Survey of Critical Wetlands and Riparian Areas in Fremont County

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Survey of Critical Wetlands and Riparian Areas in Fremont County

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Cover photograph: Beaver Creek State Wildlife Area
Photo taken by Stephanie Neid.

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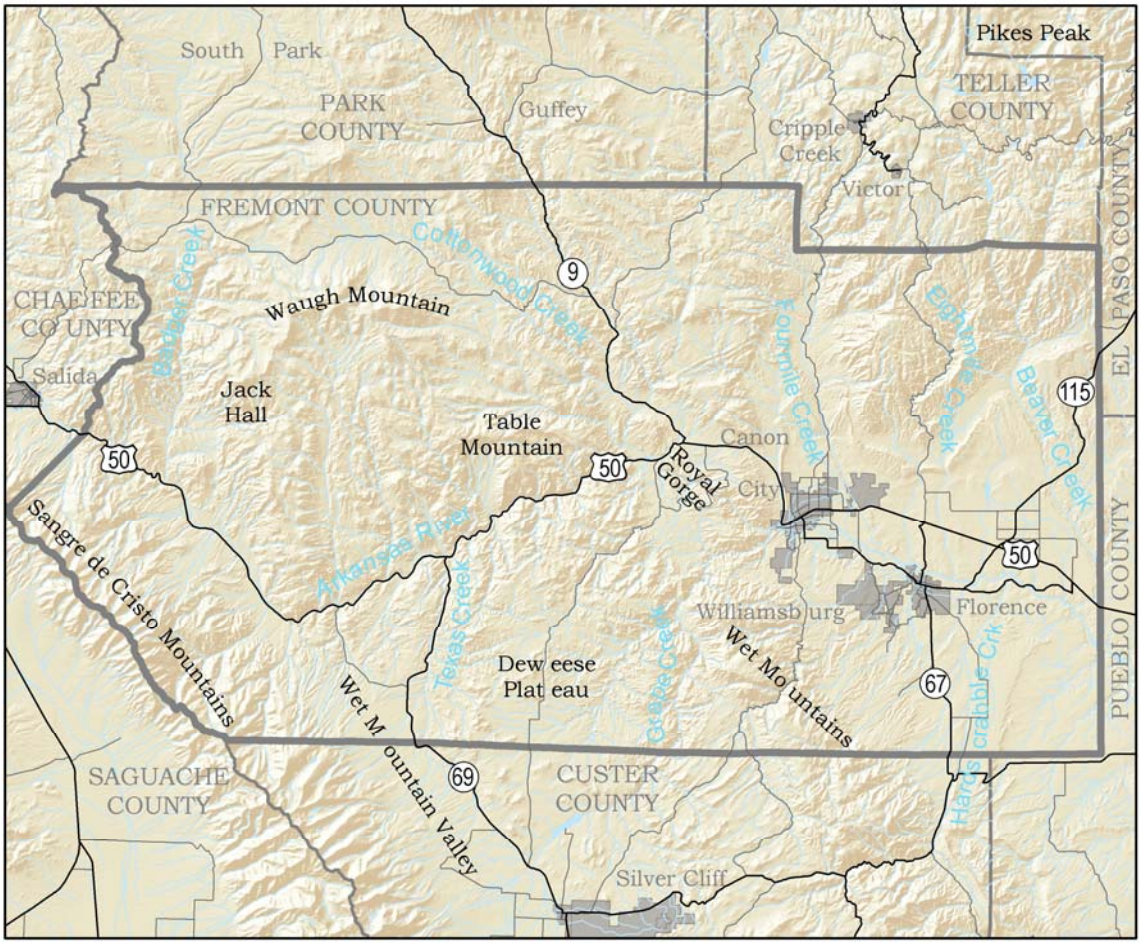

EXECUTIVE SUMMARY

Fremont County spans all major ecological zones known to occur in Colorado, from alpine, subalpine, upper montane, lower montane, foothills, and plains and is home to a vast array of plants, animals, and natural plant communities. The Arkansas River valley bisects the county and is known for several globally-rare, endemic plant species that occupy unique chalk and shale barrens habitat. On the opposite end of the moisture spectrum, wetlands are also rare in Fremont County as in the arid West in general. Wetlands and riparian areas comprise less than 2% of the land area in Colorado. Although these areas occupy very little of the landscape, they support a disproportionate amount of biodiversity.

Although the rate of wetland loss in Fremont County is difficult to quantify, it is clear that many wetlands 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 have been developed for irrigation and drinking water supplies. Such activities have eliminated or altered some wetlands, and created other wetlands 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.

In 2003, the Colorado Natural Heritage Program (CNHP) received funding from the Colorado Department of Natural Resources (CDNR) through a grant from the U.S. Environmental Protection Agency (EPA), Region 8 to survey for critical wetlands within Fremont 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) Colorado Wetlands Initiative Legacy Project, a wetlands protection partnership that includes the Colorado Division of Wildlife, the Colorado Chapter of The Nature Conservancy, Colorado State Parks, Partners for Wildlife, Ducks Unlimited, and GOCO;
(2) the CNHP's Comprehensive Statewide Wetland Classification and Characterization Project;
(3) The Nature Conservancy's Priority Conservation Sites identified in the Southern Rocky Mountain Ecoregional plan;
(4) the hydrogeomorphic (HGM) wetland functional assessment program;
(5) the Wetland Bioassessment method or Index of Biological Integrity (IBI) project;
(6) the Colorado Division of Wildlife Wetlands Monitoring and Evaluation Project.

This project supports the Index of Biological Integrity (IBI) and HGM development process by identifying potential reference wetlands and the range of variation and potential subclasses within Fremont County. CNHP's wetland work provides input to the Wetlands Initiative Partners 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 early June of 2005 and continued through the end of September. Wetlands and riparian areas occurring on private lands adjacent to public lands were given the highest priority for inventory. Such locations were identified by: (1) examining existing biological data for rare or imperiled plant and animal species and significant plant communities (collectively called elements) from the Colorado Natural Heritage Program's database, (2) accumulating additional existing information on these elements and, (3) input from the Royal Gorge Office of the Bureau of Land Management and the Colorado Division of Wildlife, and (4) 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).

Results of the 2005 Fremont County survey confirm that there are many wetland and riparian areas with high biological significance. Several rare plants and animals depend on these areas for survival. All together 22 wetland or riparian communities of concern and one imperiled wetland plant species were documented in Fremont County in 2005 and covered in this report. The CNHP database currently houses more than 244 element occurrence records within Fremont County including all upland, wetland, and riparian elements. As part of this project, thirty new element occurrence records were created and 24 element occurrence records were updated.

CNHP has identified 42 Potential Conservation Areas (PCAs) in or partially contained in Fremont County. Twenty-four of these PCAs address wetland or riparian elements and are presented in this report. 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 and riparian areas in Fremont 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.

Of the 24 wetland and riparian area PCAs presented in this report, ten are of **very high significance** (B2), twelve are of **high significance** (B3), one is of **moderate significance** (B4), and one is of general biodiversity significance (B5). Of the 24 PCAs presented in this report, eleven are newly created based on fieldwork from 2004. Twelve existing wetland or riparian PCAs were updated with changes in site boundaries and in element occurrences of interest. Among the PCAs not presented in this report there is one that is of outstanding biodiversity significance (B1) that addresses globally rare, upland, endemic plants of the chalk barrens in the Arkansas River valley

The results of the survey will be available to the public on the CNHP website (http:\\www.cnhp.colostate.edu).

INTRODUCTION

Fremont County spans all major ecological zones known to occur in Colorado, from alpine, subalpine, upper montane, lower montane, foothills, and plains and is home to a vast array of plants, animals, and natural plant communities. The Arkansas River valley bisects the county and is known for several globally-rare, endemic plant species that occupy unique chalk and shale barrens habitat. On the opposite end of the moisture spectrum, wetlands are also rare in Fremont County as in the arid West in general. Wetlands and riparian areas comprise less than 2% of the land area in Colorado (Dahl 1990). Although these areas occupy very little of the landscape, they support a disproportionate amount of biodiversity. According to the Colorado Division of Wildlife (CDOW), wetlands and riparian areas are critical to 75% of the wildlife species known or that likely occur in the state for all or for some portion of their life cycle (Colorado Division of Wildlife 2006).

Wetlands are defined as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Environmental Protection Agency 2006). Riparian areas are adjacent to surface or groundwater of perennial or ephemeral water bodies including rivers, streams, lakes, ponds, or playas. They are vegetated with plant communities that are distinctly different than the surrounding uplands (Colorado Division of Wildlife 2006). 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 Fremont County is difficult to quantify, it is clear that many wetlands 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 have been developed for irrigation and drinking water supplies. Such activities have eliminated or altered some wetlands, and created other wetlands 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.

Although Colorado has diverse biological resources, the numbers and locations of these organisms and their habitats are not fully understood. Landowners, local and state governments, federal agencies, and non-profit organizations, particularly in rapidly growing parts of Colorado, are expressing a desire to better understand their natural heritage resources. The Colorado Natural Heritage Program (CNHP) approached this

project with the intent of addressing this need. This survey of critical biological resources of Fremont County is part of an ongoing biological inventory of Colorado counties by CNHP. To date, similar inventories have been conducted in all or parts of 26 Colorado counties. CNHP has completed the Comprehensive Statewide Wetland Characterization and Classification Project (Carsey et al. 2003), which compiled data from multiple sources to produce a comprehensive wetland classification for the state of Colorado.

In 2003, the Colorado Natural Heritage Program (CNHP) received funding from the Colorado Department of Natural Resources (CDNR) through a grant from the U.S. Environmental Protection Agency (EPA), Region 8 to survey for critical wetlands within Fremont 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:

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(3) The Nature Conservancy's Priority Conservation Sites identified in the Southern Rocky Mountain Ecoregional plan (Neely et al. 2001);
(4) the hydrogeomorphic (HGM) wetland functional assessment program (Colorado Geological Survey et al. 1998);
(5) the Wetland Bioassessment method or Index of Biological Integrity (IBI) project (Rocchio 2006);
(6) the Colorado Division of Wildlife Wetlands Monitoring and Evaluation Project.

This project supports the Index of Biological Integrity (IBI) and HGM development process by identifying potential reference wetlands and the range of variation and potential subclasses within Fremont County. 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.

This *Survey of Critical Wetlands and Riparian Areas in Fremont County* used the methods that are employed worldwide throughout Natural Heritage Programs and Conservation Data Centers. The primary focus was to identify the locations of the plant and animal populations and plant communities on CNHP's list of rare and imperiled elements of biodiversity, assess their conservation value, and systematically prioritize these for conservation action.

The locations of biologically significant areas 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 (e.g., interviews of local experts)
- Conducting extensive field surveys.

Locations in the county with wetlands and riparian areas of natural heritage significance (those places where these elements have been documented) are presented in this report as Potential Conservation Areas (PCAs). The goal of PCAs 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' habitat and life history is used in conjunction with information about topographic, geomorphic, and hydrologic features, vegetative cover, and 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 recommend exclusion of 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 that occur at a site. A thorough analysis of the human context and potential stresses was not conducted. All land within the conservation planning boundary should be considered an integral part of a complex economic, social, and ecological landscape that requires wise land-use planning at all levels.

CNHP uses the Heritage Ranking Methodology to prioritize conservation actions by identifying those areas that have the greatest chance of conservation success for the most imperiled elements. The sites are prioritized according to their **biodiversity significance rank**, or "B-rank," which ranges from B1 (outstanding significance) to B5 (general or statewide significance). These ranks are based on the conservation (imperilment or rarity) ranks for each element and the element occurrence ranks (viability 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. Based on current knowledge, the sites in this report represent areas CNHP recommends for protection in order to preserve the natural heritage of Fremont County.

This document should be considered a tool for managing lands that support rare wetland species and plant associations within Fremont County, although there are limitations to

the information within it. In particular, the survey work was conducted over a one-year period. The distribution and abundance of all organisms change with time, and it is anticipated that the conservation areas described in the report will also change with time. Also, many areas of Fremont County were not surveyed due to limitations of time, plant phenology, 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 associations found within Fremont 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). The primary objective was to identify biologically significant wetlands within Fremont County.

In addition to presenting prioritized PCAs, this report also includes a section with summaries of selected plants and plant communities that are known to be found within the PCAs.

THE NATURAL HERITAGE NETWORK RANKING SYSTEM 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 very diverse 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.

Recognition and protection of rare and imperiled species and their habitat is crucial to preserving Colorado's diverse natural heritage. 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 rare and/or vulnerable Colorado habitats; among them are Bell's twinpod (a wildflower), the greenback cutthroat trout, 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. A decline of these specialized species often indicates disruptions that could permanently alter entire ecosystems.

Colorado is inhabited by some 800 vertebrate species and subspecies, and tens of thousands of invertebrate species. In addition, the state has approximately 4,600 species of plants (vascular and nonvascular) and more than 450 recognized plant communities that represent terrestrial 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 favored 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 from extinction. The ranking system is scientifically based upon the number of known locations of the species as well as its biology and known threats. By ranking the relative 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 fifty U.S. states, eleven Canadian provinces and territories, and many countries in Latin 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 of or even restricted to an area. The U.S. National Vegetation Classification (USNVC) is the accepted national standard for vegetation and it 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" (Anderson et al. 1998).

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.

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 and the results of their activities are also closely linked to all levels of this hierarchy and are integral parts of most landscapes. 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's 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 fourteen 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.

All Natural Heritage Programs house data about imperiled species and plant associations and are implementing use of the Biodiversity Tracking and Conservation System

(BIOTICS) developed by NatureServe. This database includes taxonomic group, global and state rarity ranks, federal and state legal status, observation source, observation date, county, township, range, watershed, and other relevant facts and observations. BIOTICS also has an ArcView based mapping program 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 may be threatening the biodiversity at 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, the U.S. Forest Service, the U.S. Fish and Wildlife Service, and the Department of Defense. 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 communities according to their imperilment status provides guidance for where Natural Heritage Programs should focus their information-gathering activities. For species and communities deemed secure, only general information needs to be maintained by Natural Heritage Programs. Fortunately, these constitute the majority of most groups of organisms. On the other hand, for those species and communities that are by their nature rare, more detailed information is needed. Because of their rarity, gathering comprehensive and detailed 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 vulnerable to extinction 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 1.

Table 1. 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.

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 1, 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.

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 2 defines the special status assigned by these agencies and provides a key to abbreviations used by CNHP.

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. This factor takes into account aspects 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). This factor for an occurrence is evaluated relative to other known, and/or presumed viable, examples.

Condition/Quality – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. This includes measures such as reproduction, age structure, biological composition (such as the presence of exotic 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 aspects such as a species having access to habitats and resources

Table 2. 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.
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.
PDL	Proposed for delisting.
XN	Nonessential experimental population.
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.

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 rank and D representing a poor rank. These ranks for each factor 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 3.

Table 3. 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

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 PCA is designed 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, and hydrologic features; vegetative cover; and current and potential land uses. In developing the boundaries of a PCA, 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 exotic 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 that may extend far beyond PCA boundaries are necessary as well. This 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 4 for a summary of these B-ranks.

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 5 summarizes the P-ranks and their definitions.

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 may include the following

- 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.

Table 4. 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.

Table 5. 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.

Management Urgency Ranks

Management urgency ranks (M-ranks) indicate the timeframe in which it is recommended that a change occur in management of the 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 exotics, mowing, etc.) or people and site management (building barriers, re-routing 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 6 summarizes M-ranks and their definitions.

Table 6. 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.

Sites of Local Significance

Sites of Local Significance (SLS) are sites that include good examples of species or natural communities that may be too small or whose biological or ecological significance is not great enough to be considered exemplary in a statewide context. Therefore, these sites do not meet the minimum criteria for a PCA. However, they do contribute to the character of the local area and the overall local diversity of plants and communities present, and therefore warrant consideration at some planning level. SLS typically include sites that were surveyed but do not contain tracked species or communities. In some cases they are based on plot data where the full extent of a community is not known and the surveyed areas do not meet the minimum size requirement for an occurrence.

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 and 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, or 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 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. 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 a region 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 seventeen feet (5 m) on the ground (Mitsch and 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 San Miguel County, Boulder County, and City of Boulder.

In Colorado, the U.S. Fish and Wildlife Service, Region 6 has digital information available in the San Luis Valley, along the Front Range, and Montezuma County. The digital data is based on aerial photography from the the 1980s (U.S. Fish and Wildlife Service 2005). Printed maps are available for most of the state http://www.fws.gov/nwi/.

Colorado Division of Wildlife Riparian Maps

The Colorado Division of Wildlife (CDOW) riparian mapping project is a cooperative, interagency, multi-jurisdictional effort to provide spatial data of riparian and wetland habitat in Colorado. It supports a coordinated effort among agencies and land managers to protect and manage these important habitats by providing basic locational information on which habitats occur in what areas and regions. Partner agencies include the U.S. Forest Service, the Bureau of Land Management, the Environmental Protection Agency, the San Isabel Foundation, Great Outdoors Colorado, Ducks Unlimited, and the Colorado Natural Heritage Program. This effort began in 1990 and to date portions of approximately half of the quadrangles in Colorado have been mapped (Colorado Division of Wildlife 2006). All mapping in Fremont County has been completed.

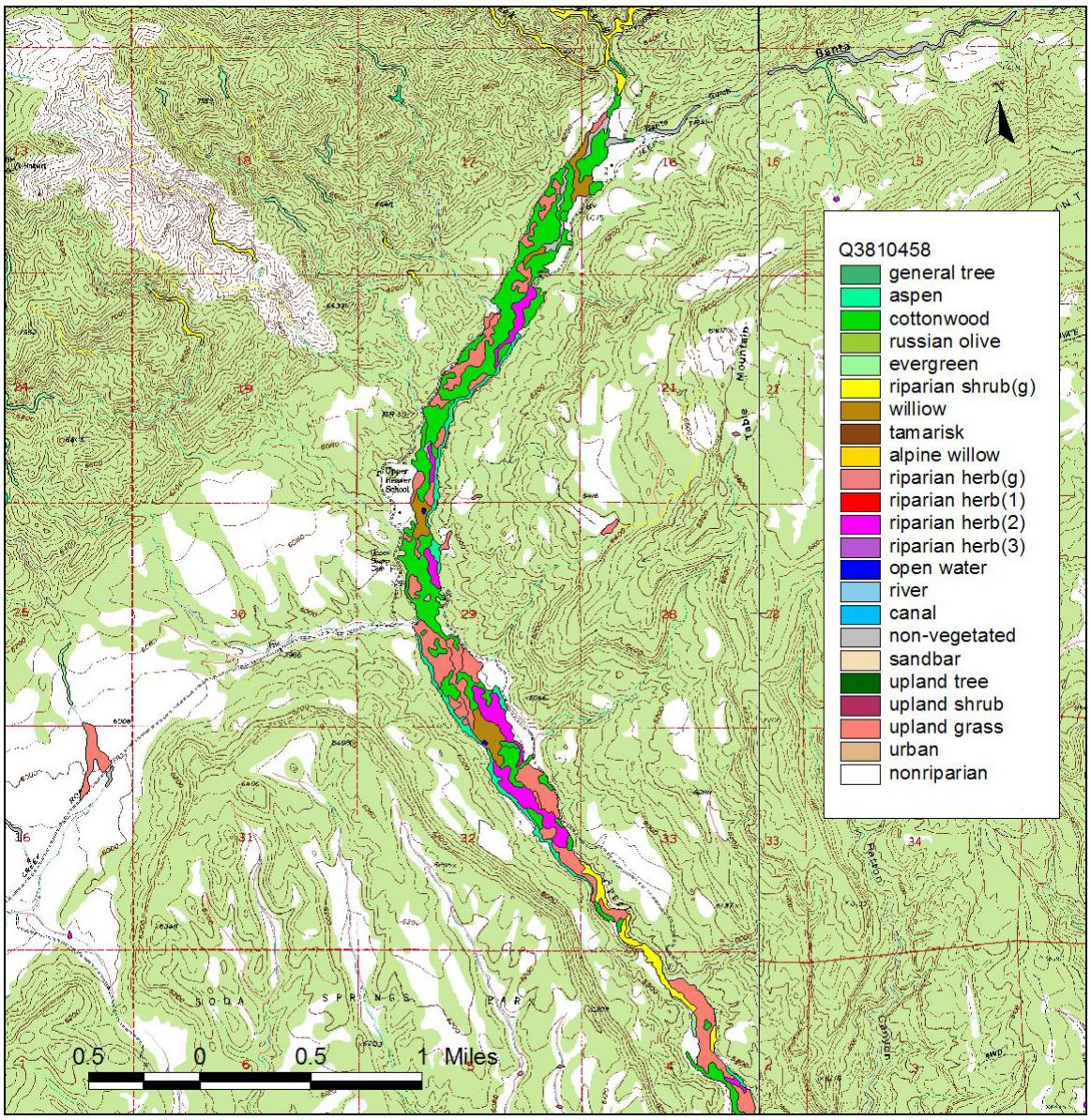
The mapping methodology used in this effort is photo interpretation of National Aerial Photography Program (NAPP) color infrared (CIR) aerial photos. Photos used to map Fremont County were taken in 1988 (McClean personal communication 2005). Riparian and wetland vegetation is mapped in stereo (using 3-dimensions) at a scale of 1:24,000 for a 7.5' USGS quadrangle map. Vegetation is delineated using the classification scheme presented in Table 7. Vegetation classes are identified on the CIR photos by color and structure and then by texture. Delineations of vegetation used line features for riparian corridors less than eighty feet wide and longer than five hundred feet. Polygon features were used where riparian vegetation was greater than eighty feet wide and a half an acre in size. Dominant and subdominant vegetation categories are identified. Delineated lines and polygons are then scanned into GIS (Colorado Division of Wildlife 2006). See Figure 1 for an example of a CDOW riparian mapping overlay on a quadrangle map.

Table 7. Colorado riparian habitat mapping project classification scheme (http://ndis1. nrel. colostate. edu/riparian/ClassScheme.htm).

CATEGORY	MAP CODE
RIPARIAN DECIDUOUS TREES	
Riparian Deciduous Tree - General	RT
Riparian Deciduous Tree - Aspen	RT1
Riparian Deciduous Tree - Cottonwood	RT2
Riparian Deciduous Tree - Russian Olive	RT3
Riparian Deciduous Tree - Birch	RT4
Riparian Deciduous Tree - Boxelder	RT5
Riparian Deciduous Tree - Green Ash	RT6
Riparian Deciduous Tree - Mulberry	RT7
RIPARIAN EVERGREEN	
Riparian Evergreen Tree - General	RE
Riparian Evergreen Tree - Blue Spruce	RE1
Riparian Evergreen Tree - Engleman Spruce	RE2
Riparian Evergreen Tree - Douglas Fir	RE3
Riparian Evergreen Tree - Lodgepole Pine	RE4
Riparian Evergreen Tree - Spruce/Fir	RE5
Riparian Evergreen Tree - Ponderosa Pine	RE6
Riparian Evergreen Tree - Cedar/Juniper	RE7
Riparian Evergreen Tree - Pinon/Juniper	RE8
Riparian Evergreen Tree - Juniper	RE9
RIPARIAN SHRUBS	
Riparian Shrub - General	RS
Riparian Shrub - Willow	RS1
Riparian Shrub - Tamarisk	RS2
Riparian Shrub - Alpine Willow	RS3
Riparian Shrub - Gambel Oak	RS4

CATEGORY	MAP CODE
Riparian Shrub - Sagebrush	RS5
Riparian Shrub - Alder	RS6
RIPARIAN HERBACEOUS	
Riparian Herbaceous - General	RH
Riparian Herbaceous - Cattails/Sedges/Rushes (With permanent standing water)	RH1
Riparian Herbaceous - Sedges/Rushes/Mesic Grasses (Waterlogged or Moist Soils)	RH2, RH3
WATER BODIES	
Open Water - Standing	OW1
Open Water - Riverine	OW2
Open Water - Canal	OW3
Open Water - Ephemeral	OW4
OTHER RIPARIAN	
Unvegetated	NV
Sandbar	SB
NON-RIPARIAN	
Upland Tree	UT
Upland Shrub	US
Upland Grass	UG
Upland Grass (Subirrigated Fields)	UG1
Irrigated Agriculture (Note: Only occurs as a subdominant class)	IA, AI, IR
Non-Riparian	X
Both polygon features and line features are mapped using this classification scheme, color infrared (CIR) aerial photographs, 7.5 minute topographic base maps and a minimum mapping unit (MMU) of 0.5 acres. This classification scheme utilizes a dominant/subdominant methodology of describing riparian habitat. Unless a polygon is at least 75% homogeneous, the dominant category is listed first followed by a slash (/) and the subdominant category. Example: RT1/RS1 = Aspen/Willow with aspen being the dominant category within the mapped polygon. NOTE: categories and map codes are condensed and lumped for certain National Forests. See CDOW (2006) for details.	

Figure 1. Colorado Division of Wildlife riparian mapping example.



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 groundwater 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—the 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.

When these wetland functions have an identifiable economic value to society they are referred to as ecological services. For example, the wetland function of floodflow alteration is the temporary storage of water. This function provides the ecological service of flood abatement, which can prevent monetary damage to resources. "Values" are subject to societal perceptions, whereas "functions" are biological or physical processes that 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. Two additional values that are independent of wetland function identified by Adamus and Stockwell (1983) include recreation and uniqueness/heritage value. Wetlands provide areas for fishing, bird watching, and other forms of recreation. Wetlands also support rare and unique plants, animals, and plant associations.

Groundwater Recharge and Discharge

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.). Groundwater 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 and Flood Attenuation

Dynamic surface water storage refers to the potential of the wetland to capture water from precipitation and upland surface (sheet flow). Sheet flow is non-channelized 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. 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.

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 streambanks and in vegetation, low gradient, formation of sand and gravel bars, high density of small and large depressions, and dense vegetation. Thus wetlands are capable of detaining 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.

Removal/Retention of Imported Nutrients, Toxicants, and Sediments

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.

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_2O) 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, a gently sloped gradient, and location next to beaver dams or human-made detention ponds/lakes.

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.

General Wildlife and Fish Habitat Diversity and Uniqueness

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 high vegetation cover. Wetland characteristics indicating good wildlife habitat are: good edge ratio, islands, high plant diversity, diversity of vegetation structure, and a sinuous and irregular basin.

Habitat diversity refers to the number of habitat types (e.g. Cowardin wetland classes, USNVC plant associations) 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. Uniqueness is as a value expresses the general distinctiveness 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.

Wetland Condition Assessment

For past county wetland survey and assessment projects, CNHP performed qualitative, descriptive functional assessments of wetlands. These assessments provided a rapid determination of each wetland's functional integrity based on qualitative indicators of structure, composition, and land use listed above according to the best professional judgment of CNHP ecologists. Assumptions required for most functional assessments include selecting a combination of measured variables that adequately represent wetland function and that such a combination results in an estimation of the degree to which the function is being performed. However, recent analysis suggests that most functional assessments are not rapid and do not directly measure functions (Cole 2006).

Given CNHP's goal of this survey in Fremont County is to identify and prioritize ecologically significant wetlands, surveys focused on assessing the ecological integrity or condition of each wetland rather than specific ecological functions, services or values. Condition assessments are 'holistic' in that they consider ecological integrity to be an "integrating super-function" (Fennessy et al. 2004). They provide insight into the integrity of a wetland's natural ecological functions that are directly related to the underlying integrity of biotic and abiotic processes. This measure of wetland condition assumes that ecological functions follow similar trends. This assumption may not be true for all functions, especially ecological services or those functions which provide specific societal value. For example, ecological services such as flood abatement or water quality improvement may still be performed even if ecological integrity has been compromised. CNHP's element occurrence ranking process is a rapid assessment of the condition of on-site and adjacent biotic and abiotic processes that support and maintain the element. This method was used to assess wetland condition for this report.

Hydrogeomorphic (HGM) Classification

Among other wetland classification approaches (e.g., Cowardin classes, USNVC plant associations), the hydrogeomorphic, or HGM, approach to wetland classification is being developed for Colorado 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). Thus it is called a "hydrogeomorphic" classification (Brinson 1993). There are four hydrogeomorphic classes present in Colorado: riverine, slope, depression, and mineral soil flats (Table 8). 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.

Table 8. 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 (down-stream)	R1-steep gradient, low order streams	Riparian communities in the upper reaches corridors flowing down the Sangre de Cristo Mountains, i.e. Bear Creek, Hayden Creek
				R2-moderate gradient, low to middle order	Chandler Creek
				R3-middle elevation, moderate gradient along small/mid-order stream	Lower reaches of Hamilton Creek and the unnamed tributary of Badger Creek at Howard
				R4-low elevation canyons or plateaus	Tributaries of Beaver Creek and of Eightmile Creek through Phantom Canyon
				R5-low elev. floodplains	Arkansas River
Slope	At the base of slopes, e.g., along the base of the foothills; also, places where porous bedrock overlying 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.	None identified during this survey, but fens potentially occur in the Sangre de Cristo Mountains
				S2-subalpine and montane fens on calcareous substrates	Falls Gulch wetland approaches this type
				S3-wet meadows at middle elev.	Mountaintop wetlands on Tanner Peak, Cooper Mountain, and likely others.
				S4-low elevation	Cottonwood Creek

Class	Geomorphic setting	Water Source	Water Movement	Subclass	Examples
				meadows	
Depressional	In depressions caused by glacial action (in the mountains) or oxbow ponds of 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	Bushnell Lakes and other high elevation lakes in the Sangre de Cristo Mountains
				D2-low elevation basins that are permanently or semi-permanently flooded	Highway 120 Wetland
				D3-low elevation basin with seasonal flooding	Depressional wetlands in Arkansas River floodplain
				D4-low elevation basins that are temporarily flooded	Abandoned beaver ponds
				D5-low elevation basins that are intermittently flooded	Playa lakes, such as Poncha Park
Mineral Soil Flat	Topographically flat wetland	Precipitation and groundwater	Two directional	F1-low elevation with seasonal high water table	Brush Hollow Reservoir

One of the fundamental goals of HGM is to create a system whereby every wetland is evaluated according to the same standard, especially for wetland functional assessments. 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 by employing a widely applicable classification tied to 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).

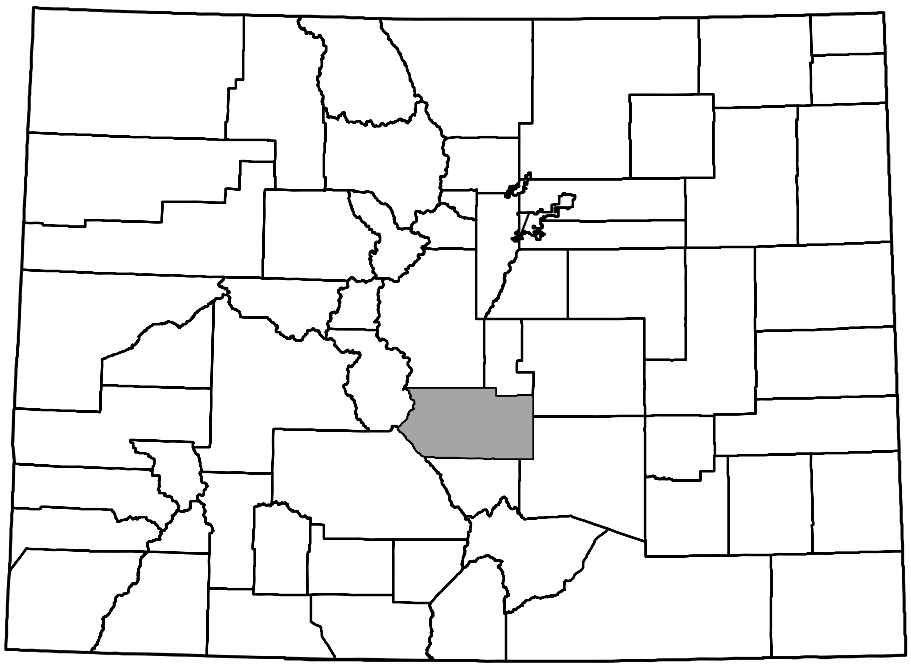
HGM assumes that the highest, sustainable functional capacity is achieved in wetland ecosystems and landscapes that have not been subject to long-term anthropogenic disturbance. Under these conditions, the structural components and physical, chemical, and biological processes in the wetland and surrounding 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.

PROJECT BACKGROUND

Location of Study Area

Fremont County is located along the convergence of the high plains and the Rocky Mountains in central Colorado (Figure 2). It encompasses 1533 square miles (397,045 ha) and ranges in elevation from 5000 to 13,105 feet (1523-3995 m). The lowest elevation occurs at the outflow of the Arkansas River from Fremont County on the eastern border. The highest elevations occur in the Sangre de Cristo Range on the west side of the county, with Bushnell Peak forming the highest point at 13,105 feet. In addition to the Sangre de Cristo Range, the principal mountainous features located within Fremont County include the Wet Mountains in southeastern portion and the foothills of Pikes Peak in the northeast. Additional local heights of land include mountains and hills in the vicinities of Waugh, Jack Hall, and Arkansas mountains. The northernmost area of the Wet Mountain Valley, the DeWeese Plateau, occupies the valley between the Sangre de Cristo and Wet mountains in southwestern Fremont County. The southernmost end of South Park occurs in the northwest portion of the county.

