Wildlife Habitat	High	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds of prey such as eagles, hawks, and falcons. Structural diversity and density of the vegetation is high and thus excellent habitat for birds. Open water provides habitat for waterbirds, beavers, etc.
General Fish/Aquatic Habitat	High	Fish habitat is excellent given the diversity of pools, riffles, dense overhanging vegetation, and abundance of invertebrates.
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. Dense streamside vegetation, pools, and cold, clear, oxygenated water likely support healthy invertebrate populations.
Uniqueness	Low	Other canyons in the immediate area support similar riparian vegetation.

Figure 33. East Salt Creek at Sugarloaf Peak Potential Conservation Area.

Lily Lake Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. This site supports an excellent example of a demonstrably globally secure (G5S1S2) plant.

Protection Rank: P4. No protection actions are needed in the foreseeable future. The site is entirely within the Grand Mesa National Forest but does not have any special protection status.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. A pack/recreation trail follows the northern shoreline, allowing easy access to the lake for hunters, anglers, hikers, cattle, etc., but no signs of disturbance to the rare plant were observed.

Location:. Lily Lake is located on Grand Mesa east of the Cottonwood Lake Campground.

U.S.G.S. 7.5-min. quadrangle: Grand Mesa.
Legal Description: T11S R94W sec. 30;
T11S R95W sec. 25.

Elevation: 10,200-10,400 ft. Size: Approximately 100 acres

General Description: Lily Lake is a small kettle pond. A small inlet, which begins at another smaller lake east of this site enters Lily Lake at its eastern end. A small creek drains downslope from the western edge of Lily Lake toward Cottonwood Lake Reservoir #1. Yellow pond lily (*Nuphar lutea*) and narrowleaf burreed (*Sparganium angustifolium*) are common in deep water. Sphagnum moss (*Sphagnum* sp.) is prevalent around the western and southern shore of the lake and in some places appears to be growing toward the center of the lake, forming a floating mat. Marsh cinquefoil (*Comarum palustre*) is found growing just behind the "leading" edge of the sphagnum mat along with buckbean (*Menyanthes trifoliata*). Other lakeshore wetland areas are dominated by planeleaf willow (*Salix planifolia*), beaked sedge (*Carex utriculata*), water sedge (*C. aquatilis*), and bluejoint reedgrass (*Calamagrostis canadensis*). Mesic spruce forests are prevalent throughout the area and dominated by dwarf bilberry (*Vaccinium cespitosum*), broom huckleberry (*V. scoparium*), alpine timothy (*Phleum alpinum*), and Engelmann spruce (*Picea engelmannii*).

Biodiversity Rank Justification: The demonstrably globally secure (G5S1S2) marsh cinquefoil (*Comarum palustre*) is found at this site. The species is circumboreal in distribution but is currently only known from six counties in Colorado. In Colorado, this species is associated with high elevation peatlands.

Table 102. Natural Heritage element occurrences at Lily Lake PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Comarum palustre	**Marsh cinquefoil**	**G5**	**S1S2**		**A**

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the element. These boundaries will ensure continued natural surface flow and thus allow lake levels to persist at natural levels, which is crucial to the survival of the marsh cinquefoil and wetland plant communities surrounding the lake.

Protection Comments: The site is entirely within the Grand Mesa National Forest but does not have any special protection status.

Management Comments: A pack/recreation trail follows the northern shoreline, allowing easy access to the lake for hunters, anglers, hikers, cattle, etc. However, the marsh cinquefoil was only found growing with the sphagnum along the western and southern shoreline and did not appear to be impacted by recreationists or livestock.

Soils Description: Organic matter accumulation along the shoreline was greatest in those areas dominated by sphagnum moss (western and southern shorelines). The northern shoreline had very little soil formation likely due to steep slopes surrounding the lake.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment for the Lily Lake PCA:
Proposed HGM Class: Depressional Subclass: D1
Cowardin System: Palustrine
CNHP's Wetland Classification: similar to *Carex utriculata/Carex aquatilis*

Table 103. Wetland functional assessment for the depressional wetland at the Lily Lake site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	Moderate	Except for the northern shoreline, which has very little shoreline vegetation, the lake is fringed with a lush growth of sphagnum moss and herbaceous wetland species.
Groundwater Discharge/ Recharge	Unknown	Unsure of potential for lake to provide groundwater recharge.
Dynamic Surface Water Storage	High	The lake and the organic rich soils near lateral fringe provide storage of water.
Biogeochemical Functions		
Elemental Cycling	Normal	Saturated soils and a carbon source maintain vital nutrient cycling processes. Soils and hydrology were not disturbed.
Removal of Imported Nutrients, Toxicants, and Sediments.	Low	Considering the remote location of the site, there is little potential for this wetland to remove sediments/ nutrients/toxicants as there are no upstream sources of excess inputs.
Biological Functions		
Habitat Diversity	High	Forested, scrub-shrub, emergent, and open water wetlands exist at this site.
General Wildlife Habitat	Moderate	Structural and habitat diversity is high. The area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and other birds.
General Fish/Aquatic Habitat	Moderate	Although no fish were observed in the lake, lush shoreline vegetation, woody debris in the water, and good water quality suggest good fish habitat. Both the inlet and outlet were not very deep or had much flow, thus any fish populations would likely be isolated.
Production Export/Food Chain Support	High	High amounts of organic matter accumulation both in the lake and along the fringe produces dissolved organic carbon sources and particulate organic carbon, that may be exported downstream. The diversity of aquatic and terrestrial habitats likely support healthy and abundant invertebrate populations.
Uniqueness	High	Although there are numerous ponds similar to Lily Lake on the Grand Mesa, very few support a population of the marsh cinquefoil.

Figure 34. Lily Lake Potential Conservation Area.

Long Canyon Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. This site supports a good example of a apparently globally secure (G4) plant community.

Protection Rank: P4. This site is entirely within the Uncompahgre National Forest. No protection actions are needed in the foreseeable future.

Management Rank: M3. New management actions may be needed within five years to maintain the current quality of the element occurrences. There is ongoing prescribed burning in the vicinity, but impacts on this plant community are not anticipated. There is some evidence of trailing but cattle normally do not stay in the riparian area.

Location:. Long Canyon is located on the western edge of the Uncompahgre Plateau, near Uncompahgre Butte.

U.S.G.S. 7.5-min. quadrangle: Uncompahgre Butte.
Legal Description: T50N R16W sec. 18;
T50N R17W sec. 13, 14, 23, 24.

Elevation: 7800-8600 ft. Size: Approximately 484 acres

General Description: Riparian vegetation in Long Canyon is dominated by blue spruce (*Picea pungens*) and red-osier dogwood (*Cornus sericea*). Other species include aspen (*Populus tremuloides*), river birch (*Betula occidentalis*), and mountain willow (*Salix monticola*). Beaver ponds are scattered along the creek.

Biodiversity Rank Justification: This site supports the apparently globally secure (G4) blue spruce/red-osier dogwood riparian forest. This plant community is a cool, moist riparian woodland occurring in deep narrow canyons and is known from Wyoming to Arizona. In Colorado, fewer than twenty stands are documented. This community is highly threatened by road improvements and maintenance, improper grazing, heavy recreational use, and development.

Table 104. Natural Heritage element occurrences at Long Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Picea pungens/Cornus sericea	**Blue spruce/Red-osier dogwood riparian forest**	**G4**	**S2**		**AB**

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage. Hydrological processes originating outside the planning boundary, including water quality, quantity, and timing, must be managed to maintain site viability.

Protection Comments: The site is entirely within the Uncompahgre National Forest. Special Area designation should not be necessary for protection if management issues are adequately addressed.

Management Comments: There is ongoing prescribed burning in the vicinity, but impacts on this plant community are not anticipated. There is some evidence of trailing but cattle normally do not stay in the riparian area. There is some elk use (transitional winter range). The forest is currently [1996] considering converting the trail that runs through the site to motorized use.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment: CNHP wetland ecologists did not visit this drainage during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 35. Long Canyon Potential Conservation Area.

No Thoroughfare Canyon Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. An excellent occurrence of aN apparently globally secure (G4G5T4) plant.

Protection Rank: P5. Land protection is complete and no protection actions are needed. The site is within Colorado National Monument with adequate protection.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. The site is not easily accessible, and vegetation is so thick along the creek that most hikers will stay on the trail above. However, development of adjacent private lands could negatively affect Colorado National Monument.

Location: The site is located at the head of No Thoroughfare Canyon in Colorado National Monument.

U.S.G.S. 7.5-min. quadrangle: Glade Park.
Legal Description: T112S R101W sec. 20, 21, 28, 29.

Elevation: 6300-6800 ft. Size: Approximately 449 acres.

General Description: This canyon is walled by steep cliffs of Wingate sandstone, with slopes of dark red Chinle sandstone at their base. Little Park Road, which becomes CS Road, skirts the canyon rim. Upper slopes have pinyon-juniper, with mountain mahogany (*Cercocarpus montanus*), serviceberry (*Amelanchier utahensis*) and sagebrush (*Artemisia* sp.), while lower slopes have dense stands of Gambel's oak (*Quercus gambelii*). The flat canyon bottom is covered with sagebrush. In some places the creek has eroded a steep sided arroyo in the soft alluvium while in other areas it has a broader floodplain. The two foot wide stream is sheltered by a dense canopy of coyote willow (*Salix exigua*), squaw-apple (*Peraphyllum ramosissimum*), wild rose (*Rosa woodsii*), and Gambel's oak, with an understory of scouring rushes (*Hippochaete* sp.), false Solomon's seal (*Maianthemum stellatum*) and canyon bog orchids (*Platanthera sparsiflora* var. *ensifolia*). There are also occasional cottonwoods (*Populus* sp.), box elders (*Acer negundo*), mountain willow (*Salix monticola*), and river birch (*Betula occidentalis*) along the riparian zone. Non-native, aggressive species are more frequent downstream, and include tamarisk (*Tamarix ramosissimum*), Russian olive (*Elaeagnus angustifolia*), and sweet clover (*Melilotus* sp.).

Biodiversity Rank Justification: The site supports an excellent occurrence of the apparently globally secure (G4G5T4) canyon bog orchid. The upper canyon contains an excellent example of the coyote willow/scouring rush (*Salix exigua/Equisetum hyemale*) community, which was previously undescribed. This community was found to be common in the sandstone canyons of Mesa County.

Table 105. Natural Heritage element occurrences at No Thoroughfare Canyon PCA.
Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Platanthera sparsiflora* var. *ensifolia	**Canyon bog orchid**	**G4G5T4**	**S3**		**A**
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T4	S3		C
Plant Communities					
Salix exigua/Equisetum hyemale	**Coyote willow/horsetail**	**G4?**	**S2S4**		**A**

*EO=Element Occurrence. Multiple listings represent separate locations.

Boundary Justification: The boundary is drawn to include the canyon bottom in the area of the element occurrences. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: The site is within Colorado National Monument with adequate protection.

Management Comments: The site is not easily accessible, and vegetation is so thick along the creek that most hikers will stay on the trail above. However, development of adjacent private lands could negatively affect Colorado National Monument. The National Park Service has noted impacts that nearby subdivisions may have on Monument lands. These include: creation of new trails that can damage sensitive soils and degrade the wilderness experience; noise from lawnmowers, dogs and vehicles; loose pets having a negative effect on wildlife; increased fire danger; degradation of air quality by wood smoke; and increase in non-native species invasion (B. Rodgers, National Park Service, personal communication). These concerns should be considered in the approval of new housing developments.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Monitor and eradicate any tamarisk (*Tamarix ramosissima*) that establishes. The National Park Service has initiated tamarisk eradication in this site.

Wetland Functional Assessment: CNHP wetland ecologists did not visit the drainages contained within this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 36. No Thoroughfare Canyon Potential Conservation Area.

Skyway Point Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. This site supports an excellent example of a demonstrably globally secure (G5S1S2) plant.

Protection Rank: P4. No protection actions are needed in the foreseeable future. The site is entirely within the Grand Mesa National Forest but does not have any special protection status.

Management Rank: M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Livestock are grazing in the area but had not impacted the area.

Location:. Skyway Point is located on Grand Mesa just east of CO Hwy. 65.

U.S.G.S. 7.5-min. quadrangle: Mesa Lakes.
Legal Description: T11S R96W sec. 36;
T12S R96W sec. 1.

Elevation: 10,500-10,600 ft. Size: Approximately 118 acres

General Description: Upstream of Reservoir #6, there are numerous small ponds connected by a continuous band of wet meadow dominated by beaked sedge (*Carex utriculata*) and Raynold sedge (*C. raynoldsii*). Yellow pond lily (*Nuphar lutea*), narrowleaf burreed (*Sparganium angustifolium*), and small burreed (*S. minimum*) are common in deep water. Marsh cinquefoil (*Comarum palustre*) is found growing with beaked sedge and Raynold sedge near the southern and eastern shoreline of one of the small ponds. Groundwater and surface water from these wetlands drain into Reservoir #6. From the Reservoir drainage proceeds downstream to Kannah Creek.

Biodiversity Rank Justification: The demonstrably globally secure (G5S1S2) marsh cinquefoil (*Comarum palustre*) is found at this site. The species is circumboreal in distribution but is currently only known from six counties in Colorado. In Colorado, this species is associated with high elevation peatlands.

Table 106. Natural Heritage element occurrences at Skyway Point PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plants					
Comarum palustre	**Marsh cinquefoil**	**G5**	**S1S2**		**A**

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the elements. These boundaries will ensure continued natural surface flow and thus allow pond levels to persists at natural levels, which is crucial to the survival of the marsh cinquefoil and wet meadows.

Protection Comments: The site is entirely within the Grand Mesa National Forest but does not have any special protection status.

Management Comments: Livestock are grazing in the area but had not impacted the area. However, the potential for soil disturbance via trampling exists and should be monitored. CO Hwy. 65 is nearby and may be contributing toxicants/sediments into the wetland.

Soils Description: Soils within the wet meadow and near the ponds had thick histic horizons. Soil pits were not dug, thus exact depths of the peat are not known.

Restoration Potential: Most of the site is functioning as expected.

Wetland Functional Assessment for the Skyway Point PCA:
Proposed HGM Class: Depressional Subclass: D1
Cowardin System: Palustrine
CNHP's Wetland Classification: *Carex utriculata*

Table 107. Wetland functional assessment for the depressional wetland at the Skyway Point site.

Function	Ratings	Comments
Overall Functional Integrity	At Potential	This wetland appears to be functioning at its potential compared to wetlands of similar HGM classification.
Hydrological Functions		
Flood Attenuation and Storage	N/A	This wetland does not flood via overbank flow.
Sediment/Shoreline Stabilization	High	All of the ponds are fringed with a lush growth of sedges.
Groundwater Discharge/ Recharge	Unknown	Unsure of potential for area to provide groundwater recharge.
Dynamic Surface Water Storage	High	The ponds and the organic rich soils found in the wet meadow provide storage of surface water.
Biogeochemical Functions		
Elemental Cycling	Normal	Saturated soils and a carbon source maintain vital nutrient cycling processes. Soils and hydrology were not disturbed. Excess livestock activity could disrupt nutrient cycles.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	The wetland may be removing excess inputs from CO Hwy. 65.
Biological Functions		
Habitat Diversity	Low	Emergent and open water wetlands exist at this site.
General Wildlife Habitat	Moderate	The area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and other birds.
General Fish/Aquatic Habitat	Low	No fish occurred in the ponds. Given the ponds' small size and isolation from large bodies of water (there was no surface connection to the reservoir downstream) it is unlikely they could support fish. However, tiger salamanders were observed in one of the ponds.
Production Export/Food Chain Support	High	High amounts of organic matter accumulation in the ponds produces dissolved organic carbon sources that may be exported downstream via groundwater flow. Export of particulate organic carbon is limited due to the lack of surface water connection to downstream areas. The diversity of aquatic habitats (open water, submergent and emergent vegetation) likely support healthy invertebrate populations.
Uniqueness	High	Although there are numerous ponds similar to those at Skyway Point on the Grand Mesa, very few support a population of the marsh cinquefoil.

Figure 37. Skyway Point Potential Conservation Area.

Willow Creek Potential Conservation Area

Biodiversity Rank: B4. Moderate biodiversity significance. This site supports a fish which is vulnerable through its range in Colorado (S3).

Protection Rank: P4. No protection actions are needed in the foreseeable future.

Management Rank: M3. New management actions may be needed within five years to maintain the current quality of the element occurrences. Intensive livestock grazing along the streambank appears to be causing erosion and sedimentation in the creeks.

Location: Willow Creek is located in the extreme northeast corner of Mesa County.

U.S.G.S. 7.5-min. quadrangle: Center Mountain, Quaker Mesa, and Flatiron Mountain.
Legal Description: T8S R90W sec. 5, 7-10, 15-22, 28-32;
T8S R91W sec. 24-26, 35, 36;
T9S R90W sec. 5, 6;
T9S R91W sec. 1.

Elevation: 6920-7400 ft. Size: Approximately 352 acres

General Description: This reach of Willow Creek consists of a narrow creek channel with riparian vegetation dominated by willows (*Salix* spp.), aspen (*Populus tremuloides*), and blue spruce (*Picea pungens*). Beaver are active along this reach. Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) were observed at five sample reaches along East Divide Creek and Gennings Creek. The samples showed a healthy age class distribution, with juveniles and adults represented. However, only 58 fish were captured (USFS 2000).

Biodiversity Rank Justification: This PCA contains an occurrence of the state imperiled (S2) Boreal Owl and the Colorado River cutthroat trout subspecies (*Oncorhynchus clarki pleuriticus*) which is vulnerable through its range in Colorado (S3).

Table 108. Natural Heritage element occurrences at Willow Creek PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Fish					
Oncorhynchus clarki pleuriticus	**Colorado River cutthroat trout**	**G4T3**	**S3**		**B**
Birds					
Aegolius funereus	Boreal owl	G5	S2	FS	E

*EO=Element Occurrence

Boundary Justification: These boundaries will ensure continued natural surface flow to sustain the fish population. Maintenance of surface flow will also allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: The southern reaches of East Divide Creek are USFS lands, while the northern reaches are mostly privately owned with some BLM lands interspersed.

Management Comments: Intensive livestock grazing along the streambank appears to be causing erosion and sedimentation in the creeks.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Excluding cattle from the streamside riparian areas would increase stream quality, reduce sedimentation and potentially benefit the cutthroat population.

Wetland Functional Assessment: CNHP wetland ecologists did not visit this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 38. Willow Creek Potential Conservation Area.

Bangs Canyon Potential Conservation Area

Biodiversity Rank: B5. General biodiversity significance. This site supports an unranked occurrence of a state imperiled (S2) frog.

Protection Rank: P5. Land protection is complete and no protection actions are needed. The area is entirely BLM, and quite inaccessible, even with high clearance four-wheel drive.

Management Rank: M5. No management needs are known or anticipated. BLM's land use plan calls for recreation management, with emphasis on non-motorized recreation, such as hiking and horseback riding.

Location: Bangs Canyon is located west of Whitewater on the eastern side of the Uncompahgre Plateau.

U.S.G.S. 7.5-min. quadrangle: Island Mesa and Whitewater.
Legal Description: T12S R99W sec. 29-32.
T12S R100W sec. 36;
T13S R100W sec. 1, 2, 10-12, 14-17, 20, 21, 29;

Elevation: 4680-7600 ft. Size: Approximately 2,847 acres.

General Description: Bangs Canyon is one of several parallel drainages of the northern part of the Uncompahgre Plateau, leading to the Gunnison River. The Tabeguache Trail runs through the site, but receives very little use. At its upper elevations, drainages are forested with ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*), while the side slopes have pinyon-juniper woodlands with mountain shrubs. The creek bottoms have narrowleaf cottonwood (*Populus angustifolia*), skunkbrush (*Rhus trilobata*), red-osier dogwood (*Cornus sericea*), and Rocky Mountain juniper (*Juniperus scopulorum*). A Cooper's Hawk nest was located here in a Douglas-fir. Dozens of tadpoles of the canyon tree frog (*Hyla arenicolor*) were found in pools of the intermittent stream. An interesting comparison of grazed and ungrazed areas can be seen at the fence line of a water catchment installation near the eastern end of this site. Inside the fence is an abundant stand of Indian rice grass (*Achnatherum hymenoides*); outside the species is completely absent.

Biodiversity Rank Justification: The state imperiled (S2) canyon tree frog is found here. The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. This desert frog reaches its northern limits in Southern Colorado. Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone.

Table 109. Natural Heritage element occurrences at Bangs Canyon PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Amphibians					
Hyla arenicolor	**Canyon treefrog**	**G5**	**S2**	**BLM, SC**	**E**

*EO=Element Occurrence

Boundary Justification: These boundaries will ensure continued natural surface flow to sustain pools for the canyon tree frog. Maintenance of surface flow will also allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage.

Protection Comments: The area has been proposed as wilderness, with proponents citing values of remoteness, and opportunities for solitude and primitive recreation (Colorado Environmental Coalition 1995). The area is entirely BLM, and quite inaccessible, even with high clearance four-wheel drive.

Management Comments: BLM's land use plan calls for recreation management, with emphasis on non-motorized recreation, such as hiking and horseback riding. Although firewood cutting is allowed, the area's inaccessibility will likely discourage most woodcutters.

Soils Description: Soils along drainages are derived from alluvium.

Restoration Potential: Ecological processes appear to be intact.

Wetland Functional Assessment: CNHP wetland ecologists did not visit this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 39. Bangs Canyon Potential Conservation Area.

Lower Little Dolores River Potential Conservation Area

Biodiversity Rank: B5. General biodiversity significance. This site supports a fair example of a riparian plant community whose global rank is currently unknown but is considered imperiled in Colorado (GUS1S2).

Protection Rank: P4. No protection actions are needed in the foreseeable future. Landowner has a conservation easement on the property.

Management Rank: M3. New management actions may be needed within five years to maintain the current quality of the element occurrences.

Location:. This site is located at the western edge of Glade Park near the Colorado-Utah state line.

U.S.G.S. 7.5-min. quadrangle: Sieber Canyon, Payne Wash, Westwater, and Bieser Creek.
Legal Description: T12S R103W sec. 7, 17-22, 26-29, 34, 35;
T12S R104W sec. 7, 10-18.

Elevation: 5400-6800 ft. Size: 4,648 acres

General Description: The red sandstone canyon of the Little Dolores River is highly scenic. The valley floor is moderately wide and flat. The river, which has incised into the valley floor, is dominated by Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*), tamarisk (*Tamarix ramosissima*), Russian olive (*Elaeagnus angustifolia*), and coyote willow (*Salix exigua*). Narrowleaf cottonwood (*Populus angustifolia*) saplings were also present. Diversity of herbaceous species is high, however the abundance of non-native species such as sweetclover (*Melilotus alba* and *M. officinalis*), alfalfa (*Medicago sativa*), horseweed (*Conyza canadensis*), Kentucky bluegrass (*Poa pratensis*), and redtop (*Agrostis gigantea*) is also quite high. Common spikerush (*Eleocharis macrostachya*), threesquare bulrush (*Schoenoplectus pungens*), Baltic rush (*Juncus balticus*), Nebraska sedge (*Carex nebrascensis*), scouring rush (*Hippochaete* sp.), horsetail (*Equisetum arvense*), and barnyard grass (*Echinochloa crus-galli*) were dominant along the streambanks and in low lying areas. Upstream agricultural water diversions have altered the river's hydrology.

Biodiversity Rank Justification: This site supports the Rio Grande riparian forest (*Populus deltoides* ssp. *wislizeni/Salix exigua*) whose globally rank is currently unknown but is considered imperiled in Colorado (GUS1S2). This is an early seral community with a mix of sapling and pole sized Rio Grande cottonwoods intermixed with coyote willow. It is recognized as the younger stage of older plains cottonwood communities that have more widely spaced trees. This community is often located on low stream banks and islands, but can also occur on overflow channels away from the main stream channel. It typically has a fairly dense tree canopy with little herbaceous ground cover. This community is located on larger, low elevation rivers on the West Slope. While this early seral stage of cottonwoods is common, the later-seral, older cottonwood stands that occur as a result of channel migration, are becoming very rare due to hydrologic manipulation of stream flows. The presence of this early seral community may be an indication of some resemblance to natural stream flow, but stands must be monitored if all stages of cottonwood riparian communities are to be protected along river corridors.

Table 110. Natural Heritage element occurrences at Little Dolores River PCA. Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Plant Communities					
Populus deltoides* ssp. *wislizeni/Salix exigua	**Rio Grande cottonwood riparian forests**	**GU**	**S1S2**		**C**

*EO=Element Occurrence

Boundary Justification: Boundaries are drawn to encompass the ecological processes believed necessary for long term viability of the riparian plant community. These boundaries will ensure continued natural surface flow and thus allow fluvial processes such as flood scouring, lateral flow, and channel meandering, to maintain a dynamic distribution of riparian and wetland plant communities along the drainage. Hydrological processes originating outside the planning boundary, including water quality, quantity, and timing, must be managed to maintain site viability.

Protection Comments: This PCA consists of private land. Landowners have a conservation easement on the property.

Management Comments: Eradication of tamarisk and other non-native species. Efforts should be given to work with upstream water users to ensure spring flooding persists and thus encourages cottonwood regeneration.

Soils Description: Much of the floodplain is mapped as the Glenberg series, Coarse-loamy, mixed (calcareous), mesic, Ustic Torrifluvents. These soils mainly occur on floodplain along the Little Dolores River and are typically sandy loams (USDA 1978).