Figure 2. Location of Fremont County in Colorado.



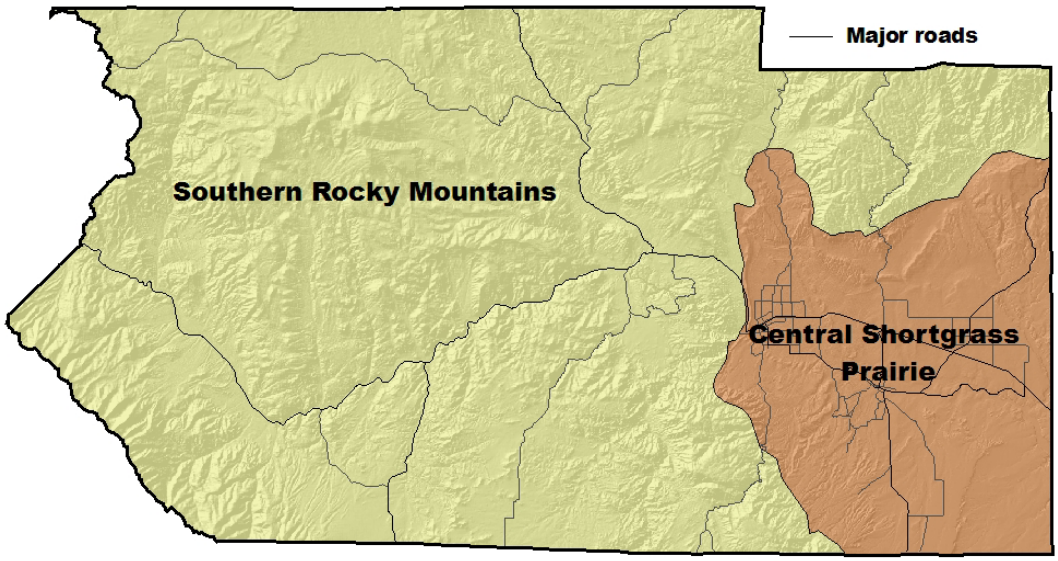
Ecoregions

Fremont County occupies an ecological transition zone between the Rocky Mountains and the Great Plains in Colorado, which creates a wide diversity of landscapes and topographic features. The flat to rolling grasslands and barrens east of Canon City give way to foothills with steep rugged canyons that carve out from the high mountains and

parklands (open grasslands) to the west. Fremont County has areas located within both the Central Shortgrass Prairie and Southern Rocky Mountains ecoregions as defined by The Nature Conservancy (modified from Bailey 1994; Figure 3). In Fremont County, the ecoregional boundary occurs on the eastern border of the county just north of Fort Carson and Beaver Creek State Wildlife Area near the El Paso County border. It bends around the foothills of Pikes Peak and extends northwest into the Beaver Creek drainage before turning south to the Wet Mountains where it skirts the foothills to the southern border of the county. The ecoregional boundary is just west of Canon City.

To the east of the ecoregional boundary is the Central Shortgrass Prairie ecoregion, which encompasses the Great Plains from southwestern Nebraska and southeastern Wyoming south through Colorado to the northeastern corner of New Mexico and the Okalahoma and Texas panhandles. Occupying the rainshadow of the Rocky Mountains, this ecoregion is dominated by shortgrass prairie with areas of mixed-grass prairie and shrublands. Its landscape is characterized by rolling plains and tablelands dissected by streams, canyons, barrens, and buttes (Central Shortgrass Prairie Ecoregional Planning Team 1998). Small patches of remnant tallgrass prairie occur along the base of the foothills and in other areas where the soils and moisture regime are appropriate. To the west of the ecoregional boundary is the Southern Rocky Mountains ecoregion, which extends from from southern Wyoming to northern New Mexico. It spans a large elevation range by including two major mountain systems and the intervening valley and parks (Neely et al. 2001). The Sangre de Cristo Mountains and the Front Range are the easternmost mountain system in the Southern Rocky Mountain ecoregion and the respective northern and southern extents of these ranges occur in Fremont County. The transition zone between the ecoregions is the foothills, which often contains biodiversity and landscape features of both ecoregions.

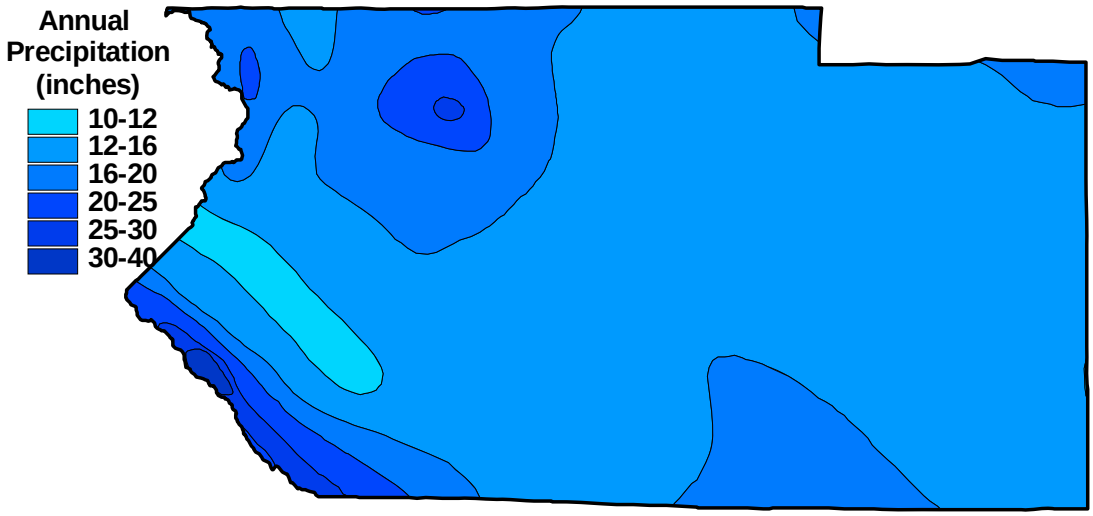
Figure 3. Ecoregions of Fremont County.



Climate

The climate within Fremont County varies greatly with elevation (Figure 4). Climate data for the past one hundred years was accessed via PRISM (Spatial Climate Analysis Service, 2005). Average annual precipitation within the region ranges from 11.5 inches (29.2cm) on the plains in southeastern Fremont County to approximately 21 inches (53cm) in the Sangre de Cristo Mountains on the southwest side of the county. Local heights of land such as Waugh Mountain and the foothills of Pikes Peak receive approximately 14 inches (35.5cm) annually while the Arkansas River Valley receives approximately 13 inches (33cm) of annual precipitation. Eighty percent of this precipitation falls between April and September. Thunderstorms are common in the mid- to late summer as wind patterns often shift to more southerly directions providing monsoonal moisture to convection storms (Doesken et al. 2003).

Figure 4. Annual precipitation in Fremont County.



Average annual maximum temperature ranges from 67.8ºF in the plains to 50.3ºF in the Sangre de Cristo Mountains. Average annual maximum temperature at Waugh Mountain is 62.4ºF. Valleys in Fremont County are cooler because of cold air drainage. Summers are hot with July tending to be the hottest month. Average annual minimum temperatures range from 35.3ºF on the plains to 21.2ºF in the mountains. Lowest average temperatures occur in January.

Elevation and orientation of mountain ranges affect general air movements in Fremont County and these affect local climatic conditions (Doesken et al. 2003). Wind patterns in Fremont County are predominately westerlies. This combined with proximity to mountain ranges sets the stage for periodic severe Chinook winds, which moderate the climate of the foothills. In fact, below Royal Gorge, winds persist to such a degree as to moderate localized climate near Canon City and Penrose, making the winter climate milder than anywhere else in Colorado (Doesken et al. 2003). The growing season is approximately 130 days in Canon City, whereas it is 81 days in Salida just west of the Fremont-Chaffee county line (Wheeler et al. 1995).

During the winter of 2004-2005, the Arkansas River watershed had 128% of average snowpack as of April 14, 2005. However, it had only 20% of average snowpack by June 24, 2005 (National Water and Climate Center 2005). Spring runoff (as measured at the Parkdale gauge station) began on May 16, 2005 and discharge fluctuated between 1000 and 2000 cubic feet per second (cfs) through July 7 with minor episodes of greater discharge over the next weeks before tailing off to 300-500 cfs for the remainder of the summer and fall (U.S. Geological Survey 2005).

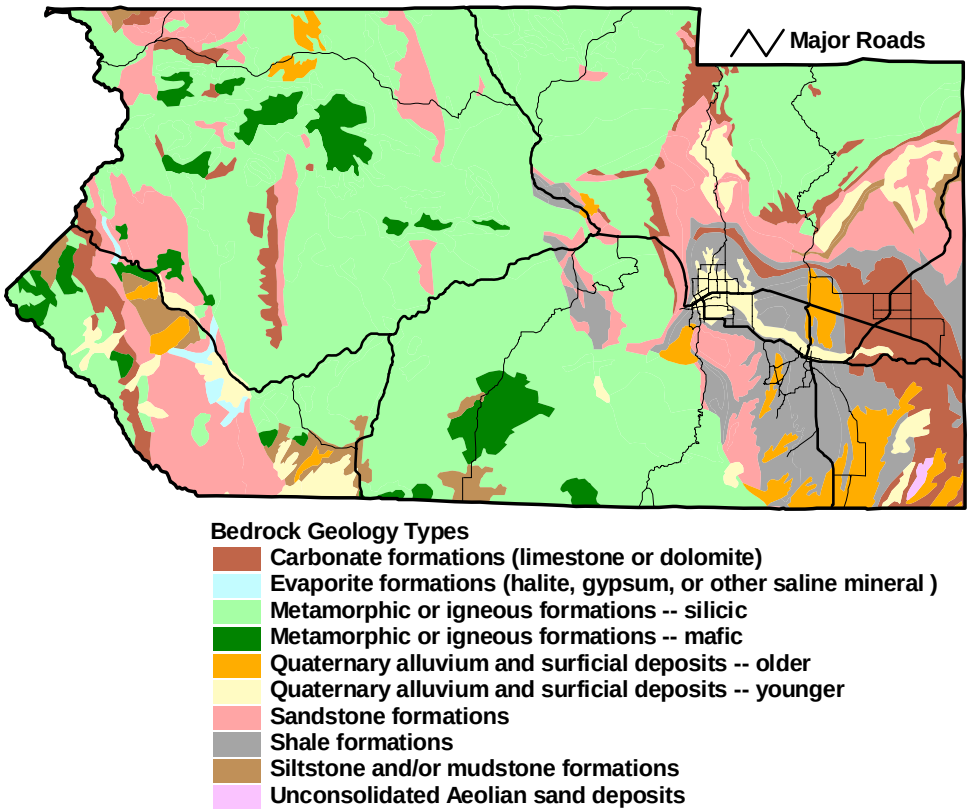
Geology

Bedrock types in Fremont County are diverse ranging from Precambrian basement rocks to Quaternary alluvium (National GAP Analysis Program 2005; Figure 5). Fremont County is in the tension between the mountains and plains; it demonstrates many important features of Colorado's geologic history. The mountains and foothills are remnants of the series of mountain building processes with their uplift and erosion cycles. The plains area, known as the Canon City Embayment, is the deposition zone of eroded materials from the orogenies as well as the edge of the inland seaways that covered the interior of the continent in times past.

The Canon City Embayment sits between the Wet Mountains and the southern end of the Front Range; it curls north of Canon City into the Fourmile drainage below the Cripple Creek area. Thick layers of limestones and shales were deposited, some of which were tilted up by the adjacent mountain building to form hogbacks and ridges (Beach 1982, Scott 1977, Wynne 1962, Gerhard 1967). The sequence of ebb and flow of marine waters over this landscape led to a temporal pattern as the area alternately supported a broad, swampy floodplain or formed a beach along the inland seas. Extensive evidence of dinosaur activity is found in Fremont County and its environs (Henry et al. 2004, Schultze and Enciso 1983). The differential erodability of some limestones, shales, and sandstones affects drainage patterns in this area. Drainages carving through sandstone hogbacks often have surficial water flow as they proceed through the gap in the hogback while the flow goes underground elsewhere in the drainages (away from the gap) during the dry seasons.

The sequence of mountain building and erosion alternating with influxes of inland marine seas led to an unusual distribution of limestones, dolostones, and shales in western Fremont County. Extensive areas of surficial bedrock geology dominated by limestones (although much of this is covered by Quaternary sediments) occur on the plains. However, seaways from the Early Paleozoic, before the orogeny of the Ancestral Rockies laid down limestones, shales, and sandstones including the Minturn and Belden Formations (Salotti 1961, Taylor et al. 1975a, Wallace and Lawson 1998, Anderson 2006). These layers were lifted by mountain building, covered by volcanic activity, and exposed again by erosion in the mountainous areas of western Fremont County. These formations are found high in the Sangre de Cristo Mountains and along Bernard Creek along 11 Road north of Cotopaxi. Waters flowing through some limestones, dolostones, and some mafic volcanic rocks become enriched, which can affect plant

Figure 5. Geology of Fremont County (National GAP Analysis Program 2006).



composition. Several rare wetland plants and plant communities are often found in these circumstances (Carsey et al. 2003).

The uplift of the Sangre de Cristo and Wet Mountains corresponded with the descent or downward movement of the adjacent Wet Mountain Valley and San Luis Valley, which are graben features (Colorado Geological Survey 2003, Hopkins and Hopkins 2000). Early uplift of these mountain ranges began around sixty million years ago. Thirty-five million years ago, a major period of volcanic activity erupted in the immediate vicinity of what is now Fremont County. The Thirtynine Mile and Cripple Creek volcanic centers near Guffey and the Mt. Princeton area in the Sawatch Range just northwest of Salida violently erupted, which dramatically changed the surrounding landscape (Epis 1979, Wobus et al. 1977, Wobus et al. 1979, Henry et al. 2004). Ash and debris were strewn across the area, much of it collecting in valleys (Wallace and Lawson 1998, Wallace et al. 1999). Andesitic lava flows from this time period are the basis for the bedrock types in much of northwestern and western Fremont County, extending to Table Mountain in the center of the county and beyond (Taylor et al. 1975b). These porous rock types are very permeable and seldom support surface water accumulation. The Cripple Creek volcanism led to mineralization and creation of gold-bearing ores that would dramatically impact land use and human settlement in the region during the late 1800's.

Continual uplift during the Tertiary unleashed the erosive capacity of rivers as their gradients steepened with the inexorable mountain building. The Arkansas River became

a predominant force, carving majestic canyons through what is now Fremont County. The river corridor near Cotopaxi and in the Royal Gorge are primary examples of this force. These areas are predominantly hard, granitic Precambrian bedrock, but they gave way to the erosive power of flowing water (Colorado Geological Survey 2003). After passing through its canyon in the mountains and foothills, the Arkansas River spills out onto the plains once it leaves Royal Gorge. The alluvial fan from this landscape juxtaposition covers the west portion of the Canon City Embayment area. No longer constricted in the canyon, the Arkansas River broadens into a wide floodplain as it begins to traverse the lower gradient in the plains.

The elevation achieved during the uplift of the mountains was high enough to harbor glacial ice during the Quaternary ice ages in the Sangre de Cristo Mountains and in the Pikes Peak area. Jagged peaks and U-shaped valleys characteristic of this mountain range are landforms carved by glacial activity (Colorado Geological Survey 2003). Glaciers also formed in the Sawatch Range. As the glaciers melted, large amounts of water-transported rocks, gravel, and sand were distributed in the outwash zones, which included Fremont County.

Soils

Soils in Fremont County are categorized by landform; they are divided by occurrence in the plains, foothills, or mountains (Wheeler et al. 1995). Plains soils occur in the eastern portion of the county between 5000 and 6000 feet (1525-1830 m) in elevation. They are generally well-drained and loamy having formed from alluvium derived from shale, limestone, or eolian sand and silt. Midway and Limon soils are exceptions; these are derived from shale and have clay textures. These clay soils can tend to build up salts in the root zone. In the foothills, between 5300 and 8500 feet (1615-2590 m), soils are highly variable, derived from many processes and rock types. However, foothills soils are generally shallow and have loamy and gravelly texture. Gneiss and granite are common bedrock types in this elevation zone and pinyon-juniper woodland is the dominant vegetation. One exception within the group of foothills soils is the Nunn series, which occupy fans and foot slopes. Nunn soils are generally clayey and support grassland vegetation. Mountain soils are generally found above 8000 feet (2440 m) although they occur at lower elevations in rock outcrop settings. They are primarily derived from igneous and metamorphic rocks and support conifer forests. Texture is generally loamy and gravelly or cobbly often with a high proportion of surface rock exposed.

Hydric soils in Fremont County consist of aquolls, aquic ustifluvents riverwash, and Bloom loam (USDA Soil Conservation Service 1993). Aquolls, Bloom loam, and cumulic cryaquolls form on stream and river terraces. Aquic ustifluvents and riverwash form in channels and on floodplains. Several soils mapped as clay loams and silty clay loams (e.g. Jodero clay loam variant, Manvel silty loam) as well as very poorly drained areas in loams (e.g., Shanta loam, Shrine loam) have inclusions of hydric soils. Of all mapped soils in Fremont County, only 0.02 percent are hydric soils (Natural Resources Conservation Service 2005).

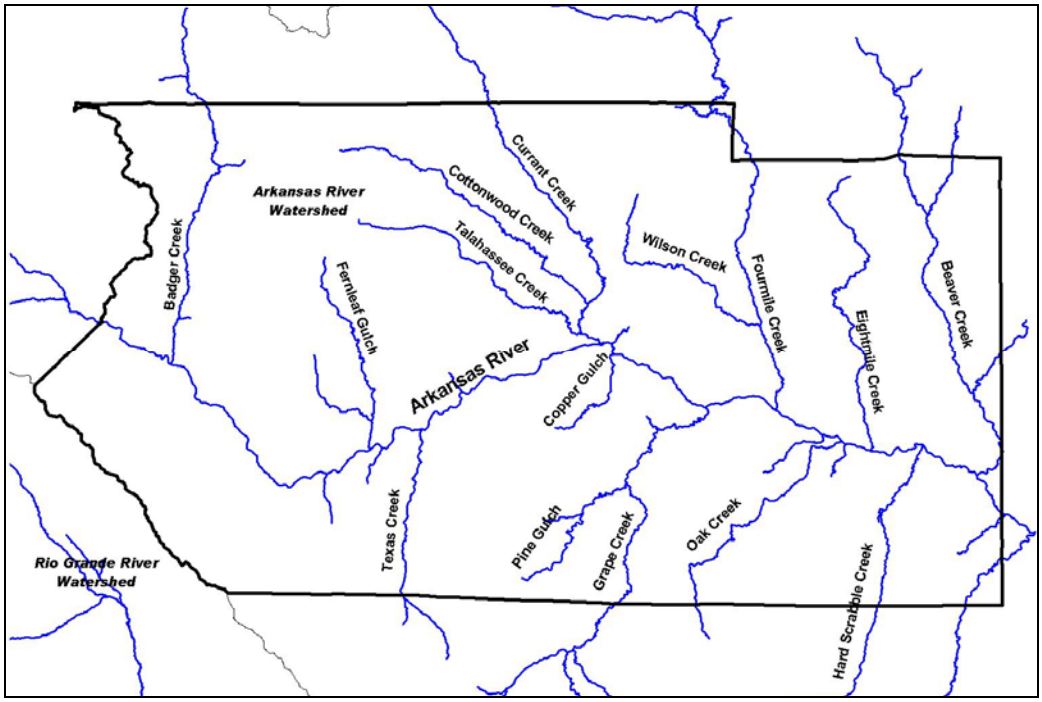
Rivers

The principal drainage within Fremont County is the Arkansas River. The headwaters of the Arkansas River are in the Sawatch Range near Leadville in Lake County, Colorado. By the time it flows out of Colorado; water in the Arkansas River drops more than 10,000 feet in elevation (Topper et al. 2003). In Fremont County the Arkansas River is a predominant influence on the landscape. Its tributaries have formed narrow, V-shaped canyons before flowing into the wider river valley running west to east through the central portion of the county. The mainstem forms a striking canyon in several areas of the county with a deep, rocky gorge, the Royal Gorge, through the northernmost Wet Mountains. Primary perennial drainages in Fremont County are shown in Figure 6.

Current impacts to water quality and quantity in the Arkansas River include ten major trans-basin diversions of surface water into the Arkansas River above the Pueblo Reservoir (Topper et al. 2003). Historically, mining was the major industry in the upper Arkansas Valley. Acid mine drainage negatively impacts water quality from the headwaters area downward, beginning with the California Gulch Superfund site in Leadville. In Fremont County, the river corridor is constricted by natural canyon features as well as by the rights-of-way for Highway 50 and the railroad, both of which follow the river through most of the county.

Alluvial aquifers associated with the Arkansas River are sparse in Fremont County and occur only in the eastern portion of the county at the confluence of Eightmile and Beaver creeks in Canon City and near Florence. There is also alluvial groundwater associated with the reach of Hardscrabble Creek within Fremont County. Surface waters contribute greater than 90% of the water withdrawals in Fremont County (Topper et al. 2003).

Figure 6. Major drainages in Fremont County.



Ecological Systems

The diversity of climate, geology, elevation, and soils within Fremont County leads to a wide range of ecological systems. Ecological systems are dynamic assemblages of plant and animal communities that occur together on the landscape, unified by similar ecological processes (e.g. climate as moderated by elevation and natural disturbance processes) and/or underlying abiotic environmental factors or gradients (e.g. bedrock geology and hydrology; NatureServe 2003). Ecological systems in the county range from alpine tundra at the highest elevations in the county on its west side to shortgrass prairie occupying the lowest elevations on the east side; all told, Fremont County spans all major ecological zones known to occur in Colorado, from alpine, subalpine, upper montane, lower montane, foothills, and plains.

The diversity of ecological systems in Fremont County may be best described along the wide elevation gradient contained within it. At the highest elevations, alpine tundra and shrublands grade into subalpine forests dominated by Engelman spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). These spruce-fir forests in turn grade into upper montane forests of mixed conifers and aspen (*Populus tremuloides*). Lodgepole or limber pine (*Pinus contorta* and *Pinus flexilis*) with small patches of bristlecone pine (*Pinus aristata*) grade into Douglas-fir (*Pseudotsuga menziesii*) and white fir (*Abies concolor*), often on north-facing slopes. Ponderosa pine (*Pinus ponderosa*) is common and dominant in many areas, although pinyon-juniper (*Pinus edulis-Juniperus monosperma-Juniperus scopulorum*) is the most prevalent woodland, especially on dry slopes at lower elevations. The foothills between the mountains and plains are characterized by Gambel oak (*Quercus gambelii*) scrub and/or mountain mahogany (*Cercocarpus montanus*) shrublands that blanket the dry, shallow soils of hogbacks and often intermingle with pinyon-juniper and ponderosa pine woodlands on slopes. Grasslands occupy valleys and are scattered in areas of deeper soils throughout the montane and foothill areas in the county. However, low elevations in the eastern portion of Fremont County fall in the rainshadow of the mountains to the west. Receiving less moisture, this region of the county is comprised of mid- and shortgrass prairie ecological systems. The prairie area in the eastern portion of Fremont County is strewn with areas of dry shale barrens that harbor endemic plants.

With the wide range of elevation in Fremont County there is a concurrent diversity of riparian ecological systems. These riparian systems are defined based on elevation and vegetation structure. These are linear systems that often form ecotones between upland and wetland systems (NatureServe 2003). Riparian systems in Fremont County include Upper Montane/Subalpine Riparian Forest and Woodland, Upper Montane/Subalpine Riparian Shrubland, Lower Montane Riparian Woodland, and Foothills Riparian Woodland and Shrubland ecological systems (Rondeau 2001).

The subalpine and upper montane zones have two systems, Upper Montane/Subalpine Riparian Forest and Woodland and Upper Montane/Subalpine Riparian Shrubland. These occupy elevations between 8000 to 11,000 feet (2440-3350 m) depending on aspect and topography. Forests and woodlands tend to occur on steeper gradients and in narrower valleys relative to shrublands, which tend to occupy broad shallow valleys in

this elevation zone. Upper Montane/Subalpine Riparian Forest and Woodlands comprise riparian corridors dominated by Engelman spruce-fir, blue spruce (*Picea pungens*), and aspen with spruce-fir occupying the subalpine and blue spruce and aspen occurring in the upper montane. Understories of these forests can be shrubby or herbaceous depending on soil characteristics and stream gradient. Upper Montane/Subalpine Riparian Shrubland are characterized by several willow species (*Salix bebbiana, S. boothii, S. drummondiana, S. geyeriana, S. monticola, S. brachycarpa, S. planifolia, S. wolfii*), thinleaf alder (*Alnus incana*), river birch (*Betula occidentalis*), red-osier dogwood (*Cornus sericea*), and shrubby cinquefoil (*Dasiphora fruticosa*). Several willows, barrenground willow (*Salix brachycarpa*), planeleaf willow (*S. planifolia*), and wolf willow (*S. wolfii*), tend to occupy the subalpine, whereas the remainder of the shrubs are more prevalent in the upper montane zone. Predominant understory species in these shrublands tend to be graminoids, especially sedges (*Carex* spp.) but wetter areas are often dominated by forbs (Rondeau 2001).

Riparian corridors in the lower montane elevation zone generally occur in V-shaped valleys in Fremont County between 6000 and 9000 feet (1830-2740 m). They are strongly dominated by narrowleaf cottonwood (*Populus angustifolia*) and generally have a somewhat well-defined to a well-defined shrub layer comprised of various species. Shrubs include thinleaf alder, river birch, red-osier dogwood, chokecherry (*Prunus virginiana*), and various willows. They often occur in monotypic stands but also form very diverse, intermixed stands. Lower Montane Riparian Woodland systems usually form immediately adjacent to river and stream reaches and in small patches surrounding springs. Herbaceous understories in these systems are highly variable.

The Foothills Riparian Woodland and Shrubland ecological system is generally found between 5000 and 7000 feet (1524-2133 m) on low to moderate gradient reaches. Woodlands are strongly dominated by plains cottonwood (*Populus deltoides*) although peachleaf willow (*Salix amygdaloides*) also occurs sporadically. Shrublands are more variable, but are often dominated by coyote willow (*Salix exigua*). Herbaceous understories in these systems are highly variable.

Variability in vegetation composition and spatial juxtaposition of tree and shrub species often reflects a patchy mosaic resulting from the dynamics of flooding. The severity and periodicity of flooding at local scales strongly influences the vegetation composition and structure that occurs at a site as well as the successional pathways that ensue (Campbell and Green 1968, Douhovnikoff et al. 2005). Watershed characteristics influence the flood regime, affecting the magnitude and frequency of flood events. These characteristics contribute to the pattern of annual hydrographs, the pattern of sediment delivery, and the characteristics of the sediment (Baker and Walford 1995). Vegetation and soil characteristics also have an impact on flooding. Vegetation and soils in the arid West have less ability to absorb and intercept rainfall relative to more humid regions. This lower ability to attenuate runoff leads to larger maximum flood peaks and flash flood potentials. Flooding in more arid regions are thus more likely to cause landform change (Osterkamp and Friedman 2000). As the scale of rainfall events that may induce

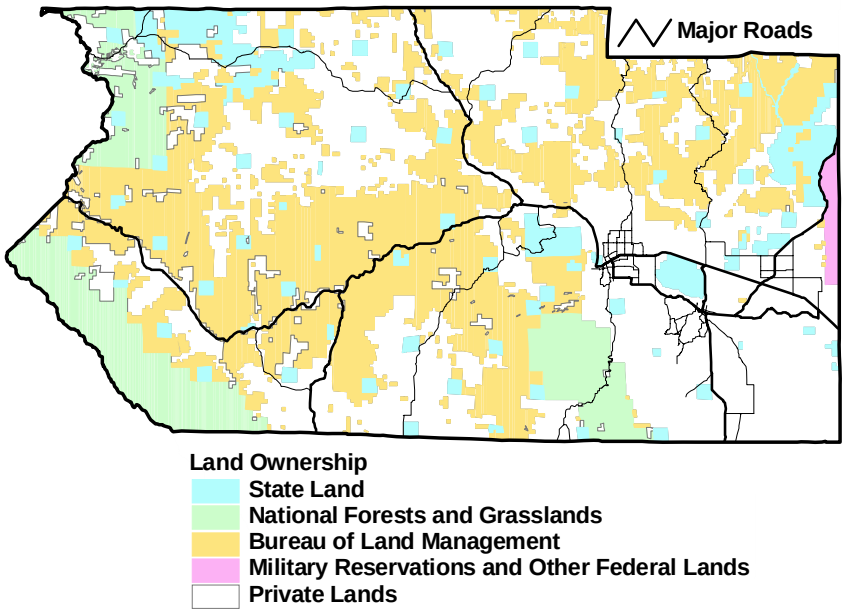
Top left: Lower montane narrowleaf cottonwood woodland; **Top right**: Subalpine aspen riparian forest; **Bottom left**: Arkansas River; **Bottom right**: Foothills riparian woodland. Photos taken by S. Neid.

flooding (like thunderstorm downbursts) is often local, unpredictable and relatively infrequent, channel and vegetation characteristics can be widely variable over space and time (Friedman and Lee 2002).

Land Ownership

Approximately half of the land within Fremont County is privately owned (Figure 7). Private lands are predominantly in southeast corner of the county as well as throughout the northern half of the county and along the south-central border in the Wet Mountain Valley. U.S. Forest Service lands occupy approximately ten percent of the county. The San Isabel National Forest occupies three separate areas in two ranger districts within the county. Two are in the Salida Ranger District on either side of Highway 50 and the Arkansas River, and the third area is in the Wet Mountains in the San Carlos Ranger District. The Bureau of Land Management holds approximately 34% of the county with one Area of Environmental Concern (ACEC) near Royal Gorge and two Wilderness Study Areas (WSAs) around Beaver and Grape creeks. Fort Carson Military Reservation occupies the northeastern border of Fremont County. State lands comprise eight percent of the land in Fremont County with two State Wildlife Areas and sixteen state trust lands managed by Colorado Division of Wildlife. There are several State Land Board sections and state and federal penitentiary lands.

Figure 7. Land ownership in Fremont County.



Population

Fremont County, with an estimated population size of 47,556, ranks twelfth in the state for this statistic. About half of the county's population is concentrated in the eastern half of the county in Canon City, Florence, and Penrose. The population increased by 43% between 1990 and 2000 (U.S. Census Bureau 2005). In the county, development is

occurring around Canon City, north of Cotopaxi, and in the northern portion of the county along 2 Road in the north. Residential development is occurring at all scales including high-density subdivisions and 35-acre parcels.

Land Use History

Fremont County has had a long history of settlement, being one of the first areas in what is now Colorado to be explored and settled (Campbell 1972). The Arkansas River was the de facto southern boundary of the Louisiana Purchase in 1803. Zebulon Pike and his exploration party explored what is now the Pikes Peak area in 1806, camping at the mouth of Royal Gorge.

Settlers first arrived to the plains area of what is now Fremont County in 1838, settling along Hardscrabble Creek and establishing trading posts. The population of settlements gradually grew as coal and oil were discovered in the greater Canon City area in the 1860's. Due to the mild climate in the area, a fruit-growing industry was established, expanding irrigation practices in the region. The railroad industry pushed through the region intensively by the 1880's. This infrastructure aided the population explosion that ensued when gold was discovered in the Cripple Creek/Victor area in the 1890's.

Extensive food production began, both agriculture and cattle ranching, and resource extraction intensified. In addition to the mineral extraction that was occurring timber cutting greatly increased for infrastructure (railroads, buildings, bridges) to support the mining boom. The effects of these activities are still visible on the landscape today. Episodes of catastrophic flooding impacted the infrastructure and economy of the region in the early 1900's, likely exacerbated by hydrologic alterations, extensive forest denudation, and intensive grazing in the region in prior decades. Riparian areas in several drainages like Eightmile and Grape creeks were completely washed out and stripped of vegetation.

As the mining era passed its zenith, tourism began to grow as a suspension bridge over Royal Gorge opened in 1929. Visitation to the region grew over the next decades. By the 1980's, utilization of the Arkansas River for recreation began in earnest and now a quarter million people float down the river in rafts each year.

Current land use in Fremont County is greatly influenced by topography and climate. Human use and development is highest in the eastern part of the county. This area contains many communities that are growing and serve as homes for people commuting to the cities of Canon City, Penrose, Florence, and Colorado Springs. The rest of the county, however, still retains a semblance of rural or small-town character, although that too is being increasingly altered by growth. Ranching, primarily livestock production, is widespread. Irrigated croplands occur in several parts of the county, especially in mountain and foothill valleys. Fruit production, orchards mostly, is still prevalent in the Canon City-Florence-Penrose area.

Mineral extraction is still prominent in the area. Numerous oil and gas wells, limestone mines, and sand and gravel quarries exist. Sand and gravel mining occur along most of the major drainages in the eastern part of the county.