Restoration Potential: Tamarisk removal is needed at this site. Because tamarisk is known to release excessive amounts of salt to soils and that many areas have accumulated salts due to a lack of flooding, some areas may have to be treated for excess salts prior to revegetation efforts (Sala 1996). Any revegetation efforts should only use native wetland vegetation. Various methods exist to accomplish this, such as flooding the area with water that has a lower soluble salt content than the soil. This should be conducted in the winter months when plant uptake is minimal. Another treatment option is to amend the soils with gypsum to neutralize the affects of sodium. Although cottonwood regeneration appear to be occurring at this site, efforts should be given to work with upstream water users to ensure spring flooding persists and thus encourages cottonwood regeneration.

Wetland Functional Assessment for the Little Dolores River PCA:
Proposed HGM Class: Riverine Subclass: R4
Cowardin System: Palustrine
CNHP's Wetland Classification: *Populus deltoides* ssp. *wislizeni/Salix exigua*

Table 111. Wetland functional assessment for the riverine wetland at the Little Dolores River site.

Function	Ratings	Comments
Overall Functional Integrity	Below Potential	This wetland is functioning below potential mainly due to the dominance of non-native species. Altered hydrology from upstream water diversions is also contributing to altered functions.
Hydrological Functions		
Flood Attenuation and Storage	Moderate	The floodplain along this stretch of the Little Dolores River is vegetated with a high density of non-native shrubs (tamarisk), although some areas are sparse due to the presence of hay fields. Upstream water diversions, have altered hydrological patterns and thus have forced the river to incise portions of its channel.
Sediment/Shoreline Stabilization	Moderate	Most of the river banks are vegetated with shrubs, trees, and herbaceous species, however some areas have been heavily impacted by overgrazing, altered hydrology, and subsequent channel incision which decreases the ability to perform this function.
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	Disrupted	The presence of aerated water (the river) and a few areas of saturated soil (oxbows, sloughs) provide a gradient for various nutrient transformations. The abundance of tamarisk may also be altering nutrient cycles due to the excessive salts tamarisk contributes to the soil (Sala 1996). Altered hydrology has also altered nutrient cycles by eliminating normal flushing cycles and lack of deposition of organic material from floodwaters.
Removal of Imported Nutrients, Toxicants, and Sediments.	Moderate	Removal of excess nutrients and sediment (e.g. from upstream and local livestock and agricultural activity) is likely being performed, although excess salts in the soil (derived from tamarisk and lack of historical flooding) may be disrupting nutrient cycling processes. Toxicants and sediments from nearby roads are likely intercepted in the floodplain prior to reaching the river.
Biological Functions		
Habitat Diversity	Moderate	Forested and scrub-shrub wetlands exist in the area. Small emergent wetlands line the riverbank. Hay meadows and the prevalence of non-native species have decreased habitat diversity in many areas. Altered hydrological patterns limit habitat creation from fluvial processes.
General Wildlife Habitat	Moderate	This area provides browse and cover for deer, coyote, black bear, and other large and small mammals and cover, nesting habitat, and food for songbirds and birds or prey such as eagles, hawks, and falcons. Hay meadows and non-native

		species have eliminated some wildlife habitat.
General Fish/Aquatic Habitat	Low	The Little Dolores is an intermittent stream and thus provides little fish/aquatic habitat except on a seasonal basis. Altered hydrology and tamarisk may be affecting this function.
Production Export/Food Chain Support	Low	A lack of diversity of structural vegetation classes (e.g. herbaceous layer is minimal and monotonous tamarisk stands) and intermittent stream flow limit production export. This function is negatively affected by the dominance of non-native species such as tamarisk and lack of the historical flooding regime.
Uniqueness	Moderate	The Little Dolores River serves as an important corridor for wildlife. The surrounding landscape is arid and has abundant topographic relief, thus the presence of periodic water and riparian vegetation provides important habitat.

Figure 40. Little Dolores River Potential Conservation Area.

West Creek at Fall Creek Potential Conservation Area

Biodiversity Rank: B5. General biodiversity significance. This site supports an unranked breeding occurrence of a state imperiled (S2B) bird.

Protection Rank:P4. No protection actions are needed in the foreseeable future. Private land but no foreseeable threats are known.

Management Rank:M4. Current management seems to favor the persistence of the elements, but management actions may be needed in the future to maintain the current quality of the element occurrences. Maintain hydrology of marsh and current land use.

Location: This site is located along CO Hwy. 141 approximately 20 miles west of Whitewater.

U.S.G.S. 7.5-min. quadrangle Snyder Flats.
Legal Description: T14S R101W sec. 32;
T15S R101W sec. 4, 5.

Elevation: 6920-7400 ft. Size: Approxiamtely 352 acres

General Description: This is the only documented nesting site in Mesa County for the sandhill crane (*Grus canadensis tabida*). The owner of the site has observed a nesting pair here, in a cattail marsh surrounded by a hayfield, for at least five years (L. Renner, CDOW, personal communication).

Biodiversity Rank Justification: An unranked state rare (G5T4/S2) occurrence. This site is the only documented nesting site in Mesa County for the Greater Sandhill Crane. The rancher who owns the site has observed a nesting pair here, in a cattail marsh surrounded by a hayfield, for at least five years.

Table 112. Natural Heritage element occurrences at West Creek at Fall Creek PCA.
Elements in bold are those upon which the PCA's B-rank is based.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	EO* Rank
Birds					
Grus canadensis tabida	**Greater sandhill crane**	**G5T4**	**S2B, S4N**	**T**	**E**

*EO=Element Occurrence

Boundary Justification: The boundary encompasses the cattail marsh and surrounding hayfields, with a small buffer to protect the nesting birds from direct disturbance.

Protection Comments: Private land but no foreseeable threats are known.

Management Comments: Maintain hydrology supporting the marsh. Current land use appears to be compatible with the Greater Sandhill Cranes.

Soils Description: Soils are mapped as wet alluvium. The alluvial soils are deep and highly stratified and consist mainly of sandy loam or fine sandy loam (USDA 1978).

Restoration Potential: Ecological processes appear to be intact.

Wetland Functional Assessment: CNHP wetland ecologists did not visit this site during the 2001 field season. Thus, a functional assessment could not be conducted.

Figure 41. West Creek at Fall Creek Potential Conservation Area.

Highline Lake Site of Local Significance

Location: Highline Lake is located north of Loma.

U.S.G.S. 7.5-min. quadrangle Highline Lake.
Legal Description: T9S R102W sec. 7, 18;
T9S R103W sec. 11-14;
T2N R3W sec. 4, 5.

Elevation: 4700-4800 ft. Size: Approximately 917 acres

General Description: This site consists of Highline and Mack Mesa Reservoirs and their associated canals. The Audubon Society has identified this area as a Colorado Important Bird Area (National Audubon Society 2000). More than 200 species of birds, including waterfowl, shorebirds, neotropical songbirds, and raptors have been recorded here (Western Colorado Five River Wetland Focus Area Committee 2002). The area also serves as an important migratory refuge and holds numerous winter residents, including up to 10,000 duck at one time (Western Colorado Five River Wetland Focus Area Committee 2002).

Protection Comments: Most of the site is contained within the Highline Lake State Recreation Area. BLM lands also comprise a large percentage of the site while private lands occupy less.

Management Comments: The area is managed for recreation such as hunting and fishing and as a water supply.

Soils Description: Soils are not mapped by the Soil Survey of Mesa County.

Restoration Potential: The area is managed and does not perform self-sustaining natural functions. Water management results in the high wildlife value associated with this site. Thus, true restoration (returning the site to its ecological condition prior to disturbance) would likely decrease current wildlife values. Enhancement efforts could be directed to controlling non-native species around the reservoir (e.g. tamarisk).

Figure 42. Highline Lake Site of Local Significance.

Jerry Creek Reservoirs Site of Local Significance

Location: Jerry Creek Reservoirs are located near the confluence of Jerry Creek and Plateau Creek just west of Molina.

U.S.G.S. 7.5-min. quadrangle: Molina.
Legal Description: T10S R96W sec. 8-10, 15-17.

Elevation: 5250-5600 ft. Size: Approximately 989 acres

General Description: Two reservoirs are found at this site (notice that the map on the following page predates the reservoirs); #1 is 80 acres while #2 is 196 acres (Western Colorado Five River Wetland Focus Area Committee 2002). The reservoirs serve as the terminal storage pools of the Ute Water Conservancy District and supply much of the Grand Valley's domestic water (Western Colorado Five River Wetland Focus Area Committee 2002). Jerry Creek Res. #1 is one of the few regular Barrows Goldeneye (*Bucephala islandica*) wintering sites in Colorado and has winter populations of a dozen species of ducks during migration and winter seasons, although ice can limit populations during cold winters (Western Colorado Five River Wetland Focus Area Committee 2002). Jerry Creek Res. #2 typically has less species than #1, but rare species such as the Pacific Loon (*Gavia pacifica*) and Greater Scaup (*Athya marila*) are known to use the reservoir (Western Colorado Five River Wetland Focus Area Committee 2002). Bald (*Haliaeetus leucocephalus*) and Golden Eagles (*Aquila chrysaetos*) are regularly seen near the reservoirs. A small marsh exists between the two reservoirs and along Plateau Creek just downstream of the reservoirs. Species such as Virginia Rail (*Rallus limicola*), Common Snipe (*Gallinago gallinago*), Willow Flycatcher (*Empidonax traillii*), and corn snake (*Elaphe guttata*) have been observed in the marshes and riparian areas (Western Colorado Five River Wetland Focus Area Committee 2002).

Protection Comments: The site is owned by the Ute Water Conservancy District.

Management Comments: The area is managed as a water supply. No camping, open fires, pets, swimming, or boating are allowed in the area and the hike uphill to the reservoirs limits human use (Western Colorado Five River Wetland Focus Area Committee 2002).

Soils Description: Soils mapped by soil survey have been altered by inundation of the reservoirs.

Restoration Potential: The area is managed and does not perform self-sustaining natural functions. Water management results in the high wildlife value associated with this site. Thus, true restoration (returning the site to its ecological condition prior to disturbance) would likely decrease current wildlife values. Enhancement efforts could be directed to controlling non-native species around the reservoir.

Figure 43. Jerry Creek Reservoirs Site of Local Significance.

Natural History Information

Rare and Imperiled Plants Dependent on Wetlands of Mesa County

Southern Maidenhair Fern (*Adiantum capillis-veneris*) - G5S2
Status: USFS Sensitive Species
The delicate fronds of this small fern are pinnately compound with broad fan-shaped pinnules. The dark rachis (stem) is smooth and shiny. The fern is widespread in North America, known from British Colombia east to South Dakota and south to Texas, as well as from Missouri, Virginia and Florida (Welsh *et al.* 1993). In Colorado, its habitat is quite rare. It grows in seeps and hanging gardens, usually in sandstone. Other species that are often found in the same location include the yellow Mancos columbine (*Aquilegia micrantha*), Eastwood monkey-flower (*Mimulus eastwoodiae*), and helleborine orchid (*Epipactis gigantea*). There are a total of twelve documented occurrences in Colorado, from Las Animas, Mesa, Moffat, Montezuma, Montrose and Ouray counties. Only one location has been documented in this study area, in Dolores Canyon just north of the Montrose County line.

Arizona Centaury (*Centaurium arizonicum*) - G5?S1
Arizona centaury is known from just three locations in Colorado: one in Mesa County and two in Delta County. It is known from Arizona and New Mexico. It is a delicate, grass-like wetland plant with bright pink flowers. It grows with spike rushes and sedges. The plant is closely related to two other species of Centaurium, C. calycosum and C. exaltum.

Marsh Cinquefoil (*Comarum palustre*) - G5S1S2
Marsh cinquefoil is a species associated with high elevation peat bogs. A member of the rose family, it flowers in July and August. The species is circumboreal in distribution. It is known in Colorado from five counties: Mesa, Delta, Gunnison, Routt, and Jackson. This species is threatened by peat removal and other habitat alteration.

Giant Helleborine (*Epipactis gigantea*) - G3S2
Status: USFS Sensitive Species
Epipactis gigantea is one of the few orchids which grows in the desert. It is readily identified by its conspicuous greenish flowers with purple-brown markings. It grows along streambanks and near springs and seeps in the pinyon-juniper zone. Some common associates are scouring rush, horsetails, starry Solomonseal, Coyote willow, and skunkbush. Although the species is widespread in the southwestern region, its specific habitat requirements limit its numbers.

Kachina Daisy (*Erigeron kachinensis*) - G2S1
Status: BLM Sensitive Species
The Kachina Daisy was first discovered and named in Utah in 1968. The plant has been documented in Montrose County close to the Mesa County line but never in Mesa County. The daisy has a small, white flower head and dark green, shiny spatulate leaves grouped in large clumps. A Colorado Plateau endemic, it is known only from a few locations in southeastern Utah, and two in Montrose County. It is found in horizontal crevices of seeping alcoves in sandstone cliffs, often along with Mancos Columbine (*Aquilegia micrantha*). Research presently being conducted on the species may result in the Colorado populations being segregated into a separate variety from the Utah plants (Loreen Woolstenhulme, personal communication 1999). In this case, the variety will be even more rare, and in greater danger of extinction because of its rarity. Clusters of plants can most easily be seen near the Mesa/Montrose county line in the Dolores River Canyon.

Dolores Skeletonplant (*Lygodesmia doloresensis*) - G1QS1
Status: BLM Sensitive Species
Lygodesmia doloresensis is an attractive, pink-flowered member of the Asteraceae, or sunflower family. It is known only from Mesa and San Miguel counties. It occurs on the reddish alluvial soils on both sides of the Dolores River between Gateway and the Utah border. It has also been reported from the Dolores

Canyon south of Gateway, John Brown Canyon, Bar X Wash and Rabbit Valley. The collections from Bar X Wash and Rabbit Valley were small isolated occurrences outside the main population center, and warrant further taxonomic study. The San Miguel County occurrence is along the Dolores River. The plant is similar in appearance to the more common *Lygodesmia grandiflora*, but differs in the involucres having 5 or 6 principal bracts (not 8 or 9) per head, and in its very narrow leaves (Tomb 1980).

Eastwood Monkey-flower (*Mimulus eastwoodiae*) - G3S2
Status: BLM Sensitive Species
Eastwood monkey-flower has a bright crimson flower and sharply toothed leaves. It grows in hanging gardens with a year round moisture supply. The plants put down new roots from points where their stems contact the sandy soil, and thus often are found growing in a line in horizontal cracks of sandstone canyon walls. The tubular flowers bloom in late July to early September. The plants are frequently associated with the yellow Mancos columbine (*Aquilegia micrantha*) and the giant helleborine orchid (*Epipactis gigantea*). The species' global range includes Utah, Arizona and four counties in southwest Colorado: Mesa, Montrose, San Miguel and Delta (Spackman *et al.* 1997

Canyon Bog Orchid (*Platanthera sparsiflora* ssp. *ensifolia*) (or *Limnorchis ensifolia*) - G4G5T4?S3
The canyon bog orchid is a tall spike-like plant with small greenish flowers scattered along the stem, and tulip-like leaves. The genus is also classified by some botanists as *Habenaria* or *Platanthera.* It grows in moist or wet soil in mountain meadows, marshes, swamps, fens, open or dense forests, on stream banks and open seepage, 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. The combination of grazing and trampling by livestock in the mucky areas where the orchid grows may eradicate the plant

Rare and Imperiled Animals Dependent of Wetlands of Mesa County

Canyon Treefrog (*Hyla arenicolor*) - G5S2
Status: Colorado State Species of Special Concern, BLM Sensitive Species
The canyon tree frog inhabits rocky canyons along intermittent or permanent streams. The canyon treefrog has expanded paddle-like toe tips, and a light brown or gray back. These frogs are easily recognized by the suction like toe pads that assist in gripping and walking on canyon walls.

The canyon treefrog occurs from western Colorado and southern Utah south to central Mexico (Stebbins 1985). This desert frog reaches its northern limits in Southern Colorado. This species occurs in the canyonlands of the western slope and the Mesa de Maya region of the eastern plains (Hammerson 1999). Although primarily terrestrial, it breeds in canyon bottom pools surrounded by rock. It is usually found near permanent pools or cottonwoods in the pinyon-juniper zone. In spite of its name, the frogs do not climb trees. The adults feed on insects and spiders; larvae eat suspended organic matter in the pools. Most active at night, the frogs retreat to rock crevices in hot weather and during the cold season. They can sometimes be found during the day, resting in small depressions in solid rock near pools of water (Hammerson 1999). Threats to the treefrogs appear to be modest or localized. The primary factors justifying a conservation concern for canyon treefrogs are the small number of occurrences, restricted range and relatively low numbers (qualitative judgement) of individuals. There are no quantitative data on population size or trends.

Northern Leopard Frog (*Rana pipiens*) - G5S3
Status: Colorado Species of Special Concern, USFS and BLM Sensitive Species
The northern leopard frog occurs in a wide range of habitats throughout Colorado. However, some areas in Colorado have seen a decline in this species, especially those at high elevations. Part of the decline seems to be due to predation by the increasingly abundant bullfrog (*Rana catesbiana*), which is native to the eastern U. S., but introduced in Colorado. However, the leopard frog is also becoming uncommon in areas where bullfrogs are absent. The exact cause of the declines is unknown and needs further investigation (Hammerson 1999). The leopard frog inhabits springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes; usually in permanent water with rooted aquatic vegetation. In summer, the frog commonly occupies wet meadows and fields. Metamorphosed frogs eat various small invertebrates; larvae eat algae, plant tissue, organic debris, and probably some small invertebrates.

Great Basin Spadefoot Toad (*Scaphiopus intermontanus*) - G5S3
Status: Colorado Species of Special Concern, BLM Sensitive Species
The Great Basin spadefoot toad is found in a wide variety of habitats, from low elevation shrublands to spruce-fir forests, and from British Columbia to Northwestern Arizona. In Colorado, it frequents pinyon-juniper woodlands, sagebrush and semi-desert shrublands, usually in or near dry rocky slopes or canyons (Hammerson 1999). It may dig a burrow in loose soil, or use ready-made burrows of small mammals. It breeds in temporary or permanent water, including rain pools and flooded areas along streams. Adult toads eat insects, and larvae probably eat algae, organic debris and plant tissue.

Asio flammeus **(Short-Eared Owl)**

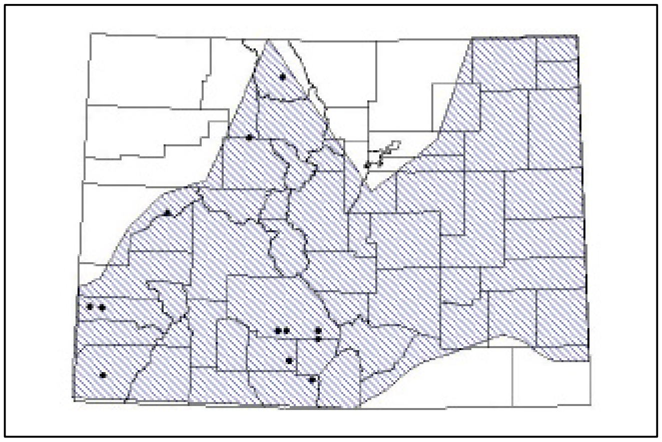
Taxonomy:
Class: Aves
Order: Strigiformes
Family: Tytonidae
Genus: *Asio*

Taxonomic Comments:

CNHP Ranking: G5 S2B, SZN

State/Federal Status:

Habitat Comments: The Short-eared Owl inhabits open fields, marshes, dunes, and grasslands (NGS 1987), as well as shrub-steppes and agricultural lands (Kingery 1998). They nest on the ground amid vegetation tall and dense enough to conceal the incubating female (Clark 1975).



Distribution: This owl's winter range extends from the southern one-third of the western U.S. across to the southern two-thirds of the eastern U.S. (CNHP 1997). In cooler parts of their range, including Colorado, they migrate seasonally, and Colorado hosts more of this species in the winter than in the summer (Kingery 1998).

Important Life History Characteristics: The Short-eared Owl nests and fledges their young between Late-May and Mid-June (Kingery 1998).

Known Threats and Management Issues: Loss of habitat due to more intensive agriculture and urbanization, including the greening of the formerly treeless Great Plains with shelterbelts and riparian forests may partly explain the apparent decline of Short-eared Owl populations in Colorado, especially near the Front Range (Kingery 1998). Nest predation may also increase when nest-destroying feral dogs and cats, foxes, and skunks proliferate with human settlement (Kingery 1998).

Barrow's Goldeneye (*Bucephala islandica*)

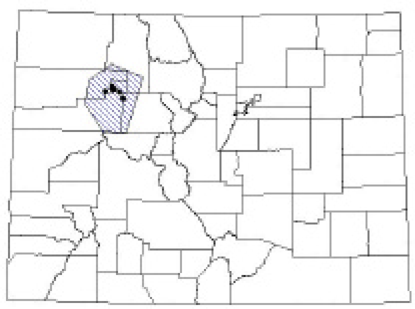
Taxonomy:
Class: Aves
Order: Anseriformes
Family: Anatidae
Genus: *Bucephala*

Taxonomic Comments: Subfamily Anatinae

CNHP Ranking: G5 S2B,SZN

State/Federal Status: Colorado Species of Special Concern, BLM Sensitive Species

Habitat Comments: Barrow's Goldeneyes are cavity nesters, and find nest holes among beetle-killed trees in the vicinity of montane lakes (Kingery 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 (KIngery 1998).

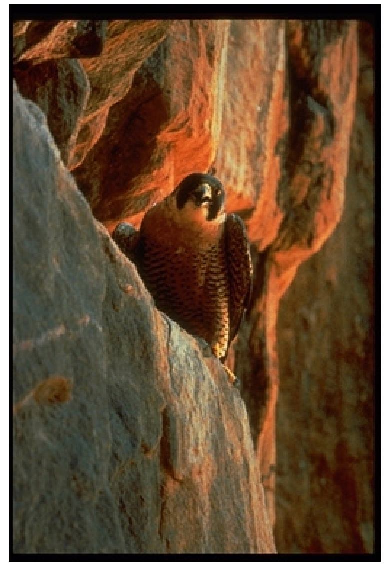
Important Life History Characteristics: Courtship begins in late May and fledged young are observed into late July (Kingery 1998). Barrow's goldeneye is a secondary cavity nester, and relies upon primary cavity nesters to excavate nest sites. This bird competes with fish for the aquatic invertebrate 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 (Kingery 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 (Kingery 1998).

Gunnison Sage Grouse (*Centrocercus minimus*) - G1 S1
Status: Colorado Species of Special Concern, BLM Sensitive Species
The Gunnison Sage Grouse is a small grouse, about two-thirds the size of Sage Grouse elsewhere. Their whiter, more distinct tail feathers, and more colorful filoplume feathers also distinguish the birds. Sage Grouse range across much of the Colorado and Columbia Plateaus. Colorado is in the southeastern portion of that range (Andrews and Righter 1992). In the 1980's researchers became aware that the Sage Grouse in the Gunnison Basin, Colorado, were distinct from Sage Grouse found elsewhere in most of the United States. The Gunnison species occurs south of the Colorado River from southeastern Utah east to the San Luis Valley. The total breeding population in Colorado includes approximately 5,000 individuals (Braun and Young 1995). However, specialized monitoring data in Colorado show that population numbers have been reduced, and that available habitat has become more fragmented and degraded, in part due to the application of fire and herbicides on sagebrush habitats (Braun *et al.* 1994). Additionally, pinyon-juniper woodlands encroaching upon sagebrush parks due to long-term fire suppression may be a significant factor contributing to the decline (Ron Lambeth personal communication). This species is ranked G1/S1 because populations and available habitat have been reduced in quantity and quality. Subsequently, the potential for large-scale impact with minimal disturbance is real. There are an estimated 15 to 20 occurrences in southwestern Colorado (Braun 1995). Populations of this species are currently limited to southwestern Colorado and southeastern Utah. The largest remaining population of over 2,000 birds is found in Gunnison County. Although the Sage Grouse historically occurred throughout approximately 15 counties in western Colorado, its entire historical range is unknown. It is presently restricted to one large, contiguous population in southern and central Gunnison and northeastern Saguache counties, and several much smaller populations sporadically located across Mesa, Montrose, Ouray, San Miguel, and Dolores counties (Braun *et al.* 1994).

Threats include habitat loss, fragmentation, and degradation of sagebrush lands by development, agriculture, and grazing. Populations have declined in some areas, apparently in response to widespread chaining, spraying, and burning of sagebrush-dominated rangeland to benefit livestock production (see Ritchie *et al.* 1994). Use of organophosphorus insecticides on agricultural lands adjacent to sagebrush resulted in grouse die-offs in southeastern Idaho (Blus 1989). Large-scale treatment of sagebrush lands with herbicide and fire has negatively impacted Sage Grouse habitat (Braun *et al.* 1994). Existing populations have become smaller and more fragmented. Protection of identified seasonal habitats (wintering, breeding, nesting and brooding) is important for continued existence of this species in Colorado.

American Peregrine Falcon (*Falco peregrinus anatum*)



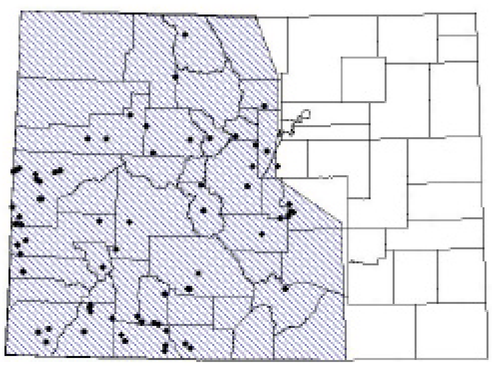
Taxonomy:
Class: Aves
Order: Falconiformes
Family: Falconidae
Genus: *Falco*

Taxonomic Comments: *Falco peregrinus anatum* refers to the populations of *F. peregrinus* that once ranged the continent and now occur across the western and interior portions of North America, while *F. p. pealei* and *F. p. tundrinus* refer to the northwest coastal and northern North American populations respectively.

CNHP Ranking: G4T3 S2B,SZN

State/Federal Status: Colorado Species of Special Concern

Habitat Comments: Peregrine falcons nest on foothill and mountain cliffs from 4,500 to over 9,000 feet in elevation (Rocky Mtn./SW Peregrine Recovery Team 1977). Pinyon/Juniper occurs in the vicinity of about half of all nest sites, and ponderosa pine at about one-quarter of the sites (Kingery 1998).



Distribution: *Falco peregrinus anatum* once ranged the entire continent, but is now restricted to the western part of the U.S. where it is a full-time resident (NGS 1987). The peregrine falcon breeds in several locations along Colorado's Front Range, but higher concentrations nest in the river valleys and canyons of the Western Slope, including the Dolores and Colorado River drainages and Dinosaur National Monument (Kingery 1998).

Important Life History Characteristics: Pairs defend a small area around the nest of about 100 yards. Females lay 3-4 eggs and the young remain in the nest for about 39-46 days after hatching (Kingery 1998).

Known Threats and Management Issues: Though breeding occurrence numbers appear stable to increasing, 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 species (CNHP 1997). Continued existence of Peregrine Falcons in Colorado is dependent upon protection of traditional nesting sites, identification and protection of critical habitat both for the breeding areas and for wintering, foraging, and roosting areas. Some additional relief to the peregrine's plight in Colorado can be provided by keeping the remaining nest sites free from human intrusions during nesting season and by ensuring that land use changes protect habitat that supports the peregrine's prey species.

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.

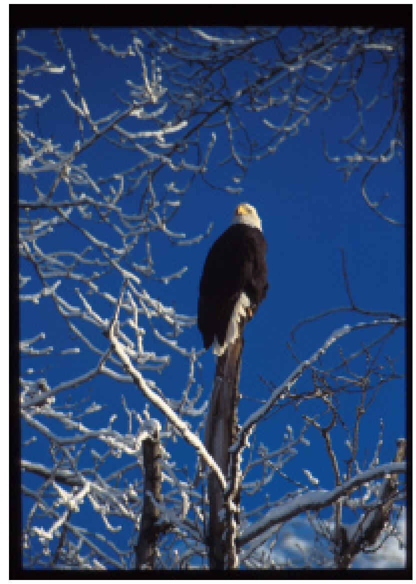
Habitat Comments: Along river valleys of the eastern plains, and valleys and parklands of the western mountains of Colorado

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.

Bald Eagle (*Haliaeetus leucocephalus*)



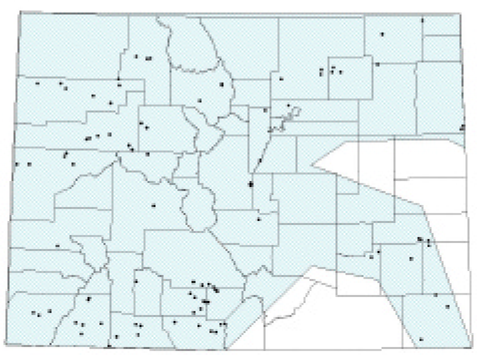
Taxonomy:
Class: Aves
Order: Falconiformes
Family: Accipitridae
Genus: *Haliaeetus*

Taxonomic Comments: none.

CNHP Ranking: G4 S1B,S3N

State/Federal Status: Federally Threatened, State 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 (KIngery 1998).

Important Life History Characteristics: Bald Eagles begin nesting in late February, and can often be observed feeding their young into late June (Kingery 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).

Flannelmouth Sucker (*Catostomus latipinnis*)

Taxonomy:
Class: Actinopterygii
Order: Cypriniformes
Family: Catostomidae
Genus: *Catostomus*

Taxonomic Comments:

CNHP Ranking: G3G4 S3

State/Federal Status: Colorado Species of Special Concern, BLM Sensitive Species

Habitat Comments: The flannelmouth sucker 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.

Humpback chub (*Gila cypha*) - G1S1
Status: Federally Endangered, State Threatened
The humpback chub was historically widely distributed throughout the Colorado River Basin to which it is endemic. Its habitat has been altered by the construction of dams, and today it is found in widely separated river areas in the upper and lower Colorado Basin. Not only is the species rare, but it is threatened by hybridization with the roundtail chub (*Gila robusta*). Reduced river flows allow the round tail chub to successfully inhabit some deep water areas during low water periods where humpback chubs were previously isolated, resulting in competition and hybridization. Intermediates between the species occur in altered river systems, but not in unaltered rivers, emphasizing the importance of natural riverine environments for the recovery of the species (Tyus and Karp 1989)

Colorado pikeminnow (*Ptychocheilus lucius*) - G1S1
Status: Federally Endangered, State Threatened
The Colorado pikeminnow was once an important food and commercial fish, living throughout the Colorado River drainage in mainstream channels, including the Green, Yampa, White, Colorado, Gunnison, Dolores, and Animas rivers. Its current distribution is restricted to the lower reaches of the these rivers, except the Dolores and Animas (Woodling 1985.) The decline of the fish is not fully understood. It is thought that dams have restricted spawning migrations, and that lowered water temperatures resulting from cold water releases prevent the development of fertilized eggs. Biotic interactions with other introduced fish species may also have impacted their decline (Woodling 1985). The young pikeminnow prefer small, quiet backwaters. Adults use various habitats, including deep, turbid, strongly flowing water, eddies, runs, flooded bottoms, or backwaters (especially during high flow). Lowlands inundated during spring high flow appear to be important habitats (Tyus and McAda 1984). Efforts for the recovery of the pikeminnow include reintroduction and the construction of fish ladders to facilitate their natural migration (Anderson, personal communication.)

Roundtail Chub (*Gila robusta*)

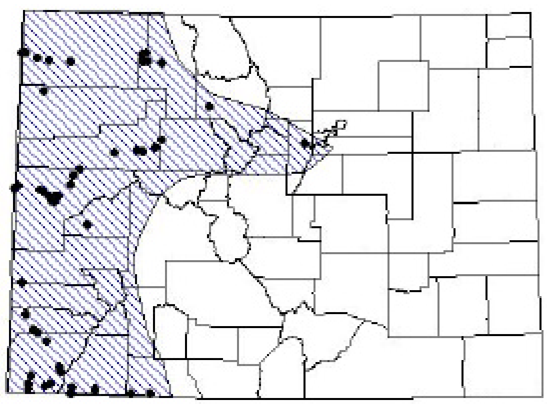
Taxonomy:
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae
Genus: *Gila*

Taxonomic Comments: Subclass Neopterygii

CNHP Ranking: G3 S2

State/Federal Status: Colorado Species of Special Concern, BLM Sensitive Species

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.

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: Threats include low water temperatures, attributed to cold water releases from dams, that may affect reproductive patterns (Woodling 1985; Vanicek and Kramer 1969), and interactions of watershed changes such as reductions in suitable habitat due to impoundment, channel downcutting, substrate sedimentation, water diversion, and groundwater pumping, and displacement through invasion of non-native predatory and competitive species (Hubbs 1954, Miller 1961, Minckley and Deacon 1968, Meffe 1985). The importance of retaining a natural flow regime in southwestern streams has been emphasized repeatedly (e.g., see Meffe and Minckley 1987).

Management needs include careful monitoring of existing populations and eliminating detrimental water and land use and exposure to non-native fishes. Large stream areas that incorporate diverse habitats (pools, riffles, runs, backwaters, adequate substrate, and current diversity) are especially important. Fish barriers (or enhancing natural barriers) can help protect populations not impacted by non-native species. Barrier design should not significantly alter stream flow and the potential impact on natural upstream and downstream movements of native fishes should be assessed.

Razorback Sucker (*Xyrauchen texanus*)

Taxonomy:
Class: Osteichthyes
Order: Cypriniformes
Family: Catostomidae
Genus: *Xyrauchen*

Taxonomic Comments:

CNHP Ranking: G1 S1

State/Federal Status: Federally Endangered, State Endangered

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 1989, 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.

Colorado River Cutthroat Trout (*Oncorhynchus clarki pleuriticus*)

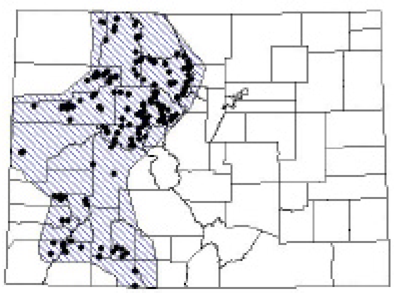
Taxonomy:
Class: Actinopterygii
Order: Salmoniformes
Family: Salmonidae
Genus: *Oncorhynchus*

Taxonomic Comments: Subclass - Neopterygii

CNHP Ranking: G4T3 S3

State/Federal Status: Colorado Species of Special Concern, USFS and BLM Sensitive Species

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, 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).

Sister (*Adelpha bredowi*) - G5S1?
This butterfly occupies moist lowland areas and forested riparian canyons. Males congregate in puddles and moist sandy patches along streams. Adults perch at the ends of branches to sun themselves. Its host plant in Mesa County is Gambel's oak. The only Mesa County record of the species is from Unaweep Seep.

Yuma Skipper *Ochlodes yuma* - G5 S2S3
This butterfly is a Great Basin endemic, and is distributed from northern Arizona and western Colorado, across southern Utah, Nevada, and into eastern California (Scott 1986). Colonies are usually small, rare, and strictly limited to stands of its host plant, the giant reed (Pyle 1989). In Colorado this butterfly is associated with natural wetlands and riparian habitat that is often subject to alteration, but irrigation may favor this species by the establishment of the giant reed. There are only four records of the Yuma skipper, three from Mesa and Delta counties in the late 1970's and early 1960's, and one from San Miguel County in 1999. The extent of its host plant along the Dolores River suggests this butterfly might have an extensive distribution along the river. The Yuma skipper is of conservation concern in the state because there are so few occurrences, small populations, colonial breeding, and its restriction to wetland habitats. Tamarisk invasion, common through its range, may threaten Yuma skipper habitat by displacing the giant reed (CNHP 1999). Protection of natural wetlands with stands of giant reeds will help to assure continued existence of this species in Colorado.

Nokomis fritillary (***Speyeria nokomis nokomis***)

Taxonomy:
Class: Insecta
Order: Lepidoptera
Family: Nymphalidae

Taxonomic Comments: There are six subspecies described for this species. The subspecies *S. n. nokomis* is found in Colorado and Utah.

CNHP Rank: G4T2S1

Distribution: Global range: The range for the Nokomis fritillary (*Speyeria nokomis*) includes Colorado, New Mexico, Arizona, Utah, Nevada, California and into Mexico (Ferris and Brown 1981). State range: Subspecies *S. n. nokomis* occurs in southwestern Colorado and eastern Utah.

Habitat Comments: Colonies of this fritillary are confined to mesic, protected areas in a generally desert landscape in southwestern Colorado and eastern Utah. Habitat is defined by the presence of permanent water, which is necessary to support healthy populations of its larval foodplant, the northern bog violet (*Viola nephrophylla*) and adult nectar sources, usually thistle (*Cirsium* spp.) or dogbane (*Apocynum* spp.) (Britten et al. 1994, Ferris and Brown 1981). These sites are characterized by wide, flat, seepy meadows along creeks occurring at the bases of cliffs, which often made up of sedimentary substrates. Vegetation is usually dominated by sedges (*Carex* spp.) and rushes (*Juncus* spp.), with patches of willow (*Salix* spp.).

Phenology: This butterfly is single-brooded, and adults may be observed from mid- to late-August through mid-September. The bright orange males will often be observed patrolling rapidly in the vicinity of the wetland in pursuit of females. Eggs are laid singly and haphazardly near the hostplant, often under the protection of shrubby vegetation, usually willow (*Salix* spp.) (Ferris and Brown 1981). The first instar larvae will hibernate over the winter. The larvae are nocturnal in their activity.

Food Comments: The larval hostplant is the northern bog violet (*Viola nephrophylla*). Adults will nectar on species of thistle (*Cirsium* spp.) and dogbane (*Apocynum* spp.).

Known Threats and Management Issues: The Nokomis fritllary is restricted to protected seeps and sloughs in primarily desert landscapes (Ferris and Brown 1981). Although population numbers among colonies can be variable, this species is very local, restricted in habitat and quite rare over the major portion of its range (Britten et al. 1994; Ferris and Brown 1981). These small and often isolated populations are exposed to a variety of demographic and environmental threats (Britten et al. 1994). The disappearance of some colonies has been due to conversion of habitat, either for agricultural use (hay meadows, stock ponds), water diversion projects (reservoirs, dams), or for recreational purposes (golf courses). Additionally, this species is very popular among collectors for trade and profit. Because of its colonial nature and habitat isolation, there exists the possibility of extirpation or a drop in colony numbers due to collecting pressures.

Abies lasiocarpa-Picea engelmannii/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*. 1985a), 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.* 1997), 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).

Acer negundo-Populus angustifolia/Celtis reticulata

boxelder-narrowleaf cottonwood/netleaf hackberry

Global Rank: G1Q
Global Rank Comments: This community is known from only one stand in Colorado. The Q in the rank indicates the taxonomy is tentative.
State Rank: S1Q
State Rank Comments: This community is known from only one stand in Colorado. The Q in the rank indicates the taxonomy is tentative.

General Description and Comments: The *Acer negundo-Populus angustifolia/Celtis reticulata* (boxelder-narrowleaf cottonwood/netleaf hackberry) plant association is a tall (12-25 ft., 4-8 m), multi-layered deciduous forest. It is a new type described from only one location on a seep in Unaweep Canyon in Mesa County. This forest occurs in a complex wetland with several other tentatively described woody and herbaceous plant associations. The forest occurs in dense patches around several small channels fed by the seep. Along these rivulets are communities of *Eleocharis palustris-Scirpus validus* (creeping spikerush-softstem bulrush) and *Eleocharis palustris-Phragmites australis* (creeping spikerush-common reed) wet meadows. The hillside seep drains into a fast moving creek with *Alnus incana/Eupatorium maculatum* (thinleaf alder/Joe-Pye weed)

Recognition/Classification 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 1996a). It can also occur on the Colorado western slope, along railroad lines and at homestead sites (Weber and Wittmann 1996b).

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is known from only one occurrence in Unaweep Canyon in Mesa County (Kittel and Lederer 1993).

Elevation Range: 5900 ft (1800 m).

Site Geomorphology: This plant association occurs on a hillside seep above a moderately wide valley. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are tiny rivulets draining a hillside seep. (Rosgen's Channel Type: unknown).

Soils: Soils are shallow silty clay loam and sandy loam.

Vegetation: This plant association is characterized by a deciduous tree canopy of 50% cover of *Celtis reticulata* (netleaf hackberry), 10% cover of *Populus angustifolia* (narrowleaf cottonwood) and scattered cover of *Acer negundo* (boxelder). The shrub understory includes 75% cover of *Clematis ligusticifolia* (white virgin's-bower), 25% cover each of *Rhus trilobata* (skunkbush) and the non-native *Rubus discolor* (Himalayan blackberry), and 15% cover of *Betula occidentalis* (water birch). The herbaceous undergrowth is dense, but dominated by non-native, weedy species (eg. *Melilotus officinalis* (sweet clover), *Taraxacum officinal* (dandelion), and *Nepeta cataria* (catnip).

Successional and Ecological Processes: This plant association appears similar to the *Acer negundo-Populus angustifolia/Cornus sericea* association, but the one known stand in Colorado does not occur on an alluvial floodplain. Seed deposition and establishment of the dominant canopy species in the *Acer negundo-Populus angustifolia/Celtis reticulata* association is not dependent on alluvial processes, but rather on wind.

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).

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. Any alteration of the seep hydrology may negatively affect this association. The forage production is high and palatable to livestock. Limited, short term grazing is best. Season long grazing allows non-native aggressive weeds to gain a foothold. No grazing for successive years resulted in an overgrowth of *Salix exigua* (coyote willow) and the reduction in a *Viola* sp. (violet), a known food source of a rare butterfly at the Unaweep Seep (Colorado Natural Heritage Program 1997).

Acer negundo/Equisetum hyemale

Box elder/scouring rush riparian shrubland

Global Rank: GUQ
Global Rank Comments: There is very little information about the global distribution of this plant association. The Q in the rank indicates the taxonomy is tentative.
State Rank: SUQ
State Rank Comments: This plant association is known from one location occur in Mesa County. The Q in the rank indicates the taxonomy is tentative.

General Description and Comments: There is very little information about this plant association. The narrow riparian area in the canyon bottom in which this association is found has scattered box elders (*Acer negundo*) that are regenerating. The stream bank has a dense growth of scouring rushes (*Equisetum* sp.), with hundreds of giant helleborine orchids (*Epipactis gigantea*) growing among them. Other riparian species include Baltic rush (*Juncus balticus*), skunkbrush (*Rhus trilobata*), coyote willow (*Salix exigua*), mountain willow (*S. monticola*), and cattails (*Typha* sp.).

Recognition/Classification 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 1996a). It can also occur on the Colorado western slope, along railroad lines and at homestead sites (Weber and Wittmann 1996b).

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is known from only one occurrence in Mee Canyon in Mesa County (Lyon et. al. 1996).

Elevation Range: 5900 ft (1800 m).

Site Geomorphology: This plant association occurs within a narrow sandstone canyon.

Soils: Not enough information.

Vegetation: This plant association is characterized by a deciduous tree canopy of cover of box elders (*Acer negundo*). The herbaceous undergrowth is a dense growth of scouring rushes (*Equisetum* sp.), with hundreds of giant helleborine orchids (*Epipactis gigantea*) growing among them. Other riparian species include Baltic rush (*Juncus balticus*), skunkbrush (*Rhus trilobata*), coyote willow (*Salix exigua*), mountain willow (*S. monticola*), and cattails (*Typha* sp.).

Successional and Ecological Processes: 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).

Management: Because the regeneration and establishment of new stands of *Acer negundo* (boxelder) are dependent upon flooding events, any alterations to the natural flow regime of a river can affect the ecosystem. The forage production is high and palatable to livestock. Limited, short term grazing is best. Season long grazing allows non-native aggressive weeds to gain a foothold.

Alnus incana ssp. tenuifolia-Cornus sericea
thinleaf alder-red-osier dogwood

Global Rank: G3Q
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 1998). 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).

Alnus incana/Mesic forbs

thinleaf alder/Mesic Forbs

Global Rank: G3G4Q
Global Rank Comments: This plant association was once common and widespread, but is now declining. This association is rarely found in good condition without non-native species in the undergrowth. Because this community can change significantly with improper grazing, this plant association may not be recognized as the same type across state lines, and thus the taxonomy is in question (a Q in the rank).
State Rank: S3
State Rank Comments: There are over 30 documented occurrences of this plant association in Colorado. However, non are very large and only one or two are in pristine condition. All stands are highly threatened by improper livestock grazing, stream flow alterations, road and railroad improvements and maintenance and heavy recreational use.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia*/mesic forb (thinleaf alder/mesic forb) plant association is characterized by stands of medium-tall, deciduous shrubs and a thick herbaceous undergrowth of forbs and wetland-indicator grasses. A low canopy of shorter shrubs may also be present with *Ribes* (currant) and *Salix* (willow) species and *Cornus sericea* (red-osier dogwood). Undisturbed stands have abundant forbs and native grasses. Stands disturbed by season-long livestock grazing have reduced forb cover and an increase in non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop). Large, 22,500 sq. ft (>100 m^2), stands with the native herbaceous undergrowth intact are uncommon.

Regional Distribution: This plant association occurs in Oregon (Kovalchik 1987), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Montana (Hansen *et al*. 1995), Idaho, Wyoming (Youngblood *et al.* 1985a, Jones 1992), and Colorado (Cooper and Cottrell 1990, Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs throughout the Rocky Mountains of Colorado (Cooper and Cottrell 1990, Johnston 1987, Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Kettler and McMullen 1996, Richard *et al.* 1996, Kittel *et al*. 1999, Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6400-9600 ft (2000-2900 m).

Site Geomorphology: This plant association occurs along narrow, 130-230 feet (40-70 m) wide, alluvial benches and terraces of canyons and valleys. It also occurs as narrow bands in wider valleys, >400 feet (>120 m), and occasionally forms a wide band on the floodplain. Stream channels were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are highly variable. They can be steep (3-12%) gradient and narrow (Rosgen's Channel Type: A3, A4, A6, G4) or wider, rocky, and moderately sinuous (Rosgen's Channel Type: B2, B3, B4, B5). Occasionally, stream channels are low gradient and highly sinuous (Rosgen's Channel Type: C3, C4), narrow and highly sinuous (Rosgen's Channel Type: E3), or braided (Rosgen's Channel Type: D5).

Soils: Soils are well drained silt loams, loams, sandy clay loams, sandy loams, or just sand. Some profiles have a high percentage of organic matter and are either skeletal or stratified with skeletal layers. Some profiles have significant silt fractions in the upper layers. Soils in the Colorado River Basin, classify as sandy oxyaquic Cryumbrepts, loamy typic Cryorthents, fragmental (calcareous) Cryaquents and loamy over sandy typic Cryoboralfs.

Vegetation: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) creates a dense, tall (15-25 feet) shrub canopy with 20-95% cover. Other shrubs can be present, although no single species is consistently so. Shrub species include: *Salix drummondiana* (Drummond willow) (1-20%), Rosa woodsia (woods rose) (1-70%), *Salix monticola* (mountain willow) (1-10%), *Salix lasiandra* var. *caudata* (whiplash willow) (1-32%), *Lonicera involucrata* (honeysuckle) (1-30%), *Ribes inerme* (current) (1-30%), *Salix geyeriana* (Geyer willow) (1-30%), *Salix bebbiana* (Bebb willow) (1-11%), and *Ribes montegeum* (gooseberry currant) (2-31%). A few trees may be present along the edges of the stand including *Picea engelmannii* (Engelmann spruce) (1-13%), *Populus tremuloides* (quaking aspen) (1-20%), and *Populus angustifolia* (narrowleaf cottonwood) (8-21%).

The ground is generally very wet and covered with tall, 3-7 feet (1-2 m), forbs and graminoids. Forb cover is high in undisturbed stands, with total cover often exceeding 60%. Dominant forb species include *Heracleum maximum* (cow parsnip) (1-70%), *Angelica ampla* (giant angelica) (3-45% cover), *Aconitum columbianum* (monk's hood) (1-14% cover), *Mertensia ciliata* (mountain bluebells) (1-19% cover) and *Rudbeckia laciniata* (cutleaf coneflower) (3-20% cover), *Viola canadensis* (Canada violet) (1-7%), and *Streptopus amplexifolius* (twisted stalk) (1-10%). Graminoid species include *Glyceria* striata (mannagrass) (1-11%), *Calamagrostis canadensis* (bluejoint reedgrass) (1-20%), *Carex utriculata* (beaked sedge) (1-6%), and *Carex microptera* (small-wing sedge) (1-10%). A dense cover of up to 30% *Equisetum arvense* (field horsetail) and up to 10% cover each of *Equisetum pratense* (meadow horsetail) and *Hippochaete hyemalis* (scouring rush) may also be present.

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 the amount deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer 1998). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

Management: The *Alnus incana* ssp. *tenuifolia/*mesic forb (thinleaf alder/mesic forb) plant association is a relatively long-lived and stable community, but can change in response to the impacts of improper livestock grazing. Dense stands of *Alnus incana* (thinleaf alder) may hinder livestock access. *Alnus incana* (thinleaf alder) is not particularly palatable to livestock, but can be trampled as animals search for more palatable forb species (Hansen *et al*. 1995). Season-long grazing reduces the native forb cover and allows non-native grasses to increase. This may convert the site to an *Alnus incana*/mesic graminoid (thinleaf alder/mesic grasses) community. With rotation and rest, this type may be reverted back to the *Alnus incana* ssp. *tenuifolia*/mesic forb plant association (Padgett *et al.* 1989, Hansen *et al.* 1995).

In addition, if the herbaceous undergrowth of the *Alnus incana/*mesic forb plant association is dominated by non-native, weedy species, the stand may be a product of improper grazing. If the undergrowth is dominated by native forbs, the site is near potential.

Most fires kill *Alnus incana* (thinleaf alder) dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death. *Alnus incana* ssp. *tenuifolia* sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings 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).

Alnus incana ssp. *tenuifolia*-Mixed *Salix* species
thinleaf alder-mixed willow species

Global Rank: G3
Global Rank Comments: This association is widespread in Colorado. It is expected to occur in other Rocky Mountain states.
State Rank: S3
State Rank Comments: This association is known from throughout the western slope and in the mountains of the Front Range.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia*/mixed *Salix* species (thinleaf alder/mixed willow species) plant association is a more general type than other *Alnus incana* types. It has a high diversity of associated shrub species, unlike the nearly pure stands of alder found in other *Alnus incana* ssp. *tenuifolia* dominated plant associations. The abundance of other shrubs may represent a transition in the physical setting, for example, from a broad floodplain dominated by *Salix* to a narrow valley bottom and channel lined with only *Alnus incana* (alder*)*.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Yampa (Kittel and Lederer 1993), White, Colorado (Kittel *et al*. 1994), Gunnison (Kittel *et al*. 1995), and Rio Grande and Closed Basin Watersheds (Kittel *et al*. 1999), and the San Juan National Forest (Richard *et al*. 1996).