CONSERVATION ASSESSMENT

Potential Impacts to Biological Diversity in Fremont County

General threats that may affect biodiversity on a large, landscape-level scale in Fremont County are summarized below. We understand that the issues discussed below are often important parts of a healthy economy and contribute to the well being of our society. We mention these general "impacts to biodiversity" with the hope that good planning can minimize the impacts where critical habitat resides.

Hydrological Modifications

River impoundment in the form of lakes, reservoirs, irrigation ditches, and canals can affect aquatic dependent plants and animals (Chien 1985, Friedman et al. 1998). Reservoirs affecting waters in Fremont County mostly occur outside of the county. Annual flooding is a natural ecological process that can be severely altered by the construction of dams, reservoirs, and other water diversions. These water diversions and impoundments have altered the normal high peak flows that were once a part of the natural hydrological regimes of the rivers and their tributaries. These periodic floods are necessary for continued viability of most riparian vegetation. For example, many plants, including cottonwood trees, reproduce primarily with flooding events (Rood and Mahoney 1993). As plant composition changes in response to alterations in the flooding regime, the composition of the aquatic and terrestrial fauna may also change.

In addition to 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. For example, point bars are required for some species of willows to regenerate, terraces are required for mature cottonwood/shrubland forests, and old oxbow reaches may eventually provide habitat for many wetland communities. By stabilizing a river, the creation of these geomorphic settings is often eliminated. Thus, the plant communities that require such fluvial processes are no longer able to regenerate or survive. In general, the cumulative effects from dams, reservoirs, and channelization on plant communities 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 groundwater withdrawals. Many historical wetlands, such as seeps and springs, have been lost or altered due to water "development" projects, such as water diversions or impoundments. The number of species supported by a manmade pond with minimal edge habitat is generally less than the number supported by an extensive intact seep and spring wetland or naturally occurring pond.

Development

Residential development is a localized but increasing impact in Fremont County, especially near Canon City and in scattered areas throughout the rest of the county. Development creates a number of stresses, including habitat loss and fragmentation, introduction and proliferation of non-native plant species, fire suppression, and predation and disturbance from domestic animals (dogs and cats) (Oxley et al. 1974, Coleman and Temple 1994). Increasing human density in an area can lead to a change in the composition of wildlife populations (e.g., numbers of foxes and coyotes may increase, or number of bird species present may decrease), and may also alter movement patterns and behavior of wildlife. Loss of habitat to development is considered irreversible.

Recreation

Recreation, once very local and perhaps even unnoticeable, is increasing and having a greater impact on natural ecosystems in Fremont County. Different types of recreation (e.g., motorized versus non-motorized activities) typically have different effects on ecosystem processes. All-terrain vehicles (ATVs) can disrupt migration and breeding patterns of many animal species and fragment habitat for native resident species. This activity can also threaten rare plants found in non-forested areas. ATVs have also been identified as a vector for spreading invasive non-native plant species.

Non-motorized recreation, mostly hiking but also some mountain biking and rock climbing, presents a different set of issues (Cole and Knight 1990, Knight and Cole 1991; Miller et al. 1998, 2001). Wildlife behavior can be significantly altered by repeat visits of hikers or bicyclists. Trail placement should consider the range of potential impacts on the ecosystem. Considerations include minimizing fragmentation by leaving large undisturbed areas of wildlife habitat where possible (Colorado Department of Natural Resources 1998). Miller et al. (1998) found lower nest survival for grassland birds adjacent to trails; they also found that grassland birds were more likely to nest away from trails with a zone of influence approximating 250 feet (75 meters). 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 can be high.

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 Gambel oak scrub next to a grassland; Forman and Godron 1986). Edges are often created by naturally occurring processes such as floods, fires, and wind. Edges can also be created by human activities such as roads, trails, timber harvesting, agricultural practices, and rangeland management. Edges are often dominated by plant and animal species that are adapted to disturbance. As the landscape is increasingly fragmented by large-scale, rapid anthropogenic conversion, these edges become increasingly abundant in areas that may have had few “natural” edges. The overall reduction of large landscapes jeopardizes the existence of specialist species (e.g.,

forest interior birds), may increase non-native species, and may limit the mobility of species that require large landscapes or a diversity of landscapes for their survival (e.g., large mammals or migratory waterbirds).

Roads

There is a complex, dense network of roads in many parts of Fremont County due primarily to mining, agricultural uses and residential development. Expansion of the existing road network in some areas will detrimentally affect the biodiversity of the region. Roads are associated with a wide variety of impacts to natural communities, including invasion by non-native plant species, increased depredation and parasitism of bird nests, increased impacts of pets, fragmentation of habitats, erosion, pollution, and road mortality (Noss et al. 1997).

Roads function in a variety of ways for different species. They can act as conduits for or barriers to dispersal, and as habitats, and therefore, as sources or sinks for some species. Roads create edges along otherwise unfragmented landscapes, thus creating habitat 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 patterns, and therefore inhibit important interior species (Forman and Alexander 1998).

Effects on wildlife can be categorized as road avoidance and mortality due to vehicular collisions (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); thus, these species will not be located along roads.

Non-native Species

Although non-native species are mentioned repeatedly as stresses in the above discussions because they may be introduced through so many activities, they are included here as a general threat as well. Non-native plants or animals can have wide-ranging impacts. Non-native plants can increase dramatically under the right conditions and dominate a previously natural area (e.g., a native grassland adjacent to a railroad right-of-way). This can generate secondary effects on animals (particularly invertebrates) that depend on native plant species for forage, cover, or propagation. Effects of non-native fishes include competition that can lead to local extinctions of native fishes and hybridization that corrupts the genetic stock of the native fishes. Riparian corridors in Fremont County, as with much of the arid West, have been impacted by invasion of tamarisk (*Tamarix ramosissimum*) and Russian olive (*Eleagnus angustifolia*) (Lesica and Scott 2001, Stromberg 1988). Non-native pasture grasses that are prevalent in Fremont County wetlands include timothy (*Phleum pretense*), redtop (*Agrostis gigantea*),

Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), common dandelion (*Taraxacum officinalis*), sweet clovers (*Melilotus* spp.), white Dutch clover (*Trifolium repens*), red clover (*Trifolium pratense*), and quackgrass (*Elytrigia repens*).

Livestock Grazing

Domestic livestock grazing has been a traditional livelihood in Fremont County since the late 1800s and has left a broad and sometimes subtle impact on the landscape. For some prairie species, such as the Mountain Plover and McCown's Longspur, properly managed grazing is not only a compatible activity, but is, in fact, considered essential (e.g. see Gillihan et al. 2001 for grazing recommendations for shortgrass prairie bird species). However, some range management practices can adversely affect the region's biological resources. Many riparian areas in Fremont County are used for rangeland. Because there is little surface water available in the county, riparian areas often serve as the only available water. Additionally, riparian areas are often areas of the highest production of grasses and forbs. Long-term, incompatible livestock use of wetland and riparian areas can potentially erode stream banks, cause streams to downcut, lower the water table, alter channel morphology, impair plant regeneration, establish non-native species, shift community structure and composition, degrade water quality, and diminish general riparian and wetland functions (Windell et al. 1986). Depending on grazing practices and local environmental conditions, impacts can be minimal and largely reversible (slight shifts in species composition) to severe and essentially irreversible (extensive gullying and introduction of non-native forage species).

Logging

Most logging operations require a network of roads. The impacts from roads can result in threats to biodiversity (see "Roads" for more detailed discussion). Other logging impacts include loss of wildlife habitat, habitat fragmentation, soil erosion, and lower water quality for aquatic species. The U.S. Forest Service monitors logging closely; nonetheless, problems can still occur (Husong and Alves 1998). The effects of logging on biodiversity have not been determined in Fremont County.

Recommended Conservation Strategies

Conservation Strategies can be classified as three major types:

1. Land protection accomplished through conservation easements, land exchanges, long term leases, purchase of mineral, grazing, or water rights, acquisition, or government regulation;

2. Management of the land influenced so that significant resources are protected; and

3. Public education about the significant ecological values of the county to engender support for land use decisions that protect these values.

The first step in facilitating any of the conservation strategies suggested above is to identify the significant elements of biodiversity and their locations in the county. This report and the accompanying GIS data provide information necessary for this first step. The next step is to use this information to conserve these elements and the areas that support them. The PCA descriptions within this report provide protection and management suggestions for most areas identified during the inventory. However, some general recommendations for conservation of biological diversity in Fremont County are given here.

1. Develop and implement a plan for protecting the Potential Conservation Areas profiled in this report, with most attention directed toward areas with a biodiversity rank of B1, B2 and B3. The PCAs in this report provide a basic framework for implementing a comprehensive conservation program. The B1, B2 and B3 sites, because they have global biological significance, are in need of priority attention. Consider incentive-based programs such as 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 state and federal funding for conservation projects, such as those offered through the Colorado Division of Wildlife or the Farm Bill. Continue to promote cooperation among local entities to preserve the county's biodiversity. Encourage county leadership to institutionalize consideration of significant biological resources in land use planning. There are no B1 sites for wetland or riparian areas in Fremont County, however there are several for endemic upland plants.

2. Use this report in the review of proposed activities in or near Potential Conservation Areas to determine whether or not activities adversely affect elements of biodiversity. All of the PCAs presented contain elements of biodiversity of state or global significance. Weighing the biodiversity represented by PCAs should allow planners and biologists to consider natural resource conservation when making land use decisions.

Certain land uses on or near a site may affect the element(s) present there. Range-restricted species may be especially vulnerable to habitat destruction, while 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 are considered, they should be compared to the maps presented herein (also available in GIS format). 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. Also, CNHP is continually

updating biodiversity data throughout the state and can provide up-to-date information in the area of concern. To contact CNHP's Environmental Review Coordinator call (970) 491-7331. Other key partners, such as the Colorado Division of Wildlife, can be valuable resources as well, particularly in evaluating potential impacts to biological resources not tracked by CNHP (e.g., game species).

3. Recognize the importance of larger, contiguous natural communities. While the PCAs identified in this report contain 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 part of our natural diversity, and their needs for winter range and access to 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 educated 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 *Planning Trails with Wildlife in Mind* published by the State Trails Program (Colorado Department of Natural Resources 1998) for suggestions regarding planning trails with minimum impacts to wildlife.

4. Increase efforts to protect biodiversity by promoting cooperation and incentives among landowners, pertinent government agencies, and non-profit conservation organizations. Involve all stakeholders in land use planning. The long-term protection of natural diversity in Fremont County will be facilitated by the cooperation of 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. By developing incentives that encourage biodiversity considerations in land-use planning, the likelihood of conserving biodiversity should increase. Such incentives will make planning for conservation a higher priority for private and public entities.

5. Promote wise management of the biodiversity resources that exist within Potential Conservation Areas. Development of a site-specific conservation plan is a necessary component of the long-term protection of a PCA. Because some of the most serious impacts to Fremont 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 current rate of population growth in Colorado, rare and imperiled species will likely decline if not given appropriate protection or management attention.

Coordinate with managers of public parks or other public lands that support sensitive biological resources. Engage local citizens, groups, and organizations (e.g., schools, 4-H clubs, Native Plant Society) in assisting with management and monitoring projects on public lands. Make a concerted effort to involve individual landowners in conservation dialogue, as applicable.

6. Stay informed and involved in public land management decisions. Approximately fifty percent of Fremont County is publicly owned. The Bureau of Land Management owns approximately thirty-five percent and the U.S. Forest Service approximately ten percent. The State and the Department of Defense own approximately eight percent and one percent, respectively. Many of the PCAs in Fremont County are on public land and may be protected from development, but not from incompatible uses. Even ownership is not always secure, since federal and state agencies are becoming more and more involved in land exchanges. Encourage protection for the most biologically significant sites on public lands by implementing compatible management activities designated in Forest Management Plans, Grazing Management Plans, etc.

7. Continue inventories and monitoring where necessary, including inventories for species that cannot be surveyed adequately in one field season and continue inventories on lands that CNHP could not access in 2005. Not all targeted inventory areas can be surveyed in one field season due to several factors, including 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 were not documented during the survey. Thus, it is recommended that this report and the data included within it serve as a guide for subsequent surveys of Fremont County.

8. Continue to take a proactive approach to weed and exotic species 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, exotic, invasive species such as tamarisk, Russian olive, dalmation toadflax (*Linaria dalmatica*), purple loosestrife (*Lythrum salicaria*), and non-native fish species. Further, natural area managers, public agencies, and private landowners should be encouraged to remove these species from their properties. Enforce the use of weed-free forage on horse trails. Encourage the use of native species for revegetation and landscaping efforts. Ideally, seed should be locally harvested. This includes any seeding done on county road right-of-ways. The Colorado Natural Areas Program has published a book entitled *Native Plant Revegetation Guide for Colorado* that describes appropriate species to be used for revegetation. This resource is available on the World Wide Web at http://www.parks.state.co.us/home/publications.asp#CNAP.

9. Encourage public education functions and publications. A significant early step in the process of conserving biodiversity is educating local citizens and other stakeholders on the value that such areas offer the public. As described in this report, Fremont County is rich in animal and plant diversity and includes 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 Fremont 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. Consider developing a community conservation website to provide information on natural resources, biological diversity, and conservation opportunities in Fremont County. Enlist the assistance of local media in public education efforts.

10. Develop and implement comprehensive program 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 (i.e., 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 Fremont County wetlands. Encourage and support statewide wetland protection efforts such as CDOW's Wetlands Program. 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 Fremont County.

METHODS

The methods for assessing and prioritizing conservation needs over a large area are necessarily diverse. The Colorado Natural Heritage Program follows a general method that is continuously being developed specifically for this purpose. The Natural Heritage Survey described in this report was conducted in several steps summarized below. Additionally, input from the Royal Gorge Office of the Bureau of Land Management and the Colorado Division of Wildlife were sought at all stages.

Collect Available Information

CNHP databases were updated with information regarding the known locations of species and significant plant communities within Fremont County. A variety of 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, Rocky Mountain Herbarium, and local private collections. The Colorado Division of Wildlife provided extensive data on a range of species. Both general and specific literature sources were incorporated into CNHP databases, either in the form of locational information or as biological data pertaining to a species in general. Other information was gathered to help locate additional occurrences of natural heritage elements. Such information covers basic species and community biology including range, habitat, phenology (reproductive timing), food sources, and substrates. This information was also entered into CNHP databases.

Identify Rare or Imperiled Species and Significant Plant Communities with the Potential to Occur in the County

The list of wetland plant associations thought to occur in Fremont County was derived from the Colorado Statewide Wetland Classification and Characterization (CSWCC) project (Carsey et al. 2003), which is based on the U.S. National Vegetation Classification (Anderson et al. 1998), the accepted national standard for vegetation. The CSWCC utilized and integrated previously collected data from the Classification of Riparian Wetland Plant Associations of Colorado (Kittel et al. 1999), CNHP wetland surveys, and Colorado State University. The CSWCC incorporated all these data on riparian and other wetlands collected during the past fifteen years as well as data from other researchers to avoid duplication of effort.

The information collected in the previous step was used to refine a list of potential species and natural plant communities and to refine our search areas. In general, species and plant communities that have been recorded from Fremont County or from adjacent counties, are included in this list. Species or plant communities preferring habitats that are not included in this study area were removed from the list. Over 150 rare species and significant plant communities were targeted in these surveys. Given the limited amount of time and funding for this research, a specific subset of species and communities were the priority of our inventory efforts. These elements were considered to be a priority because of their high level of biological significance (G1-G3) and/or because they are

known to occur in areas that are subject to various development pressures such as hydrological alterations and residential development.

The amount of effort given to the inventory for each of these elements was prioritized according to the element's global status rank. Globally rare (G1-G3) elements were given highest priority; globally common (G4 or G5) elements that are rare in the state (S1-S3) were of a lower priority.

Identify Targeted Inventory Areas

Survey sites were chosen based on their likelihood of harboring rare or imperiled species or significant plant communities. Previously documented locations were targeted and additional potential areas were chosen using available information sources. Areas with potentially high natural values were selected using aerial photographs, geology maps, vegetation surveys, personal recommendations from knowledgeable local residents, and numerous roadside surveys by our field scientists.

Using the biological information stored in the CNHP databases, areas having the highest potential for supporting specific elements were identified. Those chosen for survey sites appeared to be in the most natural condition. In general, this means those sites that are the largest, least fragmented, and relatively free of visible disturbances such as roads, trails, fences, and quarries were identified.

The above information was used to delineate Targeted Inventory Areas (TIAs) that were believed to have relatively high probability of harboring significant natural resources. These areas focused on private lands. Additional TIAs were identified by the Bureau of Land Management and the Colorado Division of Wildlife.

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

Because there were limited resources to address an overwhelming number of potential sites, surveys for all elements were prioritized by the degree of imperilment. For example, the species with Natural Heritage ranks of G1-G3 were the primary target of our inventory efforts. Although species with lower (less rare) Natural Heritage imperilment 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 if encountered.

Contact Landowners

Obtaining 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 GIS

land ownership coverage obtained from Fremont County Planning and Zoning Department. Landowners were then either contacted by phone 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 private properties surveyed without landowner permission.**

Conduct Field Surveys

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

The methods used in the surveys 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 to document their presence. These are summarized below:

- Amphibians: visual observation and capture using aquatic dip nets
- Reptiles: visual observation
- Mammals: live traps, pitfall traps and mist nets
- Birds: visual observation or identification by song or call
- Insects: aerial net and visual observation
- Plants: visual observation
- Plant communities: visual observation

The 2005 survey of Fremont County focused on wetland and riparian plants and plant communities. Where necessary and permitted, voucher specimens were collected and deposited in local university museums and herbaria.

When a rare species or significant plant community was discovered, its precise location and known extent was recorded with a global positioning system (GPS) unit. Other data recorded at each occurrence include 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 size of the population or community, the condition or naturalness of the habitat, and the landscape context (its connectivity and its ease or difficulty of protecting) of the occurrence. These factors are combined into an element occurrence rank, useful in refining conservation priorities. See the previous section on Natural Heritage Methodology for more about element occurrence ranking.

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. 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 targeted inventory area (TIA), which can include ditching, adventive plant species, plant species indicative of intensive livestock use, stream bank destabilization, major hydrologic alterations, extensive 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 assessments were the preferred method as it is the only technique that can yield high-confidence statements concerning the known or potential presence of rare and imperiled elements or excellent examples of common natural communities. On-site assessments are also the most resource intensive because of the effort required to contact landowners. In a few 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 CHHP was unable to contact the landowner during the time frame of this study.

Delineate Potential Conservation Areas

Finally, since the objective for this inventory is to prioritize specific areas for conservation efforts, Potential Conservation Area (PCA) boundaries were delineated. The goal of the PCA 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, and hydrologic features; vegetative cover, and current and potential land uses. In developing the boundaries of a PCA, 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 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 exotic species;
- land necessary for management or monitoring activities.

Delineate Networks of Conservation Areas

- Occasionally a landscape area will encompass many Potential Conservation Areas that share similar species or natural communities and ecological processes. Or a landscape will stand out on a regional scale as a large and minimally fragmented

area that is relatively ecologically intact. In these cases, a Network of Conservation Areas (NCA) is delineated. For example, in South Park, Park County, Colorado, there are numerous extreme rich fens that are physically isolated from one another, yet they all contain the same types of rare plants and plant communities. Each of the isolated fens has been included in its own PCA. Yet, when considering the "big picture" of the overall landscape, these fens probably interact with each other and influence each other on a larger scale. In order to capture this repeating pattern and higher-level interactions on the landscape scale, a NCA is delineated. An example of a relatively intact landscape on a regional scale is the Laramie Foothills in northeastern Larimer County. Most NCAs are drawn at a regional scale that may be best represented on a statewide map.

Delineate Sites of Local Significance

After PCAs and NCAs have been delimited, the remaining data collected is evaluated for inclusion as Sites of Local Significance (SLS). These are sites that include good condition but small size or of species or natural communities that are common and already documented in the study area. However, they do contribute to the character of the local area and the overall local diversity of plants and communities present, and therefore warrant consideration at some planning level.

RESULTS

One hundred twenty-eight Targeted Inventory Areas (TIAs) for wetland and/or riparian areas were identified for evaluation during the 2005 field season. Eighty-nine TIAs (70%) were visited during 2005 (Figure 8); an effort was made to select TIAs that potentially had natural hydrology, native species composition, and vegetation structure intact. Of the 128 TIAs, fifty (39%) were addressed within Potential Conservation Areas and nine (7%) became sites of local significance. On-site inspection of 28 (22%) TIAs revealed impacts from roads, buildings, non-native species, agriculture, and/or grazing and data were not processed. Due to time limitations, 39 (30%) of the TIAs were not visited. All TIAs are shown on Figure 8.

Results of the 2005 Fremont County survey confirm that there are many wetland and riparian areas with high biological significance. Several rare plants and animals depend on these areas for survival. All together 22 wetland or riparian communities of concern and one imperiled wetland plant species have been documented in Fremont County in this report (Table 9). The CNHP database currently houses more than 244 element occurrence records within Fremont County. As part of this project, thirty new element occurrence records were created and 24 element occurrence records were updated.

CNHP has identified 42 Potential Conservation Areas (PCAs) in or partially contained in Fremont County. Twenty-four of these PCAs address wetland or riparian elements and are presented in this report (Figure 9 and Table 10). Seventeen of these PCAs include private or state lands. Of the 24 PCAs presented in this report, ten are of very high biodiversity significance (B2), twelve are of high biodiversity significance (B3), one is of moderate biodiversity significance (B4), and one is of general biodiversity significance (B5). Of the 24 PCAs presented in this report, eleven are newly created based on fieldwork from 2004. Twelve existing wetland or riparian PCAs were updated with changes in site boundaries and in element occurrences of interest. Among the PCAs not presented in this report there is one that is of outstanding biodiversity significance (B1) that addresses globally rare, upland, endemic plants of the chalk barrens in the Arkansas River Valley. Sites of Local Significance are listed in Table 11 and discussed after the PCAs.

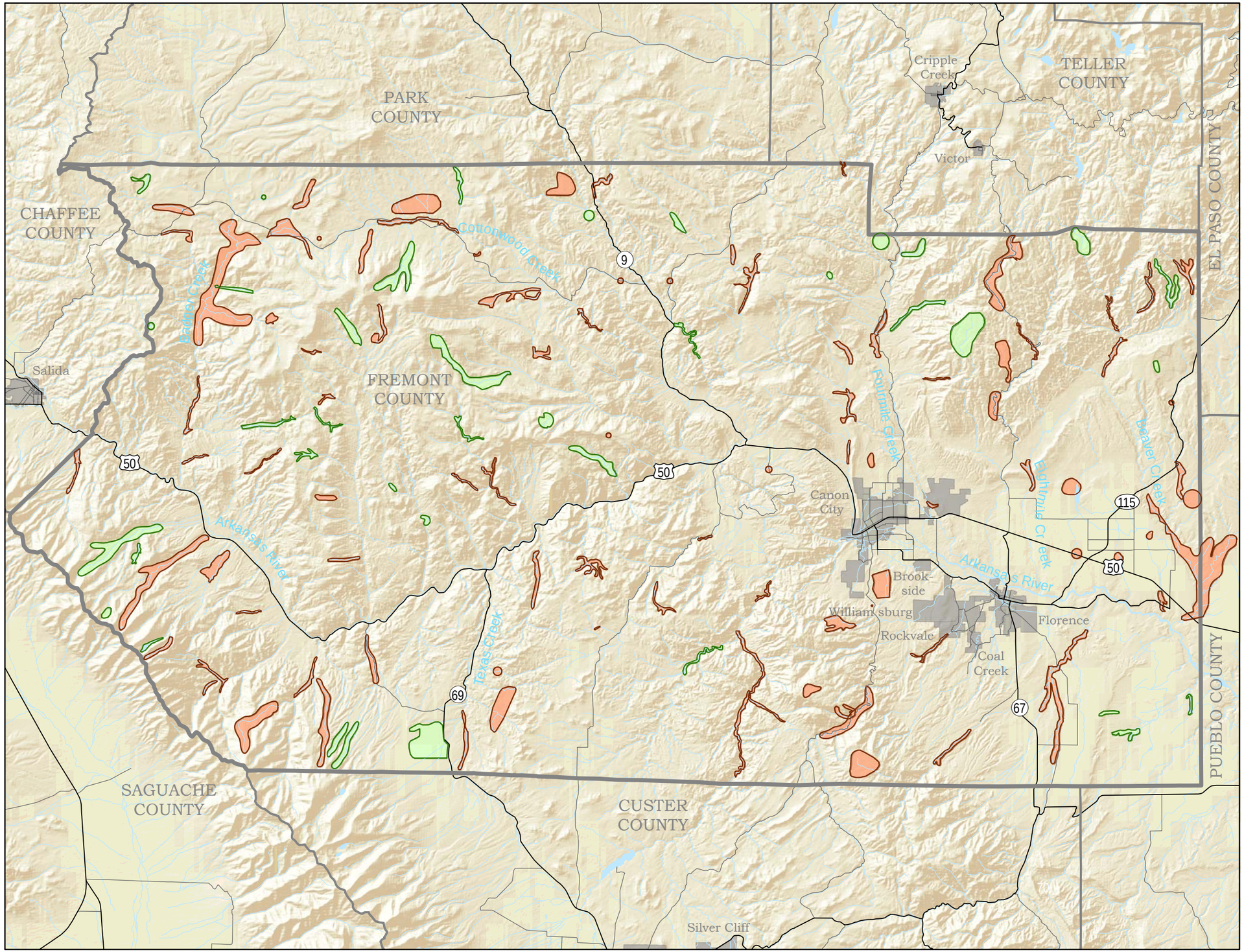
Table 9. List of known wetland and riparian elements of concern for Fremont County.

Element	Common Name	G-rank	S-rank
PLANTS			
Sisyrinchium pallidum	pale blue-eyed grass	G2G3	S2
PLANT COMMUNITIES			
Abies concolor - Picea pungens - Populus angustifolia / Acer glabrum Forest	Montane Riparian Forests	G2	S2
Abies lasiocarpa / Mertensia ciliata Forest	Montane Riparian Forests	G5	S5
Alnus incana / Mesic Graminoids Shrubland	Montane Riparian Shrubland	G3	S3
Betula occidentalis / Maianthemum stellatum Shrubland	Foothills Riparian Shrubland	G4?	S2
Betula occidentalis / Mesic Graminoids Shrubland	Lower Montane Riparian Shrublands	G3	S2
Carex simulata Herbaceous Vegetation	Wet Meadow	G4	S3
Eleocharis palustris Herbaceous Vegetation	Emergent Wetland	G5	S4
Juniperus scopulorum / Cornus sericea Woodland	Riparian Woodland	GNR	S3S4
Picea pungens / Betula occidentalis Woodland	Montane Riparian Woodland	G2	S2
Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3
Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2
Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3
Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S2
Populus angustifolia / Salix exigua Woodland	Narrowleaf Cottonwood Riparian	G4	S4
Populus angustifolia / Salix irrorata Woodland	Foothills Riparian Woodland	G2	S2
Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland	Plains Cottonwood Riparian Woodland	G3G4	S3
Populus tremuloides / Alnus incana Forest	Montane Riparian	G3	S3
Populus tremuloides / Betula occidentalis Forest	Montane Riparian Forests	G3	S2
Pseudotsuga menziesii / Betula occidentalis Woodland	Montane Riparian Forest	G3?	S3
Pseudotsuga menziesii / Cornus sericea Woodland	Lower Montane Riparian Forests	G4	S2
Salix planifolia / Mesic forbs Shrubland	Subalpine Willow	G4	S4

Element	Common Name	G-rank	S-rank
Sarcobatus vermiculatus / Distichlis spicata Shrubland	Saline Bottomland Shrublands	G4	S2

Table 10. Fremont County wetland and riparian Potential Conservation Areas

Potential Conservation Area	Protection Urgency Rank	Management Urgency Rank
B2: Very High Biodiversity Significance		
Beaver Creek at Sugar Loaf	P5	M4
Cottonwood Creek at Little Crampton Mountain	P4	M3
Felch Creek	P4	M4
Grape Creek	P4	M4
Hayden Creek	P4	M4
Little High Creek at Booger Red Hill	P5	M4
Little Mack	P4	M5
Phantom Canyon of Eightmile Creek	P4	M4
Poncha Park	P5	M4
Unnamed Tributary to Badger Creek at Howard	P5	M5
B3: High Biodiversity Significance		
Bear Creek below Simmons Peak	P4	M4
Big Cottonwood Creek at Battle Mountain	P5	M3
Chandler Creek	P5	M5
Cottonwood Creek at Little Crampton Mountain	P4	M3
East Gulch at Bull Gulch	P4	M4
Falls Gulch	P3	M3
Hamilton Creek	P4	M4
Lion Canyon	P5	M4
Little Badger Creek	P3	M2
Red Creek Canyon	P4	M4
Sand Gulch at Copper Mountain	P4	M4
Stout Creek	P4	M4
B4: Moderate Biodiversity Significance		
Mill Gulch Tributary	P4	M3
B5: General Biodiversity Significance		
Brush Hollow Reservoir	P3	M3



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Map Date: 5/16/2006

Legend

CNHP Wetland/Riparian Targeted Inventory Areas

- Visited
- Not Visited

Colorado Base Data

- Counties
- Municipalities
- Lakes, Reservoirs
- Rivers, Streams, Creeks
- Highways
- Major Roads

Digital Elevation Model Produced by the U.S.G.S.

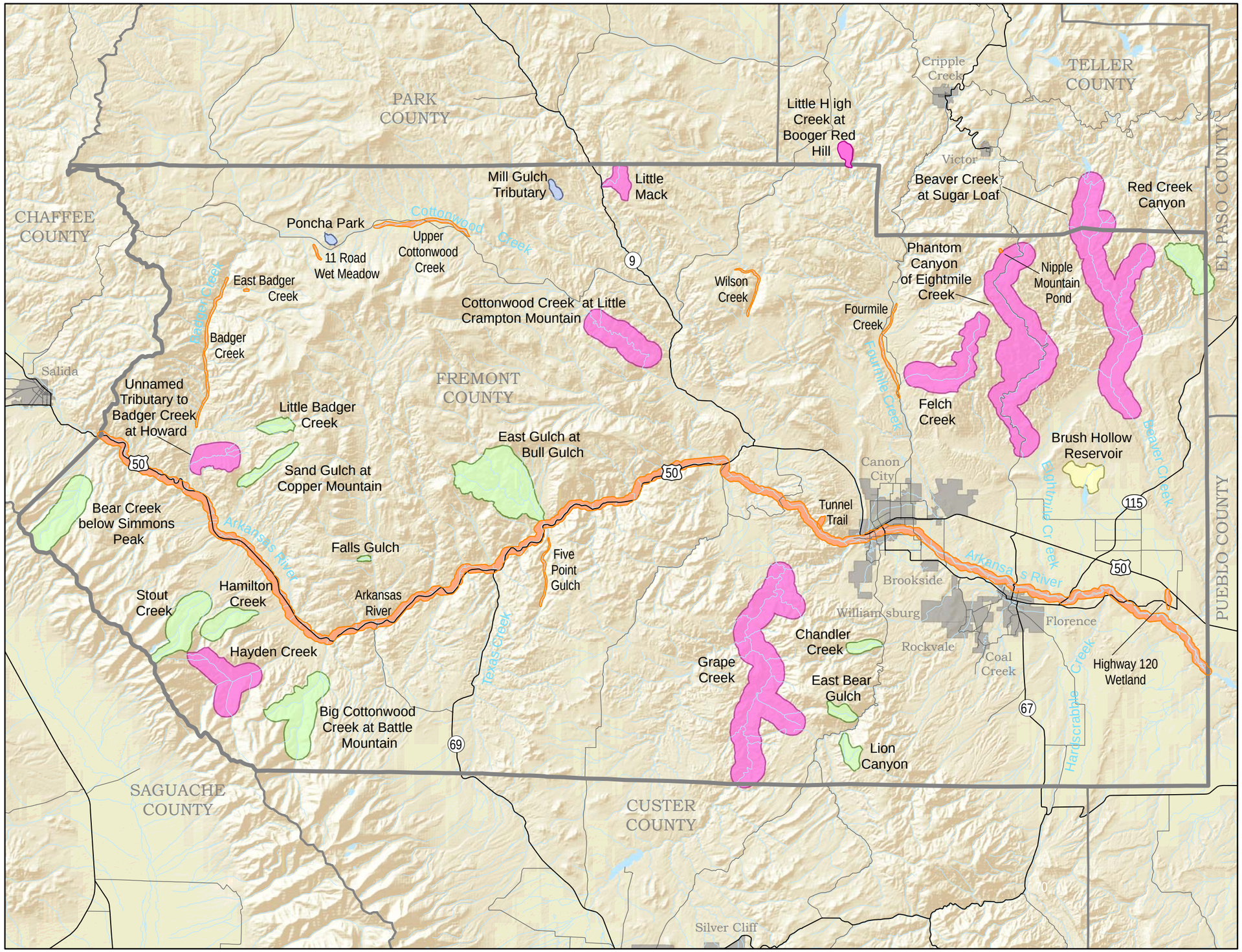
Location in Colorado

Targeted Inventory Areas are believed to have a relatively high probability of harboring significant biological resources.