Elevation Range in Colorado: 7200-8900 ft. (2200-2700 m).

Site Geomorphology: This association occurs along narrow, moderately steep streams (10-20 meters wide with a gradient of 3-10%) and in moderately wide to wide river valleys on cobble point bars, islands, flat alluvial benches, and large alluvial floodplains. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3), moderately steep and wide (Rosgen's Channel Type: B3, B4, B6), or wide and sinuous (Rosgen's Channel Type: C3, C4).

Soils: Soils are poorly developed with loamy sands, sand, sandy loams, and silt loams over coarse alluvium.

Vegetation: This plant association is characterized by the dominance of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) with 15-100% cover. There is considerable variation of associated shrub species the stands. Several willow species are often present, but no single willow species consistently occurred in all stands. Shrubs other than *Alnus incana* ssp. *tenuifolia* occurred with less than 50% frequency, and include *Salix monticola* (mountain willow) (1-41%), *Salix lasiandra* var. *lasiandra* (longleaf willow) (3-24% cover), *Salix drummondiana* (Drummond willow) (1-40% cover), *Salix bebbiana* (Bebb willow) (3-39% cover), *Salix exigua* (coyote willow) (1-39% cover), *Salix lasiandra* var. *caudata* (whiplash willow) (3-50% cover), *Acer glabrum* (Rocky Mountain maple) (1%), *Salix geyeriana* (Geyer willow) and *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (3-40%) , and *Amelanchier alnifolia* (serviceberry) (1% cover).

Tree cover is sparse, but can include *Picea pungens* (Colorado blue spruce) (1%), *Populus tremuloides* (quaking aspen) (5%), and *Populus angustifolia* (narrowleaf cottonwood) (3-11), and *Picea engelmannii* (Engelmann spruce) (10%).

The herbaceous undergrowth is varied with 10-90% total cover. Herbaceous species include: *Taraxacum officinale* (dandelion) (1-20%), *Poa pratensis* (Kentucky bluegrass) (1-70%), *Equisetum arvense* (scouring rush) (1-30%), *Heracleum maximum* (1-21%) (cow parsley), *Rudbeckia laciniata* var. *ampla* (cone flower) (3-40%), *Mertensia ciliata* (chiming bells)(1-19%), *Calamagrostis canadensis* (Canadian reedgrass) (3-

20%), *Cardamine cordifolia* (1-19%) (bitter cress), *Carex utriculata* (1-10%) beaked sedge, and *Trifolium repens* (1-27%) (sweet clover).

Successional and Ecological Processes: *Alnus incana* (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).

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 the amount deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer 1998). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) or conifers (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).

In Colorado, the *Alnus incana*-mixed *Salix* species plant association may represent response to recent changes in the environment. Several stands occur on abandoned beaver dams, for example. This shift in the physical environment may explain the diverse mix of shrub species in the canopy. If the water table lowers, this plant association may succeed to a more stable, drier communities such as *Salix geyeriana* (Geyer willow) or *Populus tremuloides* (quaking aspen) associations. Other stands appear to be disturbed by livestock grazing and may represent a grazing-induced stage of the *Alnus incana* ssp. *tenuifolia/*mesic forb plant association.

Management: Dense stands of *Alnus incana* (thinleaf alder) hinder livestock access. *Alnus incana* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species (Hansen *et al*. 1995). Most *Salix* (willow) species are highly palatable to livestock, large mammals, and beaver. Open stands may provide moderate forage and shade in the summer (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. *Alnus incana* (alder) sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings 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).

Alnus incana* ssp. *tenuifolia-Salix drummondiana
thinleaf alder-Drummond willow

Global Rank: G3
Global Rank Comments: This plant association has only been documented from Colorado.
State Rank: S3
State Rank Comments: This is small, but widespread plant association. It is highly threatened by improper livestock grazing and stream impoundments.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia-Salix drummondiana* (thinleaf alder-Drummond willow) is a common plant association. The association is generally found along steep-gradient streams with stable, shaded stream banks.

Regional Distribution: This plant association has not been documented outside of Colorado. It is expected to occur in other Rocky Mountain States (Colorado Natural Heritage Program 1998).

Distribution in Colorado: This association occurs in the Gunnison and Arkansas River Basins and the San Juan and Rio Grande National Forests (Kittel *et al*. 1995, Colorado Natural Heritage Program 1998, Richard *et al*. 1996, Kittel *et al*. 1999).

Elevation Range in Colorado: 7300-9700 ft. (2200-3000m).

Site Geomorphology: This association occurs along very steep, fast-moving streams in sheer-walled, confined canyons. It also occurs along or within the active channel of moderately to slightly entrenched channels in wider valleys. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and rocky (Rosgen's Channel Type: A1, A2), less steep with limited floodplains and gravel and cobble bottoms (Rosgen's Channel Type: B3, B4), or wide and sinuous (Rosgen's Channel Type: C3, C4).

Soils: Soils of this association are highly variable, but most are stratified alluvium with buried A horizons. Stands with a rich, herbaceous undergrowth have a thick layer, 5-10 inches (10-30 cm), of fine sandy loam and sandy clay loam over a coarse alluvial deposit. Stands with little shrub cover and herbaceous growth have coarse, skeletal soils without an accumulated fine layer at the surface.

Vegetation: This plant association is characterized by a dense, closed canopy of 10-100% cover of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and 10-60% cover of *Salix drummondiana* (Drummond willow) bordering the stream. Other shrubs occasionally present (in order of decreasing frequency) include: *Salix monticola* (yellow willow) (63% freq., 1-43% cover), *Lonicera involucrata* (honeysuckle) (63% freq., 1-20% cover), *Ribes inerme* (whitestem gooseberry) (31% freq., 1-10% cover), *Cornus sericea* (red osier dogwood) (25% freq., 1-10% cover), *Rosa woodsii* (woods rose) (25% freq., 1-3% cover), *Amelanchier utahensis* (serviceberry) (25% freq., 1-2% cover), *Acer glabrum* (Rocky Mountain maple) (19% freq., 1-16% cover), *Symphoricarpos rotundifolius* (snowberry) (19% freq., 1-11% cover), *Salix boothii* (13% freq., 3-10% cover), *Ribes montigenum* (current) (13% freq., 4-6% cover), *Salix exigua* (coyote willow) (13% freq., 1-6% cover), *Salix lasiandra* var. *caudata* (whiplash willow) (13% freq., 5% cover), and *Salix geyeriana* (Geyer willow) (6% freq., 3% cover).

Some stands have a rich herbaceous understory that includes *Oxypolis fendleri* (cowbane) (1-14% cover), *Heracleum maximum* (cow parsnip) (3-20% cover), *Equisetum pratense* (meadow horsetail)(1-30% cover), *Mertensia ciliata* (chiming bells) (1-12% cover), *Rudbeckia laciniata* (cutleaf coneflower) (1-10%), and *Angelica ampla* (angelica) (10%). In some stands, the herbaceous undergrowth is sparse (<10% cover) where heavy shading and coarse substrates from recent flood scouring limit herbaceous growth. In one degraded stand, *Agrostis stolonifera* (red-top) occurred with 30% cover.

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 the amount deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer 1998). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

The *Alnus incana* ssp. *tenuifolia-Salix drummondiana* (thinleaf alder-Drummond willow) plant association is an early to midseral community restricted to stream margins, rarely forming large, extensive stands. Both species are prolific seed producers and are the first to colonize coarse-textured cobble bars and recently scoured alluvial surfaces. When young, these shrubs are flexible, can tolerate most flood events, and readily resprout. With time, *Salix drummondiana* may become more abundant by taking advantage of the nitrogen-rich soils associated with *Alnus incana* ssp. *tenuifolia* (Kittel *et al*. 1995).

Management: Dense stands of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) hinder livestock access. *Alnus incana* ssp. *tenuifolia* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species (Hansen *et al*. 1995). *Salix drummondiana* (Drummond willow) is highly palatable to livestock, large mammals, and beaver (Kovalchik *et al*. 1988). Open stands may provide moderate forage and shade in the summer (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 (Hansen *et al.* 1995). *Alnus incana* (alder) sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings 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).

Aquilegia micrantha - Mimulus eastwoodiae
Columbine - Eastwood Monkeyflower Hanging Garden

Global Rank: G2G3
Global Rank Comments: This is a locally endemic plant association best represented in the sandstone canyons of the Colorado River drainage in the Colorado Plateau ecoregion.
State Rank: S2S3
State Rank Comments: This is a locally endemic plant association in Colorado.

General Description and Comments: This plant association is found in seeps at the base of the Wingate sandstone formation just above contact with the underlying Chinle formation in Colorado. The seeps are often under overhanging cliffs or emerge from a vertical sandstone face. Mancos columbine (*Aquileiga micrantha*) is typically abundant while Eastwood monkeyflower (*Mimulus eastwoodiae*) is less so.

From Welsh 1989: Hanging gardens in the Colorado Plateau ecoregion are surrounded by an arid environment and associated with canyon country. Scattered on the sandstone canyon walls are moist places clothed in green. Annual precipitation is low and varies from 5 to 14 inches. While mean annual temperatures are high. Extreme temperatures are probably more important than means to the survival of plants. Summer temperatures greater than 100 degrees Fahrenheit are common.

In general, the hanging gardens are the result of the ancient swales or valleys in a sand dune-swale system that developed between the Cretaceous and Pennsylvanian periods (65-310 mya). Massive sandstones seem to be best suited for alcove development coincidental with garden formation, some better than others. The formations with greatest development are the Navajo and Entrada, both of them cross-bedded, massive formations composed of wind-blown sand and contain ancient pond bottoms that serve as impervious bedding planes. Wingate Formation lacks significant hanging gardens. The sands of formations suitable for hanging garden development were deposited mainly on lands, as dunes with interdunal valleys. The interdunal valleys were often the sites of lakes, whose bottoms were made impervious by accumulations of dust and other fine particles. Turned to stone, the ancient lake and pond basins continue to exist within the strata. Water percolating through the porous rock encounters the ancient bedding planes, still impervious and capable of holding water. When filled to overflowing, these bedding planes carry the water downward to the next bedding plane beneath or to another impervious stratum at the base of the formation. Joint systems within the rock act as passageways for water. Where the joint systems are exposed along canyon walls the water flows over the moist surfaces.

Three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems.

Complexity of the plant community within a hanging garden is a function of quantity and quality of water, developmental aspects, and accessibility of plant species to it. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. They vary in size, aspect, exposure to the elements, water quantity and quality, number of bedding planes, and amount of light received.

Water quality, in some degree, controls the kinds of plants in hanging gardens. Quality of water is dictated by the nature of the formations through which the water passes. Water is often drinkable quality, however, water may be saline or laden with calcium, which results in tufa deposits in the gardens. Generally, however, water from the gardens is potable.

Regional Distribution: Hanging gardens are best represented in the sandstone canyons of the Colorado River drainage in the Colorado Plateau ecoregion (Welsh 1989). The adjacent Utah High Plateaus ecoregion has a hanging garden system but it is generally associated with shale rather than sandstone cliffs. The Utah High Plateaus hanging gardens has its own suite of endemic species.

Distribution in Colorado: This association has been documented in Delta, San Miguel, Montrose, and Mesa counties in Colorado (Colorado Natural Heritage Program 2002).

Elevation Range in Colorado: 5200-6200 ft.

Site Geomorphology: This plant association occurs on seeping sandstone walls and alcoves.

Soil: Soil development at these seeps is minimal as this association is found in near vertical positions. Soil develop does occur at the base of these seeps and springs.

Vegetation: This plant association is typically characterized by an abundance of Mancos columbine (*Aquileiga micrantha*) while Eastwood monkeyflower (*Mimulus eastwoodiae*) is mostly, but not always present. Other species found in these seeps include the southern maidenhair fern (*Adiantum capillus-veneris*), giant helleborine orchid (*Epipactis gigantea*), and occassionally the globally imperiled (G2) Kachina daisy (*Erigeron kachinensis*). Species growing at the base of these seeps, where soil development can occur include *Cirsium calcareum*, *Calamagrostis scopulorum*, *Phragmites australis*, *Aster laevis*, and *Muhlenbergia andina*.

From Welsh 1989: The vegetation may overlap with the nearby riparian vegetation, but there are a series of species that are unique to hanging gardens. Several species of algae are restricted to these hanging gardens. The classic alcove type of hanging garden in the Canyonlands of southeastern Utah consists of an overhanging back wall, a vaulted face wall, a detrital slope, and a plunge basin. The back and face walls support clinging plants of maidenhair fern (*Adiantum capillus-veneris*, *Primula specuilcola, Mimulus eastwoodiae,, Petrophytum caespitosum* , and several other species. The wet, sandy detritus supports *Carex aurea*, *Aquilegia micrantha*, *Calamagrostis scopulorum, Epipactis gigantean*, *Perityle specuicola*, *Panicum acuminatum, Cirsium rydgbergii,* and *Zigadenus vaginatus*. A fringing margin *Cercis occidentalis, Celtis reticulata,* and *Quercus gambelii* often occurs outward from the foot slope where the plants tend to conceal the alcove base. The outer and drier edges support grasses typical of the prairies and plains of the western U.S.

Terrace and windowblind gardens have a similar floristic composition, however, unless there is at least some alcove development, the typical garden species are lacking or occur in reduced numbers.

Variation in hanging garden vegetation varies from canyon to canyon as well as separate alcoves within a canyon. The vegetation of hanging gardens generally have some common species that are found at most of the hanging gardens, e.g., *Smilicina stellatum*, *Adiantum capillus-veneris, Adiantum pedatum,* and *Mimulus* spp. But numerous endemics occur of which may be represented by just one or two sites.

The following species are endemic to hanging gardens of the Colorado Plateau ecoregion *Aquilegia micrantha, Carex curatorum, Cirsium rydbergii, Erigeron kachensis* (one occurrence outside of hanging gardens in the Abajo Mts.)*, Erigeron sionis, E. zothecinus, Habenaria zothecina, Mimulus eastwoodiae, Perityle specuicola),* and *Primula specuicola.*

Successional and Ecological Processes: Ground water quality and quantity as well as natural erosion are the primary processes the effect hanging gardens.

Glen canyon was named by John Wesley Powell in 1869 because of the numerous hanging gardens throughout the sandstone canyon. Flooding of Glen Canyon reduced the number of hanging gardens. It is suggested that all alcoves along Glen canyon whether now vegetated or not, are the result of previous hanging garden and wet bedding plane interaction.

Water in the gardens is utilized by animals of many kins. And, since the water supply of the gardens is more or less independent of the climatic regime of the region, plant growth in them is independent of current annual rainfall. Because of the productivity of the gardens, several species of small desert mammals survive in them during periods of drought. Canyon tree frogs and red-spotted toads congregate in the plunge basins.

Management: This association typically occurs in areas too steep or inaccessible to be affect by most management activities. Management should focus on control of non-native species such as tamarisk (*Tamarix ramsissima*) and maintenance of groundwater recharge.

Hanging gardens are very sensitive to alteration of quality and quantity of ground water, direct trampling, and introduced species. Glen Canyon dam, have flooded numerous hanging gardens. Although reservoirs are the number one source of eliminating hanging gardens, direct trampling and dumping can be seen at easily accessible occurrences. Non-native species are also a serious threat.

Betula occidentalis/Cornus sericea
river birch/red-osier dogwood

Global Rank: G3?
Global Rank Comments: This association is well documented in the western states.
State Rank: S1S2
State Rank Comments: In Colorado, five 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: Stands of this association are known from floodplains of streams at low elevations (4730-6020 feet), on loam or clay soils. In stands of this association, *Betula occidentalis* dominates a tall-shrub layer. *Cornus sericea* often codominates the tall-shrub layer with *Betula occidentalis*, but it may be shorter and it may contribute less cover. Scattered *Populus angustifolia* often are present, but the trees contribute little cover (<10%). A number of other shrubs and trees may be present. Because it commonly occurs in small, difficult to sample patches, it is not well sampled.

Regional Distribution: This water birch shrubland is found in floodplains of the western United States, ranging sporadically from Wyoming and South Dakota west to Washington, south to California, and east to Utah.

Distribution in Colorado: This community is documented in Mesa and Douglas counties but expected to occur widely throughout Colorado.

Elevation Range in Colorado: 6000-7900 ft (1800-2400 m).

Site Geomorphology: This stand occurs as small patches within floodplains.

Soils: In Utah, soils supporting stands of this association classify mainly as Cryoborolls and Haploborolls, with some Cryaquents, Udifluvents, and Xerofluvents. Stands also occur on Cryaquepts.

Vegetation: The tall-shrub layer is dominated by *Betula occidentalis*. *Cornus sericea* often codominates the tall-shrub layer with *Betula occidentalis*, but it may be shorter and it may contribute less cover. Scattered *Populus angustifolia* often are present, but the trees contribute little cover (<10%). A number of other shrubs and trees may be present (Evans 1989, Hansen et al. 1988, Padgett et al. 1989, 1989a, Youngblood et al. 1985b, Marriott and Faber-Langendoen 2000).

Successional and Ecological Processes:

Management: Due to the dense shrub cover, stands of this plant association may hinder livestock access. *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 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.

Soils: 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).

Carex pellita
woolly sedge

Global Rank: G3
Global Rank Comments: This community is documented from Oregon east to South Dakota and Montana south to Colorado and Kansas.
State Rank: S3
State Rank Comments: In Colorado, this community has increased in abundance along regulated rivers on the Western Slope and may have decreased in abundance on streams on the eastern plains. Few, pristine high quality stands are known, and no stands are formally protected.

General Description and Comments: *Carex pellita* (woolly sedge) is a distinctive wetland-indicator sedge that forms small- to medium sized meadows. It occurs in depressions and swales at the saturated edge of stream channels or in standing water. On the eastern plains of Colorado, it can occur under the canopy of cottonwood trees, forming the *Populus deltoides* ssp. *monilifera/Carex pellita* (plains

Regional Distribution: This plant association occurs in North and South Dakota, Nebraska, Kansas, Montana (Hansen *et al*. 1988, Hansen *et al*. 1991), Oregon, Utah, Idaho, and Colorado (Kovalchik 1987, Bourgeron and Engelking 1994, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is documented from the Gunnison (Kittel *et al*. 1995), South Platte (Kittel *et al*. 1996, Kittel *et al*. 1997), and Rio Grande River Basins (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5000-7400 ft (1500-2300 m).

Site Geomorphology: This plant association occurs in very wet conditions, generally at the saturated edge of the stream channel or in standing water. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are sinuous with a moderate gradient (Rosgen's Channel Type: C4, C6).

Soils: Soils are deep silt loams to clays. Mottling often occurs throughout the profile.

Vegetation: This plant association is characterized by a nearly monotypic stand of 40-90% cover of *Carex pellita* (woolly sedge). Other graminoid cover is minor, but includes *Phalaris arundinacea* (reed canarygrass) (10%), *Carex nebrascensis* (Nebraska sedge) (2%), *Schoenoplectus pungens* (threesquare bulrush) (1%), *Equisetum arvense* (field horsetail) (1%), *Equisetum hyemale* (scouring horsetail) and *Poa pratensis* (Kentucky bluegrass) (8%). Scattered forbs include *Mentha arvense* (field mint) (8-13%), and *Cirsium arvense* (Canadian thistle) (4%).

Successional and Ecological Processes: The *Carex pellita* (woolly sedge) plant association appears to be a fairly stable community because of its strongly rhizomatous roots and well developed soils (Padgett *et al.* 1989). In Montana, the *Carex pellita* plant association can be associated with large amounts of *Carex lasiocarpa* (slender sedge). With season-long grazing, *Carex pellita* decreases in abundance, shifting dominance towards Poa pratensis (Kentucky bluegrass). In Colorado, stands of *Carex pellita* that occur on stream banks with a consistent water table depth and heavy, cohesive clay soils, appear stable and long-lived as long as the water table remains at current levels.

Management: *Carex pellita* (woolly sedge) is highly palatable to most livestock when young. Overuse of this plant association may result in the increase of *Poa pratensis* (Kentucky bluegrass) and compaction of saturated soils. Periods of rest from livestock grazing are necessary in order to maintain the vigor of this association. Due to its long, creeping rhizomes, *Carex pellita* is an effective stream bank stabilizer and is resistant to fire damage (Hansen *et al.* 1988).

Cornus sericea
red-osier dogwood

Global Rank: G4Q
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).

Soils: 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).

Eleocharis palustris
creeping spikerush

Global Rank: G5
Global Rank Comments: This association is known throughout the western states.
State Rank: S4
State Rank Comments: This association is a common, if small, component of many streams in Colorado.

General Description and Comments: The *Eleocharis palustris* (creeping spikerush) plant association is a conspicuous, common emergent association that occurs in shallow, mostly still water. Most of the sites where it occurs experience water levels that fluctuate to some degree throughout the growing season. It is recognized by the clear dominance, although sometimes sparse cover, of *Eleocharis palustris*.

Regional Distribution: The *Eleocharis palustris* (creeping spikerush) plant association occurs in Oregon (Kovalchik 1987), Idaho, Wyoming (Youngblood *et al.* 1985a), Montana (Hansen *et al.* 1995), Utah (Padgett *et al.* 1989), New Mexico (Durkin *et al.* 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: The *Eleocharis palustris* plant association is common throughout the state and is documented to occur in the Yampa and San Miguel River Basins (Kittel and Lederer 1993), Routt and San Juan National Forests (Kettler and McMullen 1996, Richard *et al.* 1996), near Crested Butte (Cooper 1993), in the Rio Grande and Closed Basins (Cooper and Severn 1992, Colorado Natural Heritage Program 1997), and on the eastern plains in the Arkansas River Basin (Colorado Natural Heritage Program 1998).

Elevation Range in Colorado: 4600-11,400 ft (1400-3500 m).

Site Geomorphology: This association occurs on wet sand bars and on finer substrates in backwater areas within the stream channel at low elevations. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association usually occurs along narrow, sinuous (Rosgen's Channel Type: E3, E4, E6) headwater rivulets where ground water flow is lateral, primarily fed from toe slope seeps.

Soils: High elevation stands consistently occur on organic (highly sapric) soils, or on a thick organic horizon that overlays fine to coarse alluvial material. Lower elevation stands occur on fresh alluvial deposits of fine-textured loamy sands, clays, clay loams, and sandy clays. Two samples from the Arikaree River had considerable organic content in the upper 4-8 in. (10-20 cm). Soils from four plots on San Juan National Forest classified as Cumulic and Histic Cryaquolls.

Vegetation: This community can be very sparse (<5% total vegetative cover) to quite dense (90%), but *Eleocharis palustris* (creeping spikerush) always the dominant species (10-90%), and the only species with 100% constancy. Because the *Eleocharis palustris* plant association occurs within a wide elevational range, the species composition can be quite variable, but this community is easy to recognized by its single, low herbaceous canopy cover of bright green, nearly pure stands of *Eleocharis palustris* (spikerush). Other species, when present, can contribute as much as 40% cover, but never exceed that of the *Eleocharis palustris* cover.

On the western slope in low elevation stands, co-occurring species can include: *Phalaroides arundinacea* (common reed) (10%), *Juncus balticus* (mountain rush)(1%) and *Schoenoplectus pungens* (threesquare bulrush) (1-5%) as well as the introduced *Melilotus officinale* (sweet clover) and *Bromus inermis* (smooth brome). Forb cover may include: *Sparganium angustifolium* (narrowleaf bur-reed)(1%), *Lemna* spp. (duckweed) and *Potamogeton* spp. (pondweed) (1-3%).

On the eastern plains, co-occurring species can include: *Leersia oryzoides* (rice cutgrass) (15-40%), *Schoenoplectus pungens* (threesquare bulrush) (20-30%), *Panicum virgatum* (switchgrass) (10-15%), *Carex pellita* (woolly sedge) (10%), and *Spartina pectinata* (prairie cordgrass) (10%)

At higher, montane elevations other graminoids present include: *Carex aquatilis* (water sedge) (10-30%), *Carex utriculata* (beaked sedge) (1-5%), and *Deschampsia cespitosa* (tufted hairgrass) (1%). Forb cover is typically low, but can be occasionally abundant (30%) in some stands. Common forb species include: *Pedicularis groenlandica* (elephant head) (3%), *Rhodiola integrifolia* (king's crown), and *Caltha leptosepala* (marsh marigold) (3-20%).

Successional and Ecological Processes: At lower elevations the *Eleocharis palustris* plant association occurs well within the active channel and is inundated annually. This early seral community colonizes backwater eddies and shallow edges of slow moving reaches of small and larger rivers. It is probably an ephemeral community, scoured out each year during high spring flows. This association has been described as an early seral stage by Padgett *et al.* (1989). They describe light colored soils for the sites, indicating an early phase of soil development. At montane elevations, this association occurs in ponded sites on faster moving streams. If siltation occurs, sites may become dominated by *Carex utriculata* (beaked sedge). At higher elevations, this association appears to be stable. It occurs near seeps on soils with deep organic layers, often sapric, and saturated throughout the growing season.