N

0 2 4 8 Miles

Map 1. Wetland/Riparian Targeted Inventory Areas in Fremont County



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Legend

CNHP Wetland/Riparian Potential Conservation Areas (PCAs) by Biodiversity Significance Rank

- B2: Very High Biodiversity Significance
- B3: High Biodiversity Significance
- B4: Moderate Biodiversity Significance
- B5: General Biodiversity Interest

Upland PCAs are not displayed on this map

- Sites of Local Significance

Colorado Base Data

- Counties
- Municipalities
- Lakes, Reservoirs
- Rivers, Streams, Creeks
- Highways
- Major Roads

Digital Elevation Model Produced by the U.S.G.S.

Location in Colorado

PCAs represent CNHP's best estimate of the primary area supporting long-term survival of targeted species, subspecies and natural communities.

N

0 2 4 8 Miles

Map 2. Wetland/Riparian Potential Conservation Areas and Sites of Local Significance in Fremont County

Table 11. Sites of Local Significance in Fremont County.

Name	**Quadrangle map**	**Plant association**
11 Road Wet Meadow	Black Mountain	*Dasiphora fruticosa / Deschampsia flexuosa* Shrubland
Arkansas River	several	several
Badger Creek	Jack Hall Mountain, Howard	*Populus angustifolia / Salix exigua* Woodland
Cottonwood Creek	Black Mountain, Thirtynine Mile Mountain	*Juncus balticus* Herbaceous Vegetation, *Carex nebrascensis* Herbaceous Vegetation
East Badger Creek	Jack Hall Mountain	*Alnus incana* / Mesic forbs Shrubland
Five Points Gulch	Echo	*Populus angustifolia – Juniperus scopulorum* Woodland, *Carex nebracensis* Herbaceous Vegetation
Fourmile Creek	Cooper Mountain	*Populus deltoides – (Salix amygdaloides) / Salix exigua* Woodland
Highway 120 Wetland	Pierce Gulch	*Typha latifolia* Herbaceous Vegetation
Tunnel Trail	Royal Gorge	*Aquilegia chrysantha* var. *rydbergi*

DISCUSSION

General patterns of riparian biodiversity in Fremont County are dictated by elevation, landform, and stream gradient. Thus, different areas of Fremont County have different expressions of wetland and riparian biodiversity. General areas with distinct patterns are found in the Sangre de Cristo and Wet Mountains; the low, rugged hills surrounding the Arkansas River; and the plains surrounding Canon City to the eastern border of the county.

Headwaters of riparian systems flowing down the north face of the Sangre de Cristo Mountains begin in alpine zones, often in glaciated cirques. These riparian systems descend rapidly to their confluence with the Arkansas River, dropping 6000 feet (1830 m) in less than ten miles. High-elevation riparian communities begin below the talus slopes. Alpine willow carrs of planeleaf willow (*Salix planifolia*) and wolf willow (*Salix wolfii*) intermingle with and then transition to spruce-fir (*Picea engelmanii – Abies lasiocarpa*) riparian communities. Aspen (*Populus tremuloides*) begins to enter the canopy forming mixed aspen-evergreen and then aspen-dominated reaches depending on beaver activity. Lower in the montane zone, the tree canopy (as well as the underlying shrub layer) of the riparian corridor becomes very diverse before transitioning to narrowleaf cottonwood (*Populus angustifolia*) to the confluence at approximately 8000 feet (2440 m). The shrub layers in these corridors are often dense and very diverse. They seldom form extensive monotypic stands, instead forming intermingled patches. Riparian corridors in the Wet Mountains follow a similar pattern although they lack the alpine and subalpine components. Bear Creek below Simmons Peak PCA, Big Cottonwood Creek at Battle Mountain PCA, and Lion Canyon PCA are examples of this pattern of riparian biodiversity.

The rugged, low elevation (6000-8500 feet; 1830-2590 m) hills that comprise the majority of Fremont County have intermittent to ephemeral drainages that carve through the rocky landscape. These drainages often have variable stream gradients and valley depths. Deeper, more canyon-like, tributaries tend to have higher gradients and are vegetated with Narrowleaf cottonwood – Douglas fir (*Populus angustifolia – Pseudotsuga menziesii*) or Narrowleaf cottonwood / Bluestem willow (*Populus angustifolia / Salix irrorata*) woodlands. Beaver Creek at Sugar Loaf PCA and Little High Creek at Booger Red Hill PCA are examples of this landform and biodiversity pattern. Broader, more moderate to low gradient corridors are often dry, sandy washes characterized by Narrowleaf cottonwood – Rocky Mountain juniper (*Populus angustifolia – Juniperus scopulorum*) Woodlands. Cottonwood Creek at Little Crampton Mountain PCA, Phantom Canyon of Eightmile Creek PCA, and Unnamed Tributary to Badger Creek at Howard PCA are examples of this expression. Throughout this area, the most common riparian vegetation is Narrowleaf cottonwood / Coyote willow (*Populus angustifolia / Salix exigua*) Woodland, which is also common throughout the state. This plant association represents an early successional stage.

The plains area occupies the lowest elevations in Fremont County. Many tributaries are downcut through the dry, erodable soils. Plains cottonwood (*Populus deltoides*) is the characteristic tree throughout this area and Plains cottonwood – (peachleaf willow) / coyote willow (*Populus deltoides – (Salix amygdaloides) / Salix exigua*) Forest is most common along riparian areas. The Beaver Creek at Sugar Loaf PCA contains an element occurrence of this plant community.

In addition to the general patterns of biodiversity, several plant associations were identified that are unique in Fremont County. Some are relatively common on a statewide scale, but uncommon in Fremont County and vice versa.

Scattered throughout Fremont County there is a relatively high proportion of river birch (*Betula occidentalis*) compared to the rest of the state. It often co-occurs with thinleaf alder (*Alnus incana*). It is hypothesized that river birch indicates groundwater seepage or more aerated substrates (Carsey et al. 2003). In Fremont County, river birch is often found in reaches with known springs or groundwater inputs (e.g. Mill Gulch Tributary PCA and East Gulch at Bull Gulch PCA). Several sites in Fremont County have both thinleaf alder and river birch, sometimes in distinct patches and sometimes intermingled in the shrub layer. These riparian areas would be good study sites for research directed at identifying environmental parameters that may drive the prevalence of one shrub species over the other.

Top left: Engelman spruce-subalpine fir/Fringed Bluebells Forest and Planeleaf willow/Mesic forbs Shrubland at Bushnell Lakes. **Top right**: Narrowleaf cottonwood-Douglas fir Woodland in a tributary of Eightmile Creek. **Bottom left**: Narrowleaf cottonwood-Rocky Mountain juniper Woodland in Five Point Gulch. **Bottom right**: playa in Poncha Park. Photos taken by S. Neid.

There are very few jurisdictional wetlands in Fremont County and only one was identified as having biodiversity that is unique within the county. Falls Gulch PCA contains the only wetland in Fremont County surveyed in 2005 that is dominated by analogue sedge (*Carex simulata*). This is a relatively common wetland association in Colorado (it is ranked S4). The particular site at Falls Gulch is a spring-fed wetland that has soil characteristics approaching that of montane fens. The peaty muck substrate was measured at 12.6 inches (32 cm), which is less than the threshold identified for fens (U.S. Fish and Wildlife Service 1998). However, there may be small areas within this wetland that have deeper organic soils.

The Poncha Park PCA contains the only natural playa from the surveyed Targeted Inventory Areas. Other playas likely existed in the eastern portion of the county in the Central Shortgrass Prairie ecoregion; they may have been converted to stock ponds, tailings ponds, or water treatment facilities. Poncha Park is at the southern end of South Park, which contains several complexes of playas (Rondeau personal communication 2005). The playa in Poncha Park is isolated from other playas, but still may provide important habitat.

The Brush Hollow Reservoir PCA is the only example of the flats hydrogeomorphic class from the surveyed Targeted Inventory Areas in Fremont County. Although much more common in the San Luis Valley and in the Great Basin outside of Colorado, Brush Hollow contains an area of greasewood (*Sarcobatus vermiculatus*) that is only found in small patches in the eastern portion of the county. This area of greasewood around Brush Hollow Reservoir is likely smaller than it may have originally been due to the creation of the reservoir.

Lastly, there were several natural community occurrences already known from Fremont County that were documented in the mid- to late 1990's. Several of these occurrences on BLM lands were re-visited and re-assessed; they showed positive ecological improvements as a result of land management changes since their initial survey. Grape Creek is an example. After years of monitoring and attenuating grazing impacts by BLM staff, riparian vegetation is expanding. Cottonwood trees, devastated by torrential annual flooding, have established in many areas and are maturing (see photos below).

Photo of Grape Creek Wilderness Study Area taken by R.J.Rondeau 8-12-1995

Photo of Grape Creek Wilderness Study Area 7-29-2005
Biggest changes in ten years are the establishment of *Populus angustifolia* in creek foreground and herbaceous riparian vegetation is expanding.

POTENTIAL CONSERVATION AREA PROFILES

The 24 Fremont County PCAs documented in this report are profiled in this section. The PCAs are organized in ascending order according to their Biodiversity Rank (e.g., B1 to B5). Although the amount of information we have on the PCAs is highly variable, each PCA profile includes the following information:

Biodiversity Rank (B-rank): The overall significance of the PCA in terms of rarity of the Natural Heritage resources and the quality (condition, abundance, etc.) of the occurrences. Please see Table 4 for rating criteria for the biodiversity ranks.

Protection Urgency Rank (P-rank): An estimate of the timeframe in which conservation protection should occur. This rank generally refers to the need for a major change of protective status (e.g., ownership or designation as a natural area). Please see Table 5 for the definitions of the ranks.

Management Urgency Rank (M-rank): An estimate of the timeframe in which conservation management should occur. Using best scientific estimates, this rank refers to the need for management in contrast to protection (legal, political, or administrative measures). See Table 6 for the definitions of the ranks.

Location: General location and specific road/trail directions.

Legal Description: U.S.G.S. 7.5-minute quadrangle name.

General Description: A brief narrative describing the topography, vegetation, current use, and size of the potential conservation area. Common names are used along with the scientific names.

Key Ecological Processes: A list of natural disturbance or environmental properties that define the vegetation within a PCA.

Biodiversity Comments: A synopsis of the rare species and significant plant communities that occur in the PCA. A table within the PCA profile lists the element occurrences found within the PCA, their rarity ranks, the occurrence ranks, federal and state agency designations, and the last observation date. When the same element is listed more than once in the table, it is because there are multiple element occurrences of that element within the PCA. Where there is more than one element occurrence in the PCA, the occurrence(s) of primary of concern is in boldface in the table. See Table 1 for explanations of global and state imperilment ranks and Table 2 for legal designations.

Boundary Justification: Justification for the location of the preliminary conservation planning 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 Comments: A summary of major land ownership issues that may affect the PCA and the element(s) in the PCA.

Management Comments: A summary of PCA management issues that may affect the long-term viability of the PCA.

Please note that 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 manager may wish to consider how specific activities or land use changes within or near the PCAs 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.

Beaver Creek at Sugar Loaf

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Big Bull Mountain, Mount Big Chief, Mount Pittsburg, Phantom Canyon

Size: 12,893 acres (5,218 ha) **Elevation:** 5,750 - 9,800 ft (1,753 - 2,987 m)

General Description: Beaver Creek drains the southern slopes of Pikes Peak and forms a steep-sided valley that winds through craggy granitic hills before spilling out onto the plains below. The foothills above the riparian corridor are rugged; their steep sides have shallow soils interspersed among rock outcrops. They are blanketed with a mix of ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*), which transitions to pinon - juniper woodland (*Pinus edulis - Juniperus scopulorum* and *J. monosperma*) at lower elevations. The plains below are a mosaic of shale barrens and prairie interspersed among ranches and low intensity residential development. Beaver Creek and its tributaries span elevation zones from upper and lower montane to foothills to plains and the character of the riparian vegetation shifts with elevation and stream gradient. Higher in the watershed, in the foothills and montane zones, the steep, rugged, sparsely vegetated hills lead to flashy flood regime. The channel is boulder-strewn and fast-flowing. The moderately high gradient of Beaver Creek above the confluence of the east and west branches has carved steep-sided, narrow valleys where Douglas-fir (*Pseudotsuga menziesii*) is more prevalent than narrowleaf cottonwood (*Populus angustifolia*). Below the confluence, the somewhat steep gradient along the riparian corridor has a mosaic of riparian shrubland and riparian woodland vegetation associations; portions of the reach have thinleaf alder (*Alnus incana*) dominated shrublands, others are dominated by river birch (*Betula occidentalis*). Amidst these, emerge sections with narrowleaf cottonwood canopy over mixed thinleaf alder and river birch. Coyote willow (*Salix exigua*) forms locally dominant patches where the channel is more sandy and chokecherry (*Prunus virginiana*) forms dense copses higher above the channel. The ground layer, where present, has limited abundance of mesic herbs due to heavy shade and lots of poison ivy (*Toxicodendron radicans*). As Beaver Creek emerges from its canyon, bluestem willow (*Salix irrorata*) becomes abundant and the stream gradient lessens. Plains cottonwood (*Populus deltoides*) becomes dominant in the canopy as the creek leaves the foothills, widens, and rolls through the barrens and prairie to the Arkansas River. The riparian corridor is lined with coyote willow and pockets of lush herbs. In the lower portion of the site, Beaver Creek is lined with hay meadows and there are some old homesteads scattered along the reach. There are irrigation ditches and small local diversions to the adjacent hay fields. Far upstream

in the watershed is Skagway Reservoir.

Key Environmental Factors: Montane, foothills, and plains elevation zones; moderate to high stream gradient.

Biodiversity Significance Rank Comments (B2): This site encompasses a good (B-ranked) occurrence of a globally imperiled (G2/S2) riparian natural community, narrowleaf cottonwood / bluestem willow (*Populus angustifolia / Salix irrorata*) woodland. It has several excellent (A-ranked) occurrences of globally vulnerable riparian natural communities; one each of narrowleaf cottonwood / thinleaf alder (*Populus angustifolia / Alnus incana*) woodland (G3/S3), narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland (G3/S2), and thinleaf alder / mesic graminoids (*Alnus incana* / mesic graminoids) shrubland (G3/S3). There is a good (B-ranked) occurrence of the globally vulnerable Geyer willow - mountain willow / mesic forbs (*Salix geyeriana - Salix monticola* / mesic forbs) shrubland (G3/S3), an excellent (A-ranked) occurrence of the apparently globally secure (G4?/S2) river birch / starry false lily of the valley (*Betula occidentalis / Maianthemum stellatum*) shrubland and a good (B-ranked) occurrence of the globally vulnerable (G3G4/S3) plains cottonwood - (peachleaf willow) / (coyote willow, sandbar willow) (*Populus deltoides* - (*Salix amygdaloides*) / *Salix* (*exigua, interior*) woodland.

Natural Heritage element occurrences at the Beaver Creek at Sugar Loaf PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia / Salix irrorata Woodland	Foothills Riparian Woodland	G2	S2				B	2005-07-29
Natural Communities	Alnus incana / Mesic Graminoids Shrubland	Montane Riparian Shrubland	G3	S3				A	2005-07-29
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				A	2005-07-25
Natural Communities	Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3				A	2005-07-29
Natural Communities	Salix geyeriana - Salix monticola / Mesic Forbs Shrubland	Geyer's Willow - Rocky Mountain Willow/Mesic Forb	G3	S3				B	1995-09-09
Natural Communities	Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland	Plains Cottonwood Riparian Woodland	G3G4	S3				B	2005-07-25
Natural Communities	Betula occidentalis / Maianthemum stellatum Shrubland	Foothills Riparian Shrubland	G4?	S2				A	2005-07-29

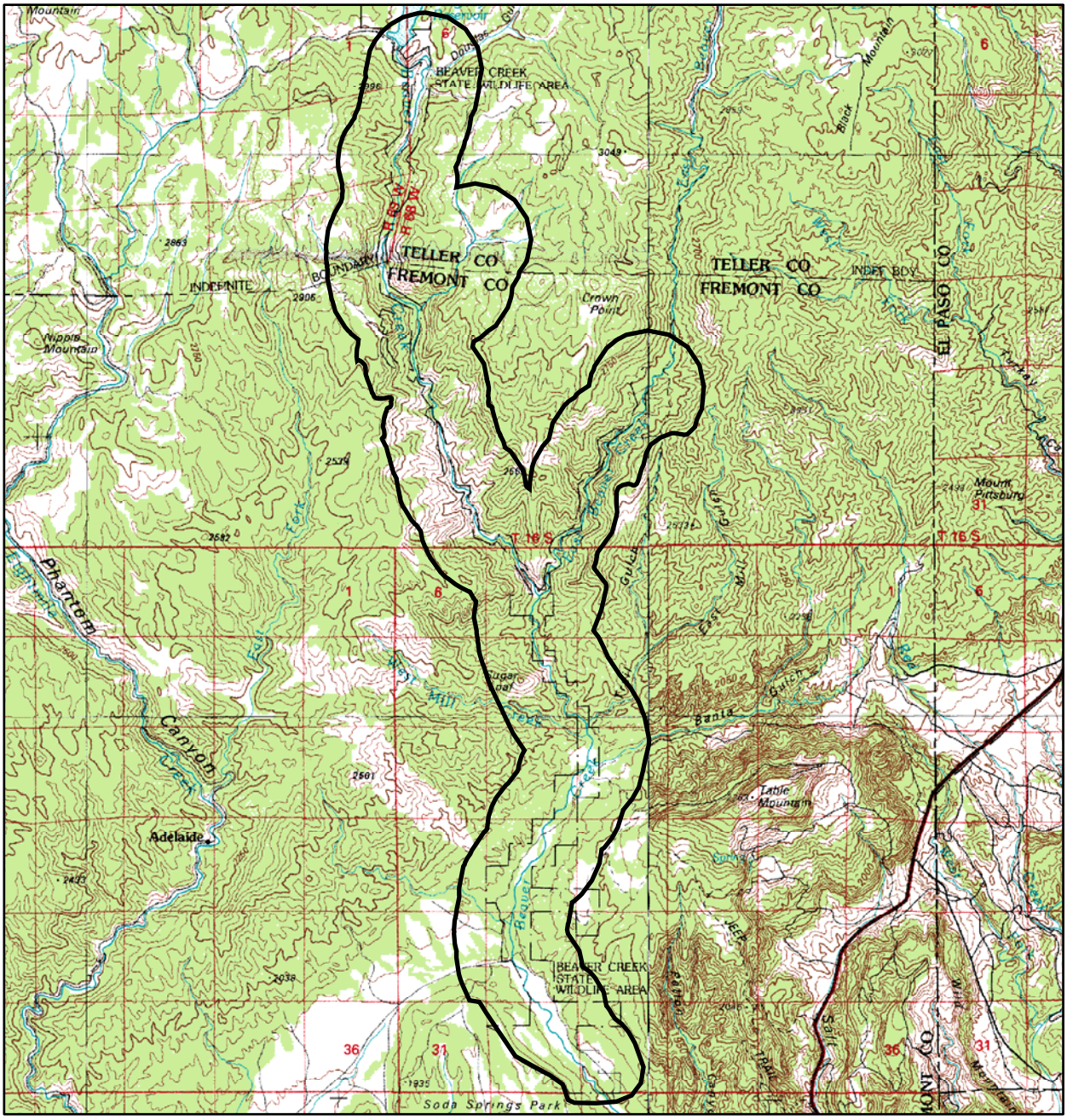
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn as a 1 km buffer of the riparian corridor clipped at the upper end by the watershed boundary. The north end extends to Skagway Reservoir. The southern boundary corresponds with Beaver Creek SWA boundary.

Protection Urgency Rank Comments (P5): Much of this site is within the Beaver Creek State Wildlife Area that is surrounded by BLM land designated as a wilderness study area.

Management Urgency Rank Comments (M4): At the lower elevations, non-native hay grasses, especially smooth brome (*Bromus inermis*), are abundant in the

herbaceous layer. It is difficult to control smooth brome in the best of situations, much less when it has been planted in adjacent fields for a hay crop. A concerted decision to restore the hay fields to a natural floodplain would have to occur in order to address the herbaceous understory of the occurrence. There are irrigation ditches and small local diversions to the adjacent hay fields. Far upstream in the watershed is a reservoir. Despite these alterations to hydrology, perennial flow is currently maintained in this riparian system, which is beneficial to the ecological processes that drive the riparian biodiversity.



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Map Date: 03/13/2006

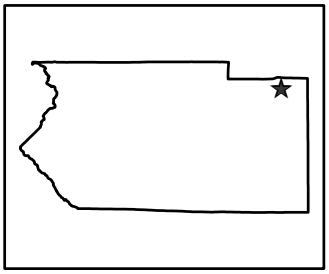
Legend

PCA Boundary

Colorado Springs, 38104-E1
Pikes Peak, 38105-E1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 3. Beaver Creek at Sugar Loaf Potential Conservation Area, B2: Very High Biodiversity Significance

Cottonwood Creek at Little Crampton Mountain

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M3: Needed within 5 Years to Maintain Quality

U.S.G.S. 7.5-minute quadrangles: Gribble Mountain, Hall Gulch

Size: 3,449 acres (1,396 ha) **Elevation:** 6,800 - 8,500 ft (2,073 - 2,591 m)

General Description: Cottonwood Creek is a perennial stream that begins several miles upstream in South Park, a montane grassland system that blankets undulating hills punctuated by isolated mountains and buttes. The site begins downstream where the creek enters a forested landscape of more rugged and crowded low elevation hills (7,000-8,500 feet) north of the Arkansas River valley; the creek becomes more sinuous in this area as it winds around the hills. Old "Highway" 2 used to follow Cottonwood Creek until the early 1900's; an old road bed is present along creek through the site. The reach has some plunge-pool areas along an otherwise moderate gradient. At the upstream end, the riparian corridor is comprised of willow carr before cottonwood trees begin to form groves above the shrub layer. Downstream, flow becomes intermittent, shrubs largely drop out, and the corridor has a sparse mix of narrowleaf cottonwood (*Populus angustifolia*) and Rocky Mountain juniper (*Juniperus scopulorum*) over a narrow band of mesic herbs immediately adjacent to the stream channel. Immediately above the riparian corridor, north-facing slopes are a mixed forest canopy of ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and a small amount of aspen (*Populus tremuloides*). South-facing slopes are sparsely vegetated with shrub scrub of Gambel oak (*Quercus gambelii*) and mountain mahogany (*Cercocarpus montanus*) on steep, shallow, rocky soils with many rock outcrops.

Key Environmental Factors: Lower montane elevation; moderate gradient; intermittent to perennial flow

Biodiversity Significance Rank Comments (B2): This site encompasses a good (B-ranked) occurrence of a globally imperiled (G2G3/S2S3) riparian natural community, narrowleaf cottonwood - Rocky Mountain juniper (*Populus angustifolia - Juniperus scopulorum*) woodland. There is also a good (B-ranked) occurrence of an apparently globally secure (G4/S4) riparian natural community, narrowleaf cottonwood / coyote willow (*Populus angustifolia / Salix exigua*) woodland.

Natural Heritage element occurrences at the Cottonwood Creek at Little Crampton Mountain PCA.

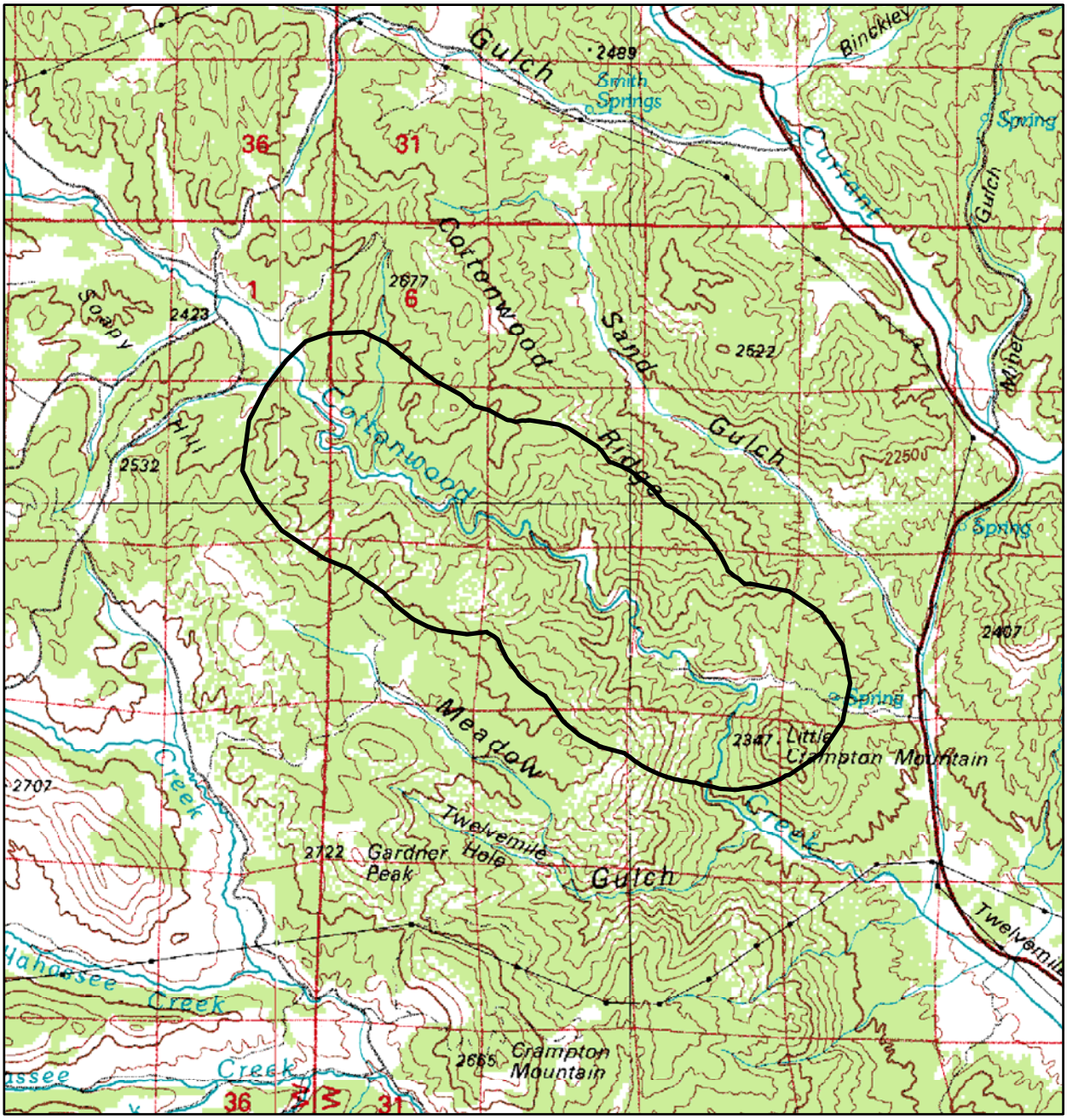
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3				B	2005-07-22
Natural Communities	Populus angustifolia / Salix exigua Woodland	Narrowleaf Cottonwood Riparian Forests	G4	S4				B	2005-07-22

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn as a 1 km buffer of the riparian corridor, which roughly approximates the adjacent ridgelines surrounding Cottonwood Creek for immediate watershed protection.

Protection Urgency Rank Comments (P4): The majority of the site is on BLM land. There is a State Land Board section at the downstream end. The upper end is in private ownership.

Management Urgency Rank Comments (M3): Grazing occurs along the reach; the impact of this land use is currently minimal throughout much of the site. Continuing to monitor usage will help to maintain its current condition. One area at the downstream end of the occurrence has an adjacent pasture on State Land Board property that is denuded of native vegetation and dominated by non-native weeds. Reducing the usage of this pasture and restoring native vegetation will eliminate a primary source of non-native herbaceous material in the immediate environs of the riparian corridor.



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Map Date: 03/13/2006

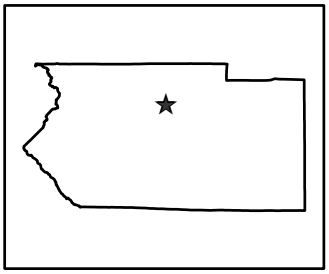
Legend

PCA Boundary

Pikes Peak, 38105-E1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 4. Cottonwood Creek at Little Crampton Mountain Potential Conservation Area, B2: Very High Biodiversity Significance

Felch Creek

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Cooper Mountain

Size: 4,000 acres (1,619 ha) **Elevation:** 6,000 - 9,144 ft (1,829 - 2,787 m)

General Description: Felch Creek plunges down the south side of Cooper Mountain, a local height of land within a landscape of low elevation hills and hogbacks. The riparian system primarily carves through Precambrian granitic rocks. Felch Creek is an ephemeral stream has several areas where there are braided channels with unsorted deposits that range from sand and gravel to boulders and huge boulders. High energy flooding is evident. Channel characteristics may have been affected by logging in the late 1800's (channels seem more incised than expected for the amount of surface water); however, they are currently vegetated. The canopy is mixed evergreen-deciduous and dominated by Rocky Mountain juniper (*Juniperus scopulorum*) and narrowleaf cottonwood (*Populus angustifolia*), which both form multiple-age class stands. The riparian system crosses elevation zones with the low end of the reach crossing through pinon - juniper (*Pinus edulis / Juniperus* spp.) woodland, which transitions to ponderosa pine forest then aspen forest higher in the reach. In the immediate vicinity are sandstone and shale hogbacks, which house several globally rare plant species.

Key Environmental Factors: Lower montane elevation; moderate to high stream gradient; ephemeral to intermittent flow

Biodiversity Significance Rank Comments (B2): This site is drawn for an excellent (A-ranked) occurrence of a globally imperiled (G2G3/S2S3) riparian natural community, narrowleaf cottonwood - Rocky Mountain juniper (*Populus angustifolia - Juniperus scopulorum*) woodland.

Natural Heritage element occurrences at the Felch Creek PCA.

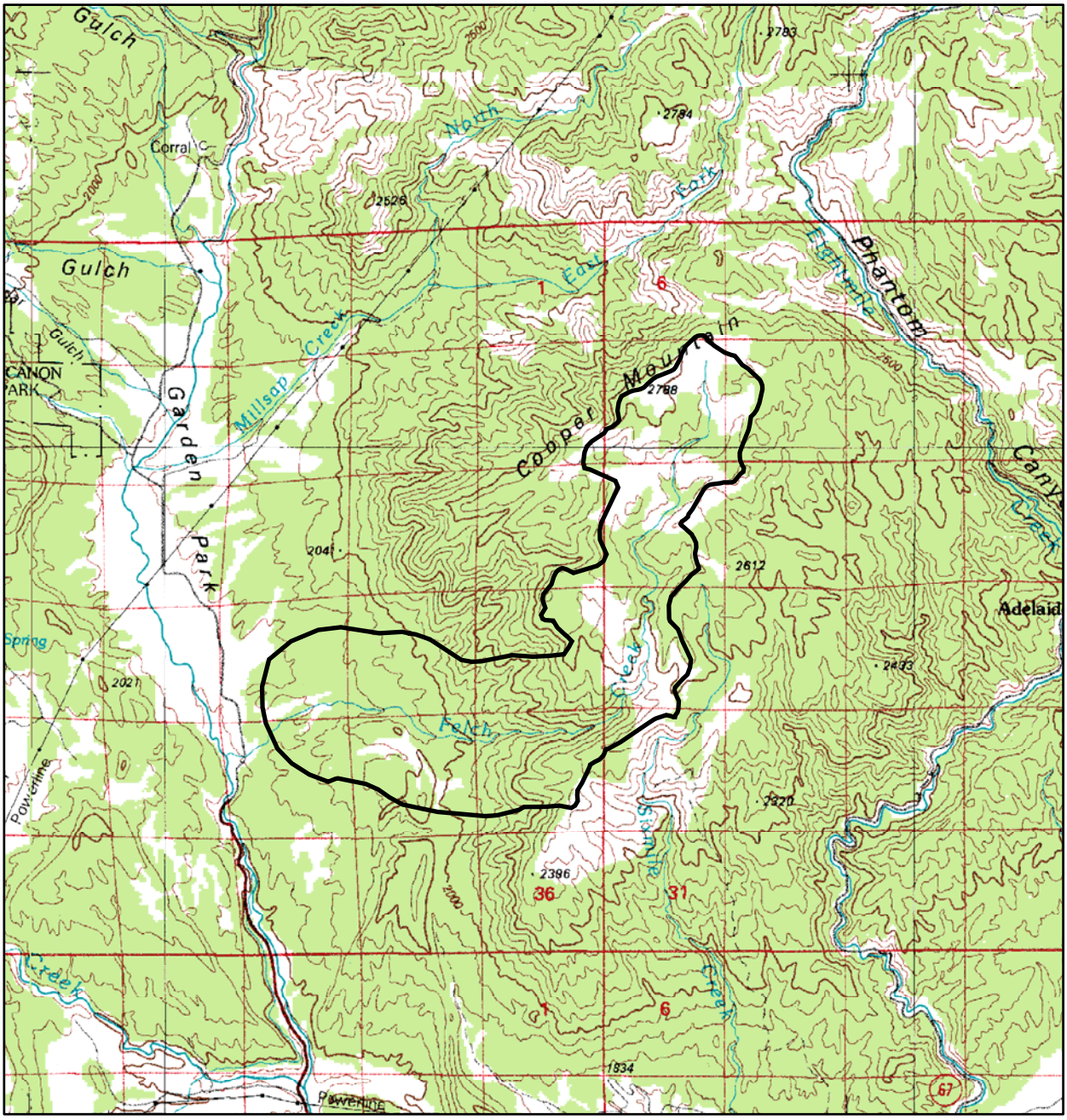
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3				A	2005-07-13

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn along watershed boundary to north and east and south, then roughly follows 1 km buffer in lower reach.