Management: The low palatability of *Eleocharis palustris* and seasonally wet soils limit the grazing value of this type for livestock (Hansen *et al.* 1995).

Eleocharis rostellata
beaked spikesedge

Global Rank: G2G3
Global Rank Comments:
State Rank: S2S3
State Rank Comments:

General Description and Comments: This association is uncommon and localized to calcareous wet meadows, seeps and stream margins, often associated with mineral springs.

Regional Distribution: The *Eleocharis rostellata* (beaked spikesedge) association is uncommon and localized to southwest South Dakota and southwest Nebraska (Larson 1993), Mammoth Hot Springs, Wyoming (Chadde et al. 1988), and Escalante Canyon, Colorado (Colorado Natural Heritage Program 1999).

Distribution in Colorado: This plant association occurs in Escalante Canyon (Colorado Natural Heritage Program 1999). Examples of this community type can be found in the Escalate Wetland PCA.

Elevation Range: 6,200 ft (1,890 m).

Site Geomorphology: This association is found on calcareous wet meadows, seeps and stream margins, often associated with mineral springs (Larson 1993).

Soils: Substrates are composed of travertine and *Chara* deposits. A thin (5 cm) layer of undecomposed *Eleocharis* stems covers much of the substrate surface. This type is located in perennially flowing warm water. Electrical conductivity is also high (Chadde et al. 1988).

Vegetation: Species diversity of this type is low. In addition to *Eleocharis rostellata, Schoenoplectus acutus, Aster eatonii,* and *Polypogon monspeliensis* may be present in small amounts. A dense layer of algae is also typically found overlying the travertine substrate (Chadde et al. 1988).

Management:

Forestiera pubescens
wild privet

Global Rank: G1G2
Global Rank Comments: This association occurs in Colorado and is expected to occur in New Mexico and Arizona.
State Rank: S1S2
State Rank Comments: In Colorado, this association is known only to occur along the Dolores and San Miguel Rivers. It is threatened by inappropriate stream flow alterations.

General Description and Comments: The *Forestiera pubescens* (wild privet) plant association is a medium tall (3-5 ft., 1-1.5 m) shrubland, often occurs as dense thickets. It grows at the interface between the riparian area and the adjacent upland in desert areas of the southwest.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs along the San Miguel and Dolores Rivers in southwestern Colorado (Kittel and Lederer 1993, Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5500 ft. (1650 m).

Site Geomorphology: This plant association forms a narrow, but continuous, band about 10 feet (3 meters) above the channel on streambanks and natural levees. It occurs on the outer edge of the active floodplain. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The stream channel is wide and very sinuous (Rosgen's Channel Type: C5).

Soils: Soils are deep silty clays over clay loam and sandy loam.

Vegetation: This plant association is characterized by a shrub layer with 25-80% cover of *Forestiera pubescens* (wild privet) and 5-40% cover of *Rhus trilobata* (skunkbush). *Salix exigua* (coyote willow) may overlap from adjacent stands (<1% cover) and *Artemesia tridentata* (big sagebrush) may be present in the stands at the upland edge of the community with 10-25% cover. Forb and graminoid cover is low, with *Bromus tectorum* (cheat grass) (1-3%), *Artemisia ludoviciana* (Louisiana wormwood) (1%), and *Glycyrrhiza lepidota* (wild licorice) (1%)
.
Successional and Ecological Processes: This appears to be a flood-tolerant plant association located along stream margins. *Forestiera pubescens* (wild privet) usually occupies slightly drier ground than *Salix exigua* (coyote willow). More research is needed to determine the establishment conditions, long-term stability, and ecology of this unique plant association.

Management: Livestock grazing is limited in this plant association due to the dense shrub cover. *Forestiera pubescens* is not very palatable to livestock. The fruit is eaten by fox and coyote (Welsh *et al.* 1987).

Phragmites australis
common reed

Global Rank: G5
Global Rank Comments: This association is widespread and its considered a weedy invader of wetlands in the eastern United States.
State Rank: S3
State Rank Comments: The *Phragmites australis* plant association was once thought to be widespread throughout western Colorado. Now, it occurs only in small, isolated patches where water has become impounded, such as adjacent to raised railroad beds, irrigation ditches, oxbow lakes, and other low-lying swampy areas. It is threatened by stream flow alterations, road building and maintenance.

General Description and Comments: The *Phragmites australis* (common reed) plant association is a tall (3-5 ft., 1-1.5 m) reed community often growing is small wet patches in seeps and backwater areas of large floodplains, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage.

Regional Distribution: This plant association occurs in Montana (Hansen *et al*. 1995), Nebraska (Johnston 1987) and Colorado (Baker 1982, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs on the western slope in the White and Colorado River Basins (Baker 1982, Kittel *et al*. 1995) and on the eastern plains in the Arkansas River Basin (Colorado Natural Heritage Program 1998).

Elevation Range in Colorado: 3900-6500 ft. (1200-1980 m).

Site Geomorphology: This plant association occurs in seeps, along irrigation ditches and outflows, and in oxbow lakes.

Soils: Soils are deep silty clay loams and sands, often with rich mottling at the level of the fluctuating water table. Soils in the Colorado River Basin classified as coarse-loamy, calcareous typic Cryaquents.

Vegetation: This vegetation is characterized by tall (5-8 feet) grasses in small pockets and stands in marshes and wetlands on broad floodplains. *Phragmites australis* (common reed) is the dominant and diagnostic species, canopy cover ranges from 65-80%. While stands appear to be pure, monotypic stands of the reed, there are almost always a few other, if highly variable species present. For example, *Salix exigua* (coyote willow) with 1% cover, *Conyza canadensis* (horse weed) with 15% cover, or *Apocynum androsaemifolium* (creeping milkweed) with 1% cover.

Successional and Ecological Processes: *Phragmites australis* generally requires seasonal flooding in the spring (Johnston 1987). This species has strong rhizomes that allow it to out compete all but the most aggressive weedy species. With heavy disturbance, however, exotic species such as *Cirsium arvense* (Canada thistle) may invade this plant association (Hansen *et al*. 1995).

Management: *Phragmites australis* (common reed) is highly palatable to livestock and wildlife, especially when the plants are young and growing vigorously. *Phragmites australis* is moderately tolerant of grazing. However, heavy grazing pressure may reduce the size and extent of stands (Hansen *et al*. 1995).

Phragmites australis can be an effective stream bank stabilizer due to its rhizomatous growth. The rhizomes hold and stabilize the bank while above ground vegetation traps and filters sediments (Hansen *et al*. 1995).

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.* 1986, Bourgeron and Tuhy 1989), western Wyoming (Youngblood *et al.* 1985a), 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.* 1986, 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).

Soils: 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* (Colorado 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/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 recreational use.

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*-conifer 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).

Soils: 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* (strapleaf 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: S3
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.* 1985a), 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).

Soils: 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-Picea pungens/Alnus incana
narrowleaf cottonwood-Colorado blue spruce/thinleaf alder

Global Rank: G4
Global Rank Comments: This is an abundant (>100 stands) community in Colorado and is likely to occur in other Rocky Mountain states.
State Rank: S4
State Rank Comments: This is a common community of montane valleys. However, only a handful of good condition stands are known, and it is highly threatened by improper livestock grazing, heavy recreational use, and stream flow alterations.

General Description and Comments: This is a common mixed deciduous-evergreen plant association with *Populus angustifolia* (narrowleaf cottonwood) and *Picea pungens* (Colorado blue spruce) co-dominant along a stream reach. Frequently, other conifer trees are present, but not as abundant as *Picea pungens* (Colorado blue spruce). The shrub understory is typically dense and diverse. *Alnus incana* is nearly always present.

Recognition and Classification Problems: Both *Populus angustifolia* and mixed *Populus angustifolia*-conifer plant associations are in the classification. The criteria for identifying a *Populus angustifolia-Picea pungens* plant association is that both species have at least 10% cover. More often than not, the *Populus angustifolia* can be twice as abundant as the *Picea pungens*.

Regional Distribution: This plant association is reported only from Colorado, however closely related communities occur in Wyoming, New Mexico (Johnston 1987) and Utah (Padgett *et al.* 1989).

Distribution in Colorado: This plant association occurs in the Yampa, White, Colorado, Gunnison, and San Miguel River Basins and the Uncompahgre, San Juan and Rio Grande National Forests (Johnston 1987, Hess and Wasser 1982, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Komarkova 1986, Richard *et al*. 1996, and Kittel *et al*. 1999). It is also likely to occur along the Colorado Front Range.

Elevation Range in Colorado: 7300-9000 ft. (2200-2700 m).

Site Geomorphology: This association occurs in valleys with narrow to moderately wide floodplains, 30-600 feet (10-200 m), and in deep canyons. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association is commonly found on slightly meandering to meandering floodplains of broad reaches (Rosgen's Channel Type: B2-B5, C2-C4). Occasionally, stands occur along steep reaches (Rosgen's Channel Type: A2, A3).

Soils: Soils range from shallow sandy loams to silty clay loams and clays over cobbles and boulders. Profiles are generally highly stratified, with layers of fine soils over layers of coarser sediments. In the White and Colorado River Basins, the soils classify as loamy-skeletal, calcareous aquic typic Cryochrepts. Stands on the San Juan National Forest had soils that classified as Cumulic Haploborolls, Aquic udifluvents, Aquic Cryofluents, and Fluvaquentic Dystrochrepts.

Vegetation: The upper canopy is dominated by 5-95% cover of *Populus angustifolia* (narrowleaf cottonwood) and either *Picea pungens* (Colorado blue spruce) with 1-74% cover, or *Picea engelmannii* (Engelmann spruce) with 2-37% cover. Other less frequently encountered (<50% frequency) tree species may also be present and include: *Pseudotsuga menziesii* (Douglas-fir) (1-20% cover), *Abies concolor* (white fir) (1-10%), *Populus tremuloides* (quaking aspen) (3-10% cover), and *Abies lasiocarpa* (subalpine fir (10% cover).

The shrub canopy layer consists of varying amounts (3-90% cover) of *Alnus incana* (thinleaf alder), but it is always present. *Lonicera involucrata* (honeysuckle) is the most frequently encountered species after *Alnus*, it is present in nearly 70% of all sampled stands, with 1-40% cover. Many other shrub species can occur within this association, however they occur in less than 30% of the sampled stands, and can appear very abundant. These shrub species include: *Amelanchier alnifolia* (serviceberry) (1-15% cover), *Acer* *glabrum* (mountain maple) (1-10% cover), *Salix drummondiana* (Drummond willow) (3-10% cover), *Salix exigua* (coyote willow) (3-20%), *Salix lasiandra* var. *caudata* (whiplash willow) (10-30%), *Salix geyeriana* (Geyer willow) (30%), *Salix boothii* (Booth willow) (30%), *Prunus virginiana* (chokecherry) (10-30%), and *Symphoricarpos rotundifolius* (snowberry) (1-30%).

The undergrowth is diverse and can be sparse or thick, depending on local conditions. Total herbaceous cover rarely exceeds 40%. *Maianthemum stellatum* (false Solomon seal) (1-40%), and *Geranium richardsonii* (Richardson geranium) (1-30%) occur in more than 50% of sampled stands. Other forb species that occur in less than 40% of sampled stands include: *Osmorhiza depauperata* (blunt-fruit sweet-cicely) (1-20%), *Heracleum sphondylium* (cow parsley) (1-11%), *Rudbeckia laciniata* (cone flower) (1-30%), *Viola canadensis* (Canadian violet) (1-10%), *Fragaria virginiana* (wild strawberry) (1-20%). *Ligusticum porteri* (osha) (1-10%), *Erigeron* spp. (fleabane) (1-18%), *Solidago gigantea* (golden rod) (10-30%), *Sorbus scopulina* (mountain ash) 10%), and *Pyrola americana* (wintergreen) (20%).

Graminoid cover is less diverse than forb cover. Species include *Poa pratensis* (Kentucky bluegrass) (1-20%), *Equisetum hymale* (scouring rush) (1-20%), *Elymus canadensis* (Canadian wild rye) (1-10%), *Carex praegracilis* (clustered field sedge) (20%), *Carex utriculata* (beaked sedge) (10%), *Carex nebraskensis* (Nebraska sedge) (10%), and *Calamagrostis stricta* (slender reed grass) (10%).

Successional and Ecological Processes: This mixed deciduous-evergreen plant association is a mid-seral community. With continued fluvial activity, such as flooding, channel migration, sediment deposition, and scouring, narrowleaf cottonwood and blue spruce will continue to co-occur along the reach. Gradual and slightly sinuous stream channels that have overbank flow and sediment deposition favor establishment of *Populus angustifolia*. *Picea pungens* is favored along reaches in deep valleys with steep canyon walls that provide conditions for strong cold-air drainage. If the floodplain is no longer active, *i.e.,* is no longer flooded because the stream channel has become lower (surface becomes a terrace) or upstream dams control floods, then cottonwoods will eventually die and the conifers may persist.

Some authors suggest mixed riparian stands will eventually become dominated by conifer species (see Padgett *et al*. 1989, Hansen *et al.* 1995). In Colorado, observations indicate that with continued fluvial processes, cottonwoods will continue to persist on the stream banks and floodplain. The presence of conifer species on an active floodplain is not necessarily an indication of future “climax” dominance

Management: 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.

Forage productivity for this plant association can be high and very palatable to livestock. Cottonwood seedlings and saplings and the associated shrub species 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. This plant association also provides excellent hiding and thermal cover for mammals and birds (Hansen *et al.* 1995).

Populus angustifolia-Pseudotsuga menziesi
narrowleaf cottonwood-Douglas-fir

Global Rank: G3
Global Rank Comments: This association is reported from Utah, Nevada and Colorado. It is threatened by improper livestock grazing, stream flow alterations, and heavy
State Rank: S2
State Rank Comments: This association naturally occurs in small stands and is highly threatened by development, stream flow alterations and improper livestock grazing.

General Descriptions and Comments: The *Populus angustifolia-Pseudotsuga menziesii* (narrowleaf cottonwood-Douglas-fir) plant association is limited to narrow canyon bottoms and V-shaped valleys where a northern or protected aspect creates cool micro-

Regional Distribution: This plant association is reported from Colorado (Kittel *et al.* 1996, Walford 1993, Johnston 1987). Closely related, if not synonymous, communities also occur in Nevada (Manning and Padgett 1995) and Utah (Padgett *et al*. 1989).

Distribution in Colorado: This plant association occurs in the San Juan National Forest and in parts of the upper Arkansas River Basin. It is expected to occur in narrow foothill canyons of the Colorado Front Range (Richard *et al.* 1996, Kittel *et al.* 1996).

Elevation Range in Colorado: 6600-8700 ft. (2000-2700 m).

Site Geomorphology: This plant association occurs along small streams in narrow canyons and V-shaped valleys with limited floodplain development. The association grows in wash bottoms and on immediate stream banks, cobble bars, and terraces. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow with streambeds of bedrock, sand, or silt (Rosgen's Channel Type: A1-A5). This association also occurs on slightly meandering floodplains of broad reaches with coarse channel bed material (Rosgen's Channel Type: B2, B3).

Soils: The soils are derived from alluvial and colluvial deposits and are fairly shallow, 10-30 inches (25-75 cm) thick. The soils become skeletal with depth. Surface layers are sandy loams, clay loams, and loams. Subsurface layers are sandy loams with 10-30% cobbles and gravels. Organic matter from accumulated litter is concentrated in the upper layers.

Vegetation: The upper canopy of this plant association is dominated by 10-40% cover of *Pseudotsuga menziesii* (Douglas-fir) and 10-60% cover of *Populus angustifolia* (narrowleaf cottonwood). The mix of these two species as mature trees in the overstory canopy is the diagnostic characteristic for this plant association. Other tree species that may also be present include: *Juniperus scopulorum* (Rocky Mountain juniper) (70% frequency, 3-20% cover) or *Abies concolor* (white fir) (22% frequency, 5-8% cover). Several other conifer tree species may be present, but with less than 1% cover.

Shrub cover is typically low, however it is highly variable and diverse. No single species was present in all stands sampled. Shrub species include: *Acer glabrum* (Rocky Mountain maple) (67% frequency, 1-18% cover), *Salix exigua* (coyote willow) (44% frequency, 2-11% cover), *Betula occidentalis* (river birch) (22% frequency, 20-40% cover), *Alnus incana* (thinleaf alder) (22% frequency, 4-37% cover), *Quercus gambelii* (Gambel oak) (22% frequency, 10-25% cover), *Salix lucida* ssp. *caudata* (Pacific willow) (11% frequency, 10% cover), *Clematis ligusticifolia* (virgin's bower) (33% frequency, 5-17% cover), and *Ribes cereum* (wax currant) (33% frequency, 1-14% cover).

The herbaceous undergrowth can be sparse and is usually limited by heavy shade and dry soil conditions. Herbaceous species include: *Poa pratensis* (Kentucky bluegrass) (present in all sampled stands, cover 1-13%), *Taraxacum officinale* (dandelion) (78% frequency, 1-4% cover), *Achillea millefolium* (yarrow) (76% frequency, 1% cover), *Trifolium repens* (sweet clover) (33% frequency, 5-15% cover), and *Agrostis stolonifera* (redtop) (56% frequency, 1-6% cover).

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.

Pseudotsuga menziesii (Douglas-fir) is a non-obligate riparian species and in Colorado riparian communities dominated by this species are uncommon. The *Populus angustifolia-Pseudotsuga menziesii* plant association is composed of mature trees, appears to be late-seral and limited to narrow canyon bottoms where upland *Pseudotsuga menziesii* forests grade into the riparian corridor or invade late successional terraces. Narrow canyons with steep slopes create pockets of moist, cool air by funneling cold-air downwards and providing a microsite for *Pseudotsuga menziesii*. Well-drained colluvial soils favor *Pseudotsuga menziesii* establishment.

Along broader, meandering rivers, *Pseudotsuga menziesii* can occur on upper terraces with stands of *Populus angustifolia*. These stands likely represent a drier occurrence of a *Populus angustifolia* community where *Pseudotsuga menziesii* is not an indicator of riparian condition. However, at lower elevations and in narrow valleys with cold air drainage, *Pseudotsuga menziesii*, co-dominating with *Populus angustifolia* on stream banks and floodplains, represents a perpetual riparian community

Management: 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.

Forage productivity for this plant association can be high and very palatable to livestock. Cottonwood seedlings and saplings and many of the associated shrub species of this association are frequently browsed by cattle. However, the thick shrub cover may limit livestock use (Padgett *et al.*1989). Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage (Hansen *et al.* 1988, Hansen *et al*. 1995). 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. This plant association also provides excellent hiding and thermal cover for mammals and birds (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 (Hansen *et al.* 1995).

Populus angustifolia/Salix eriocephala* var. *ligulifolia-Shepherdia argentea
narrowleaf cottonwood/strapleaf willow-silver buffaloberry

Global Rank: G1
Global Rank Comments: This is an extremely limited plant association known only from southwestern Colorado. Historically, it was more widespread and common in broad river valleys (Baker 1986). Overutilization by livestock and alterations in the river flow regime
State Rank: S1
State Rank Comments: This association is known only from a few fragmented stands in south western Colorado. No large, unaltered stands are left. Remaining stands are highly threatened by improper livestock grazing, heavy recreational use, stream flow alterations, and improvements and maintenance of roads and railroads.

General Description and Comments: *Populus angustifolia/Salix eriocephala* var. *ligulifolia-Shepherdia argentea* (narrowleaf cottonwood/strapleaf willow-silver buffaloberry) is an extremely limited plant association in western Colorado. Historically, it was more widespread and common in broad river valleys. Over-utilization by livestock and alterations in the river flow regime have caused a decline in its distribution.

Regional Distribution: This plant association is only known to occur in western Colorado (Baker 1984, Baker 1989, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Gunnison and Colorado River Basins and the San Juan National Forest (Baker 1984, Baker 1989, Kittel *et al.* 1994, Kittel *et al.* 1995, and Richard *et al.* 1996).

Elevation Range in Colorado: 6000-7100 ft. (1800-2200 m).

Site Geomorphology: This plant association occurs in narrow to broad, 1000 feet (300 m) wide, alluvial valleys. Mature stands occur on terraces up to 10 feet (2.5 m) above the active channel. Mature stands spread out across wide floodplains, but also occur on narrow floodplains of constricted reaches. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and sinuous with low to moderate gradients (1-5%) (Rosgen's Channel Type: C3).

Soils: The soils are slightly to highly effervescent, deep, sandy loams that become increasingly skeletal with depth. In the Colorado River Basin, the soils classify as typic Cryopsamments.

Vegetation: This plant association is characterized by an overstory canopy of *Populus angustifolia* (narrowleaf cottonwood) and the presence and abundance of *Shepherdia argentea* (silver buffalo berry). The tree canopy consists of mature *Populus angustifolia* (narrowleaf cottonwood) (10-30%), with seeding and sapling sized *Populus angustifolia* (narrowleaf cottonwood) (3-40% cover) that can occur in bands close to rivers edge. Other trees that may be present include: *Pinus edulis* (pinyon pine) (3%) and *Populus* x *acuminata* (lance leaf cottonwood) (6%).

The shrub layer is diverse and widely spaced. *Shepherdia argentea* (silver buffalo berry) (20-59%) is the key characteristic shrub for this association. Low abundance may indicate a degraded occurrence. The presence of *Salix eriocephala* var. *ligulifolia* (strapleaf willow, formally known as *Salix ligulifolia*) is not required for a stand to key into this type (it was present in only 1 sampled stand, with 10% cover). *Rhus trilobata* (skunkbush) is present in all sampled stands with 1-40% cover. Other shrub species that may be present (75% frequency or less) include: *Alnus incana* (thinleaf alder) (1-22%), *Cornus sericea* (red-osier dogwood) (1-3%), *Rosa woodsii* (woods rose) (1-28%), *Crataegus rivularis* (river hawthorne) (10%), *Quercus gambelii* (Gamble oak) (10%), *Salix exigua* (coyote willow) (1%), *Salix irrorata* (blue-stem willow) (28%), and *Betula occidentalis* (river birch) (2%).

The herbaceous undergrowth is typically dominated by introduced hay grasses including: *Agrostis stolonifera* (redtop) (20%), *Poa pratensis* (Kentucky bluegrass) (1-10%), and *Dactylis glomerata* (orchard grass) (3%). A few native species also occur, including: *Maianthemum stellatum* (false Solomon seal))(1-3%), *Equisetum arvense* (field scouring rush) (1-3%), *Glycyrrhiza lepidota* (wild licorice) (1-3%), *Thlaspi montanum* (pennycress) (10%), and *Pascopyron smithii* (western wheat grass) (3%).

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.

The predominance of a non-native grasses in the undergrowth and widely spaced shrubs indicate heavy utilization by cattle. No undisturbed stands of the *Populus angustifolia/ Salix eriocephala* var. *ligulifolia-Shepherdia argentea* (narrowleaf cottonwood/strapleaf willow-silver buffaloberry) plant association are known in Colorado.

Management: All known occurrences of the *Populus angustifolia/Salix eriocephala var. ligulifolia-Shepherdia argentea* plant association are heavily degraded by improper grazing and/or altered hydrology. Further research is needed to determine the amount, frequency, and duration of spring floods and late-season draw-down rates to provide for riparian forest regeneration and maintenance. 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 can be high and very palatable to livestock. Cottonwood and willow 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 angustifolia/Salix exigua
narrowleaf cottonwood/coyote willow

Global Rank: G4
Global Rank Comments: This is a common, early-seral stage of most *Populus angustifolia* dominated associations. It occurs in New Mexico and Colorado, and is expected to occur in Wyoming and Montana.
State Rank: S4
State Rank Comments: This association is widespread with >100 estimated stands. It is an important indicator of fluvial process and riparian health. It is an early-seral stage of other *Populus angustifolia* communities, many of which are imperiled or vulnerable. Many streams and rivers support this stage of cottonwood regeneration, however, channelization and flood control has curtailed cottonwood growth and stand development beyond this stage.

General Description and Comments: This is a very common plant association of young seedling and sapling *Populus angustifolia* (narrowleaf cottonwood) intermixed with *Salix exigua* (coyote willow). The association occupies point bars, gravel bars, benches and low areas that are flooded annually.

Regional Distribution: The *Populus angustifolia/Salix exigua* plant association occurs in New Mexico and Colorado (Durkin *et al.* 1994, 1995, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa, White, Gunnison, Rio Grande and Arkansas River Basins, and the San Juan and Rio Grande National Forests (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1996, Johnston 1987, Richard *et al.* 1996, Kittel *et al*. 1999).

Elevation Range in Colorado: 6300-7500 ft. (1900-2300 m).

Site Geomorphology: This plant association occurs on recently flooded point bars, low terraces, and stream benches. It is usually well within the active channel and immediate floodplain of the stream and does not occur more than 3-6 feet (1-2 m) above the high-water mark. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and slightly sinuous (Rosgen's Channel Type: B3, B4) or wide and moderately sinuous (Rosgen's Channel Type: C3, C4).

Soils: Soils are skeletal (40% gravel and 10-20% cobbles) and shallow, 15 inches (35 cm) deep, sands, sandy loams, sandy clay loams, or silty clays over coarse alluvial material.