Protection Urgency Rank Comments (P4): The majority of this site is owned by the BLM.

Management Urgency Rank Comments (M4): Off-road vehicle use occurs on adjacent land. Increased activity may degrade surrounding landscape.



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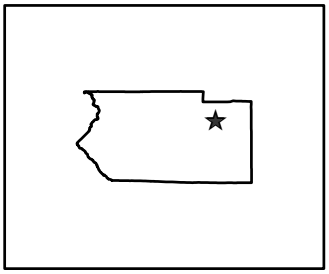
PCA Boundary

Pikes Peak, 38105-E1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 5. Felch Creek Potential Conservation Area, B2: Very High Biodiversity Significance

Grape Creek

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Curley Peak, Royal Gorge

Size: 13,094 acres (5,299 ha) **Elevation:** 5,700 - 8,045 ft (1,737 - 2,452 m)

General Description: Grape Creek is a long, perennial drainage that winds through rugged, granitic, lower montane hills west of the north end of the Wet Mountains. The steep canyon slopes above the stream are sparsely covered with rocky pinon - juniper woodland (*Pinus edulis - Juniperus* spp.) with mountain mahogany (*Cercocarpus montanus*) and Gambel oak (*Quercus gambelii*) groves. There are small prospect mines in the hills of the stream valley. This perennial stream is recovering from intensive land use in the past (grazing, railroad corridor). It previously washed out annually during high energy spring flooding once water flow resumed after being much reduced in winter by Deweese Reservoir upstream. This repeatedly stripped all vegetation out of the riparian corridor until recent years when the streambank vegetation has held. Intensive land use has been curbed and the riparian vegetation is recovering. Currently, the predominant vegetation within the corridor is the graminoid-dominated streambanks that have been gradually expanding. The entire reach is dotted with Rocky Mountain juniper (*Juniperus scopulorum*) and one seed juniper (*Juniperus monosperma*) individuals interspersed with groves of narrowleaf cottonwood (*Populus angustifolia*) and/or plains cottonwood (*Populus deltoides*). There are some groves of mature cottonwoods where the ground has significant woody debris as well as areas of regenerating cottonwoods that likely will replace the junipers as canopy dominants in the future. Shrubs are sparse along the reach, but show signs of establishment and regeneration in many places. Coyote willow (*Salix exigua*) is the most common, although peachleaf willow (*Salix amygdaloides*) saplings are also present. The herbaceous cover is lush along the banks. Dominant graminoids include pasture grasses like quackgrass (*Elymus repens*) and Kentucky bluegrass (*Poa pratensis*), although native Nebraska sedge (*Carex nebrascensis*), common spikerush (*Eleocharis palustris*), and scouring rush horsetail (*Equisetum hyemale*) are common and abundant. There are scattered forbs throughout, including wild mint (*Mentha arvensis*), water horehound (*Lycopus americana*), and others. Vines such as riverbank grape (*Vitis riparia*) and clematis (*Clematis ligusticifolia*) crawl up and cover rock outcrops and juniper and cottonwood trees in several areas. Tributaries of Grape Creek are moderate to high gradient sandy washes with ephemeral to intermittent flow. Tree canopies, where present, are mixed evergreen-deciduous woodlands, often with sporadic cover.

Key Environmental Factors: Lower montane elevation; moderate gradient; perennial flow.

Land Use History: A railroad was built through Grape Creek canyon in the late 1800's. It was abandoned and dismantled after repeated flooding washed out the tracks. Small mines dot the canyonsides in some areas.

Biodiversity Significance Rank Comments (B2): This site encompasses an excellent (A-ranked) and a good (B-ranked) occurrence of a globally imperiled (G2G3/S2S3) riparian natural community, narrowleaf cottonwood - Rocky Mountain juniper (*Populus angustifolia - Juniperus scopulorum*) woodland. Additionally, there is a good (B-ranked) occurrence of the globally vulnerable (G3/S2) narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland and a good to fair (BC-ranked) occurrence of the apparently globally secure but state imperiled (G4/S2) Rocky Mountain juniper / Red-osier dogwood (*Juniperus scopulorum / Cornus sericea*) woodland. Several fair (C-ranked) occurrences of a globally imperiled (G2/S2) plant, Arkansas Canyon stickleaf (*Nuttallia densa*), have also been documented.

Natural Heritage element occurrences at the Grape Creek PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3				A	2005-08-15
Natural Communities	Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3				B	2005-07-28
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				B	2005-07-28
Natural Communities	Juniperus scopulorum / Cornus sericea Woodland	Riparian Woodland	G4	S2				BC	2005-07-28
Vascular Plants	Nuttallia densa	Arkansas Canyon stickleaf	G2	S2			BLM	C	1992-06-25
Vascular Plants	Nuttallia densa	Arkansas Canyon stickleaf	G2	S2			BLM	C	1995-08-12

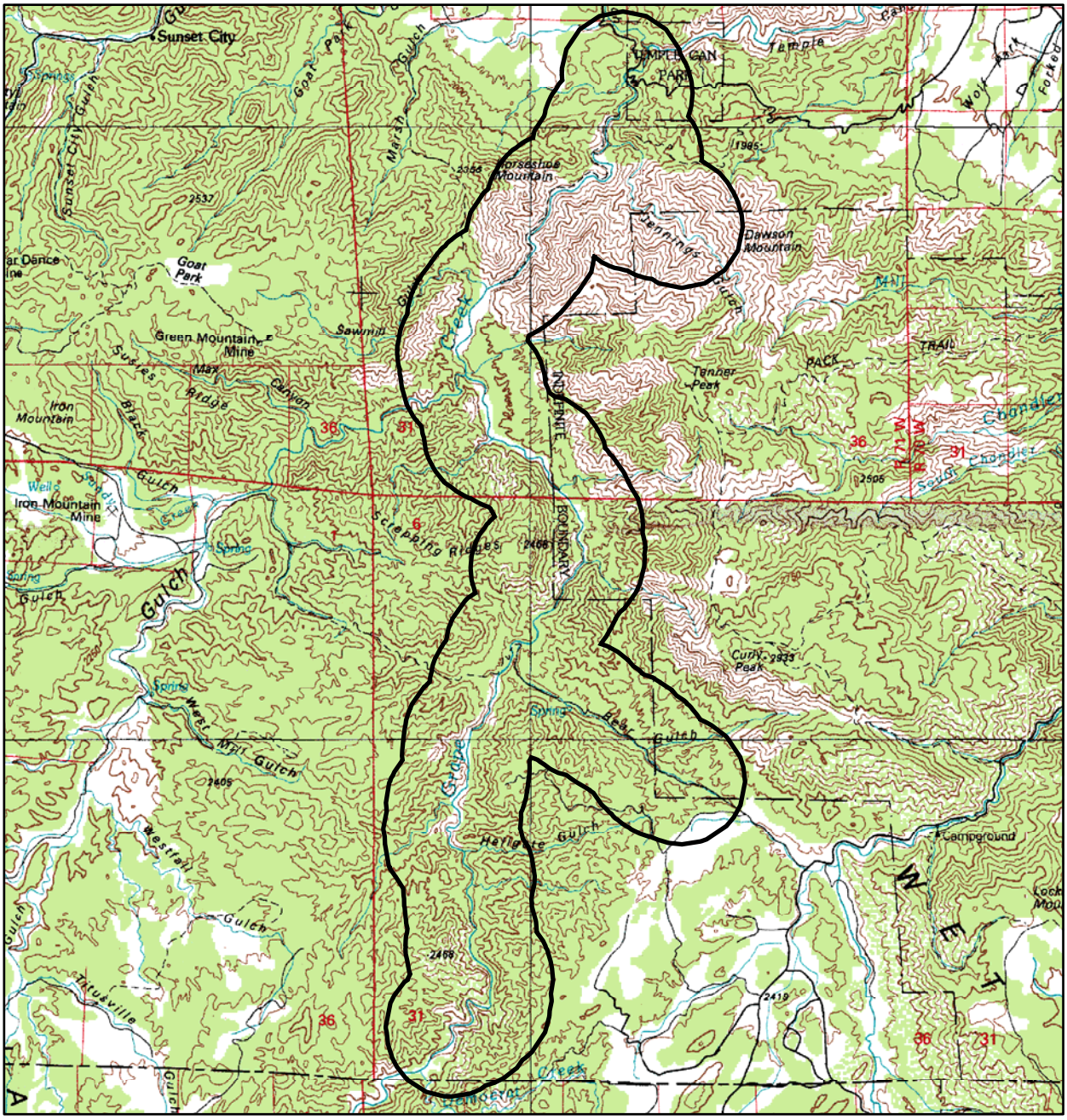
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn as a 1 km buffer of the riparian corridor, which roughly approximates the adjacent ridgelines surrounding Grape Creek for immediate watershed protection.

Protection Urgency Rank Comments (P4): The majority of this site is owned by the BLM, although portions are owned by USFS and State Land Board. Much of this area is within a BLM Wilderness Study Area.

Management Urgency Rank Comments (M4): Grape Creek has received restoration attention in the past 10-15 years. The BLM has been implementing limited grazing along Grape Creek for the past 5-10 years and has addressed water flow fluctuations administered by the DeWeese Reservoir upstream. Also, tamarisk has been removed in much of the lower reach. Given these efforts, the management urgency has lessened; maintaining the current restoration management will continue the recovery of vegetation and riparian system health. Continuing to encourage riparian stewardship by private landowners and lessees (e.g. eradicate tamarisk, manage grazing levels) will contribute to the overall health and recovery of Grape Creek.

Off-Site Considerations: Hydrological processes originating outside of the planning boundary, including water quality, quantity, timing and flow must be managed to maintain site viability.



Colorado Natural Heritage Program Colorado State University 254 General Services Building 8002 Campus Delivery Fort Collins, CO 80523-8002 Ph (970) 491-1309 Fax (970) 491-3349 www.cnhp.colostate.edu Map Date: 03/13/2006	**Legend** PCA Boundary Canon City, 38105-A1 30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey	Location in Fremont County

Map 6. Grape Creek Potential Conservation Area, B2: Very High Biodiversity Significance

Hayden Creek

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Coaldale

Size: 3,712 acres (1,502 ha) **Elevation:** 7,200 - 10,300 ft (2,195 - 3,139 m)

General Description: The Hayden Creek watershed contains an extensive riparian system that spans subalpine, upper, and lower montane elevation zones before reaching its confluence with the Arkansas River. The riparian system drains a portion of the north face of the Sangre de Cristo Range. At the top of the watershed the peaks are glaciated, steep and craggy rock faces and talus slopes. Treeline is formed by subalpine spruce-fir forest that transitions to montane forest. The montane elevations are comprised of mixed aspen-evergreen forest on north-facing slopes and ponderosa pine - Gambel oak (*Pinus ponderosa - Quercus gambelii*) woodland on south-facing slopes. The subalpine to lower montane sections of the North and South Prongs of Hayden Creek are encompassed by this site. The South Prong is characterized by perennial flow, cobble and gravel channel bed, and some small eddy pools. It has a mixed evergreen-deciduous riparian forest dominated by white fir (*Abies concolor*) with narrowleaf cottonwood (*Populus angustifolia*) in the canopy and subcanopy. The shrub layer is a diverse and discontinuous mix of species. The herbaceous layer occupies small, wet, seepy benches along the stream channel as well as lines the streambanks within 1-2 feet of the channel. The North Prong has a moderately steep gradient as it tumbles down through a narrow channel bed. The deciduous riparian woodland vegetation is dictated by elevation with aspen (*Populus tremuloides*) dominant at higher elevations (above 8,200 feet) and narrowleaf cottonwood at lower elevations in the montane zone. The shrub layer is relatively discontinuous and sparse; it does not form a solid layer of vegetation adjacent to the channel. The ground layer is characterized by lush forb cover.

Key Environmental Factors: Subalpine and montane elevation zones; moderate to high gradient; perennial flow.

Biodiversity Significance Rank Comments (B2): This site encompasses an excellent (A-ranked) occurrence of a globally imperiled (G2/S2) riparian natural community, white fir - blue spruce - narrowleaf cottonwood / Rocky Mountain maple (*Abies concolor - Picea pungens - Populus angustifolia / Acer glabrum*) forest, an excellent (A-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural community, quaking aspen / thinleaf alder (*Populus tremuloides / Alnus incana*) woodland, and a good (B-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural

community, narrowleaf cottonwood / thinleaf alder (*Populus angustifolia / Alnus incana*) woodland.

Natural Heritage element occurrences at the Hayden Creek PCA.

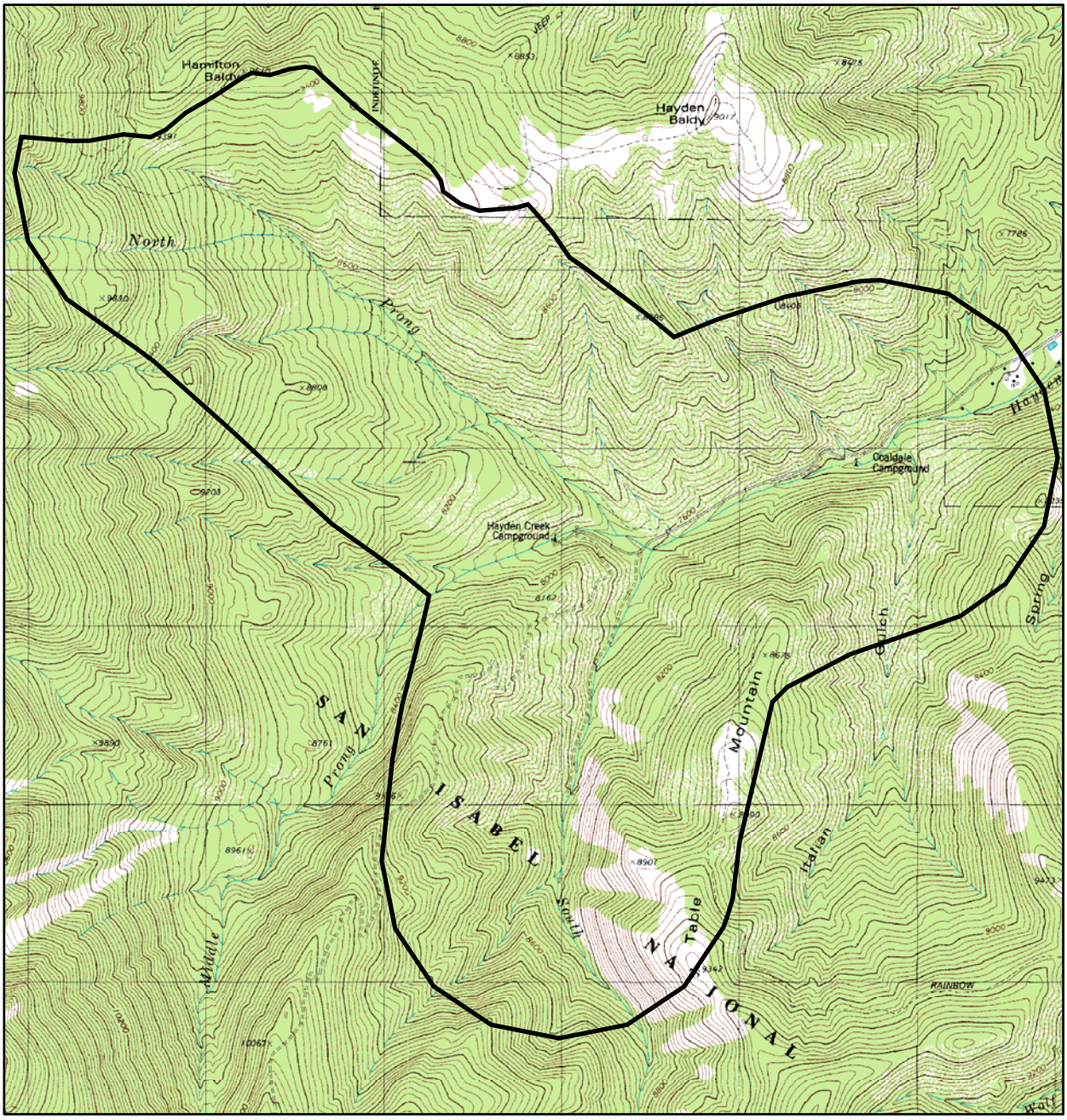
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Abies concolor - Picea pungens - Populus angustifolia / Acer glabrum Forest	Montane Riparian Forests	G2	S2				A	2005-08-03
Natural Communities	Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3				B	2005-08-03
Natural Communities	Populus tremuloides / Alnus incana Forest	Montane Riparian Forests	G3	S3				A	2005-08-03

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn as a 1 km buffer of the riparian corridor clipped at the upper end by the watershed boundary.

Protection Urgency Rank Comments (P4): This drainage is primarily on the San Isabel National Forest on the border of the Sangre de Cristo Wilderness Area. There is a small area on Bureau of Land Management lands. The downstream end is in private ownership and managed as a campground.

Management Urgency Rank Comments (M4): Monitor for any establishment of invasive species. Monitor impacts of campgrounds and "unsanctioned" camping spots within the site.



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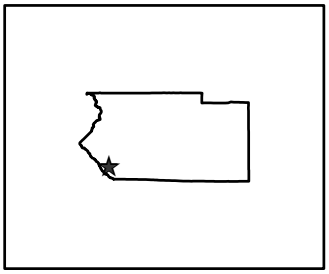
Legend

PCA Boundary

Coaldale, 38105-C7

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 7. Hayden Creek Potential Conservation Area, B2: Very High Biodiversity Significance

Little High Creek at Booger Red Hill

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: High Park

Size: 399 acres (162 ha) **Elevation:** 7,400 - 8,200 ft (2,256 - 2,499 m)

General Description: The riparian corridor of Little High Creek flows through a deep, steep-sided canyon in the rugged, low elevation foothills of Pikes Peak. The canyon sides are blanketed with mixed evergreen forest on the sheltered north-facing slopes and have sparse pinon - juniper (*Pinus edulis - Juniper* spp.) woodland on rocky south-facing slopes. The riparian system has a relatively steep gradient over the length of the section. The majority of the gradient occurs in two steep plunge-pool series that keep this reach inaccessible. High energy flood scouring is evident. The riparian corridor has a mosaic of narrowleaf cottonwood / bluestem willow (*Populus angustifolia / Salix irrorata*) woodland and narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland plant associations with mature canopy trees and diverse shrubs. There are invasive exotic species in the herbaceous layer (smooth brome, *Bromus inermis*, and Canada thistle, *Cirsium canadensis*). Little High Creek meets Fourmile Creek at the downstream end of the site.

Key Environmental Factors: Steep stream gradient with high energy flooding; lower montane elevation; narrow, steep-sided canyon.

Biodiversity Significance Rank Comments (B2): This site encompasses a good (B-ranked) occurrence of a globally imperiled (G2/S2) riparian natural community, narrowleaf cottonwood / bluestem willow (*Populus angustifolia / Salix irrorata*) woodland. A good (B-ranked) occurrence of narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland, a globally vulnerable (G3/S3) riparian natural community, also exists at this site.

Natural Heritage element occurrences at the Little High Creek at Booger Red Hill PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia / Salix irrorata Woodland	Foothills Riparian Woodland	G2	S2				B	2005-08-16
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				B	2005-08-16

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

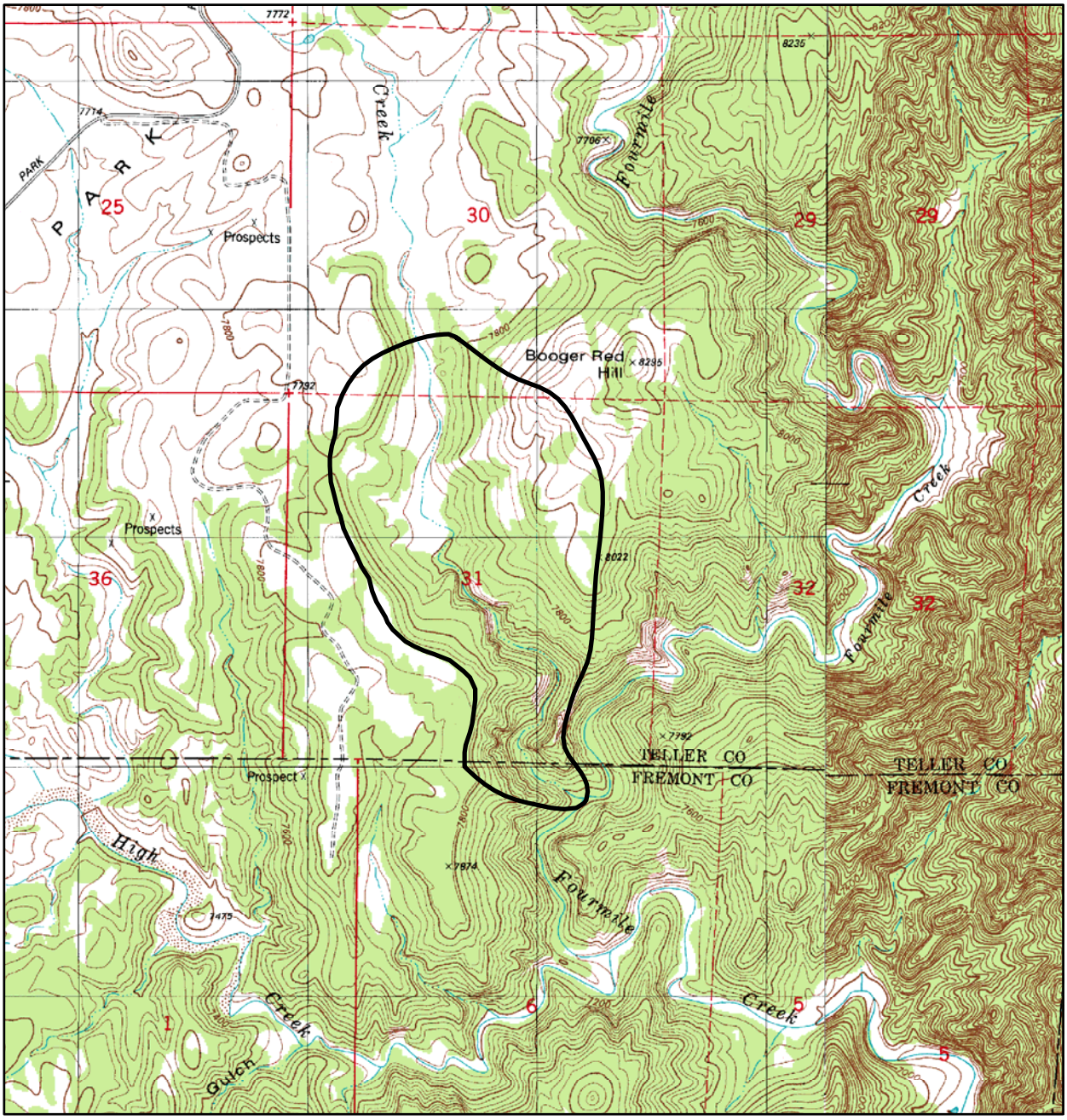
Boundary Justification: Boundary drawn along adjacent ridgelines, which includes the watershed boundary to the south and west, for immediate watershed protection. Boundary includes 1km buffer upstream.

Protection Urgency Rank Comments (P5): The canyon is relatively inaccessible. It is owned and managed by the BLM.

Management Urgency Rank Comments (M4): Eradication of smooth brome (*Bromus inermis*) and Canada thistle (*Cirsium canadensis*) would reduce the threat of invasive, exotic species in herbaceous understory.

Exotic Species Comments: Localized area with dense *Bromus inermis* and *Cirsium canadensis*.

Off-Site Considerations: There is a grazed meadow immediately upstream from the site, which is a likely source of the exotic species.



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Map Date: 03/13/2006

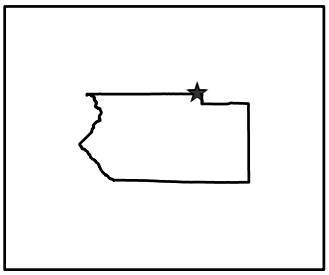
Legend

PCA Boundary

High Park, 38105-F3

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 8. Little High Creek at Booger Red Hill Potential Conservation Area, B2: Very High Biodiversity Significance

Little Mack

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M5: Not Needed; No Threats Anticipated

U.S.G.S. 7.5-minute quadrangles: Cover Mountain

Size: 860 acres (348 ha) **Elevation:** 8,200 - 9,270 ft (2,499 - 2,826 m)

General Description: Little Mack is a moderately-sloped drainage flowing through a narrow, sinuous, steep-sided valley carved out of granitic bedrock southeast of South Park. The riparian corridor winds across the ecotone between upper and lower montane life zones in this area. Accordingly, the tree canopy in the upper section of the drainage is characterized by blue spruce (*Picea pungens*) and aspen (*Populus tremuloides*), which transitions to Douglas-fir (*Pseudotsuga menziesii*) in the midreach before shifting to narrowleaf cottonwood (*Populus angustifolia*) in the lower reach. Balsam poplar (*Populus balsamifera*), a boreal species that reaches the southernmost extent of its range in this area, is a canopy associate throughout. River birch (*Betula occidentalis*) is a constant shrub throughout the drainage, casting dense shade in many areas. The hydrology of this reach appears to have a groundwater seepage component that enters near the top of the reach. It is short-lived and goes underground again before the confluence with Currant Creek in the valley below. Above the riparian corridor, steep, rocky, south-facing slopes have Gambel oak (*Quercus gambelii*) and mountain mahogany (*Cercocarpus montanus*) shrublands with pockets of ponderosa pine (*Pinus ponderosa*) near the ridgetop. Shaded north-facing slopes have dense evergreen forest dominated by Douglas-fir. There are extensive montane grasslands on high mesas in the vicinity above the drainage that extend down to the top of the riparian woodlands. There is a small series of holding/stock ponds in the montane grasslands above the occurrence within this drainage, the impact of which may be minor.

Key Environmental Factors: Narrow, sinuous, deep riparian valley at the ecotone between upper and lower montane life zones.

Biodiversity Significance Rank Comments (B2): This site is drawn for a riparian system that spans elevation zones. It contains an excellent (A-ranked) occurrence of three natural communities: the globally imperiled (G2/S2) blue spruce / river birch (*Picea pungens / Betula occidentalis*) woodland, the globally vulnerable (G3?/S3) Douglas-fir / river birch (*Pseudotsuga menziesii / Betula occidentalis*) woodland and the globally vulnerable narrowleaf (G3/S2) cottonwood / river birch (*Populus angustifolia / Betula occidentalis*) woodland.

Natural Heritage element occurrences at the Little Mack PCA.

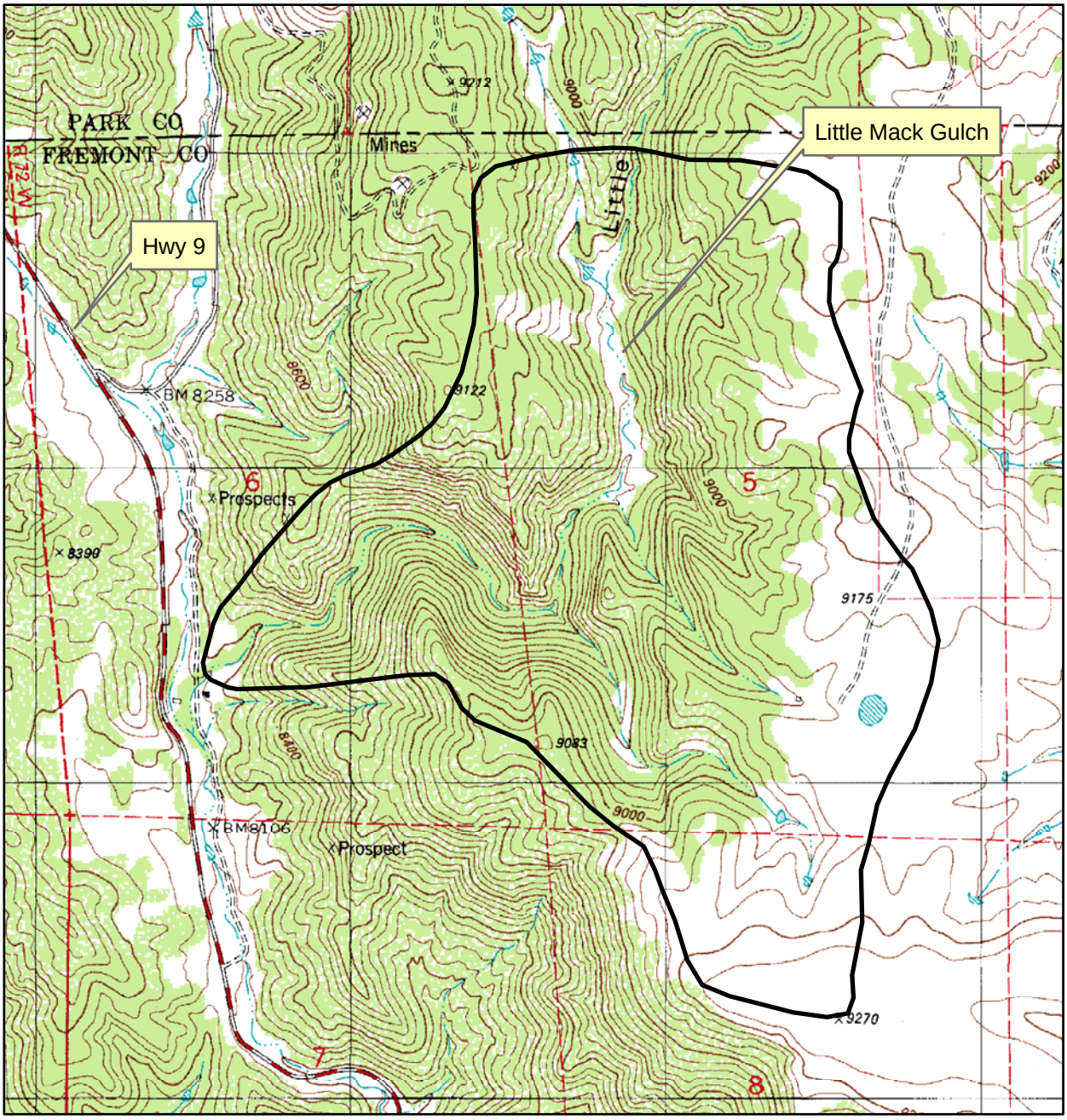
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Picea pungens / Betula occidentalis Woodland	Montane Riparian Woodland	G2	S2				A	2005-07-19
Natural Communities	Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S2				A	2005-08-10
Natural Communities	Pseudotsuga menziesii / Betula occidentalis Woodland	Montane Riparian Forest	G3?	S3				A	2005-07-19

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary is drawn along adjacent ridgelines, which includes the watershed boundary to the east, for immediate watershed protection. Boundary includes 1km buffer upstream.

Protection Urgency Rank Comments (P4): The majority of the site is owned by the BLM. The downstream end at the confluence with Currant Creek is in private ownership; a house, barns, and corrals are at the mouth of the drainage and the area is grazed by horses.

Management Urgency Rank Comments (M5): Maintain the current management regime will support the condition of element occurrences at this site.



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Map Date: 03/13/2006

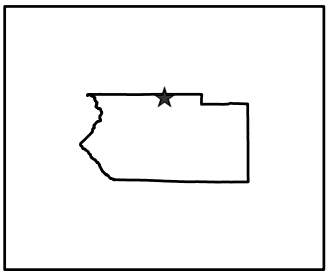
Legend

PCA Boundary

Cover Mountain, 38105-F4

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 9. Little Mack Potential Conservation Area, B2: Very High Biodiversity Significance

Phantom Canyon of Eightmile Creek

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Big Bull Mountain, Cooper Mountain, Cripple Creek South, Florence, Phantom Canyon

Size: 11,722 acres (4,744 ha) **Elevation:** 5,800 - 9,300 ft (1,768 - 2,835 m)

General Description: Eightmile Creek has carved Phantom Canyon through rugged, low elevation, granitic hills southwest of Pikes Peak. This site spans upper and lower montane elevation zones; upland vegetation reflects this. At the upstream end, dense Douglas-fir (*Pseudotsuga menziesii*) forest occupies north-facing slopes while relatively sparse ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*) are on south-facing slopes. At lower elevations, the upland vegetation transitions to pinon - juniper (*Pinus edulis - Juniperus scopulorum*) woodland. Canyon sides are quite steep in some places with many cliff faces and rock outcrops. Tributaries of Eightmile Creek are moderately to somewhat steep, boulder-strewn channels at the bottom of narrow, sinuous valleys that course down the canyon sides. The riparian corridor within Phantom Canyon is predominantly a mixed evergreen-deciduous woodland with a variable, broken canopy along a dry, sandy wash. Eightmile Creek has ephemeral to intermittent flow, the latter occurring at higher elevations within the riparian system. Higher in the watershed, where there is more intermittent water flow, there is a greater diversity of conifer species, with Douglas-fir and white fir (*Abies concolor*) commonly occurring amidst areas of alder or willow shrub carr vegetation. However, the vast majority of the riparian canopy at lower elevations is comprised of scattered narrowleaf cottonwood (*Populus angustifolia*), plains cottonwood (*Populus deltoides*), and lanceleaf cottonwood (*Populus acuminata*) groves (the latter two species occur at the downstream end, below about 6,800 feet) sprinkled with Rocky Mountain juniper (*Juniperus scopulorum*) in the canopy, subcanopy, and shrub layer throughout. The shrub layer is almost non-existent other than sporadic areas of regeneration of canopy species and occasional copses with hoptree (*Ptelea trifoliata*) and prairie rose (*Rosa arkansana*) although vines often drape the subcanopy and shrub layers. The herbaceous understory is likewise sparse and primarily comprised of drier, more upland species although there are very local patches of more mesic herbs. The stream channel is primarily sand and gravel or cobbles with occasional areas having boulders. Catastrophic flooding has occurred repeatedly in Phantom Canyon. Upland vegetation was, by all reports, denuded during railroad construction during early mining era at Cripple Creek (late 1800's). A devastating flood occurred in 1912 when "a 30-foot high wall of water roared down the canyon in a torrent that ripped 12

bridges from their abutments and destroyed miles of [railroad] track" (BLM interpretive sign at Steel Bridge). As part of the Goldbelt Scenic Byway, a road that replaced the railroad follows the entire reach through Phantom Canyon. The most recent significant flood washed out Phantom Canyon Road in 1995.

Key Environmental Factors: Lower to upper montane elevations; moderate gradient; ephemeral to intermittent flow; historic catastrophic flooding.

Land Use History: A narrow gauge railroad was built through Phantom Canyon in the late 1800's to early 1900's to transport gold and materials between Cripple Creek upstream in Teller County and Canon City downstream along the Arkansas River. After continual maintenance problems following catastrophic flooding episodes, the railroad was dismantled in 1915. The transportation corridor was reopened as a car road in 1918. It is now part of the Goldbelt Scenic Byway.

Biodiversity Significance Rank Comments (B2): This site is drawn for a good (B-ranked) occurrence of a globally imperiled (G2G3/S2S3) riparian natural community, narrowleaf cottonwood - Rocky Mountain juniper (*Populus angustifolia - Juniperus scopulorum*) woodland. It also encompasses a good (B-ranked) occurrence of thinleaf alder / mesic graminoids (*Alnus incana* / mesic graminoids) shrubland (G3/S3) and a good (B-ranked) and an excellent (A-ranked) occurrence of narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland (G3/S2).

Natural Heritage element occurrences at the Phantom Canyon of Eightmile Creek PCA.

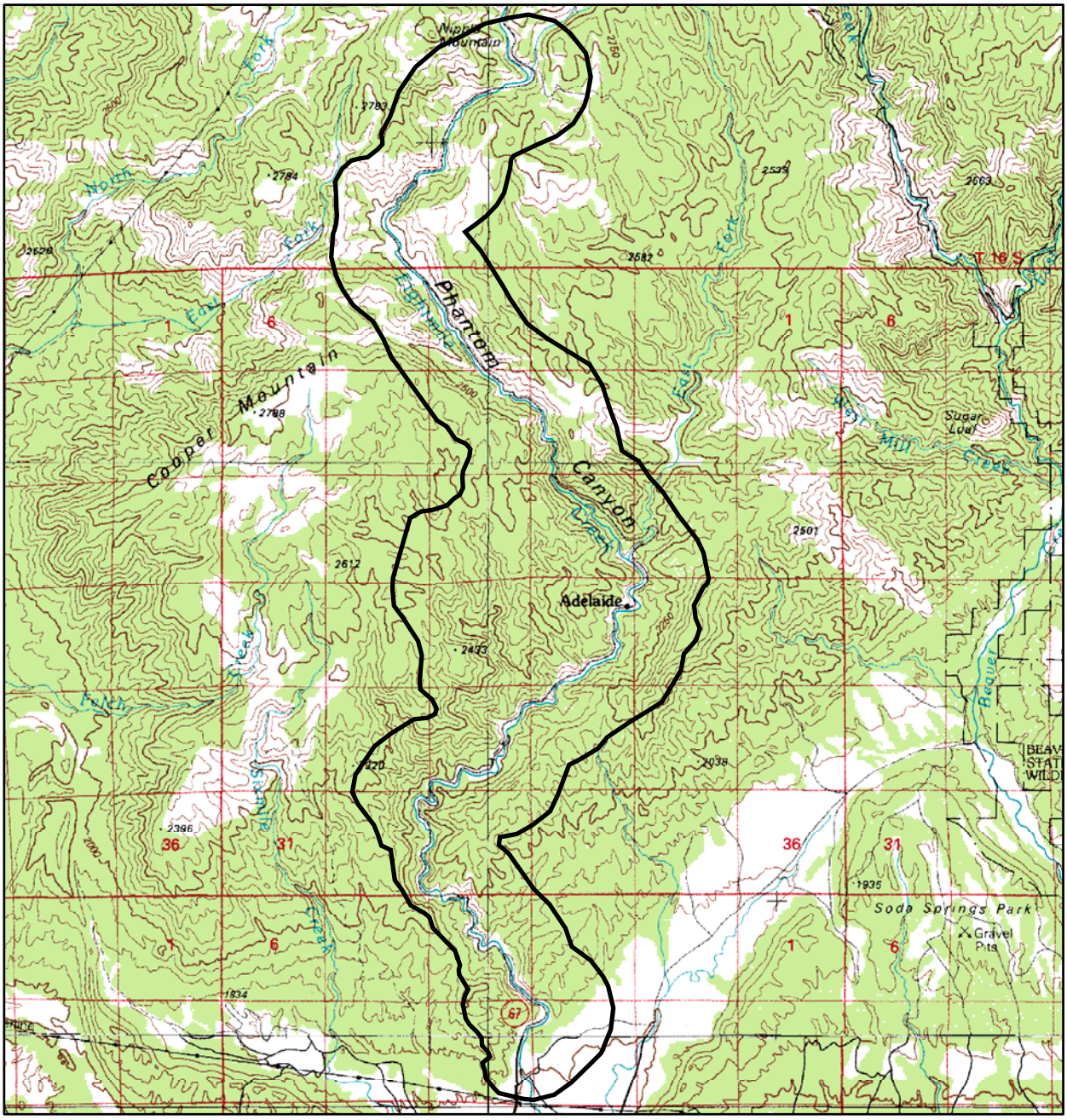
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3				B	2005-07-13
Natural Communities	Alnus incana / Mesic Graminoids Shrubland	Montane Riparian Shrubland	G3	S3				B	2005-07-12
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				A	2005-07-13
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				B	2005-07-12

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn as a 1 km buffer of the riparian corridor, which roughly approximates the adjacent ridgelines surrounding Eightmile Creek for immediate watershed protection.

Protection Urgency Rank Comments (P4): The majority of this site is owned and managed by the BLM; the remainder is in private ownership. Portions of it are within the Beaver Creek Wilderness Study Area, a BLM Area of Critical Environmental Concern.

Management Urgency Rank Comments (M4): Monitoring for and controlling any invasive species establishment will reduce this threat. As part of the Goldbelt Scenic Highway, reactive management to any hazardous spills from auto accidents will help to maintain water quality.



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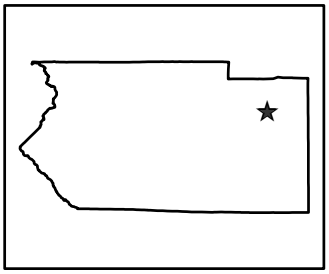
Legend

PCA Boundary

Canon City, 38105-A1
Pikes Peak, 38105-E1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 10. Phantom Canyon of Eightmile Creek Potential Conservation Area, B2: Very High Biodiversity Significance

Poncha Park

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Black Mountain

Size: 146 acres (59 ha) **Elevation:** 9,420 - 9,475 ft (2,871 - 2,888 m)

General Description: Poncha Park contains a small, isolated playa that is perched on a hill at the southern extent of South Park. It is embedded within a grassland matrix that blankets miles of rolling hills. Amidst the grassland dominated by Arizona fescue (*Festuca arizonica*), and slimstem muhly grass (*Muhlenbergia filiculmis*) are small patches of ponderosa pine (*Pinus ponderosa*) and quaking aspen (*Populus tremuloides*) forest, fragments of larger patches that occur on steeper slopes of the higher hills in the vicinity. This playa has two concentric zones of vegetation. The innermost zone is strongly dominated by common spikerush (*Eleocharis palustris*) with beaked spikerush (*E. parvula*) subdominant. The outermost zone is dominated by western wheatgrass (*Pascopyrum smithii*).

Key Environmental Factors: Playa; small closed basin.

Biodiversity Significance Rank Comments (B2): This site encompasses a playa, a unique landscape feature in this area. It contains an excellent (A-ranked) occurrence of a globally imperiled (G2/S1) natural community, western wheatgrass - spikerush species (*Pascopyrum smithii - Eleocharis* spp.) herbaceous vegetation.

Natural Heritage element occurrences at the Poncha Park PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Pascopyrum smithii - Eleocharis spp. Herbaceous Vegetation	Playa Grassland	G2	S1				A	2005-07-21

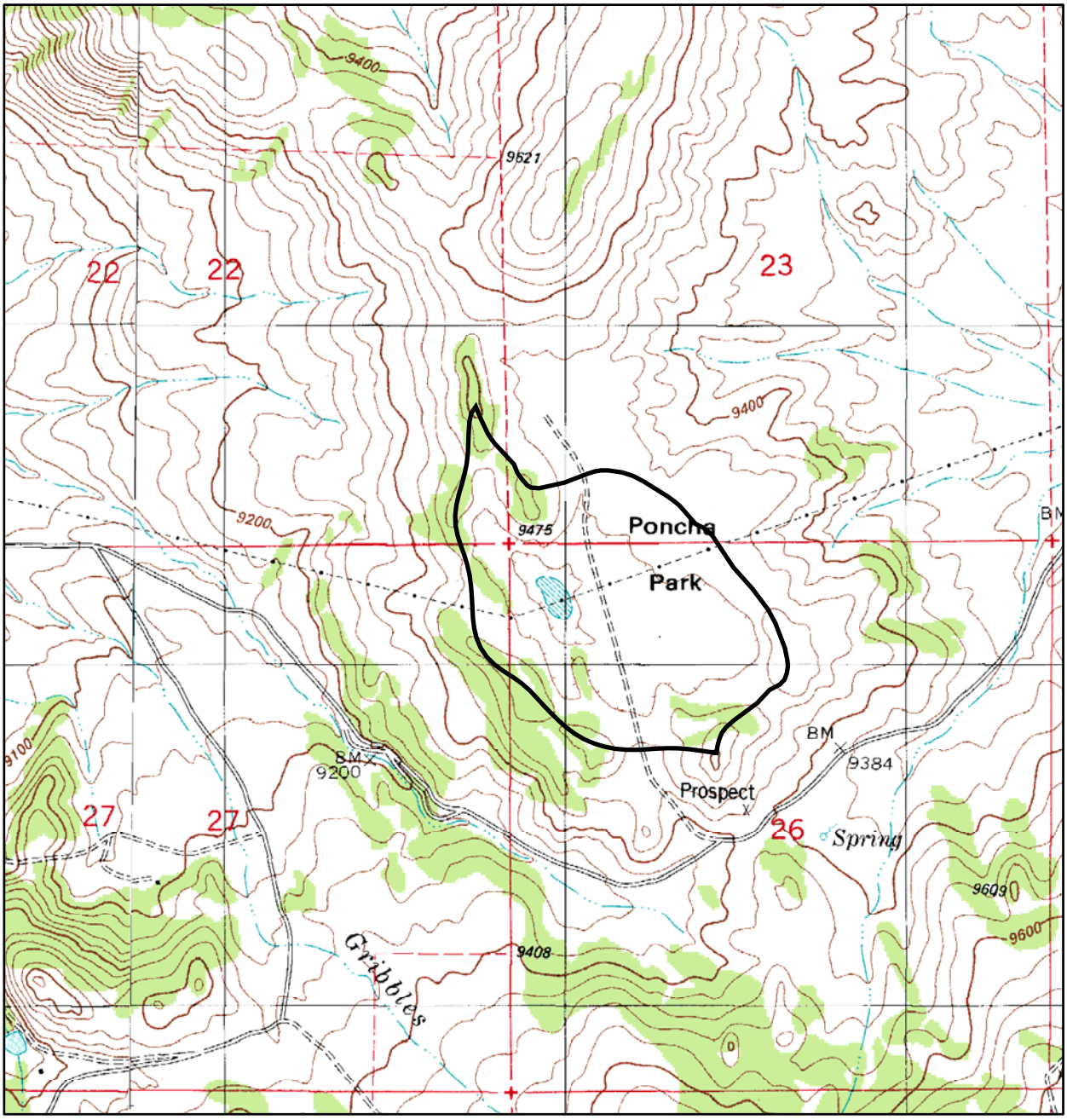
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary is drawn along adjacent ridgelines, which includes the watershed boundary to the east, for immediate watershed protection.

Protection Urgency Rank Comments (P5): This site is within the Waugh Mountain State Wildlife Area and is managed as a state trust land.

Management Urgency Rank Comments (M4): Maintain current management practices. Grazing that occurs when the playa is wet may damage the substrate.

Information Needs: Investigate seasonal hydrology of the playa and its use by wildlife.



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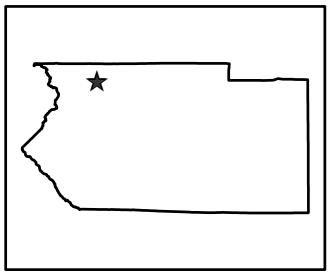
Legend

PCA Boundary

Black Mountain, 38105-F6

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 11. Poncha Park Potential Conservation Area, B2: Very High Biodiversity Significance

Unnamed Tributary to Badger Creek at Howard

Biodiversity Rank - B2: Very High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M5: Not Needed; No Threats Anticipated

U.S.G.S. 7.5-minute quadrangles: Howard

Size: 1,845 acres (747 ha) **Elevation:** 7,700 - 8,760 ft (2,347 - 2,670 m)

General Description: This small ephemeral creek drains into the lower reach of Badger Creek approximately 1.25 miles upstream from its confluence with the Arkansas River. This tributary winds through an extensive series of sandstone hogbacks that run perpendicular to the stream. The sandstone cliffs (Sangre de Cristo Formation) constrict the creek and create a narrow, sinuous drainage. The creek bed is primarily a sand wash with intermittent small saturated areas of spongy ground. Flood scouring is evident; likely from early season snow melt. The riparian vegetation is composed of approximately 80-100 year old narrowleaf cottonwood (*Populus angustifolia*) with Rocky Mountain juniper (*Juniperus scopulorum*) on terraces as well as along stream channels. North-facing slopes have Douglas-fir (*Pseudotsuga menziesii*). Narrowleaf cottonwood regeneration is evident in the stream channel.

Key Environmental Factors: Lower montane elevation; low to moderate gradient; ephemeral to intermittent flow.

Biodiversity Significance Rank Comments (B2): This site is drawn for an excellent (A-ranked) occurrence of a globally imperiled (G2G3/S2S3) riparian natural community, narrowleaf cottonwood - Rocky Mountain juniper (*Populus angustifolia - Juniperus scopulorum*) woodland.

Natural Heritage element occurrences at the Unnamed Tributary to Badger Creek at Howard PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Juniperus scopulorum Woodland	Montane Riparian Forest	G2G3	S2S3				A	2005-06-16

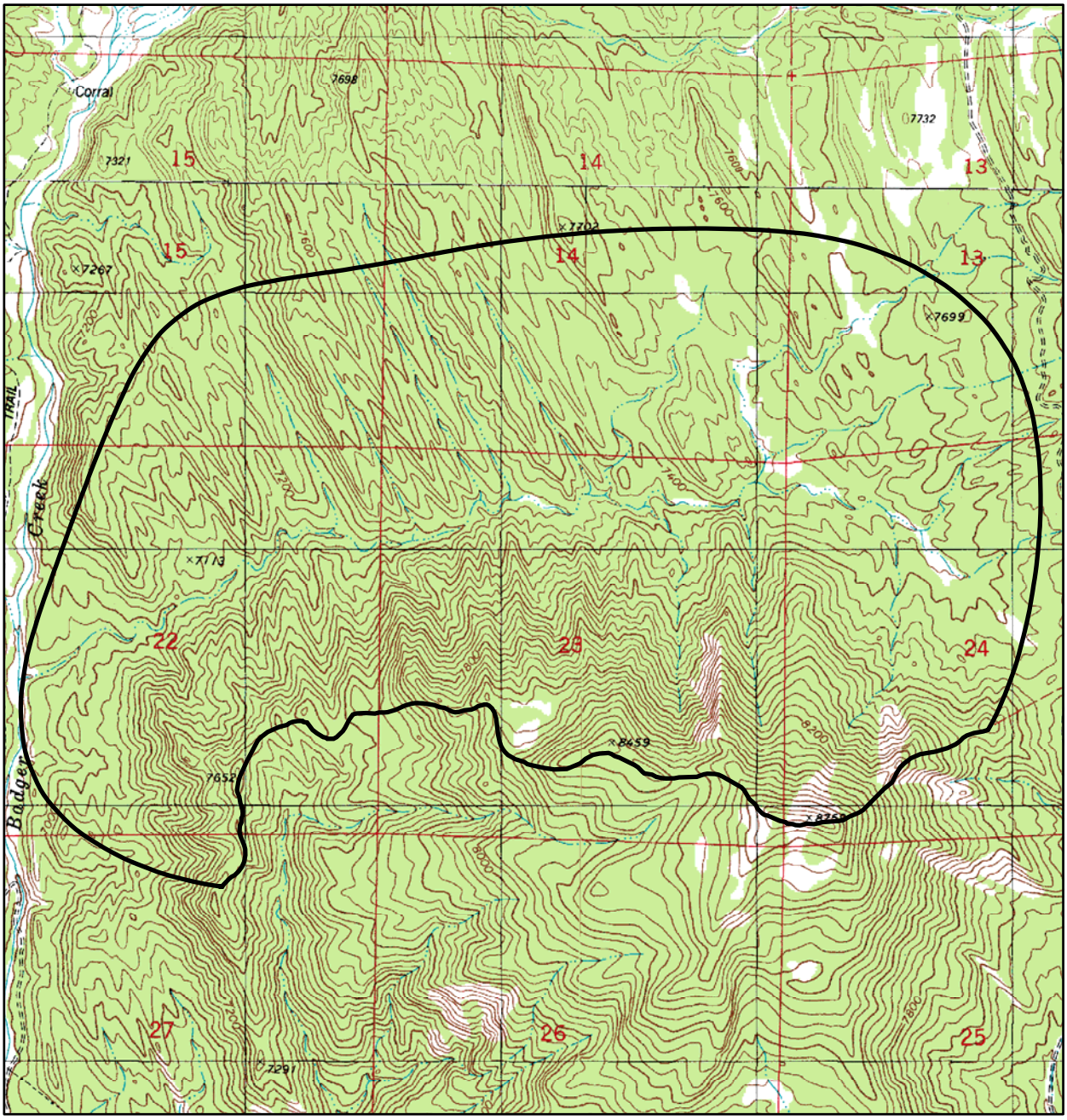
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Northern boundary includes tributary spring-fed ephemeral washes and topography that influence occurrence site. Eastern boundary includes convergence of several spring-fed ephemeral tributaries. Downstream

(western) boundary includes confluence with Badger Creek and approximately 200 yards buffer. South boundary is immediate ridgetops for watershed protection.

Protection Urgency Rank Comments (P5): This site is primarily owned by the BLM.

Management Urgency Rank Comments (M5): Formerly threatened by ATV use. This recreational use has been addressed and curbed by the BLM.



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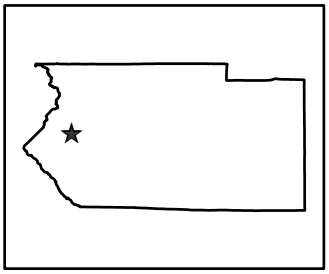
Legend

PCA Boundary

Howard, 38105-D7

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 12. Unnamed Tributary to Badger Creek at Howard Potential Conservation Area, B2: Very High Biodiversity Significance

Bear Creek below Simmons Peak

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Poncha Pass, Wellsville

Size: 3,323 acres (1,345 ha) **Elevation:** 7,700 - 12,050 ft (2,347 - 3,673 m)

General Description: Bear Creek is a moderate to high-gradient, perennial stream that plunges down the north-facing slopes of the Sangre de Cristo Range on the west side of Fremont County. The Sangre de Cristo Mountains are a linear range of steep, rugged peaks that rise out of the valleys below. Bear Creek's riparian system spans several elevation zones before its confluence with the Arkansas River. The mainstem begins in the talus slopes just above treeline below the craggy ridgeline and flows through subalpine spruce-fir forest before it grades into aspen and mixed evergreen forest where several tributary streams join the main channel. At lower elevations, the south-facing upland slopes have pinon pine (*Pinus edulis*) and Gambel oak (*Quercus gambelii*) while the north-facing slopes have mixed ponderosa pine - Douglas-fir (*Pinus ponderosa - Pseudotsuga menziesii*) forest. The tree canopy of the riparian system mirrors the upland forest canopy at higher elevations. At treeline, the stream flows through a small bowl. This lower gradient section has subalpine fir - Engelmann spruce / tall fringed bluebells (*Abies lasiocarpa - Picea engelmannii / Mertensia ciliata*) forest with spongy, mossy streambanks common at high elevations. Below the bowl, the stream corridor predominantly has a moderate to high gradient although past beaver activity has punctuated the reach with short stretches that have low gradient and small vegetated benches. Aspen (*Populus tremuloides*) is common in the tree canopy at higher elevations with quaking aspen / tall forbs (*Populus tremuloides* / tall forbs) forest the most abundant riparian natural community. At middle elevations the tree canopy becomes more mixed. Narrowleaf cottonwood (*Populus angustifolia*) and balsam poplar (*Populus balsamifera*) as well as Douglas-fir and white fir (*Abies concolor*) begin to enter the canopy. At lower elevations (approximately 8,000 feet), narrowleaf cottonwood is currently the sole canopy dominant in the riparian corridor (although the subcanopy has many conifers). On steeper reaches, there is greater shrub diversity and abundance whereas herbaceous ground cover dominates in lower gradient areas. The most frequent shrub along the reach is thinleaf alder (*Alnus incana*), although river birch (*Betula occidentalis*) is common and dominant in places. The herbaceous layer is not well-developed due to the dense shade of the shrub and canopy. However, in canopy gaps and on seepy benches, diverse forbs are present. This reach may be transitioning to a conifer-dominated riparian forest; throughout the lower and middle elevations conifer species form a subcanopy or are common in the shrub layer. Many aspen

and narrowleaf cottonwood trees have been felled by beaver or are over mature or standing dead snags.

Key Environmental Factors: Moderate to high stream gradient; beaver activity; montane, subalpine, and alpine elevation zones.

Biodiversity Significance Rank Comments (B3): This site encompasses an excellent to good (AB-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural community, quaking aspen / thinleaf alder (*Populus tremuloides / Alnus incana*) woodland and a good (B-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural community, narrowleaf cottonwood / thinleaf alder (*Populus angustifolia / Alnus incana*) woodland.

Natural Heritage element occurrences at the Bear Creek below Simmons Peak PCA.

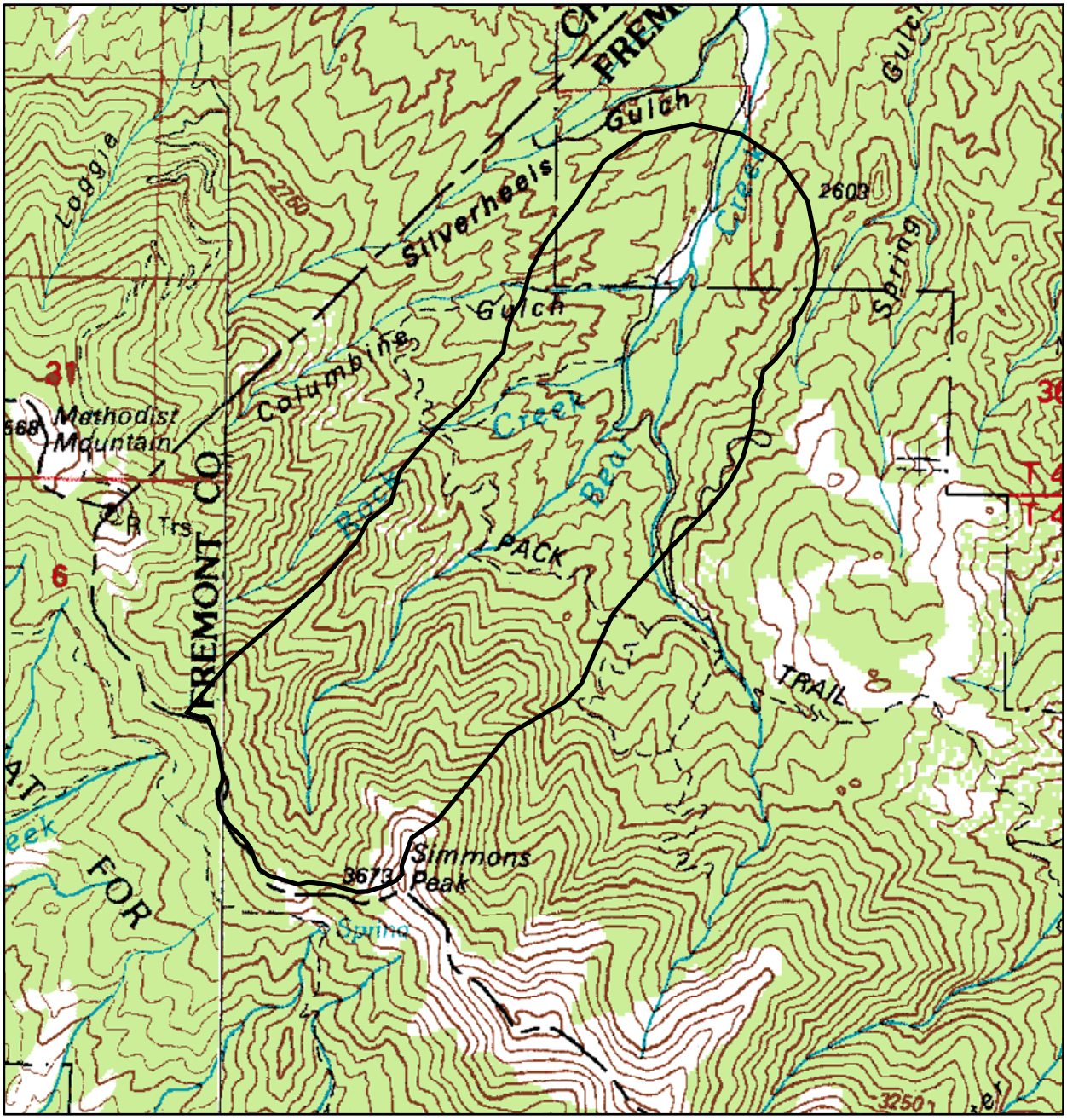
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3				B	2005-06-29
Natural Communities	Populus tremuloides / Alnus incana Forest	Montane Riparian Forests	G3	S3				AB	2005-06-29

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn as a 1 km buffer of the riparian corridor clipped at the upper end by the watershed boundary formed by the sharp, jagged ridgeline of the Sangre de Cristo Range. The lower end of the site was drawn at the upper boundary of hay meadows and where land parcels along the drainage are divided into small lots.

Protection Urgency Rank Comments (P4): The majority of this site is on the San Isabel National Forest, some of which is within the Sangre de Cristo Wilderness Area. Downstream portions are in private ownership with land immediately adjacent to the creek used for pasture and hay production.

Management Urgency Rank Comments (M4): Ensuring that all culverts in the lower end of the site are functioning properly will maintain the hydrology of the system in these areas. Ponding of water behind culverts may alter the vegetation composition.



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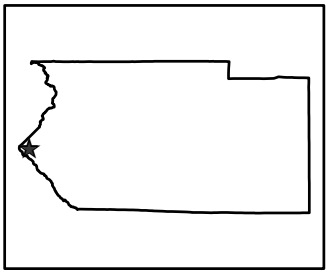
Legend

PCA Boundary

Canon City, 38105-A1
Saguache, 38106-A1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 13. Bear Creek below Simmons Peak Potential Conservation Area, B3: High Biodiversity Significance

Big Cottonwood Creek at Battle Mountain

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M3: Needed within 5 Years to Maintain Quality

U.S.G.S. 7.5-minute quadrangles: Coaldale, Cotopaxi

Size: 4,091 acres (1,656 ha) **Elevation:** 7,000 - 9,000 ft (2,134 - 2,743 m)

General Description: This riparian system drains the north face of the Sangre de Cristo Range, a linear range of steep, rugged peaks in southern Colorado. Big Cottonwood Creek spans several elevation zones before its confluence with the Arkansas River. It flows from subalpine zones, through spruce - fir (*Picea engelmannii - Abies lasiocarpa*) and aspen (*Populus tremuloides*) forests, and transitions to mixed evergreen forest in montane zones before grading into Gambel oak (*Quercus gambelii*) scrub and ponderosa pine (*Pinus ponderosa*) in the lower montane zone. The drainage cuts through Sangre de Cristo sandstone and Minturn and Belden Formations, which have lenses of marine limestone. Vegetation along the main channel of Big Cottonwood Creek changes with elevation. In upper montane zones, aspen dominates the tree canopy. Downstream, the riparian system shifts to conifer forest dominated by Douglas-fir (*Pseudotsuga menziesii*) before transitioning to narrowleaf cottonwood (*Populus angustifolia*) in the lower montane zone (below 7,300 feet). Throughout the reach, the shrub layer consists of discontinuous copses of river birch (*Betula occidentalis*) with scattered individuals of many other shrub species. Streambank vegetation is dominated by forbs and is limited to immediate streambanks in most locations, although there are several wide spots with wet seepage meadows on the sides of the stream at the base of the north-facing slopes where they meet the riparian corridor. The main channel is a rocky, tumbling creek with moderate gradient throughout much of the riparian system. However, it is punctuated by short lower gradient sections where the floodplain is wider. In these areas there can be several anastomosing channels. Wolf Creek is a tributary stream of Big Cottonwood Creek. This smaller channel is followed by an evergreen riparian woodland with a shrub layer that is a diverse mix of diffusely arranged individuals with no one species dominant along the reach as a whole. Streambank vegetation is limited to a very narrow band along the channel, which has a bed of small rocks and gravel.

Key Environmental Factors: Montane elevations; moderate stream gradient; limestone bedrock; localized groundwater seepage.

Biodiversity Significance Rank Comments (B3): This site is drawn for an excellent (A-ranked) occurrence of a globally vulnerable (G3?/S3) riparian natural community, Douglas-fir / river birch (*Pseudotsuga menziesii / Betula occidentalis*)

woodland. Additionally, there is a good (B-ranked) occurrence of the globally vulnerable (G3/S2) narrowleaf cottonwood / river birch (*Populus angustifolia / Betula occidentalis*) woodland and an excellent (A-ranked) occurrence of the globally apparently secure (G4/S2) Douglas-fir / red-osier dogwood (*Pseudotsuga menziesii / Cornus sericea*) woodland.

Natural Heritage element occurrences at the Big Cottonwood Creek at Battle Mountain PCA.