Vegetation: This plant association represents the early, successional stage of nearly all *Populus angustifolia* (narrowleaf cottonwood) dominated plant associations, and is characterized by an open to dense stand *Populus angustifolia* (narrowleaf cottonwood) young trees (> 12 cm dbh) (20-76% cover), seedlings (< 1.5 m in height) (1-3% cover), and saplings (< 12 cm in diameter) (10-44% cover) with *Salix exigua* (coyote willow) (3-64%). *Populus x acuminata* (lance-leaf cottonwood) may also be present in similar age classes (8-10%). Other, more widely scattered trees may also be present, occurring in less than 20% of sampled stands, and include: *Abies lasiocarpa* (subalpine fir) (1-2%), *Picea engelmannii* (Engelmann spruce) (3%), *Pinus ponderosa* (ponderosa pine) (15%), and *Picea pungens* (Colorado blue spruce) (6-12%).

The shrub canopy is typically at the same height of the seedling and sapling cottonwood trees, although older, transitional, stands will have taller, more mature trees with *Salix exigua* as an understory. *Salix exigua* (coyote willow) is always present with 3-64% cover. Other shrubs that may be present include: *Alnus incana* (thin-leaf alder) (3-70%), *Salix lasiandra* var. *caudata* (Pacific willow) (1-20%), *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (1-3%), *Salix boothii* (Booth willow) (1-60%), *Salix drummondiana* (Drummond willow) (3-10%), *Salix bebbiana* (Bebb willow) (10%), and *Salix lasiandra* var. *lasiandra* (whiplash willow) (10%).

The herbaceous undergrowth is generally weedy (non-native) and sparse from frequent flooding disturbance. Weedy species include: *Poa pratensis* (Kentucky bluegrass) (1-20%), *Trifolium repens* (white clover) (1-40%), *Agrostis stolonifera* (redtop) (1%), *Linaria vulgaris* (butter-and-eggs) (14%), *Taraxacum* *officinale* (1-20%), *Medicago lupulina* (1-20%), *Juncus balticus* (wire grass) (1-10%), *Phleum pratense* (1-10%), *Melilotus officinalis* (sweet clover) (1-30%), *Dactylis glomerata* (orchard grass) (1-10%), and *Elytrigia repens* (quack grass) (1-10%). Native herbaceous species that can be present include: *Equisetum arvense* (field scouring rush) (1-33%), *Achillea millefolium* (yarrow) (1-3%), *Rudbeckia laciniata* (lack-eyed Susan) (1-3%), *Carex microptera* (big head sedge) (1%), *Carex pellita* (woolly sedge) (1-5%), and *Mentha arvense* (field mint) (1-3%).

Three plots have abundant *Populus angustifolia* seedlings and little to no *Salix exigua* (coyote willow) present. These can be considered part of the *Populus angustifolia*/ Recent Alluvial Bar association described by George Jones in Wyoming (Jones 1990, Hansen *et al*. 1995).

Successional and Ecological Processes: *Populus angustifolia/Salix exigua* (narrowleaf cottonwood/coyote willow) is one of the earliest successional stages of a cottonwood-dominated plant association. *Populus angustifolia* and *Salix exigua* seeds often germinate together on freshly deposited sandbars. If the site becomes more stable and less frequently flooded (i.e., the stream channel migrates away from the site), the *Populus angustifolia* saplings mature, but the *Salix exigua* population eventually declines. The association can become one of several mid- or late-seral floodplain types including *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) and *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood).

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 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 and willow 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).

Salix exigua (coyote willow) is an excellent stream bank stabilizer that can be planted as stems or wattles for restoration purposes. However, cattle may browse the young shoots in the winter and kill newly planted poles.

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 1997).

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).

Soils: 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 deltoides* ssp. *wislizeni/Salix exigua
broad-leaf cottonwood/coyote willow

Global Rank: GU
Global Rank Comments: There is not enough information to rank this community. The similar eastern slope *Populus deltoides* ssp. *monilifera (Salix amygdaloides)/Salix exigua* community is ranked G4?
State Rank: S1S2
State Rank Comments: Currently there are five records of this community on the Western Slope, but more are expected. The eastern slope *Populus deltoides* ssp. *monilifera (Salix amygdaloides)/Salix exigua* community is ranked S3.

General Description and Comments: This is an early seral association with a mix of sapling and pole sized *Populus deltoides* (broad-leaf cottonwood, either subspecies *monilifera* (plains cottonwood) or subspecies *wislizenii* (Rio Grande cottonwood)) intermixed with *Salix exigua* (coyote willow). It is recognized as the younger stage of older plains cottonwood associations that have more widely spaced trees. This association is often located on low stream banks and islands, but can also occur on overflow channels away from the main stream channel. It typically has a fairly dense tree canopy with little herbaceous ground cover.

Related Literature and Synonyms: This association used to be separated into two types: *Populus deltoides* ssp. *wislizenii*/*Salix exigua* and *Populus deltoides* ssp. *monilifera*-(*Salix amygdaloides)/Salix exigua.* They are hereby lumped into one name: *Populus deltoides/Salix exigua* Plant Association in Colorado. The following four community names are considered synonymous with the Colorado *Populus deltoides/Salix exigua* Plant Association: 1) *Populus deltoides* ssp. *monilifera-(Salix amygdaloides)/Salix exigua* described by Jones and Walford (1995), 2) the “mixed community” consisting of *Populus sargentii, Salix amygdaloides,* and *Salix interior* (coyote willow) described by Christy (1973), 3) the *Populus sargentii/Salix* spp. plant association described by Johnston (1987), and 4) the *Populus deltoides* ssp. *wislizenii*/*Salix exigua* community type described from New Mexico by Durkin *et al.* (1995).

Similar Communities: Closely related communities include the *Populus fremontii/Salix amygdaloides* (plains cottonwood/peach-leaved willow)/mesic shrub/mesic graminoid-forb plant association (Dick-Peddie 1993) which has similar co-dominant species and environmental setting, but is dominated by a different species of cottonwood, and the *Populus deltoides/Salix amygdaloides-Salix nigra* (plains cottonwood/peach-leaved willow) and the *Salix amygdaloides-Salix exigua-Salix lucida* ssp*. caudata* (peach-leaved willow-coyote willow-Pacific willow) plant associations (Bourgeron and Engelking 1994), which have different *Salix* (willow) species in the understory.

Note that *Populus sargentii* is a synonym for *Populus deltoides* ssp*. monilifera* (Kartesz 1994).

Regional Distribution: This association occurs in Wyoming (Jones and Walford 1995), New Mexico, and Colorado (Colorado Natural Heritage Program 1998). It is expected to occur in Oklahoma, Texas, South Dakota, and Kansas.

Distribution in Colorado: In Colorado this plant association occurs along streams and rivers at the base of the Front Range foothills east to the Nebraska state line (Christy 1973, Johnston 1987, Kittel *et al.* 1996) and along the Colorado and San Juan Rivers and their tributaries west to the Utah and New Mexico state lines (Colorado Natural Heritage Program 1998).

Elevation Range in Colorado: 3500-6500 ft (1000-2000 m)

Site Geomorphology: This plant association occurs on young, alluvial surfaces such as point bars, low stream banks, and overflow areas. It occurs on immediate stream banks and low overflow areas near the main river channel, and on the floodplain of meandering, low to moderate gradient (0.5-3.0%) streams with silt and sand stream beds.. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Channels are broad and braided (Rosgen's Channel Type: C5, D5). Along smaller washes and incised reaches (e.g. Kiowa and West Bijou Creeks), the plant association occurs on higher terraces, where periodic summer flash floods disturb the entire floodplain. The washes have flat-bottomed, sandy beds (Rosgen's Channel Type: F5).

Soils: Soils are typically fresh, alluvial material with little soil development. Textures are predominately loose, friable sands interspersed with narrow bands of clay loams and sandy clays.

Vegetation: This association is characterized by seedling, sapling and pole-sized *Populus deltoides* (broad-leaf cottonwood, either ssp. *monilifera* “plains” or ssp. *wislizenii* “Rio Grande”) mixed with *Salix exigua* (coyote willow) on sand bars, point bars, and other low, frequently flooded areas. *Populus deltoides* (cottonwood) canopy cover ranges from 1 to 45% and *Salix exigua* (coyote willow) canopy cover ranges from 10% to 52%. The total height of this association is often under 1.5 m (4 ft), but a few stands have near-mature sized cottonwood trees, and represent the last transition to older, cottonwood types as the *Salix exigua* (coyote willow) is shaded out by the overstory canopy of cottonwoods. Other sapling and seedling tree species may be present; on the eastern slope, these include: *Salix amygdaloides* (peach-leaf willow) (2-27%), *Fraxinus pennsylvanica* (green ash) (5-19%), and *Ulmus pumila* (Siberian Elm) (32%). Other shrubs that may be present include: *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (1%), and *Vitis riparia* (wild grape) (8%).

The herbaceous understory is relatively sparse with *Xanthium strumarium* (cocklebur) (1-10%), *Melilotus officinalis* (sweet clover) (1-26%), *Poa pratensis* (Kentucky bluegrass) (1-19%), *Bromus inermis* (smooth brome) (14-16%), *Bromus tectorum* (cheat grass) (2-19%), *Schoenoplectus pungens* (threesquare bulrush) (1%), and *Eleocharis palustris* (creeping spikerush) (1%). If the stand is very moist, *Carex pellita* (woolly sedge) may be abundant with 25% cover.

Successional and Ecological Processes: The *Populus deltoides/Salix exigua* (broad-leaf cottonwood/coyote willow) plant association is an early to mid-seral stage. With time and tree growth, *Salix exigua* (coyote willow) is shaded by taller cottonwoods, and becomes less important. Christy (1973) suggests that this vegetation type may be transitional between an all *Salix exigua* (coyote willow) dominated association and an all *Populus deltoides* (cottonwood) dominated association. However, he considers this plant association to be a response to intermediate environmental conditions, namely intermediate soil moisture where *Salix exigua* dominates the wettest soils and *Populus deltoides* dominates the driest.

Salix amygdaloides (peach-leaved willow), commonly present in eastern slope occurrences of this association, also requires stream flooding for regenerations. *Salix amygdaloides* is a pioneer species that needs moist, sparsely-vegetated alluvium to become established from seed (Johnson, 1992, as cited by Jones and Walford 1995).

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 *Populus deltoides* (cottonwood) are 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 *Populus deltoides* 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.

Along the South Platte River, however, the removal of frequent flooding and ice-flows has encouraged riparian woody growth. Historically the South Platte River was a wide, shallow braided channel. It experienced significant floods every spring due to spring snow-melt runoff. In addition, the shallow waters of the S. Platte would freeze in the winter. These shallow sheets of ice would breakup and flow downstream in the early spring, damaging any plant life it its path. Finally, in late summer, the S. Platte would slow to barely a trickle, dropping the water table well below the ground surface of the well-drained, sandy bed material (USFWS 1994). This combination of flood, ice-flows and drought kept the S. Platte River bed clear of woody vegetation for ninety-percent of the braided channel and stream banks. The present-day expanse of woody riparian growth along the S. Platte River is due to human-caused changes to the hydrologic character of the river.

In addition, it is possible that the increase in woody canopy is a one-time event. Initial hydrological changes that have caused an increase in woody growth will also result in their decline. Continued flood control, especially to the degree below the confluence with the North Platte River, has limited further cottonwood regeneration. With time the riparian forest will narrow as the outer-most trees die and channel becomes more entrenched, reducing the extent and diversity of habitats within the riparian vegetation mosaic (Friedman et al.1997, Scott et al. 1996).

Along the Colorado River, the early seral cottonwood community has become dis-proportionately more abundant than older cottonwood stands. The Colorado is so regulated today, it is become entrenched and is much less dynamic. Older, mature cottonwood stands on upper terraces will not be replaced as they die out.

Riparian forage productivity can be high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle. However, thick willow stands of this plant association may actually prevent livestock use. 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.

Once established, *Salix amygdaloides* is a very good streambank stabilizer and should be protected by managers (Hansen *et al*. 1995). *Salix exigua* is also very useful in streambank stabilization in that it can rapidly colonize and spread on disturbed areas (Hansen *et al*. 1995). It is believed that fire in this type will result in the willow species vigorously sprouting afterward.

Populus tremuloides/Acer glabrum
quaking aspen/Rocky Mountain maple

Global Rank: G2
Global Rank Comments: This association is known 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 top 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 ruffed grouse.

Salix exigua/Equisetum hyemale

coyote willow/scouring rush riparian shrubland

Global Rank: G2G4?
Global Rank Comments: There is very little information about the global distribution of this plant association. It is expected to occur elsewhere in the Colorado Plateau region.
State Rank: S2S4
State Rank Comments: This plant association is known from two locations in Colorado, both in Mesa County. It is expected to occur in other locations on the Western Slope.

General Description and Comments: *Salix exigua* (coyote willow) is one of the most common willow species in Colorado. It comprises three associations, *Salix exigua/Equisetum hyemale*, *Salix exigua*/Mesic Graminoids, and *Salix exigua*/bare ground. An undergrowth of scouring rush (*Equisetum hyemale*) characterizes the *Salix exigua/Hippochaete hyemalis* type, while dense grasses and forbs covering at least 30% of the ground falls into the Mesic Graminoids type, and an undergrowth of a few, widely scattered forbs and grasses, where exposed cobbles or sand characterizes the ground cover, constitutes the *Salix exigua*/bare ground association. *Salix exigua*/bare ground association occurs within the annual flood zone of a river on point bars, islands, sand or cobble bars and stream banks, while *Salix exigua/Equisetum hyemale* occurs on slightly higher ground on primary floodplaing terraces which typically have fine textured alluvial soils. The *Salix exigua*/Mesic Graminoids association generally occurs along backwater channels and other perennial wet, but less scoured sites, such as floodplain swales and irrigation ditches.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 2002).

Distribution in Colorado: This plant association is currently known from canyons dissecting the northern portin of the Uncompahgre Plateau (Lyon *et al.* 1996).

Elevation Range in Colorado: 5300-6600 ft.

Site Geomorphology: This plant association usually occurs within 1 meter vertical distance of the stream channel on point bars, low floodplains, terraces and along overflow channels.

Soils: Soils are typically somewhat more developed than the *Salix exigua*/bare ground plant association due to a slightly more stable environment and greater input of organic matter.

Vegetation: *Salix exigua* dominates the canopy of this association. Other shrub species can also be present including: *Salix lutea* (yellow willow), *Salix monticola* (mountain willow), *Betula occidentalis* (river birch), and *Rhus trilobata* (skunkbrush). The understory consists of dense stands of *Equisetum hyemale* (scouring rush). Other species include *Juncus balticus* (arctic sedge), *Epipactis gigantea* (giant helleborine orchid), *Platanthera sparsiflora* var. *ensifolia* (canyon bog-orchid) and *Typha latifolia* (cattail). Occasional *Populus angustifolia* (narrowleaf cottonwood) and *Acer negundo* (box elder) also occur in the stands.

Successional and Ecological Processes: This plant association is typical of recent floodplains and highly disturbed, low, wet areas and is considered early-seral. The amount of herbaceous growth in the understory is an indication of the amount of time since the last scouring (or depositional) flood event. *Salix exigua* (coyote willow) is an excellent soil stabilizer with a deep root system and flexible stems that can withstand flooding. *Salix exigua* reduces erosion potential by increasing the friction of stream flow, trapping sediments and building a protected seed bed for a number of tree and shrub species. The presence of cottonwood seedlings within this association indicates succession to a cottonwood stand (and may represent the *Populus angustifolia* or *Populus deltoides/Salix exigua* plant associations), if seedlings survive subsequent flooding events.

Management: Forage production is typically low to moderate in *Salix exigua* stands due to the high densities of stems. The dense overstory may limit livestock movement within the association (Manning and Padgett 1995). Overgrazing by livestock will reduce the vigor of the willows present and may eventually eliminate them from the site. The opening up of *Salix exigua* stands may result in the invasion of introduced and non-palatable native species. However, release from heavy grazing pressure will allow *Salix exigua* to reestablish itself, provided it has not been completely eliminated from the site. Soil compaction is generally not a problem in this association because of the high coarse fragment content of the soils. However, fine textured soils are subject to compaction when moist (Hansen *et al.* 1995).

The limited information on fire as a management tool in this association indicates that *Salix exigua* vigorously sprouts following fire. Quick, hot fires result in more sprouts than slow fires, which are actually more damaging to willows and tend to result in fewer sprouts (Hansen *et al.* 1995).

Salix exigua is an excellent streambank stabilizer due to its ability to send up individual stems from an underground root system. It also has an excellent capability of re-colonizing and spreading on disturbed areas. Once *Salix exigua* becomes established on disturbed areas, other shrubs and herbaceous species can become established as well. Removal of this association and subsequent stream bank exposure can lead to severe degradation and devastating results (Hansen *et al*. 1995).

Salix exigua can be useful for revegetating degraded sites and exposed sand/gravel bars since it will produce many roots along the entire stem. For best results, cuttings should be taken in the spring from dormant two to four year old wood. The cuttings should be 30-50 cm (12-20 in) long and >1 cm (0.5 in) in diameter. To insure survival, the cuttings should be rooted and grown in a nursery. Roots and shoots can be expected within 10 days of planting (Hansen *et al*. 1995).

Salix exigua/Mesic Graminoid
coyote willow/mesic graminoid

Global Rank: G5
Global Rank Comments: This is a common association known from Utah to Kansas.
State Rank: S5
State Rank Comments: This is one of the most common associations in Colorado, with well over 200 stands estimated to occur.

General Description and Comments: *Salix exigua* (coyote willow) is one of the most common willow species in Colorado. It comprises two associations, the *Salix exigua*/Mesic Graminoids and the *Salix exigua*/bare ground. These are easy to recognize as they are nearly pure stands of the willow, with few other species present. An undergrowth of dense grasses and forbs covering at least 30% of the ground falls into the Mesic Graminoids type, while an undergrowth of a few, widely scattered forbs and grasses, where exposed cobbles or sand characterizes the ground cover, constitutes the *Salix exigua*/bare ground association. *Salix exigua*/bare ground association occurs within the annual flood zone of a river on point bars, islands, sand or cobble bars and stream banks, while the *Salix exigua*/Mesic Graminoids association generally occurs along backwater channels and other perennial wet, but less scoured sites, such as floodplain swales and irrigation ditches.

Regional Distribution: This plant association occurs in Wyoming (Jones and Walford 1995), Utah, Nebraska, Kansas, Oklahoma and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout the western slope: San Miguel/Dolores River Basin (Kittel and Lederer 1993) and on the San Juan National Forest (Richard *et al*. 1996), along the Colorado Front Range (Friedman 1993, Kittel et al. 1994, Cooper and Cottrell 1990), the mainstem and tributaries of the South Platte River (Christy 1973, Kittel *et al.* 1996, Kittel *et al.* 1997), and in southeastern Colorado on the Comanche National Grasslands (Culver *et al.* 1996).

Elevation Range in Colorado: 5700- 9100 ft. (1750-2700 m).

Site Geomorphology: This plant association usually occurs within 1 meter vertical distance of the stream channel on point bars, low floodplains, terraces and along overflow channels. It can also occur away from the stream channel in mesic swales or along the margins of beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are broad to narrow meandering with sand or cobble beds (Rosgen's Channel Type: C5).

Soils: Soils are typically somewhat more developed than the *Salix exigua*/bare ground plant association due to a slightly more stable environment and greater input of organic matter. However, the soils are generally thin (<1 m) and skeletal with depth (10-50% cobbles). Textures are typically loamy sands interspersed with layers of silty clays and alternating with coarse sands. Upper layers (10-30 cm) often have 25-30% organic matter.

Vegetation: *Salix exigua* dominates the canopy of this association with 5-97% cover, giving the association its characteristic grayish-green color. Other shrub species can also be present including: *Salix eriocephala* var. *ligulifolia* (strapleaf willow) (1-23%), *Salix monticola* (yellow willow) (1-13%), *Salix lasiandra* (whiplash or Pacific willow) (2-20%), *Alnus incana* (thinleaf) (1-20%), *Salix bebbiana* (Bebb willow) (1-20%), Rosa woodsii (woods rose) (1-80%), *Salix planifolia* (planeleaf willow) (70%), *Salix geyeriana* (Geyer willow) (20%). The undergrowth has at least 20-35% cover of various graminoid (and sometimes forb) species including: *Poa pratensis* (Kentucky bluegrass) (1-41%), *Juncus balticus* (arctic sedge) (1-38%), *Cirsium* spp. (thistle) (1-20%), *Carex pellita* (woolly sedge) (1-35%), and *Eleocharis palustris* (spikerush) (1-40%).

Several stands along the Arikaree River had significant amounts of *Panicum virgatum* (switchgrass), *Sorghastrum nutans* (indiangrass), and *Spartina pectinata* (prairie cordgrass) in the undergrowth due their proximity to tall-grass wet meadows. These stands are included as a variation within this plant association.

Forb cover is generally low, but can include a high percentage of non-native species such as *Medicago lupulina* (black medic) (30%) and *Melilotus officinalis* (sweetclover) (1-31%).

Successional and Ecological Processes: This plant association is typical of recent floodplains and highly disturbed, low, wet areas and is considered early-seral. The amount of herbaceous growth in the understory is an indication of the amount of time since the last scouring (or depositional) flood event. *Salix exigua* (coyote willow) is an excellent soil stabilizer with a deep root system and flexible stems that can withstand flooding. *Salix exigua* reduces erosion potential by increasing the friction of stream flow, trapping sediments and building a protected seed bed for a number of tree and shrub species. The presence of cottonwood seedlings within this association indicates succession to a cottonwood stand (and may represent the *Populus angustifolia* or *Populus deltoides/Salix exigua* plant associations), if seedlings survive subsequent flooding events.

Management: Forage production is typically low to moderate in *Salix exigua* stands due to the high densities of stems. The dense overstory may limit livestock movement within the association (Manning and Padgett 1995). Overgrazing by livestock will reduce the vigor of the willows present and may eventually eliminate them from the site. The opening up of *Salix exigua* stands may result in the invasion of introduced and non-palatable native species. However, release from heavy grazing pressure will allow *Salix exigua* to reestablish itself, provided it has not been completely eliminated from the site. Soil compaction is generally not a problem in this association because of the high coarse fragment content of the soils. However, fine textured soils are subject to compaction when moist (Hansen *et al.* 1995).

The limited information on fire as a management tool in this association indicates that *Salix exigua* vigorously sprouts following fire. Quick, hot fires result in more sprouts than slow fires, which are actually more damaging to willows and tend to result in fewer sprouts (Hansen *et al.* 1995).

Salix exigua is an excellent streambank stabilizer due to its ability to send up individual stems from an underground root system. It also has an excellent capability of re-colonizing and spreading on disturbed areas. Once *Salix exigua* becomes established on disturbed areas, other shrubs and herbaceous species can become established as well. Removal of this association and subsequent stream bank exposure can lead to severe degradation and devastating results (Hansen *et al*. 1995).

Salix exigua can be useful for revegetating degraded sites and exposed sand/gravel bars since it will produce many roots along the entire stem. For best results, cuttings should be taken in the spring from dormant two to four year old wood. The cuttings should be 30-50 cm (12-20 in) long and >1 cm (0.5 in) in diameter. To insure survival, the cuttings should be rooted and grown in a nursery. Roots and shoots can be expected within 10 days of planting (Hansen *et al*. 1995).

Salix monticola/mesic forb

Mountain willow/mesic forb

Global Rank: G4
Global Rank Comments: This association is known only from Colorado but is apparently secure.
State Rank: S4
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).

Soils: 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* (strapleaf 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).

Sarcobatus vermiculatus/Suaeda torreyana
Greasewood/sea-blite saline bottomland

Global Rank: G2G3
Global Rank Comments: This community is known from western Colorado and expected to occur in Utah and other portion of the Great Basin.
State Rank: S2S3
State Rank Comments: This community is known from six locations in western Colorado.

General Description and Comments: This greasewood association forms expansive shrublands on wet clay flats along the lower river valleys on the Western Slope (Weber 1996b) and in bottomlands along intermittent drainages. The understory is sparse, open herbaceous cover of sea-blite and other salt tolerant species.

Regional Distribution: *Sarcobatus vermiculatus/Suaeda torreyana* plant association occurs in Colorado (Colorado Natural Heritage Program 2002).

Distribution in Colorado: Stands of *Sarcobatus vermiculatus* (greasewood) have been observed on the western slope in Delta, Garfield, Mesa, Montrose, and San Miguel counties (Colorado Natural Heritage Program 2002).

Elevation Range in Colorado: 4700-5900 ft.

Site Geomorphology: This community occurs on on wet clay flats along the lower river valleys on the Western Slope (Weber 1996b) and in bottomlands along intermittent drainages.

Soils: Soils are fine textured and alluvial. Many soils are derived from Mancos shale formation.

Vegetation: The shrub canopy is fairly open cover of *Sarcobatus vermiculatus* (greasewood). Other species present are *Atriplex corrugata* (mat saltbush), *Juncus balticus* (arctic rush), *Halogeton glomeratus* (halogeton), *Salsola australis* (Russian thistle), *Bromus tectorum* (cheatgrass), *Distichlis spicata* (saltgrass), *Centaurea repens* (Russian knapweed), *Machaeranthera parviflora*.

Successional and Ecological Processes: *Sarcobatus vermiculatus* (greasewood) shrublands are long lived and self perpetuating. Seedlings can survive under parent shrubs, where salinity is the highest (Knight 1994). Seeds germinate in spring when surface soils are wet with spring runoff, and the salinity is most diluted (Knight 1994).

Although characteristic of desert climates, greasewood cannot tolerate droughts, and grow only at the edges of lakes or arroyos. Greasewood has salt glands adapted for excreting excess slats, often increasing the soil salinity over time (Knight 1994).