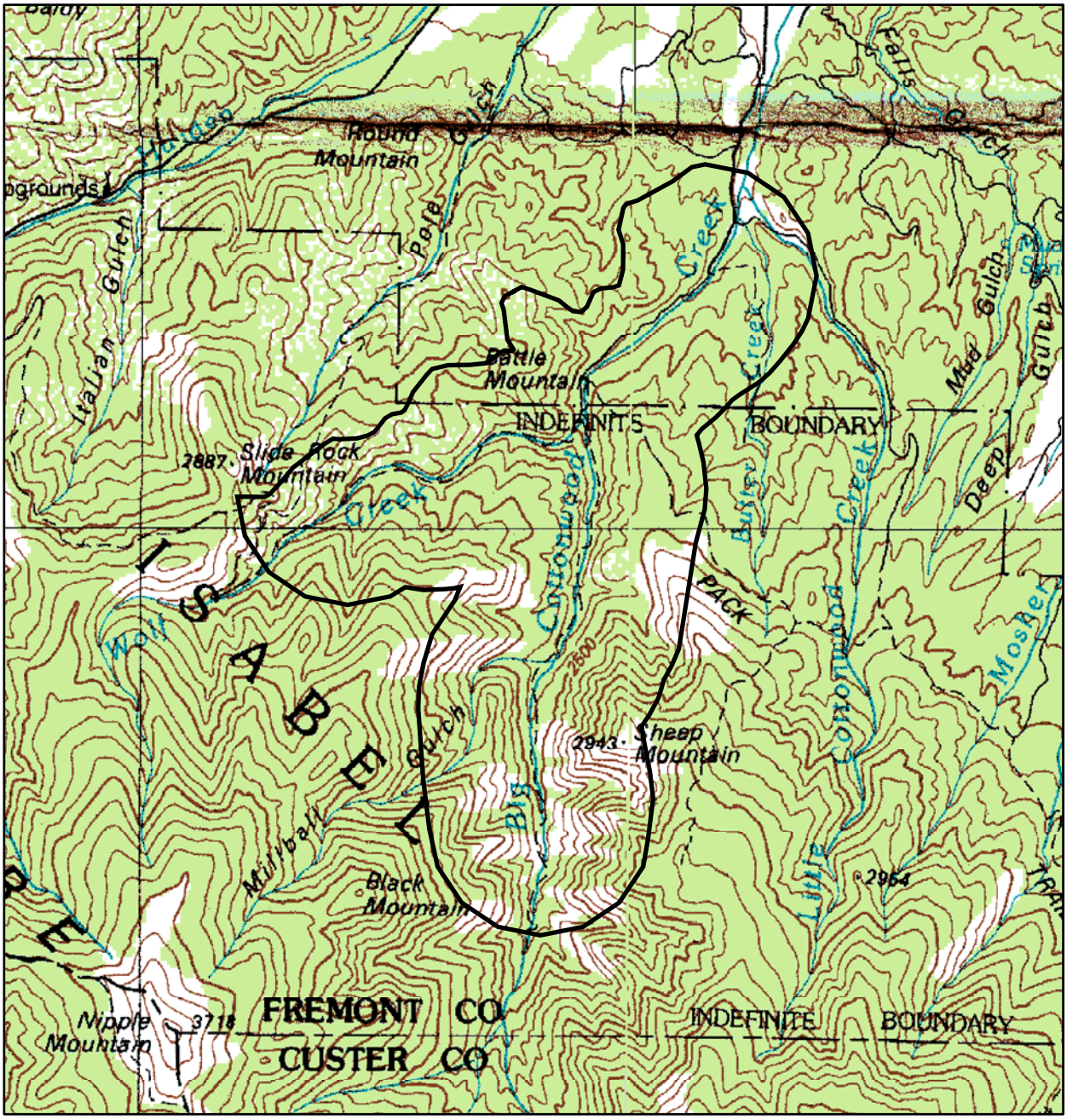
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S2				B	2005-07-20
Natural Communities	Pseudotsuga menziesii / Betula occidentalis Woodland	Montane Riparian Forest	G3?	S3				A	2005-07-20
Natural Communities	Pseudotsuga menziesii / Cornus sericea Woodland	Lower Montane Riparian Forests	G4	S2				A	2005-07-20

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn as a 1 km buffer of the riparian corridor clipped at the upper end by the watershed boundary to protect the immediate watershed.

Protection Urgency Rank Comments (P5): This site is largely contained within the San Isabel National Forest. Portions of it are on BLM land as well as State Land Board property.

Management Urgency Rank Comments (M3): There is a county road that follows this reach primarily below the site; residential development lines the stream at the lower end of the site. The State Land Board section of the occurrence has been grazed heavily; reducing grazing pressure along the streambanks would allow herbaceous layer to recover.



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Map Date: 03/13/2006

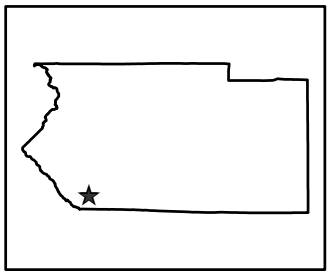
Legend

PCA Boundary

Canon City, 38105-A1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 14. Big Cottonwood Creek at Battle Mountain Potential Conservation Area, B3: High Biodiversity Significance

Chandler Creek

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M5: Not Needed; No Threats Anticipated

U.S.G.S. 7.5-minute quadrangles: Curley Peak, Rockvale

Size: 547 acres (221 ha) **Elevation:** 6,020 - 7,881 ft (1,835 - 2,402 m)

General Description: Chandler Creek is a relatively dry, intermittent stream in an east-facing, moderate-gradient drainage emerging from the northern Wet Mountains. Vegetation within the riparian corridor is relatively diverse for such dry conditions. There are patches of mixed evergreen-deciduous riparian woodland discontinuously along the reach. Between these patches are diverse shrublands interspersed with open meadows. The riparian woodland is variable with evergreen areas dominated by Douglas-fir (*Pseudotsuga menziesii*) along the midreach and mixed canopy areas elsewhere. Additional canopy species that occur within the drainage are narrowleaf cottonwood (*Populus angustifolia*), plains cottonwood (*Populus deltoides*), netleaf hackberry (*Celtis laevigata*) and white fir (*Abies concolor*). The shrub layer has patchy dominance, with some areas having dense groves of river birch (*Betula occidentalis*) as well as mixed areas with Rocky Mountain maple (*Acer glabrum*), thinleaf alder (*Alnus incana*), Rocky Mountain juniper (*Juniperus scopulorum*), and bluestem willow (*Salix irrorata*). The herbaceous understory is spotty with patches of mesic herbs interspersed with areas dominated by dry upland species. The riparian corridor is surrounded by extensive, intact uplands that are rocky and sparsely vegetated with Gambel oak (*Quercus gambelii*), ponderosa pine (*Pinus ponderosa*), pinon pine (*Pinus edulis*), and one-seed juniper (*Juniperus monosperma*). Thickets of Gambel oak extend down into the floodplain in some areas. Protected pockets of north-facing slopes are dominated by Douglas-fir forest. There is evidence of historic grazing and logging within the reach; streambanks are intact but deepened in places by erosion and there are large stumps scattered within the drainage.

Key Environmental Factors: Lower montane elevations; ephemeral to intermittent flow; low to moderate gradient.

Biodiversity Significance Rank Comments (B3): This site encompasses a good (B-ranked) occurrence of a globally vulnerable (G3?/S3) riparian natural community, Douglas-fir / river birch (*Pseudotsuga menziesii / Betula occidentalis*) woodland.

Natural Heritage element occurrences at the Chandler Creek PCA.

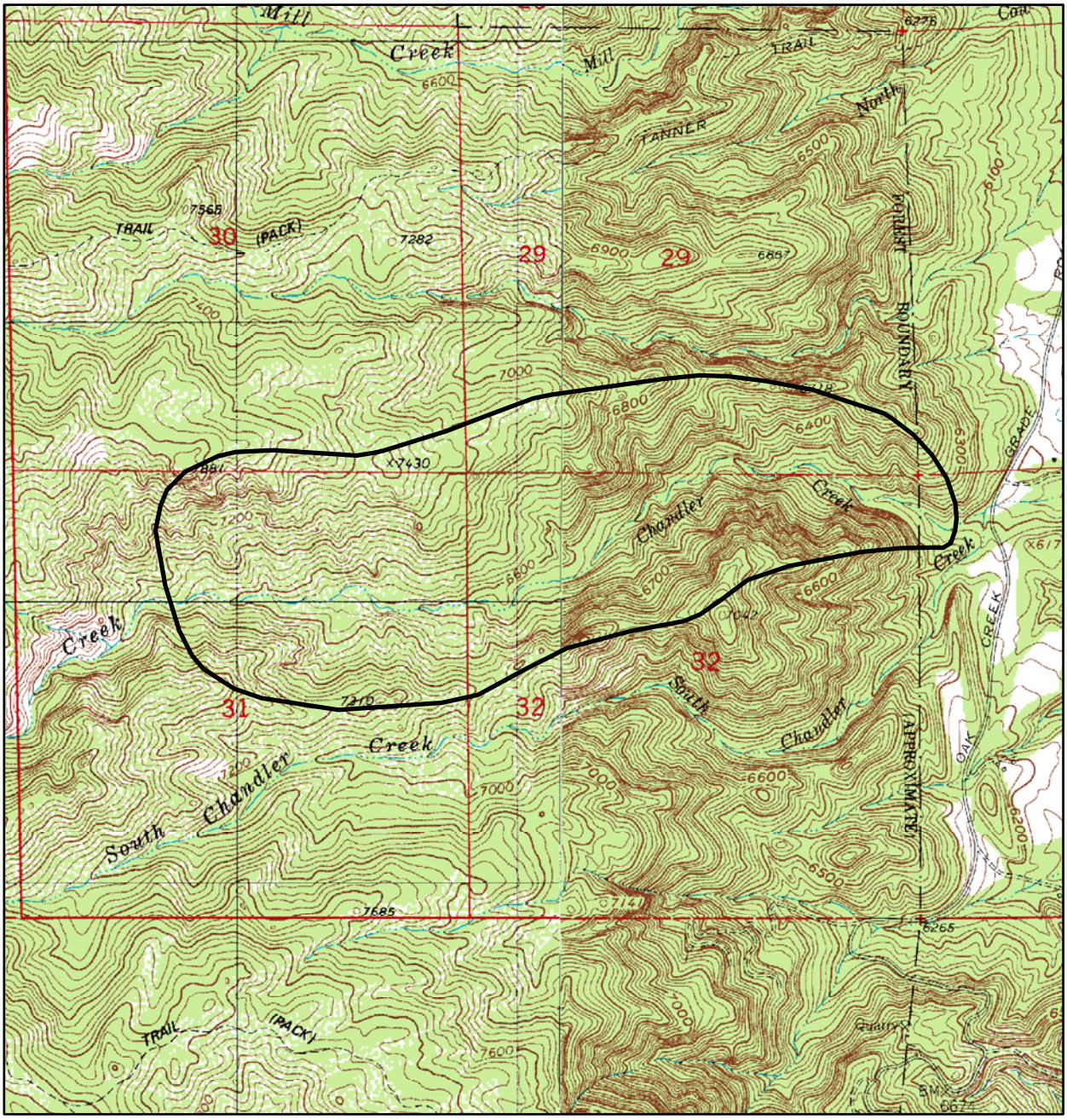
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Pseudotsuga menziesii / Betula occidentalis Woodland	Montane Riparian Forest	G3?	S3				B	2005-09-29

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary is drawn along adjacent ridgelines immediately above the drainage to 1 km above the element occurrence.

Protection Urgency Rank Comments (P5): This site is largely contained on the San Isabel National Forest.

Management Urgency Rank Comments (M5): Maintain current management regime.



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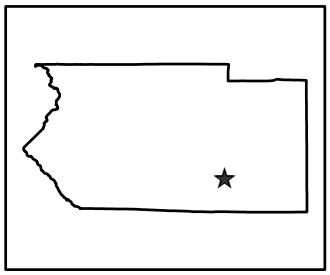
Legend

PCA Boundary

Rockvale, 38105-C2
Curley Peak, 38105-C3

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 15. Chandler Creek Potential Conservation Area, B3: High Biodiversity Significance

East Bear Gulch

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Curley Peak

Size: 571 acres (231 ha) **Elevation:** 7,350 - 9,240 ft (2,240 - 2,816 m)

General Description: East Bear Gulch is a narrow drainage below a local granitic peak (approximately 9,600 feet) in the northern Wet Mountains. An evergreen riparian woodland occupies the drainage; its tree canopy is dominated by Douglas-fir (*Pseudotsuga menziesii*), although there are scattered aspen (*Populus tremuloides*) trees throughout. Shrubs in the riparian corridor are a diverse mix of species though river birch (*Betula occidentalis*) forms somewhat dense copses along the reach. Understory herbs are lush forming a moist, green ground cover along moss-covered channel banks. Surface flow within the entire reach is intermittent, although groundwater is pushed up by narrow canyons in places forming small pools. The surrounding uplands are comprised of extensive, intact native ecological systems. South-facing slopes are dominated by gambel oak (*Quercus gambelii)* scrub with ponderosa pine (*Pinus ponderosa*), whereas north-facing slopes are dominated by Douglas-fir with ponderosa pine codominant closer to ridgetops. The peak has pockets of ponderosa pine and aspen interspersed in Parry's oatgrass (*Danthonia parryii*) grasslands. The grasslands support diverse forbs including Degener beardtongue (*Penstemon degeneri*).

Key Environmental Factors: Lower montane elevation; moderate gradient; intermittent flow.

Biodiversity Significance Rank Comments (B3): This site encompasses an excellent (A-ranked) occurrence of a globally vulnerable riparian natural community, Douglas-fir / River birch (*Pseudotsuga menziesii / Betula occidentalis*) woodland (G3?/S3).

Natural Heritage element occurrences at the East Bear Gulch PCA.

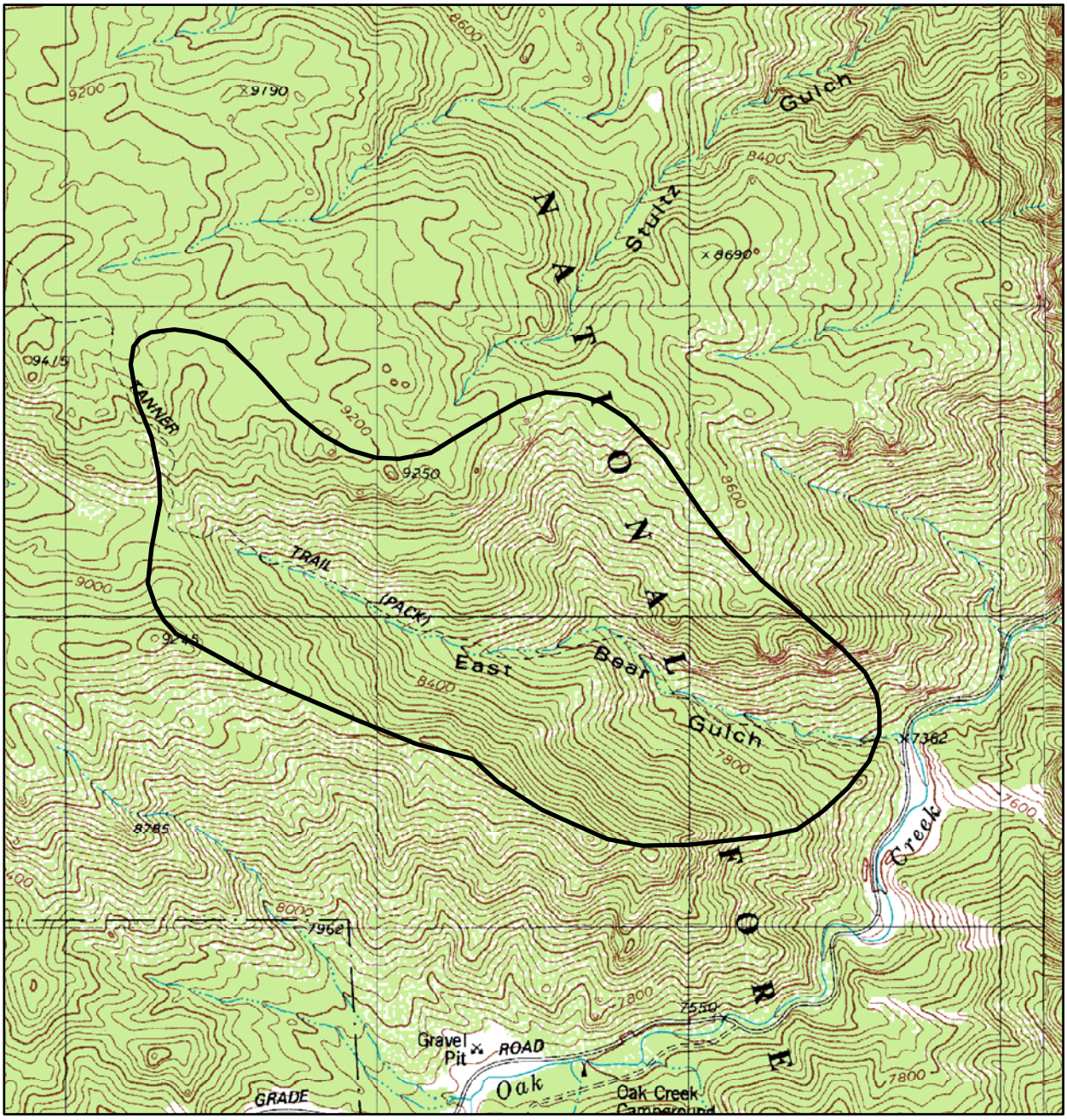
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Pseudotsuga menziesii / Betula occidentalis Woodland	Montane Riparian Forest	G3?	S3				A	2005-07-06

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn along the East Gulch watershed boundary to the south and to ridgelines to the north for immediate watershed protection.

Protection Urgency Rank Comments (P5): The area is on the San Isabel National Forest along a hiking trail.

Management Urgency Rank Comments (M4): Monitoring erosion from wheeled vehicle traffic along the trail would allow proactive management to prevent damage within the riparian corridor.



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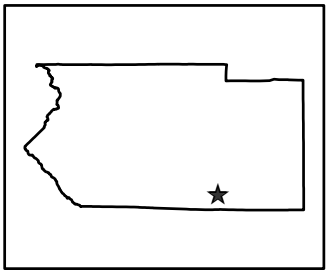
Legend

PCA Boundary

Curley Peak, 38105-C3

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 16. East Bear Gulch Potential Conservation Area, B3: High Biodiversity Significance

East Gulch at Bull Gulch

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Echo

Size: 6,173 acres (2,498 ha) **Elevation:** 6,000 - 9,400 ft (1,829 - 2,865 m)

General Description: This site is embedded within a rugged landscape of steep, low elevation (7,000-9,000 ft) hills dissected by steep, narrow gulches carved out of granitic bedrock in central Fremont County. The steep, rocky uplands have a matrix of sparse pinon - juniper (*Pinus edulis - Juniperus monosperma*) woodland with inclusions of mixed evergreen woodland of Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) on north-facing slopes. Several steep, narrow drainages tumble down the rocky slopes before joining with other intermittent streams in the valley below. These then coalesce into a single riparian corridor of East Gulch, a tributary of the Arkansas River. Bull Gulch is a steep, dry ephemeral to intermittent channel of unsorted gravel, stones, rocks, and boulders. It has a mixed evergreen-deciduous riparian woodland characterized by Douglas-fir and narrowleaf cottonwood (*Populus angustifolia*). These species have multiple age classes within this drainage; such regeneration indicates regular flooding. Shrub and herb layers are relatively diverse but sparse. Other drainages within this area are intermittent channels with more narrowleaf cottonwood, willows (*Salix exigua, Salix monticola*), and mesic herbaceous species. Channels with more water flow also have more non-native species like Kentucky bluegrass (*Poa pratensis*), dandelion (*Taraxacum officinale*), and clover (*Trifolium repens*). One spring-fed channel occurs. The perennial water flow supports a thicker canopy of narrowleaf cottonwood as well as river birch (*Betula occidentalis*) in the shrub layer. Streambanks of this channel are spongy and have relatively lush herbs. There are small reservoirs at the heads of the intermittent drainages at the top of the watershed.

Key Environmental Factors: Montane elevations; moderate and steep gradients; ephemeral to intermittent flow as well as spring-fed channels.

Biodiversity Significance Rank Comments (B3): This site encompasses an excellent to good (AB-ranked) occurrence of a globally vulnerable (G3/S2) riparian natural community, narrowleaf cottonwood / river birch (*Populus angustifolia / Betula occidentalis*) woodland and a good (B-ranked) occurrence of the globally vulnerable (G3/S2) narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland. It also has an excellent to good (AB-ranked) occurrence of the apparently globally secure (G4/S4) narrowleaf cottonwood / coyote willow (*Populus*

angustifolia / Salix exigua) woodland and a good (B-ranked) occurrence of the globally secure (G5/S5) coyote willow / mesic graminoids (*Salix exigua* - mesic graminoids) shrubland.

Natural Heritage element occurrences at the East Gulch at Bull Gulch PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				B	2005-06-22
Natural Communities	Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S2				AB	2005-06-22
Natural Communities	Populus angustifolia / Salix exigua Woodland	Narrowleaf Cottonwood Riparian Forests	G4	S4				AB	1995-08-27
Natural Communities	Salix exigua / Mesic Graminoids Shrubland	Coyote Willow / Mesic Graminoid	G5	S5				B	1995-08-27

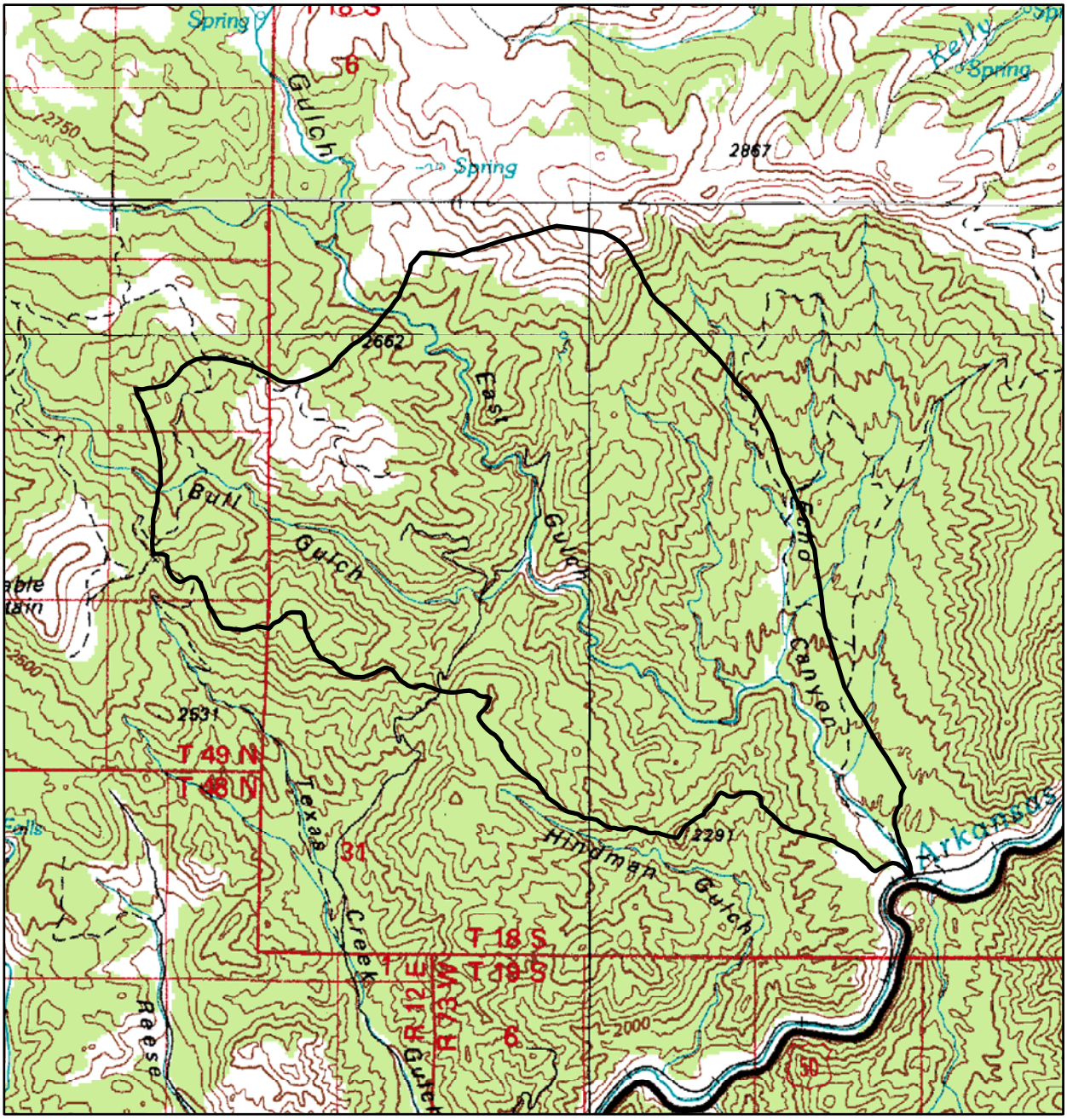
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn along East Gulch watershed boundary to the south and to ridgelines to the north for immediate watershed protection.

Protection Urgency Rank Comments (P4): The majority of this site is owned by the BLM.

Management Urgency Rank Comments (M4): The land is managed by the BLM as a grazing allotment. Monitoring any trampling effects in the narrow band of more delicate soils along the spring-fed channels would help to maintain the species diversity and structure along this corridor. Eradication of small patches of Canada thistle (*Cirsium canadensis*) would reduce the threat of invasive species.

Exotic Species Comments: There is an infestation of Canada thistle (*Cirsium canadensis*) just downstream of the spring at Echo Canyon. Some less invasive, yet persistent non-natives have established as well, e.g., Kentucky bluegrass, dandelion, clover.



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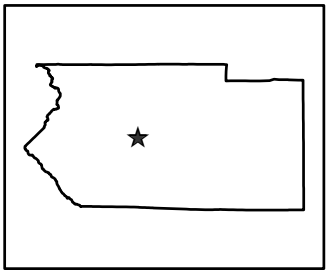
Legend

PCA Boundary

Canon City, 38105-A1

30 x 60 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 17. East Gulch at Bull Gulch Potential Conservation Area, B3: High Biodiversity Significance

Falls Gulch

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P3: Definable Threat/Opportunity but not within 5 Years

Management Urgency Rank - M3: Needed within 5 Years to Maintain Quality

U.S.G.S. 7.5-minute quadrangles: Arkansas Mountain

Size: 101 acres (41 ha) **Elevation:** 7,300 - 7,980 ft (2,225 - 2,432 m)

General Description: This site encompasses a spring-fed wetland occurring in a narrow hanging valley above a travertine cliff. The cliff is formed by a travertine plug within one of several drainages that dissect a local sandstone hogback surrounded by granitic bedrock in the western portion of the county. This plug has backed up drainage forming a wetland. A perennial stream is formed from several seepage areas that feed a network of rivulets that course through the fen-like sedge wetland perched behind the cliff. The stream plummets over the cliff as a 100-foot waterfall before joining Bernard Creek below. Xeric pinon - juniper (*Pinus edulis - Juniperus* spp.) woodland covers the surrounding hillsides in all directions. A small grove of balsam poplar (*Populus balsamifera*) occupies the mouth of the stream as it falls over the cliff face. Water birch (*Betula occidentalis*) cling to the cliff face and occupy streamsides below until the tributary meets Bernard Creek.

Key Environmental Factors: Spring-fed wetland

Biodiversity Significance Rank Comments (B3): This site is drawn for a good (B-ranked) occurrence of a globally vulnerable (G3/S2) riparian shrubland, water birch / mesic graminoids (*Betula occidentalis* / mesic graminoids) natural community. Additionally, there is an excellent (A-ranked) occurrence of an apparently globally secure, but state vulnerable (G4/S3) wetland natural community, analogue sedge (*Carex simulata*) herbaceous vegetation.

Natural Heritage element occurrences at the Falls Gulch PCA.

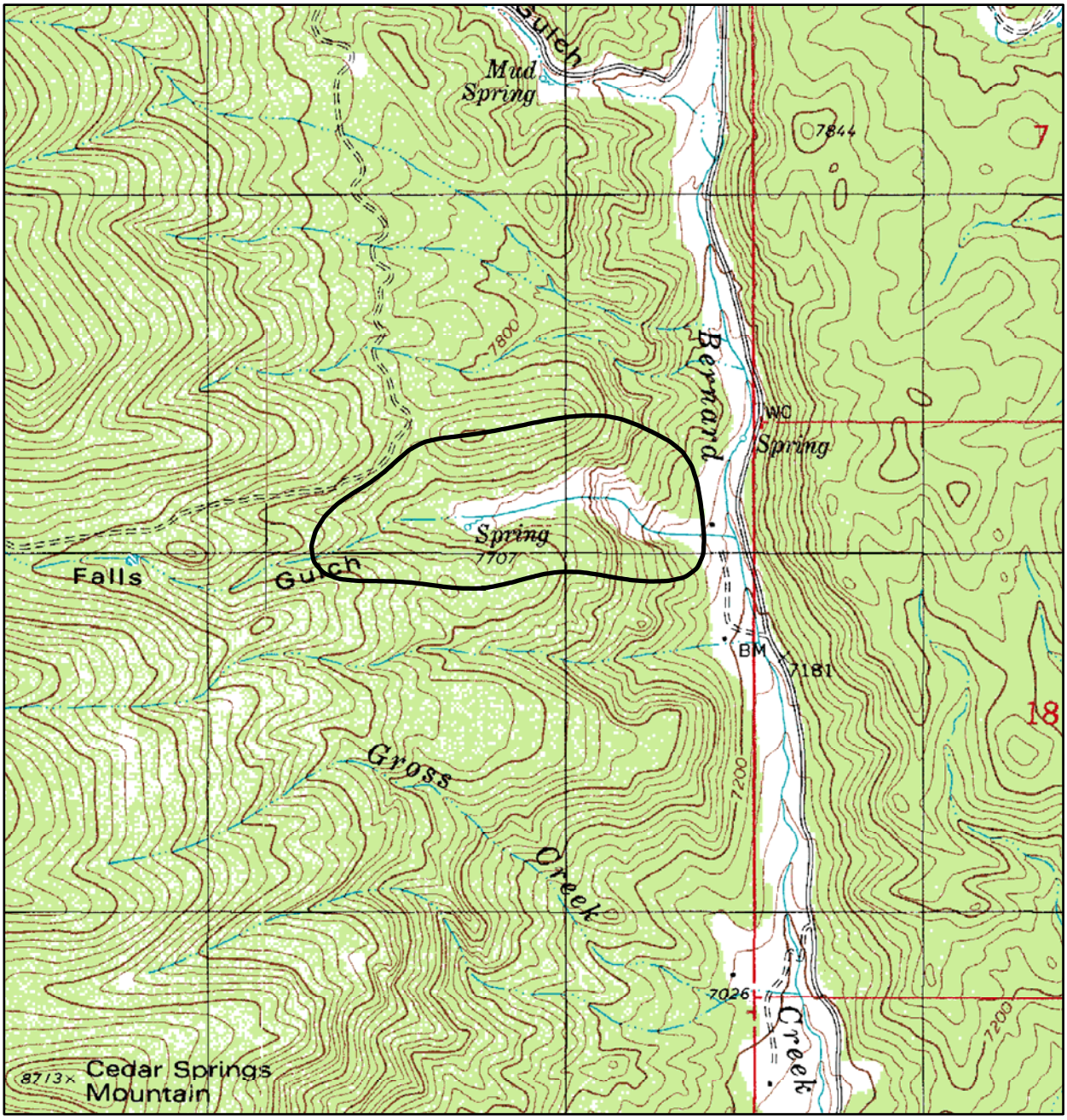
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Betula occidentalis / Mesic Graminoids Shrubland	Lower Montane Riparian Shrublands	G3	S2				B	2005-08-04
Natural Communities	Carex simulata Herbaceous Vegetation	Wet Meadow	G4	S3				A	2005-07-14

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn along adjacent ridgelines for immediate watershed protection. Boundary includes approximately 500 m buffer uphill from spring.

Protection Urgency Rank Comments (P3): There is a nonproductive mining claim on private land on the cliff that backs up the wetland. Mining activity near this spring-fed wetland may affect the hydrology that maintains it. The area behind the cliff is owned by the BLM.

Management Urgency Rank Comments (M3): There is an infestation of exotic weeds, especially Canada thistle (*Cirsium canadensis*) at the upper end of the wetland. Eradication of this weed patch will help protect the diversity and structure of the wetland.



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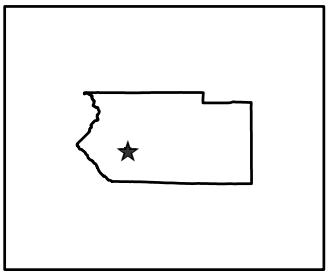
Legend

PCA Boundary

Arkansas Mountain, 38105-D6

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 18. Falls Gulch Potential Conservation Area, B3: High Biodiversity Significance

Hamilton Creek

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Coaldale, Howard

Size: 1,493 acres (604 ha) **Elevation:** 6,950 - 8,800 ft (2,118 - 2,682 m)

General Description: Hamilton Creek is a first order stream that courses down the north-facing slopes of the Sangre de Cristo Range before its confluence with the Arkansas River. This section of the reach flows through lower montane elevation zones with ponderosa pine (*Pinus ponderosa*) woodland and Gambel oak (*Quercus gambelii*) scrub that transitions to pinon - juniper - oak scrub (*Pinus edulis - Juniperus scopulorum - Quercus gambelii*) at lower elevations and spruce - fir forest (*Picea engelmannii - Abies lasiocarpa*) at higher elevations. The riparian woodland is dominated by narrowleaf cottonwood (*Populus angustifolia*) with several age classes present; these range from over-mature/senescent and mature trees to saplings and seedlings. There is an inconsistent shrub layer that has thinleaf alder (*Alnus incana*) and Rocky Mountain maple (*Acer glabrum*) as sporadically dominant species with scattered individuals of diverse shrub species also present. There is a lush understory of diverse forbs on damp stream terraces. The channel is narrow, rocky, and steep-sided, typical of high gradient first order streams in this area. Flood scouring is evident.