Management: Groundwater pumping is one of the greatest threats to the viability of greasewood communities. Surface water impoundments and diversions present an equally widespread and allied threat. Wetland vegetation is strongly affected by water salinities, and wetlands have developed unique floristic patterns based on the quantity and quality of water they receive. Water uses which perturb the timing or magnitude of surface flows, or affect the water table, have the potential to negatively affect wetlands. Even minor changes in the water depth or duration of inundation in the wetland basins can have profound effects on soil salinities, and consequently, on wetland vegetation. Wetland dependent fauna, such as nesting water birds, amphibians, or invertebrates may be affected by even brief fluctuations in wetland hydrology.

Effective management will require a much better understanding of the hydrologic connections between surface, shallow, and deep groundwater resources, and how they vary in time and space.

Schoenoplectus acutus
hardstem bulrush emergent vegetation

Global Rank: G5
Global Rank Comments: This association is common but may have declined from historical levels. It has managed to grow in human-made wetland habitats.
State Rank: S4?
State Rank Comments: This association is widespread but threatened by development, agricultural conversion, stream flow alterations, and wetland filling activities.

General Description and Comments: The *Schoenoplectus acutus* (hardstem bulrush) plant association occurs in marshes, along the margins of lakes and ponds, and in backwaters areas of rivers in water up to one meter deep.

Regional Distribution: This plant association occurs in Montana, South Dakota, North Dakota, and Colorado (Hansen *et al.* 1988, 1989, Johnston 1987,Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association has been reported from the Western Slope (Kittel *et al.* 1994, Sanderson and Kettler 1996), and occurs in small patches throughout the eastern edge of the Rocky Mountain front (Johnston 1987).

Elevation Range in Colorado: 4300-7000 ft (1300-2150m).

Site Geomorphology: The *Schoenoplectus acutus* (hardstem bulrush) plant association occurs in wet swales, overflow channels with standing water, at the edges of beaver ponds, ditches and railroad embankments. One stand occurred on a saturated floodplain where a perched water table emerged from the surrounding bedrock. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Streams are large and slightly meandering (Rosgen's Stream Type: B3, C3).

Soils: Soils of this association are deep heavy clays and silty loams with a high organic matter content. Soils remain saturated for most of the growing season and often have an anoxic gleyed layer within 20 in. (50 cm) of the soil surface, although the water table can drop as far as one meter below the surface (Hansen *et al.* 1989)

Vegetation: This association is characterized by a near mono-typic stand of *Schoenoplectus acutus* (hardstem bulrush) (80%), with a few aquatic species including *Eleocharis rostellata* (spikerush) (10%) and *Mimulus guttatus* (yellow monkey flower) (1%), *Sagittaria* spp. (arrowhead), *Carex* spp. (sedge) and *Nuphar lutea* subsp. *polysepala* (yellow pond-lily).

Successional and Ecological Processes: *Schoenoplectus acutus* stands are generally considered permanent wetland communities. They will remain in place unless the hydrologic regime is severely altered. Stands of *Schoenoplectus* are important to wildlife species, especially birds, by providing cover and nesting habitat.

Management: *Schoenoplectus* is not palatable to livestock, and the wet nature of the soils precludes any grazing activities.

Schoenoplectus maritimus
saltmarsh bulrush

Global Rank: G4
Global Rank Comments: This association is common and abundant in Montana.
State Rank: S2
State Rank Comments: In Colorado, five stands are documented to occur, although ten to twenty more are expected to occur.

General Description and Comments: This wetland plant association often occurs in standing water. The vegetation is characterized by a sparse cover of *Schoenoplectus maritimus* (saltmarsh bulrush), few associated species and mostly open water. Livestock grazing is limited in this association due to the wet conditions.

Regional Distribution: This plant association occurs in Montana (Hansen *et al*. 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa River Basin in northwestern Colorado (Kittel and Lederer 1993).

Elevation Range in Colorado: 6400-8000 ft. (2000-2400 m).

Site Geomorphology: This plant association occurs in wet swales and along narrow channels, spring-fed creeks, and back-water eddies of larger rivers.

Soils: This information is not available.

Vegetation: *Schoenoplectus maritimus* dominates this sparsely vegetated wetland with 20% cover. Associated species include 20% cover of *Salix exigua* (coyote willow) and 10% cover of *Muhlenbergia asperifolia* (alkali muhly).

Successional and Ecological Processes: *Schoenoplectus maritimus* (saltmarsh bulrush) is an early colonizer and is able to persist under wet conditions. The wet conditions limit most forms of disturbance to this plant association (Hansen *et al*. 1995).

Adjacent Riparian Vegetation: *Juncus balticus* (Baltic rush) wetlands, *Salix exigua* (coyote willow) shrublands, and *Populus deltoides* spp. *wislizenii* (Rio Grande cottonwood) forests occur in adjacent riparian areas.

Adjacent Upland Vegetation: *Pinus edulis-Juniperus* spp. (pinyon pine-juniper spp.) woodlands and *Artemisia tridentata* (big sagebrush) and *Sarcobatus vermiculatus* (greasewood) shrublands occur on adjacent hill slopes

Management: *Schoenoplectus maritimus* (saltmarsh bulrush) has low to moderate palatability to livestock and is rarely grazed. However, if water levels drop or upland forage is limited, this plant association may be heavily utilized by livestock (Hansen *et al*. 1995).

Schoenoplectus maritimus helps filter sediments to build stream banks. This species is a prolific seed producer. Its rhizomes spread quickly into exposed areas and colonize mudflats and draw down areas (Hansen *et al*. 1995).

Spartina gracilis
alkali cordgrass

Global Rank: GU
Global Rank Comments: There is not enough information to rank this association.
State Rank: SU
State Rank Comments: There is not enough information to rank this association.

General Description and Comments: The *Spartina gracilis* (alkali cordgrass) plant association is a wetland meadow with sparse to thick cover of grasses and grass-like plants. Few stands have been documented in Colorado, so its classification is tentative.

Distribution in Colorado: This association occurs on the lower Yampa River (Colorado Natural Heritage Program 1997) and in the San Luis Valley (Hanson 1929).

Elevation Range in Colorado: 5900 ft. (1800 m).

Site Geomorphology: This association occurs on moist sandy overflow channels and backwater areas of large rivers, and poorly drained swales on the eastern plains. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). One plot occurred adjacent to strongly meandering, low gradient channel (Rosgen's Channel Type: C3)

Soils: The soils are fine-textures silt-loam and clay loams and alkaline (Unger 1974).

Vegetation: *Spartina gracilis* (alkali cordgrass) is the clear dominant, although cover can be sparse (30-60%). Other graminoids present include: *Schoenoplectus pungens* (threesquare bulrush), *Elytrigia repens* (quackgrass), *Agrostis gigantea* (redtop). Forbs species present tend to be weedy and in insignificant amounts.

Successional and Ecological Processes: The *Spartina gracilis* plant association tolerates alkaline soils to the exclusion of other species. It also tolerates burial by flood deposition and readily re-sprouts, pushing up sharp shoots (Weaver 1965). If the soil salinity drops, the community will become dominated by less alkaline tolerant plants.

Management: Stands of *Spartina pectinata* (alkali cordgrass) have high production rates, however the rough-edged leaves make for poor forage quality, and it is not readily eaten by livestock or wildlife. Its tall height and thick growth provide shade and cover for wildlife and certain bird species (Hansen *et al.* 1988). It can make excellent hay if cut two or three times each growing season, thereby reducing forage coarseness (Weaver 1965, Hansen *et al.* 1988). *Spartina gracilis* (alkali cordgrass) may respond in similar ways

REFERENCES CITED

Adamus, P. R. 1993. Irrigated Wetlands of the Colorado Plateau: Information Synthesis and Habitat Evaluation Method. U.S. Environmental Protection Agency, Environmental Research Lab, Corvallis, OR.

Adamus, P. R., and L.T. Stockwell. 1983. A Method for Wetland Functional Assessment. U.S. Department of Transportation, Federal Highway Administration, Washington D.C.

Adamus, P. R., L.T. Stockwell, E.J. Jr. Clairain, M.E. Morrow, L.P. Pozas, and R.D. Smith. 1991. Wetland Evaluation Technique (WET) Vol. 1: Literature Review and Evaluation Rationale. U.S. Army Corps of Engineers, Springfield, VA.

Anderson, M., P. Bougeron, M.T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D.H. Grossman, S. Landaal, K.D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A.S. Weakley. 1998. International classification of ecological associations: terrestrial vegetation of the United States. Volume II. The National Vegetation Classification System: list of types. The Nature Conservancy, Arlington, Virginia.

Anderson, Rick. 1996. Personal communication to Mike Wunder, CNHP. Colorado Division of Wildlife.

Andrews, R.R. and R.R. Righter. 1992. Colorado Birds. Denver Museum of Natural History, Denver. 442 pp.

Aplet, G.H., R.D. Laven, and F.W. Smith. 1988. Patterns of community dynamics in Colorado Engelmann spruce-subalpine fir forests. Ecology 69:312-319.

Arizona Game and Fish Department. 1995. *Catostomus latipinnis*. Unpublished abstract, Arizona Game and Fish Department, Phoenix, AZ. 4 pp.

Arizona Game and Fish Department. 1996. Wildlife of special concern in Arizona (public review draft). Nongame and Endangered Wildlife Program, Pheonix, Arizona. 40 pp.

Atwood, D., J. Holland, R. Bolander, B. Franklin, D. E. House, L. Armstrong, K. Thorne, and L. England. 1991. Utah Threatened, Endangered, and Sensitive Plant Field Guide. US Forest Service Intermountain Region, National Park Service, Bureau of Land Management, Utah Natural Heritage Program, US Fish and Wildlife Service, Environmental Protection Agency, Navajo Nation, and Skull Valley Goshute Tribe.

Bailey, R. G., P.E. Avers, T. King, and W.H. McNab. 1994. Ecoregions and Subregions of the United States (Map). Scale 1:75,000,000; Colored. U.S. Geological Survey, Washington D.C.

Baker, W.L. 1982. Natural vegetation of the Piceance Basin, Colorado, App. D. In J.S. Peterson and W.L. Baker, eds. Inventory of the Piceance Basin, Colorado. Report submitted to the Bureau of Land Management, Craig, CO. Colorado Natural Heritage Inventory, Denver, CO.

Baker, W.L. 1984. A preliminary classification of the natural vegetation of Colorado. Great Basin Naturalist 44(4):647-676.

Baker, W.L. 1986. Riparian vegetation of the montane and subalpine zones in west-central and southwestern Colorado. Report submitted to the Colorado Field Office, The Nature Conservancy, Boulder, CO and the Colorado Natural Areas Program, Denver, CO.

Baker, W.L. 1989. Classification of the riparian vegetation of the montane and subalpine zones in western Colorado. Great Basin Naturalist 49(2):214-228.

Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. xx + 275 pp.

Behnke, R. J. and D. E. Benson. 1980. Endangered and threatened fishes of the upper Colorado River Basin. Bulletin 503A. Cooperative Extension Service, Colorado State University, Fort Collins.

Berglund J. 1996. Montana Wetland Field Evaluation Form and Instructions. Prepared by Morrison-Maierle Environmental Corporation for Montana Department of Transportation, Helena, MT.

Bestgen, K. R. 1990. Status review of the razorback sucker, *Xyrauchen texanus*. Colorado State Univ. Larval Fish Lab. Contribution 44.

Binkley, D. 1986. Forest Nutrition Management. John Wiley & Sons, Inc., New York, NY.

Blaisdell, James P. and Ralph C. Holmgren. 1984. Managing Intermountain Rangelands--Salt-Desert Shrub Ranges. Gen. Tech. Report INT-163. U. S. D. A. Forest Service, Intermountain Forest and Range Experiment Station, Ogden UT.

Blus, L.J. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. Journal of Wildlife Management. 53:1139-1146.

Boto, K. G. and W.H. Jr. Patrick. 1979. The role of wetlands in the removal of suspended sediments. *In*: Wetland Functions and Values: The State of Our Understanding. American Water Resources Association, Minneapolis, MN.

Bourgeron, P. and J.S. Tuhy. 1989. Vegetation classification for the Colorado Plateau. Rocky Mountain Heritage Task Force, The Nature Conservancy, Lakewood, CO.

Bourgeron, P.S. and L.D. Engelking, eds. 1994. A preliminary vegetation classification of the western United States. Western Heritage Task Force, The Nature Conservancy, Boulder, CO.

Bowman, W.D. and H. Steltzer. 1998. Positive feedbacks to anthropogenic nitrogen deposition in Rocky Mountain alpine tundra. Ambio 27(7):514-517.

Braun, C.E. 1995. Distribution and status of sage grouse in Colorado. Prairie Naturalist 27:1-9.

Braun, C.E. and J.R. Young. 1995. A new species of sage grouse from Colorado. Annual Mtg. Wilson Ornithological Society. Williamsburg, Virginia. Abstract No. 23.

Braun, C.E., K.M. Giesen, R.W. Hoffman, T.E. Remington, W.D. Snyder. 1994. Upland bird management analysis guide, 1994-1998. Division Reptort 19. Colorado Division of Wildlife. 48 pp.

Briggs, M.K. 1996. Riparian Ecosystem Recovery in Arid Lands. Strategies and References. The University of Arizona Press. Tucson, AZ.

Brinson, M.M., F.R. Hauer, L.C. Lee, W.L. Nutter, R.D. Rheinhardt, R.D. Smith, and D. Whigham. 1985. Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands. Wetlands Research Program Technical Report WRP-DE-11, U.S. Army Corps of Engineers Waterways Experiment Station.

Brinson, M.M. 1993. A Hydrogeomorphic Classification for Wetlands. Wetlands Research Program Technical Report WRP-DE-4, U.S. Army Corps of Engineers, Springfield, VA.

Brinson, M.M. and R. Rheinhardt. 1996. The role of reference wetlands in functional assessment and mitigation. Ecological Applications 6, 69-76.

Britten, H.B., P.F. Brussard, D.D. Murphy, G.T. Austin. 1994. Colony isolation and isozyme variability of the western seep fritillary, SPEYERIA NOKOMIS APACHEANA (Nymphalidae), in the western Great Basin. The Great Basin Naturalist 54(2): 97-105.

Brunsfield, S.J. and F.D. Johonson. 1985. Field Guide to the Willows of East-Central Idaho. Forest, Wildlife and Range Experiment Station. Bulletin No. 39. University of Idaho, Moscow, ID.

Buehler, D.A., Mersmann, T.J., Fraser, J.D. and J.K.D. Seger. 1991. Winter microclimate of bald eagle roosts on the northern Chesapeake Bay. Auk 108:612-618.

Burdick, B.D. 1995. Ichthyofuanal Studies of the Gunnison River, Colorado, 1992-1994. Aspinall Unit Umbrella Studies, Recovery Program Project No. 42, Final Report.

Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. U.S. Department of Interior, Fish and Wildlife Service, Grand Junction, CO.

Bureau of Land Management. 1990. Dolores River Instream Flow Assessment, Project Report. U.S. Department of Interior. Report # BLM/YA?PR-900/003+7200. Denver, CO.

Bureau of Land Management. 1999. Unaweep Seep Natural Area Management Plan, including the Environmental Assessment. United States Department of Interior. BLM, Grand Junction Resource Area.

Burns, R.M. and B.H. Honkala, tech. Coords. 1990. Silvics of North America, Vol. 1 Conifers. Agrucultural Handbook 654, USDA Forest Service, Washington, DC 675pp..

Carothers, S.W., G.S. Mills, and R.R. Johnson. 1990. The Creation and Restoration of Riparian Habitat in Southwestern Arid and Semi-Arid Regions. In Wetland Creation and Restoration: The Status of the Science, Vol. 1, Regional Reviews, edited by J.A. Kusler and M.E. Kentula, 359-376. Covelo, CA. Island Press.

Carter, V. and R.P. Novitzki. 1988. The Ecology and Management of Wetlands Vol. 1. Timber Press, Portland, OR.

Chadde, S.W., P.L. Hansen, and R.D. Pfister. 1988. Wetland plant communities of the northern range, Yellowstone National Park. Final contract report. School of Forestry, University of Montana, Missoula, MT.

Chapin, F.S., III, L.R. Walker, C.L. Fastie, and L.C. Sharman. 1994. Mechanisms of primary succession following deglaciation at Glacier Bay, Alaska. Ecological Monographs 64(2):149-175.

Chien, N. 1985. Changes in river regime after the construction of upstream reservoirs. Earth Surface Processes 10, 143-159.

Christy, S. 1973. An analysis of the woody vegetation on the South Platte River flood plain in northeastern Colorado. Thesis. University of Northern Colorado, Greeley, CO.

Chronic, H. 1980. Roadside Geology of Colorado. Mountain Press Publishing Co. Missoula, MT.

Clark, W. S. 1975. A Field Study of the Short-eared Owl, *Asio flammeus* (Pontoppidan), in North America. Wildlife Monographs No. 47. 67 pp.

Cole D.N. and R.L. Knight. 1990. Impacts of recreation on biodiversity in wilderness. *In*: Proceedings of a Symposium on Wilderness Areas: Their Impact. D.N. Cole and R.L. Knight, (editors).

Coleman J.S. and S.A. Temple. 1994. How Many Birds Do Cats Kill? Unpublished Report. University of Wisconsin, Department of Wildlife Ecology, Madison, WI.

Colorado Bird Observatory. 1997. 1996 Reference Guide to the Monitoring and Conservation Status of Colorado's Breeding Birds. Colorado Bird Observatory, Colorado Division of Wildlife, Great Outdoors Colorado Trust Fund, and Partners, March 21, 1997.

Colorado Department of Natural Resources. 1998. Planning trails with wildlife in mind. Colorado Department of Natural Resources, Trails Program. Denver, CO

Colorado Division of Wildlife. 1986. Colorado Stream Data Bank, Second Edition. December 1986. Colorado Division of Wildlife, Denver.

Colorado Environmental Coalition, Sierra Club, et al. 1995. Conservationists' Recommendations for BLM Lands. Denver, CO.

Colorado Geological Survey, Colorado Department of Natural Resources, Colorado School of Mines Division of Environmental Science and Engineering, & Colorado State University, Department of Earth Sciences. 1998. Characterization and Functional Assessment of Reference Wetlands in Colorado: a Preliminary Investigation of Hydrogeomorphic (HGM) Classification and Functions for Colorado's Wetlands. Colorado Department of Natural Resources and U.S. Environmental Protection Agency, Denver, CO.

Colorado Natural Heritage Program (CNHP). 1997. Biological and Conservation Data (BCD) System. Data from field surveys. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Colorado Natural Heritage Program (CNHP). 1999. Biological and Conservation Data (BCD) System. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Colorado Natural Heritage Program (CNHP). 2002. Biological and Conservation Data (BCD) System. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Cooper, D.J. 1993. Wetlands of the Crested Butte region: mapping, functional evaluation, and hydrological regime. Report submitted to the town of Crested Butte and the Environmental Protection Agency, Region VIII, Denver, CO.

Cooper, D.J. and C. D. Arp. 1999. "Colorado's Iron Fens: Geochemistry, Flora, and Vegetation." Unpublished Report submitted to the Colorado Natural Areas Program.

Cooper, D.J. and T.R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Report submitted to the Colorado Field Office, The Nature Conservancy, Boulder, CO.

Cooper, D.J. and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: an ecological study and analysis of the hydrologic regime, soil chemistry, vegetation and the potential effects of a water table drawdown. Report submitted to the State of Colorado Division of Wildlife, the US Fish and Wildlife Service and the Rio Grande Water Conservation District.

Cooper, D.J. and C. Severn. 1994. Ecological Characteristics of Wetlands at the Moab Slough, Moab, UT. Unpublished report prepared for: Recovery Program of the Endangered Fishes of the Upper Colorado River Basin U.S. Department of Interior, Fish and Wildlife Service, Denver, CO.

Cowardin, L. M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States, U. S. Department of the Interior, Fish and Wildlife Services, Office of Biological Services, Washington D.C.

Culver, D.R., M.A. March, S.M. Kettler, C.A. Pague. 1996. Natural heritage inventory of significant animals and plants and classification of riparian associations, Timpas Grazing District and Kim Grazing Association, Pike-San Isabel National Forest, Cimarron and Comanche National Grasslands. Natural Heritage Technical Report #96-1. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

D'Antonio, C. M. and P. M. Vitousek. 1992. Biological invasions by exotic grasses: the grass/fire cycle and global change. Ann. Rev. Ecol. and Syst. 23:63-87.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecological Monographs 22(4):301-330.

Dahl, T. E. 1990. Wetland Losses in the United States: 1780's to 1980's. U.S. Fish and Wildlife Service, Washington D.C.

Dahl T.E. 2000. Status and Trends of Wetlands in the Conterminous United States 1986-1997. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C. 82 pp.

Dawson, T.E. and J.R. Ehleringer. 1991. Streamside trees that do not use stream water. Nature 350:335-337.

Dawson, T.E. and J.R. Ehleringer. 1993. Gender-specific physiology, carbon isotope discrimination, and habitat distribution in boxelder, Acer negundo. Ecology 74:798-815.

DeVelice, R.L., J.A. Ludwig, W.H. Moir, F. Ronco, Jr. 1986. A Classification of Forest Habitat Types of Northern New Mexico and Southern Colorado. USDA Forest Service General Technical Report RM-131. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Dexter, Coen. September, 2001. Personal communication. Contract ornithologist with Rocky Mountain Bird Observatory and Bureau of Land Management.

Dick-Peddie, W.A. 1993. New Mexico Vegetation: Past, Present, and Future. University of New Mexico Press, Albuquerque, NM.

Donovan L.A. and J.R. Ehleringer. 1991. Ecophysiological differences among juvenile and reproductive plants of several woody species. *Oecologia* 86:594-597.

Durkin, P., M. Bradley, S.E. Carr, E. Muldavin, and P. Mehlhop. 1995. Riparian/wetland vegetation communities of the Rio Grande: a classification and site evaluation. Report submitted to the New Mexico Environment Department, Surface Water Quality Bureau. New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Erdman, James A. 1970. Pinyon-Juniper Succession after Natural Fires on Residual Soils of Mesa Verde, Colorado. Brigham Young University Science Bulletin, Biological Series, Volume XI, Number 2.

Evans, S. 1989. Riparian survey of Washington's Columbia Basin. Unpublished report prepared for The Nature Conservancy Washington Natural Heritage Program, Olympia, Washington.

Federal Interagency Stream Restoration Working Group. 1998. Stream Corridor Restoration: Principles, Processes, and Practices.

Ferris, C. D. and F. M. Brown. 1981. <u>Butterflies of the Rocky Mountain States.</u> University of Oklahoma Press, Norman, OK.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. <u>Mammals of Colorado.</u> University of Colorado Press.

Flahault, C. and C. Shroter. 1910. Rapport sur la nomenclature phytogeographique. Proceedings of the Third International Botanical Congress, Brussels 1: 131-164.

Floyd, M. L., and D. D. Hannah. 1994. *Lomatium latilobum* (Umbelliferae) population maintenance in Arches National Park, Utah: Methods comparison and preliminary data. Farmington NM.

Ford, S. and D. Skidmore. 1996. The Alamosa River Irrigation System, Western Central San Luis Valley, Colorado. *In*: Geologic Excursions to the Rocky Mountains and Beyond: Field Trip Guidebook for the 1996 Annual Meeting, Geological Society of America (Editors: R. A. Thompson, M. R. Hudson, & and C. L. Pillmore) Colorado Geological Survey, Department of Natural Resources, Denver, CO.

Forman, R. T. T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge Press, Cambridge, UK.

Forman, R. T. T., and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Reviews of Ecological Systems. pp. 207-226.

Forman, R. T. T., and M. Godron. 1986. Landscape Ecology, John Wiley & Sons, New York, New York.

Franklin, M. A. 1995. Field Survey for *Lomatium latilobum* (Rydb.) Mathias in the Grand Resource Area, Grand and San Juan Counties, Utah. Utah Natural Heritage Program. Salt Lake City, UT.

Friedman, F.M. 1993. Vegetation Establishment and Channel Narrowing along a Great-Plains Stream Following a Catastrophic Flood. Unpublished Ph.D. thesis submitted to the University of Colorado, Department of Environmental, Population, and Organismic Biology.

Friedman, J.M., M.L. Scott, G.T. Auble. 1997. Water management and cottonwood forest dynamics along prairie streams. In F.L. Knopf and F.B. Samson, eds. Ecology and Conservation of Great Plains Vertebrates. Springer-Verlag, Inc., New York, NY.

Graf, W.L. 1978. Fluvial adjustments to the spread of tamarisk n the Colorado Plateau region. Bulletin of the Geological Society of America 89: 1491-1501.

Gough, L. P., L. S. Balistrieri, F. E. Lichte, T. M. Yanosky, R. C. Serverson, and A. Archultetta. 1996. The biogeochemistry of wetland ecosystems and tree rings in the San Luis Valley, Colorado: The effect of natural and human-induced metal-rich, acid drainage. *In*: Geologic Excursions to the Rocky Mountains and Beyond: Field Trip Guidebook for the 1996 Annual Meeting, Geological Society of America (Editors: R. A. Thompson, M. R. Hudson, & and C. L. Pillmore), Colorado Geological Survey, Department of Natural Resources, Denver, CO.

Hall, E. R. 1981. Mammals of North America. John Wiley and Sons, New York, NY.

Hammerson, G. A. 1982. Amphibians and Reptiles in Colorado. Colorado Division of Wildlife, Denver, CO.

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado, 2nd ed. University Press of Colorado and Colorado Division of Wildlife. Niwot, CO. 484 pp.

Hansen, P.L., S.W. Chadde, and R.D. Pfister. 1988. Riparian Dominance Types of Montana. Montana Forest and Conservation Experimental Station Miscellaneous Publication No. 49. University of Montana, Missoula, MT.

Hansen, P., R. Pfister, K. Boggs, J. Pierce, and S. Chadde. 1989. Classification and management of riparian sites in central and eastern Montana. Draft version 1. Montana Riparian Association, University of Montana, Missoula, MT.

Hansen, P., K. Boggs, R. Pfister, and J. Jay. 1991. Classification and management of riparian and wetland sites in Montana. Draft version 1. Montana Riparian Association, University of Montana, Missoula, MT.

Hansen, P.L., R.D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D.L. Hinckley. 1995. Classification and Management of Montana's Riparian and Wetland Sites. Montana Forest and Conservation Experiment Station Miscellaneous Publication No. 54. The University of Montana, Missoula, MT.

Hanson. 1929. Range resources of the San Luis Valley. Colorado Agricultural College, Colorado Experiment Station Bulletin 335. Fort Collins, CO.

Hess, K. And C.H. Wasser. 1982. Grassland, shrubland, and forestland habitat types of the White River-Arapaho National Forest (with pages 20-22 rewritten by Barry C. Johnston, July 1987). Report submitted to the USDA Forest Service, Rocky Mountain Region, Lakewood, CO.

Hubbs, C.L. 1954. Establishment of a forage fish, the red shiner (*Notropis lutrensis*), in the lower Colorado River system. California Fish and Game 40:287-94.

Husung, B. and J. Alves. 1998. Boreal Toad Surveys in the South San Juan Mountains of Colorado. Colorado Division of Wildlife, Department of Natural Resources, Monte Vista, CO.

Irving, D.B. and B.D. Burdick. 1995. Reconnaissance Inventory and Prioritization of Existing and Potential Bottomlands in the Upper Colorado River Basin 1993-1994. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, CO.

James, D. 1993. The threat of exotic grasses to the biodiversity of semiarid ecosystems. Aridlands Newsletter 37:6-7.

Jankovsky-Jones, M. 1994. Environmental factors affecting the distribution of riparian plant associations in the Roaring Fork River Basin, Colorado. Thesis. University of Wyoming, Laramie, WY.

Johnston, B.C. 1987. Plant Associations of Region Two. 4th ed. USDA Forest Service R2-ECOL-87-02. Rocky Mountain Region, Lakewood, CO.

Jones G. 1992. A preliminary classification of riparian vegetation types of the Medicine Bow Range and the Sierra Madre. Report submitted to the Medicine Bow National Forest. Wyoming Natural Diversity Database (The Nature Conservancy), Laramie, WY.

Jones, G.P. and G.M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Report submitted to the Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database (The Nature Conservancy), Laramie, WY.

Kadlec, R. H. and J.A. Kadlec. 1979. The use of freshwater wetlands as a tertiary wastewater treatment alternative. Crit. Rev. Environ. Control 9, pp. 185-212.

Kartesz, J.T. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland, Vol. II. 2nd ed. Timber Press, Portland, OR.

Keammerer, W.R. 1974. Vegetation of the Grand Valley area. In Ecological inventory of the Grand Valley area. Report submitted to the Colony Development Operation, Atlantic Richfield Company, Denver, CO.

Keammerer, W.R. 1974. Vegetation of Parachute Creek Valley. Pages 4-91 in Environmental Inventory and Impact Analysis of a proposed utilities corridor in Parachute Creek Valley, CO. Unpublished Report prepared for Colony Dev. Op. , Denver, CO.

Kelly, J. R. Jr., M.K. Laubhan, F.A. Reid, J.S. Wortham, and L.H. Fredrickson. 1993. Options for Water-Level Control in Developed Wetlands. Leaflet 13.4.8, United States Department of the Interior, National Biological Survey, Washington D.C.

Kettler, S. and A. McMullen. 1996. Routt National Forest riparian vegetation classification. Report submitted to Routt National Forest. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kingery, Hugh, ed. 1998. Colorado Breeding Bird Atlas. Colorado Bird Atlas Partnership, co-published by Colorado Division of Wildlife.

Kittel, G.M. and N.D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores River Basins. Report submitted to the Colorado Department of Health and the Environmental Protection Agency, Region VIII. The Nature Conservancy's Colorado Program, Boulder, CO.

Kittel, G., R. Rondeau, and S. Kettler. 1995. A classification of the riparian vegetation of the Gunnison River Basin, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River Basins, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, University of Colorado, Boulder, CO.

Kittel, G., R.J. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the lower South Platte and parts of the upper Arkansas River Basins, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., E. VanWie, and M. Damm. 1997. A classification of the riparian vegetation of the South Platte River Basin (and part of the Republican River Basin), Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, Gwen M., Erika VanWie, Mary Damm, Renée Rondeau, Steve Kettler, and John Sanderson. 1999. A Classification of Riparian Plant Associations of the Rio Grande and Closed Basin Watersheds, Colorado. Prepared for: The Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII Denver, Colorado. The Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Knight R.L. and D.N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. In: Trans. 56th N.A. Wildl. and Nat. Res. Conf.

Knight, D. H. 1994. Mountains and Plains: The Ecology of Wyoming Landscapes. Yale University Press: New Haven and London. 338 pp.

Knopf, F. L., R. R. Johnson, T. Rich, F. B. Samson, and R. C. Sears. 1988. Conservation of riparian ecosystems in the United States. Wilson Bull. 10(2):272-284.

Komarkova, V. 1986. Habitat types on selected parts of the Gunnison and Uncompahgre National Forests. Report submitted to the USDA Forest Service. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Kovalchik, B.L. and W. Elmore. 1992. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. *In* W.P. Clary, E.D. McArthur, D. Bedunah, and C.L. Wambolt, compilers. Proceedings-Symposium on Ecology and Management of Riparian Shrub Communities. USDA Forest Service General Technical Report INT-289. Intermountain Research Station, Ogden, UT.

Kovalchik, B.L. 1987. Riparian Zone Associations, Deschutes, Ochoco, Fremont, and

Winema National Forests. USDA Forest Service R6 ECOL-TP-279-87. Pacific Northwest Region, Bend, OR.

Kovalchik, B.L., W.E. Hopkins and S.J Brunsfeld. 1988. Major Indicator Shrubs and Herbs in Riparian Zones on National Forests of Central Oregon. USDA Forest Service R6-ECOL-TP-005-88. Pacific Northwest Region, Bend, OR.

Larson, G.E. 1993. Aquatic and wetland vascular plants of the northern Great Plains. General Technical Report RM-238. U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh, NC.

Leupschen, Norman S. (Mesa County Horticulture Pest Inspector). 1995. Pest Inspector's Report for 1995. Grand Junction, CO

Lyon, P., C. Pague, R. Rondeau, L. Renner, C. Slater, and C. Richard. 1996. Natural Heritage Inventory of Mesa County, Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Lyon, P., J. Sovell, and J. Rocchio. 2001. Survey of Critical Biological Resources, Garfield County, Colorado. Vol. 1. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Macalady, A. 2000. Draft Report: Sand and Gravel Mining in Colorado Rivers and Riparian Areas. Impacts, Regulations and Suggestions For the Future. Prepared for the Western Slope Environmental Resource Council and the Western Colorado Congress.

Malanson, G.P. 1982. The Assembly of Hanging Gardens: Effects of Age, Area, and Location. American Naturalist, Vol. 119. Issue 1. pp. 145-150.

Manning, M.E. and W.G. Padgett. 1995. Riparian Community Type Classification for Humbolt and Toiyabe National Forests, Nevada and Eastern California. USDA Forest Service R4-ECOL-95-01. Intermountain Region, Ogden, UT.

Martinson, R. J. 1980. Macroinvertebrate Community Structure of Springbrook Habitats in the Piceance Basin, Colorado. Colorado State University, Fort Collins, CO.

Marriott, H.J. and D. Faber-Langendoen. 2000. The Black Hills community inventory. Volume 2: Plant community descriptions. The Nature Conservancy, Midwest Conservation Science Center and Association for Biodiversity Information, Minneapolis, MN. 326 pp.

Meffe, G.K. 1985. Predation and species replacement in American southwestern fishes: a case study. Southwestern Naturalist 30:173-187.

Meffe, G.K., and W.L. Minckley. 1987. Persistence and stability of fish and invertebrate assemblages in a repeatedly disturbed Sonoran desert stream. American Midland Naturalist 117:177-91.

Miller, R.R. 1961. Man and the changing fish fauna of the American Southwest. Paper Michigan Academy Science, Arts, and Letters 46:365-404.

Miller, R. F. and P. E. Wigand. 1994. Holocene changes in semiarid pinyon-juniper woodlands. Bioscience 44(7):465-474.

Minckley, W.L., and J.E. Deacon. 1968. Southwestern fishes and the enigma of "endangered species." Science 159:1424-32.

Minckley, W. L., Meffe, G. K. and D. L. Soltz. 1991. Conservation and management of short-lived fishes: the cyprinodontoids. Pages 247-82 in, Battle Against Extinction: Native Fish Management in the American West, W. L. Minckley and J. E. Deacon eds. University of Arizona Press, Tucson, Arizona.

Mitsch, W. J. and J.G. Gosselink. 1993. Wetlands. Second edition, Van Nostrand Reinhold, New York, NY.

Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000. Handbook of wetland vegetation communities of New Mexico: Classification and community descriptions (volume 1). Final report to the New Mexico Environment Department and the Environmental Protection Agency prepared by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Mutel, C. F. and J.C. Emerick. 1992 (2nd ed.). From Grasslands to Glacier: The Natural History of Colorado and the Surrounding Region. Johnson Books: Boulder, Colorado.

National Audubon Society. 2000. Important Bird Areas of Colorado. Compiled by K.A. Cafaro. Audubon-Colorado, Boulder, CO.

National Geographic Society (NGS). 1987. Field Guide to the Birds of North America. National Geographic Society, Washington, D.C.

National Research Council. 1995. Wetlands: Characteristics and Boundaries. National Academy Press, Washington D.C.

Nature Conservancy, The. 1989. Element Stewardship Abstract for *Rubus discolor*, (*Rubus procerus*) (Himalayan blackberry). Prepared by Marc Hoshovsky for The Nature Conservancy, Arlington, VA.

Nature Conservancy, The. 1996. Yampa River site conservation plan. The Nature Conservancy, Boulder, CO.

Nature Conservancy, The. 1998. Element Stewardship Abstract for *Tamarix ramosissima*, *T. pentandra*, *T. chinenesis*, and *T. parviflora* (Tamarisk). Prepared by Alan T. Carpenter, Land Stewardship Consulting, Boulder, CO for The Nature Conservancy, Arlington, VA.

Nature Conservancy, The. 1999. An Allicance Level Classification of Vegetation of the Conterminous Western United States. Submitted to the University of Idaho, Cooperative Fish and Wildlife Research Unit.

NDIS (Natural Diversity Information Source). System for Conservation Planning Available at http://ndis.nrel.colostate.edu/escop/index2.html, Accessed 1999.

Noss, R. F., M.A. O'Connel, and D.D. Murphy. 1997. The science of conservation planning: Habitat conservation under the Endangered Species Act. Island Press, Washington D.C.

Osmundson, D.B. 2001. Personal communication. Fishery Biologist, United States Fish and Wildlife Service, Colorado River Fishery Project, Grand Junction, CO.

Osmundson, D.B. 2001. Flow Regimes for Restoration and Maintenance of Sufficient Habitat to Recover Endangered Razorback Sucker and Colorado Pikeminnow in the Upper Colorado River: Interim Recommendations for the Palisade-to-Rifle Reach. Final Report. Recovery Implementation Program, Project No. 74. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, CO.

Oxley, D. J., M.B. Fenton, and G.R. Carmody. 1974. The effects of roads on populations of small animals. Journal of Applied Ecology 11, 51-59.

Padgett, W.G., A.P. Youngblood, and A.H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, Intermountain Region, Report R4-ECOL-89-01. Ogden, UT. 191 pp.

Page, L.M., and B.M. Burr. 1991. A Field Guide to Freshwater Fishes: North America North of Mexico. Houghton Mifflin Company, Boston, Massachusetts. 432 pp.

Pague, C. A., and M. Carter. 1996. Unpublished data.

Peet, R.K. 1981. Forest vegetation of Colorado Front Range: composition and dynamics. Vegetatio 45:3-75.

Peet, R. K. 1988. Forests of the Rocky Mountains. In M. G. Barbour and W. D. Billings (eds.) North American Terrestrial Vegetation. Cambridge Univ. Press, New York.

Pfeifer, F. K. and B. D. Burdick. 2000. A five year experimental stocking plan to evaluate survival of various sizes of razorback sucker. Colorado River Recovery Program, Recovery Program FY 2000 Annual Project Report; Project Number 50. U. S. Fish and Wildlife Service, Grand Junction, Colorado.

Proebstel, D.S. 1994. Taxonomic Identification of Colorado River Cutthroat Trout (*Oncorhynchus clarki pleuriticus*) in Colorado--Draft report. Progress Report October 1994.

Pyle, R.M. 1989. The Audubon Society Field Guide to North American Butterflies. Alfred A. Knopf, Inc., New York.

Reid, M. and P. Bourgeron. 1991. Vegetation Classification for Colorado. Unpublished Working Draft. Western Regional Heritage Task Force, The Nature Conservancy, Boulder, CO.

Reijnen R., R. Foppen, T.C. Braak, and J. Thissen. 1995. The effects of car traffic on breeding bird populations in woodland. Journal of Applied Ecology 32, 187-202.

Renner, L. 1996. Personal Communication. Colordo Division of Wildlife.

Renner, L., Gray, P. and V. Graham. 1991. Greater Sandhill Crane nesting success and recruitment in northwest Colorado, December 1991. Prepared by Colorado Division of Wildlife, Terrestrial Wildlife Section, Grand Junction, Colorado.

Richard, C., G. Kittel, and S. Kettler. 1996. A classification of the riparian vegetation of the San Juan National Forest. Draft 1 to be submitted to the San Juan National Forest. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Ritchie, M.E., M.L. Wolfe, and R. Danvir. 1994. Predation of artificial sage grouse nests in treated and untreated sagebrush. Great Basin Naturalist 54:122-129.

Rocky Mountain/Southwestern Peregrine Falcon Recovery Team. 1977. American Peregrine Falcon, Rocky Mountain and Southwest Population Recovery Plan. U.S. Fish and Wildlife Service. 183 pp.

Rodgers, Bill. 1996. Personal communication. USDI National Park Service, Colorado National Monument. Grand Junction, CO

Rood, S. B. and J.M. Mahoney. 1993. River damming and riparian cottonwoods: Management opportunities and problems. *In*: Riparian Management: Common Threads and Shared Interests (Editors: B. Tellman, H.J. Cortner, M.G. Wallace, L. F. DeBano, R.H. Hamre) USDA Forest Service General Technical Report RM-226, Fort Collins, CO.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Sala, A. S., S.D. Smith, and D. A. Devitt 1996. Water use by Tamarix ramosissima and associated phreatophytes in a Mojave desert floodplain. Ecological Applications 6, 888-898.

Sanderson, J. and S. Kettler. 1996. A preliminary wetland vegetation classification for a portion of Colorado's West Slope. Report submitted to the Colorado Department of Natural Resources and the U.S. Environmental Protection Agency. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Scott, J. A. 1986. The Butterflies of North America: a Natural History and Field Guide. Stanford University Press. Stsanford, California.

Scott, M.L., J.M. Friedman, and G.T. Auble. 1996. Fluvial process and the establishment of bottomland trees. Geomorphology 14:327-339.

Sigler, W. F. and R. R. Miller. 1963. Fishes of Utah. Utah State Department of Fish and Game, Salt Lake City, Utah.

Singh, Teja and Neil E. West. 1971. Comparison of some multivariate analyses of perennial Atriplex vegetation in southeastern Utah. Vegetatio 23:5-6(289-313).

Smith, R. D., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices. Technical Report WRP-DE-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Smith, S.D. and D.A. Devitt. 1996. "Physiological ecology of saltcedar: why is it a successful invader" Presentation at Saltcedar Management and Riparian Restoration Workshop, Las Vegas, NV. September 1996.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program.

Soker, D. 2002. Personal Communication. Land Acquisition Coordinator, United States Fish and Wildlife Service, Colorado River Recovery Program, Grand Junction, CO.

Stebbins, R.C. 1985. A Field Guide to Western Reptiles and Amphibians. Second Edition. Houghton Mifflin Company, Boston, Massachusetts. xiv + 336 pp.

Stevens, J. 1996. Personal Communication. Director of City of Grand Junction Park and Recreation.

Swift-Miller, S. M., B. M. Johnson, R. T. Muth, and D. Langlois. 1999. Distribution, abundance, and habitat use of Rio Grande sucker (*Catostomus plebeius*) in Hot Creek, Colorado. The Southwestern Naturalist 44, 42-48.

Tisdale, E. W., M. Hironaka, and M. A. Fosberg. 1969. The Sagebrush Region in Idaho. University of Idaho Agricultural Experiment Station bulletin 512. Moscow, Idaho.

Tomb, A. S. 1980. Taxonomy of *Lygodesmia* (Asteraceae). Systematic Botany Monographs, Vol. 1, October 1980.

Toolen, J. 2001. Personal communication. Colorado Division of Wildlife District Wildlife Manager.

Trotter, P. C. 1987. Cutthroat: native trout of the west. Colorado Associated Univ. Press, Boulder. 219 pp.

Tweto, O. (1979) Geological Map of Colorado. United States Geological Survey, Denver, CO.

Tyus, H. M., and C. A. Karp. 1989. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. U.S. Fish Wildl. Serv., Biol. Rep. 89(14). 27 pp.

Tyus, H. M., and C. W. McAda. 1984. Migration, movements and habitat preferences of Colorado squawfish, *Ptychocheilus lucius*, in the Green, White, and Yampa rivers, Colorado and Utah. Southwest. Naturalist 29:289-299.

Unger, I.A. 1974. Halophyte communities of Park County, Colorado. Bulletin of the Torrey Botanical Club 101(3)145-152.

United States Department of Agriculture (USDA) Soil Conservation Service, 1978. Soil Survey of Mesa County Area, Colorado. United State Department of Agriculture, Soil Conservation Service.

United States Department of Agriculture (USDA) Soil Conservation Service. 1989. Colorado Climate. Temperature, Precipitation, Frost, and Growth Data. SCS, Ecological Sciences and Snow Survey, Lakewood, CO.

United States Department of Agriculture (USDA) Soil Conservation Service. 1994. Keys to Soil Taxonomy. Soil Survey Staff. Sixth Edition. Pocahontas Press, Inc. Blacksburg, VA.

United States Department of Interior (USDI) Bureau of Land Management, Grand Junction Resource Area. 1985. Resource Management Plan and Environmental Impact Statement. pp. 123, 124.

United States Department of Interior (USDI) Bureau of Land Management, Grand Junction District. 1987. Grand Junction Resource Area Resource Management Plan and Record of Decision. Grand Junction, CO.

United States Department of Interior (USDI) Bureau of Land Management. 2001. Biological Soil Crusts: Ecology and Management. Technical Reference 1730-2. Bureau of Land Management Printed Materials Distribution Center, Denver, CO.

United State Department of Interior (USDI) Bureau of Land Management. 2001. Riparian area management: A guide to managing, restoring, and conserving springs in the Western United States. Technical Reference 1737-17. Bureau of Land Management, Denver, CO. BLM/ST/ST-01/001+1737. 70 pp.

United State Geological Survey (USGS). 1995. Groundwater Atlas of the United States. HA 730-C, Arizona, Colorado, New Mexico, and Utah. Online version: http://sr6capp.er.usgs.gov/gwa/ch_c/index.html

USFWS (U.S. Fish and Wildlife Service). May 22, 1990. Proposal to determine the razorback sucker (*Xyrauchen texanus*) to be an endangered species. Federal Register 55(99):21154-21161.

USFWS (U.S. Fish and Wildlife Service). 1994. Instream flow and pulse flow recommendations for the Central Platte River, Nebraska. Results of March and May 1994 workshops. *In* D. Bowman and D. Carlson, eds. US Fish and Wildlife Service Comment Enclosures 2-8 and FERC Nos. 1417 and 1835.

United States Forest Service (USFS). 2000. White River National Forest Trout Surveys for 2000. Raw data received by the Colorado Natural Heritage Program from the White River National Forest.

United States Salinity Laboratory Staff (L.A. Richards, Editor). 1954. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture Handbook No. 60, Soil Conservation Research Branch, United State Department of Agriculture, Washington D.C.

Van Cleve, K., L.A. Viereck, and R.L. Schlentner. 1971. Accumulation of nitrogen in alder (*Alnus*) ecosystems near Fairbanks, Alaska. Arctic and Alpine Research 3(2):101-114.

Vanicek, C.D., and R.H. Kramer. 1969. Life history of the Colorado squawfish, *Ptychocheilus lucius*, and the Colorado chub, *Gila robusta*, in the Green River in Dinosaur National Monument, 1964-1966. Transactions of the American Fisheries Society 98:193.

Veblen, T.T., K.S. Hadley, M.S. Reid, and A.J. Rebertus. 1991. The response of subalpine forests to spruce beetle outbreak in Colorado. Ecology 72:213-231.

Viereck, L.A. 1970. Forest succession and soil development adjacent to the Chena River in interior Alaska. Arctic and Alpine Research 2(1):1-26.

Walford, G.M. 1993. Spatial variation in riparian vegetation along the Animas River, Colorado. Thesis. University of Wyoming, Laramie, WY.

Weaver, J.E. 1965. Native Vegetation of Nebraska. University of Nebraska Press, Lincoln, NE.

Weber, William A. 1987. Colorado Flora: Western Slope. Colorado Associated University Press, Boulder, CO.

Weber, W.A. and R.C. Wittmann. 1996a. Colorado Flora: Eastern Slope. Rev. ed. University Press of Colorado, Niwot, CO.

Weber, W.A. and R.C. Wittmann. 1996b. Colorado Flora: Western Slope. Rev. ed. University Press of Colorado, Niwot, CO.

Welsh, S.L. and C.A. Toft. 1981. Biotic Communities of Hanging Gardens in Southeastern Utah. National Geographic Society Research Reports. Vol. 13 pp. 663-681.

Welsh, S.L., N.D. Atwood, L.C. Higgins, and S. Goodrich, eds. 1987. A Utah Flora. Great Basin Naturalist Memoirs No. 9. Brigham Young University, Provo, UT.

Welsh, S.L. 1989. On the distribution of Utah's Hanging Gardens. The Great Basin Naturalist Vol. 49. No. 1. pp. 1-30.

Welsh, S. L., N. D. Atwood, S. Goodrich, and L. C. Higgins, Eds. 1993. A Utah Flora. Second Edition, Revised. Brigham Young University, Provo, Utah.

Western Colorado Five Rivers Wetland Focus Area Committee. 2002. Draft Wetland Conservation Strategy and Implementation Plan.

Wilson, E. O. 1988. Bio Diversity, National Academy Press. Washington, D.C.

Windell, J. T., B.E. Willard, D.J. Cooper, S.Q. Foster, C. Knud-Hansen, L.P. Rink, and G.N. Kiladis. 1986. An Ecological Characterization of Rocky Mountain Montane and Subalpine Wetlands. Fish and Wildlife Service, U. S. Department of the Interior, Biological Report 86 (11). U. S. Department of the Interior, Washington, D. C.

Winternitz, B.L. 1998. Bald Eagle. In Colorado Breeding Bird Atlas, H.E. Kingery ed. Colorado Bird Atlas Partnership; co-published by Colorado Division of Wildlife.

Woodling, John. 1985. Colorado's Little Fish: A Guide to the Minnows and Other Lesser Known Fishes in the State of Colorado. Colorado Division of Wildlife, Department of Natural Resources, Denver, co. 77 pp.

Woods, Christopher P. and Clait E. Braun. 1995. Sage Grouse Investigations Glade Park and Pinon Mesa, Mesa County, Colorado. Unpublished Report to the Colorado Division of Wildlife. Fort Collins, CO.

Young, James A. 1981. Principles of weed control and plant manipulation. In Managing Intermountain Rangelands--Improvement of Range and Wildlife Habitats. U.S.D.A. Forest Service Intermountain Forest and Range Experiment Station, Ogden, UT 84401. Gen Tech Report INT-157.

Young, M.K., Schmal, R. N., Kohley, T. W. and V.G. Leonard. 1996. Conservation status of Colorado River cutthroat trout. General Technical Report RM-GTR-282. U.S. Forest Service, Rocky Mountain Forest and Range Experimental Station, Fort Collins. 32 pp.

Youngblood, A.P. and R.L. Mauk. 1985. Coniferous Forest Habitat Types of Central and Southern Utah. USDA Forest Service General Technical Report INT-187. Intermountain Research Station, Ogden, UT.

Youngblood, A.P., W.G. Padgett, and A.H. Winward. 1985a. Riparian Community Type Classification of Eastern Idaho-Western Wyoming. USDA Forest Service R4-ECOL-85-01. Intermountain Region, Ogden, UT.

Youngblood, A.P., W.G. Padgett, and A.H. Winward. 1985b. Riparian community type classification of northern Utah and adjacent Idaho. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 104 pp.