Key Environmental Factors: Lower montane elevation; high gradient; perennial flow; first-order stream.

Biodiversity Significance Rank Comments (B3): This site contains an excellent to good (AB-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural community, narrowleaf cottonwood / thinleaf alder (*Populus angustifolia / Alnus incana*) woodland.

Natural Heritage element occurrences at the Hamilton Creek PCA.

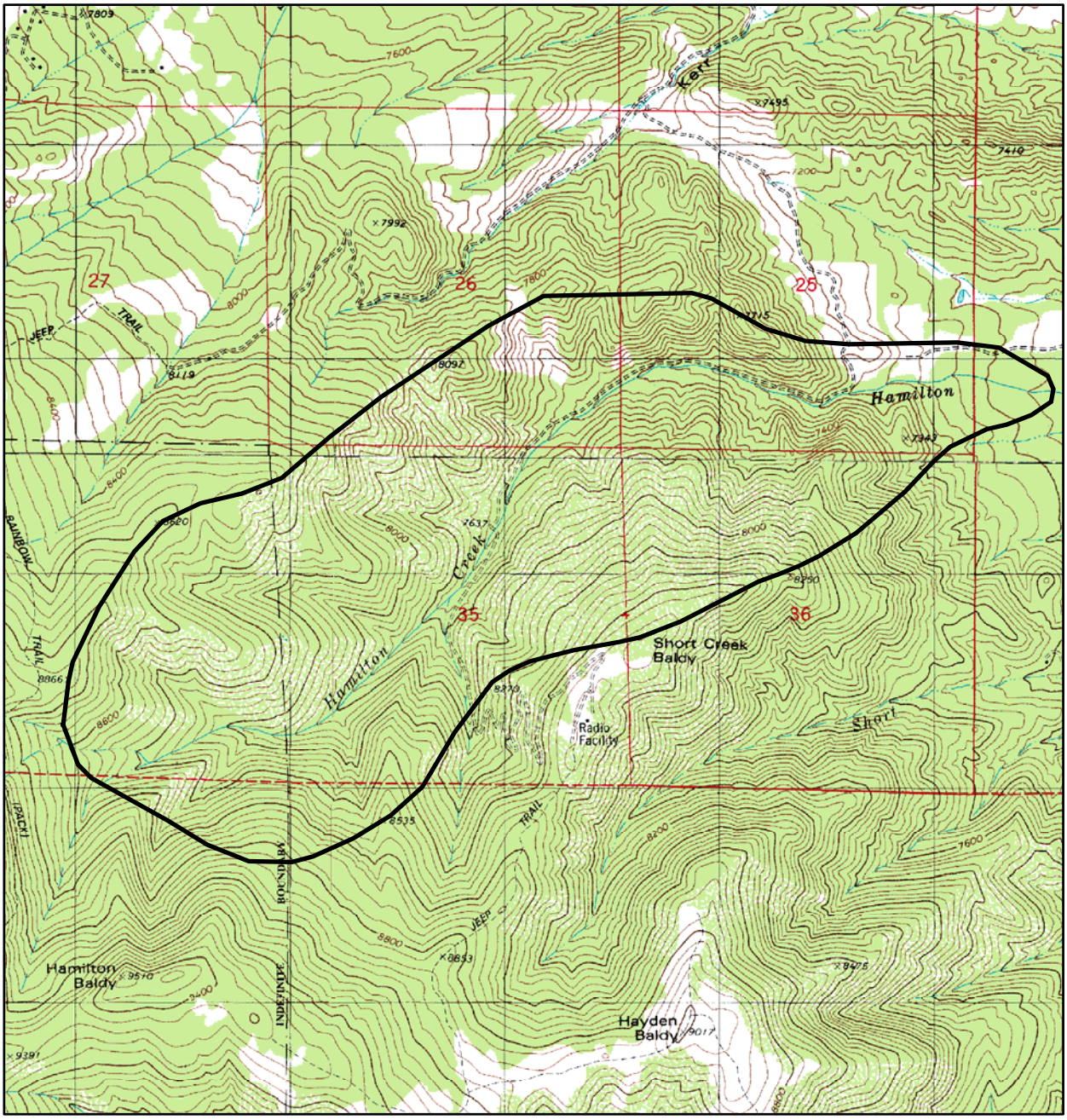
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3				AB	2005-06-17

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn along adjacent ridgeline to the west to address the immediate uplands surrounding the riparian corridor. It avoids radio tower infrastructure on the ridge to the east.

Protection Urgency Rank Comments (P4): A majority of this site is owned by the BLM. The downstream portion is in private ownership with multiple parcels and owners.

Management Urgency Rank Comments (M4): A jeep road that transitions to an ATV track services a radio facility on a local peak above the riparian corridor follows the creek before crossing it to access the radio facility. Monitoring erosion from the usage of this track would allow proactive management of sedimentation into the riparian system.



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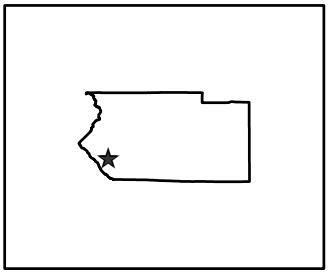
Legend

PCA Boundary

Coaldale, 38105-C7
Howard, 38105-D7

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 19. Hamilton Creek Potential Conservation Area, B3: High Biodiversity Significance

Lion Canyon

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P5: No Action to be Taken on this Site

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Curley Peak

Size: 707 acres (286 ha) **Elevation:** 7,800 - 9,240 ft (2,377 - 2,816 m)

General Description: Lion Canyon is a relatively steep, narrow drainage on the granitic, north-facing slope of a local height of land in the northern Wet Mountains. Flowing down from a montane meadow, this predominantly deciduous riparian woodland characterized by quaking aspen (*Populus tremuloides*), forms a narrow band immediately adjacent to the stream channel. White fir (*Abies concolor*) and Douglas-fir (*Pseudotsuga menziesii*) are common and white fir is nearly codominant at higher elevations. The shrub layer is not dense, but is mostly continuous along the reach. Thinleaf alder (*Alnus incana*) is the most frequent and abundant shrub. Herbaceous understory is fairly diverse and lush in the shade of the canyon and tree canopy. Southerly aspects of the surrounding uplands have Gambel oak (*Quercus gambelii*) thickets, otherwise the surrounding slopes are dominated by conifers.

Key Environmental Factors: Montane elevation; cool, north-facing slope; moderate to high gradient.

Biodiversity Significance Rank Comments (B3): This site encompasses a good (B-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural community, quaking aspen / thinleaf alder (*Populus tremuloides / Alnus incana*) woodland.

Natural Heritage element occurrences at the Lion Canyon PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus tremuloides / Alnus incana Forest	Montane Riparian Forests	G3	S3				AB	2005-07-28

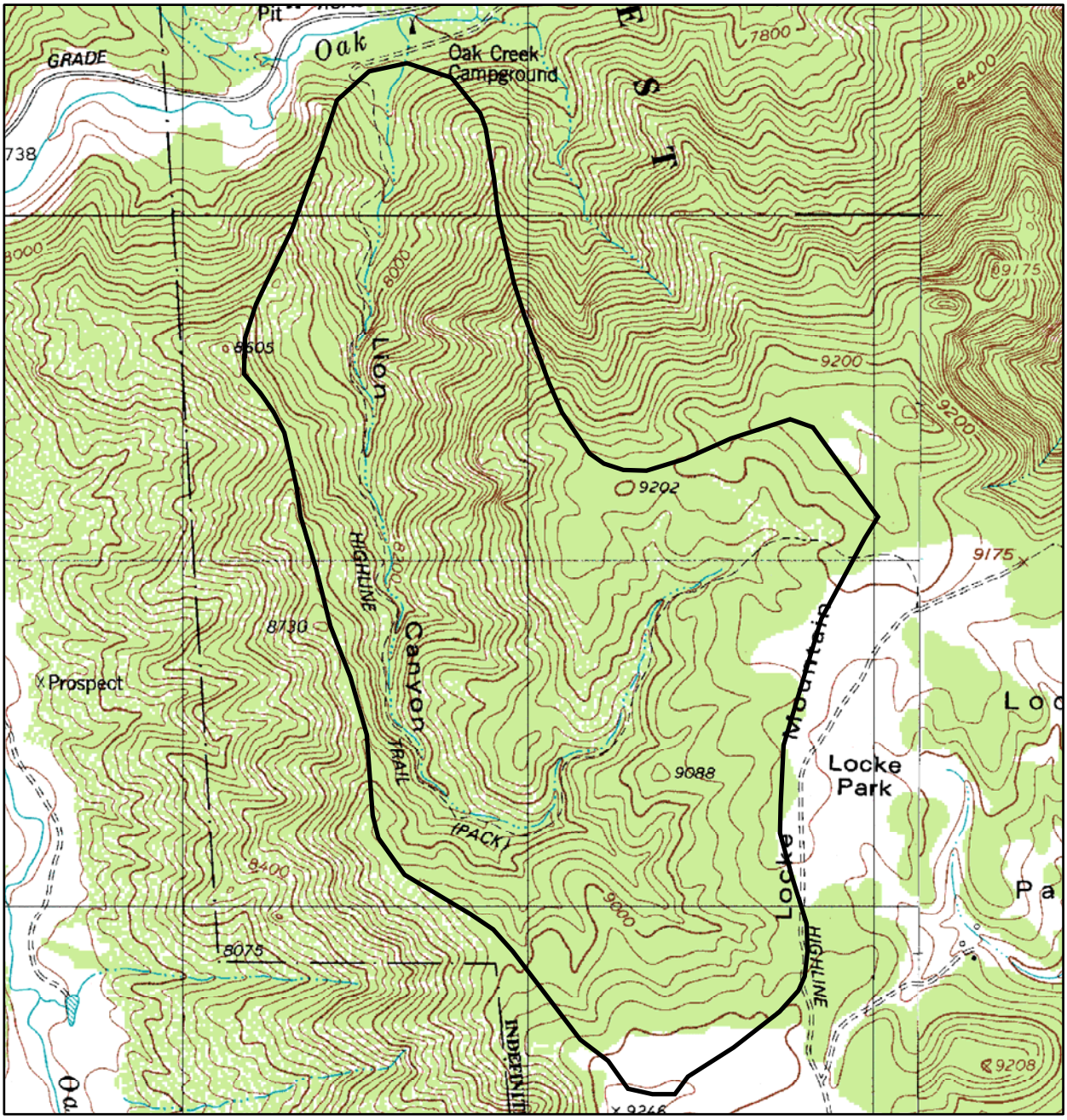
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary is drawn along Oak Creek watershed boundary to south and follows adjacent ridgelines along east and west for immediate watershed protection.

Protection Urgency Rank Comments (P5): This site is on the San Isabel National

Forest and managed for recreation.

Management Urgency Rank Comments (M4): Although currently this is not a problem, monitoring for any erosion or invasive weed establishment along the adjacent hiking trail or in the stream corridor would protect this riparian system from the threat of invasive plant species.



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Map Date: 03/13/2006

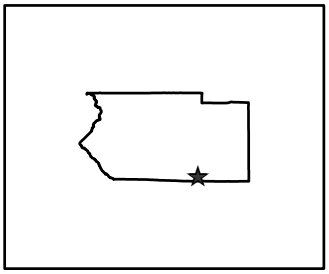
Legend

PCA Boundary

Curley Peak, 38105-C3

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 20. Lion Canyon Potential Conservation Area, B3: High Biodiversity Significance

Little Badger Creek

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P3: Definable Threat/Opportunity but not within 5 Years

Management Urgency Rank - M2: Essential within 5 Years to Prevent Loss

U.S.G.S. 7.5-minute quadrangles: Jack Hall Mountain

Size: 633 acres (256 ha) **Elevation:** 8,200 - 9,400 ft (2,499 - 2,865 m)

General Description: Little Badger Creek is a spring-fed ephemeral creek that runs through a narrow V-shaped valley within a landscape of rugged, low elevation hills (7,000-9,000 ft). The stream channel is severely entrenched, but terraces have re-established in the bottom with multiple channels running across the floodplain. The entrenched walls are steep, vertical, and unvegetated adjacent to a narrow strip of riparian vegetation along the streambanks. Narrowleaf cottonwood (*Populus angustifolia)* forms an interrupted tree canopy over copses of thinleaf alder (*Alnus incana*), river birch (*Betula occidentalis*), and willows (*Salix exigua* and *Salix lucida*). The understory is infested with non-native pasture grasses, although wetter terrace areas support native sedge meadow vegetation. The rugged upland slopes above the riparian corridor are steep and rocky, carved out of granitic bedrock. North-facing slopes have ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) while south-facing slopes have pinon pine (*Pinus edulis*).

Biodiversity Significance Rank Comments (B3): The biodiversity rank is based on a good (B-ranked) occurrence of a globally vulnerable (G3/S2) riparian natural community, narrowleaf cottonwood / river birch (*Populus angustifolia / Betula occidentalis*) woodland. Additional elements include a fair (C-ranked) occurrence of a globally vulnerable (G3/S3) riparian natural community, narrowleaf cottonwood / thinleaf alder (*Populus angustifolia / Alnus incana*) woodland and good (B-ranked) occurrences of two globally secure riparian natural communities, coyote willow / mesic graminoids (*Salix exigua* / mesic graminoids) shrubland (G5/S5) and water sedge (*Carex aquatilis*) herbaceous vegetation (G5/S4).

Natural Heritage element occurrences at the Little Badger Creek PCA.

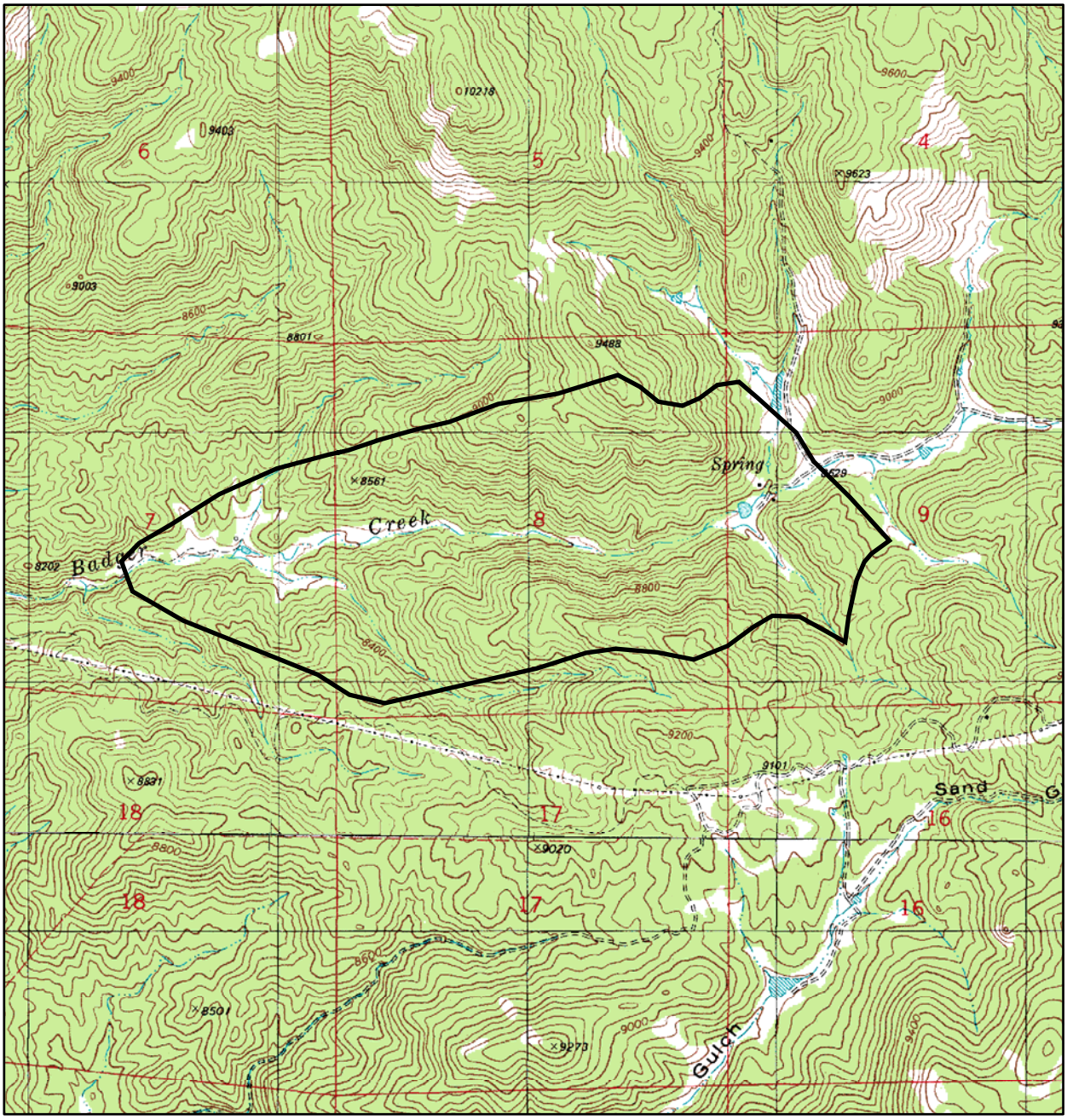
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia / Alnus incana Woodland	Montane Riparian Forest	G3	S3				C	1995-07-02
Natural Communities	Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S2				B	1995-07-02
Natural Communities	Carex aquatilis Herbaceous Vegetation	Montane Wet Meadows	G5	S4				B	1995-07-02
Natural Communities	Salix exigua / Mesic Graminoids Shrubland	Coyote Willow / Mesic Graminoid	G5	S5				B	1995-07-02

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Eastern boundary is the junction of three spring-fed tributaries. North and south boundaries are located at the top of the ridge line for immediate watershed protection. West boundary is one-half mile buffer below downstream edge of occurrence.

Protection Urgency Rank Comments (P3): The majority of the stream corridor is privately owned and grazing has affected both hydrology and riparian vegetation.

Management Urgency Rank Comments (M2): A comprehensive grazing management plan for both BLM and private lands would allow recovery of riparian vegetation and streambank stabilization.



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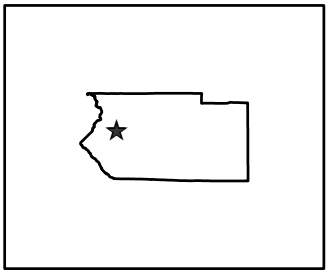
Legend

PCA Boundary

Jack Hall Mountain, 38105-E7

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 21. Little Badger Creek Potential Conservation Area, B3: High Biodiversity Significance

Red Creek Canyon

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Mount Big Chief, Mount Pittsburg

Size: 2,106 acres (852 ha) **Elevation:** 7,000 - 9,600 ft (2,134 - 2,926 m)

General Description: Red Creek Canyon is one of several granitic canyons that dissect the foothills on the southern flank of Pikes Peak. The canyon sides are moderately to somewhat steep and are predominantly covered by pinon - juniper (*Pinus edulis - Juniperus* spp.) woodland. An evergreen riparian woodland occurs along a narrow-channeled intermittent stream flowing through the canyon where the gradient is moderate. Upstream the gradient is steeper and drainage channels less defined. The valley floor is variable in width and surface topography. Coarse outwash deposits are prevalent where the valley is wider. Along the creek the riparian woodland has Douglas-fir (*Pseudotsuga menziesii*) as the most abundant canopy tree although portions of the canopy are codominated by narrowleaf cottonwood (*Populus angustifolia*) and/or white fir (*Abies concolor*). Shrubs form a discontinuous layer along the reach with interruptions in riparian shrub cover occurring where the valley widens and has thicker surficial deposits. Shrub species composition is variable, although river birch (*Betula occidentalis*) is the most constant along the reach. This drainage has largely been dry since 1999; drought may be weakening the narrowleaf cottonwood and decreasing the abundance of mesic herbaceous species.

Key Environmental Factors: Montane elevations; moderate to low stream gradient; linear valley.

Biodiversity Significance Rank Comments (B3): This site encompasses an excellent (A-ranked) occurrence of a globally vulnerable riparian natural community, Douglas-fir / river birch (*Pseudotsuga menziesii / Betula occidentalis*) woodland (G3?/S3).

Natural Heritage element occurrences at the Red Creek Canyon PCA.

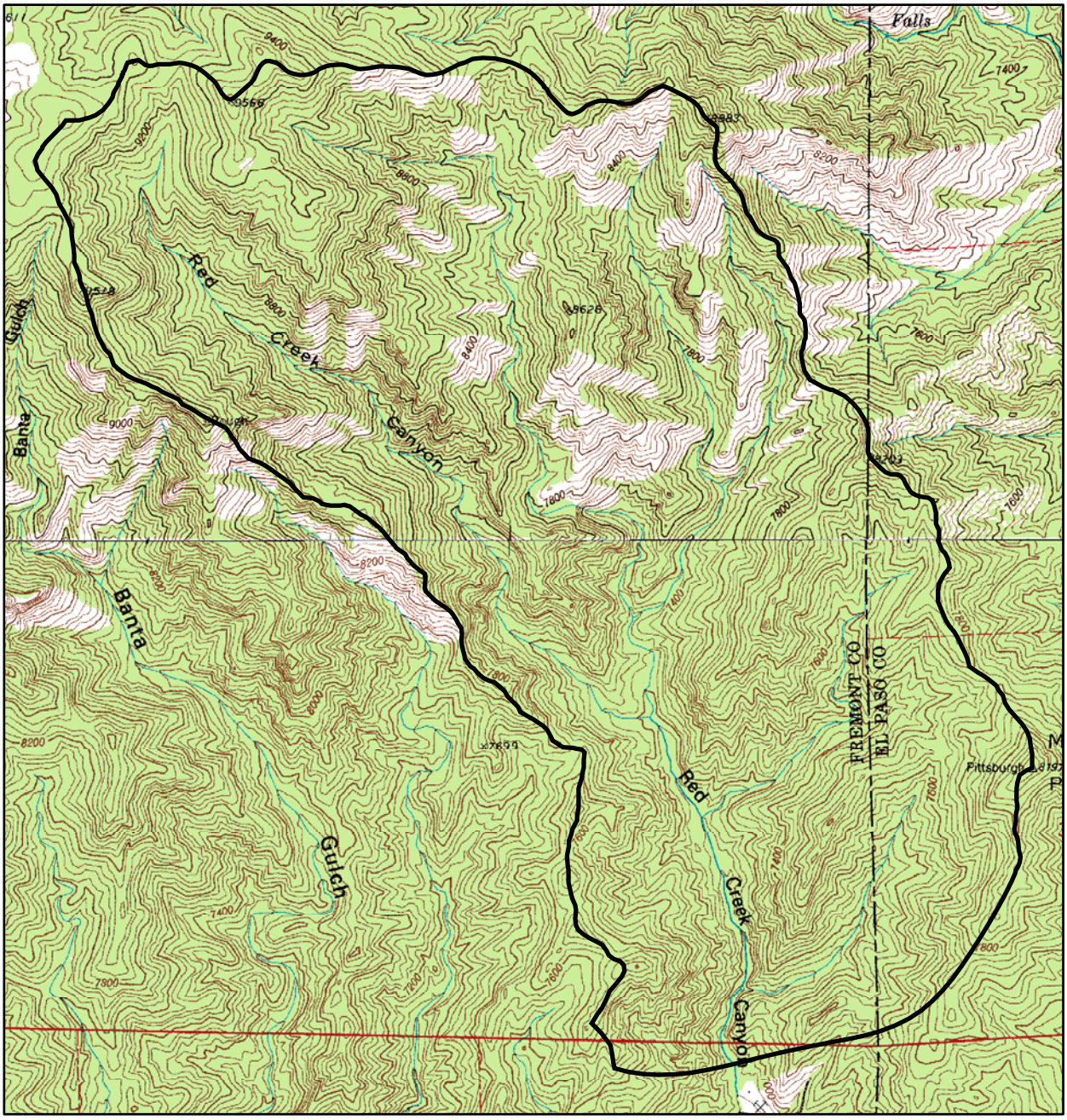
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Pseudotsuga menziesii / Betula occidentalis Woodland	Montane Riparian Forest	G3?	S3				A	2005-08-14

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary is formed by upper watershed boundary (HUC12; Red Creek) to provide immediate watershed protection.

Protection Urgency Rank Comments (P4): There is a sandstone quarry on the state land board immediately downstream of the site that limits access to the drainage, most of which is owned by the BLM.

Management Urgency Rank Comments (M4): There are patches of Canada thistle (*Cirsium canadensis*) at the lower end of the site. Eradication of these patches would prevent them from spreading and further altering the herbaceous understory in the riparian corridor.



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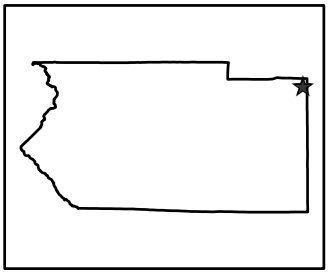
Legend

PCA Boundary

Mount Pittsburg, 38104-E8
Mount Big Chief, 38104-F8

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 22. Red Creek Canyon Potential Conservation Area, B3: High Biodiversity Significance

Sand Gulch at Copper Mountain

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Howard

Size: 971 acres (393 ha) **Elevation:** 7,400 - 9,300 ft (2,256 - 2,835 m)

General Description: This moderately steep, intermittent drainage flows through a steep-sided tributary valley that is set within a general landscape of rugged, low elevation hills (7,000-8,000 feet) composed of granite and gneiss bedrock. South-facing slopes are dominated by sparse pinon - juniper (*Pinus edulis - Juniperus monosperma*) woodland, whereas north-facing slopes have denser canopies and more ponderosa pine (*Pinus ponderosa*). The drainage is primarily a sand and gravel wash interspersed with areas where surface water emerges forming narrow, mossy rivulets. Dry areas of the channel are strewn with cobble, rocks, and boulders. The tree canopy in this relatively dry riparian corridor is dominated by Douglas-fir (*Pseudotsuga menziesii*) and narrowleaf cottonwood (*Populus angustifolia*). Shrubs and herbs are sparse and comprised of upland as well as wetland species. However, there are two areas with groves of river birch (*Betula occidentalis*), one of which has exceptionally large, multi-stemmed individuals that contribute to the canopy. This site occupies the upper portion of this tributary drainage. Below, it drains into a network of consecutively wider sand washes before its confluence with the Arkansas River.

Biodiversity Significance Rank Comments (B3): This site contains good (B-ranked) occurrences of globally vulnerable (G3/S2) riparian natural communities: narrowleaf cottonwood - Douglas-fir (*Populus angustifolia - Pseudotsuga menziesii*) woodland and narrowleaf cottonwood / river birch (*Populus angustifolia / Betula occidentalis*) woodland.

Natural Heritage element occurrences at the Sand Gulch at Copper Mountain PCA.

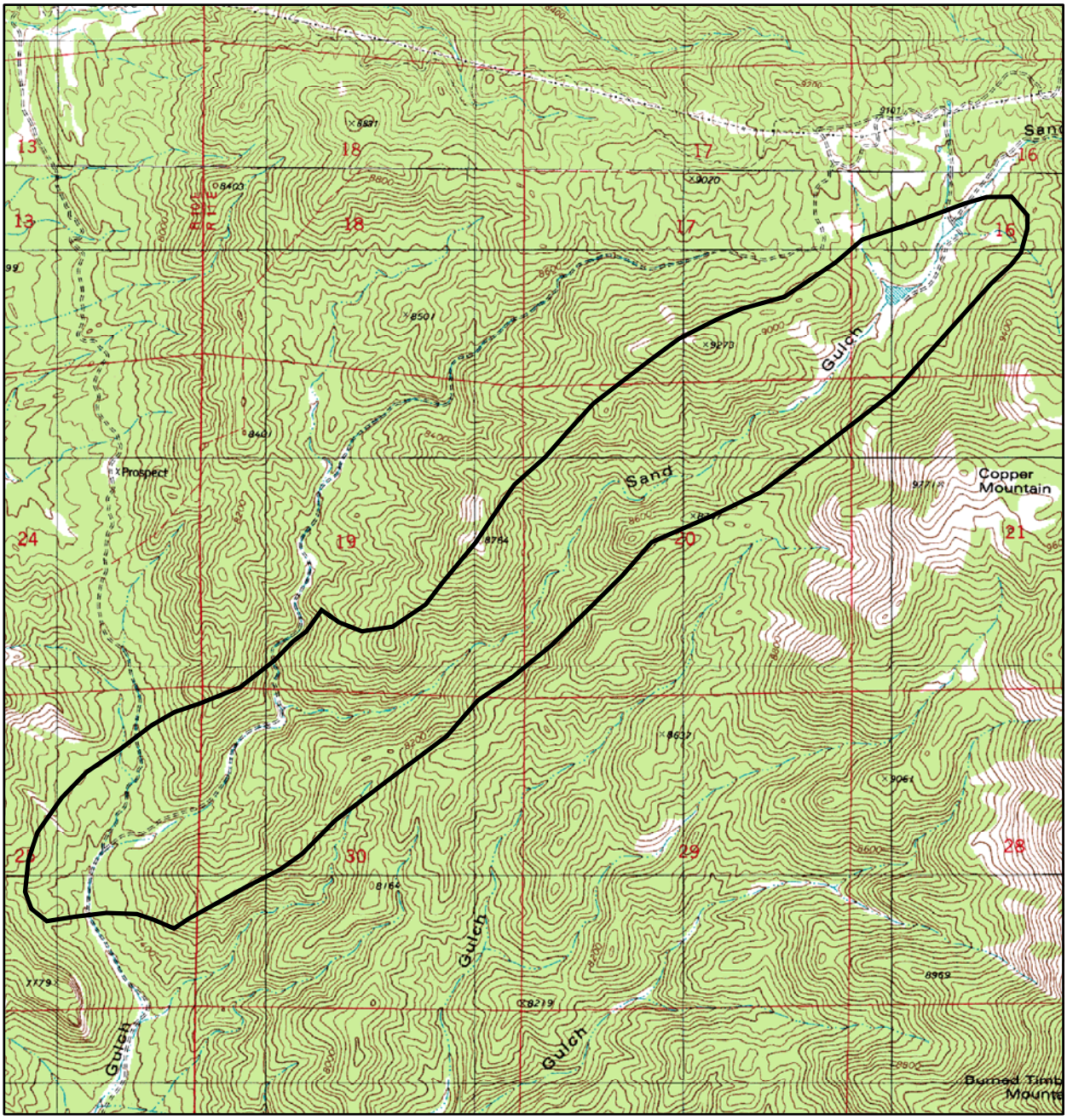
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus angustifolia - Pseudotsuga menziesii Woodland	Montane Riparian Forest	G3	S2				B	2005-06-16
Natural Communities	Populus angustifolia / Betula occidentalis Woodland	Montane Riparian Forest	G3	S2				B	2005-06-16

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Ridge tops were used as north and south boundaries for immediate watershed protection. Upper watershed boundary is the northern boundary and a few hundred yards below tributary confluence to buffer the occurrences.

Protection Urgency Rank Comments (P4): The majority of this site is owned by the BLM.

Management Urgency Rank Comments (M4): Limiting grazing within this drainage will prevent trampling and destruction of localized areas of seepy streamsides and maintain natural channel structure. Limiting water retention in the stock pond at the top of the drainage may insure some surface flow downstream, which is beneficial to the natural communities.



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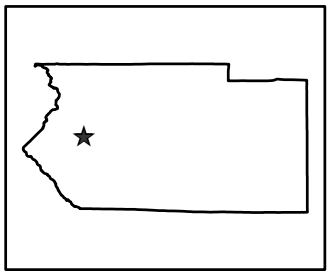
Legend

PCA Boundary

Howard, 38105-D7

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 23. Sand Gulch at Copper Mountain Potential Conservation Area, B3: High Biodiversity Significance

Stout Creek

Biodiversity Rank - B3: High Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Bushnell Peak, Coaldale, Howard

Size: 2,855 acres (1,155 ha) **Elevation:** 7,700 - 13,105 ft (2,347 - 3,994 m)

General Description: This riparian system flows down the steep north face of the Sangre de Cristo Range, beginning in glaciated valleys just below the jagged ridgeline and peaks. Stout Creek begins at Stout Creek Lakes and is joined by a major tributary that descends from Bushnell Lakes in the adjacent valley to the south. This site addresses Bushnell Lakes, although the valley of Stout Creek Lakes is likely comparable. The alpine zone is a narrow area in the bottom of the U-shaped valley and it forms a mosaic with subalpine spruce - fir forest patches right at treeline. The valley has a series of alpine lakes (Bushnell Lakes) connected by waterfalls before the stream tumbles down the north face of the mountain range. The stream flows through a mosaic of alpine meadow and subalpine spruce - fir forest at treeline. A short willow carr dominated by planeleaf willow (*Salix planifolia*) and diverse forbs lines the stream and forms a mosaic with the evergreen riparian forest (*Picea engelmannii - Abies lasiocarpa / Mertensia ciliata* forest) at subalpine elevations (above 11,000 feet). The stream continues to flow through subalpine spruce - fir forest until its confluence with Stout Creek before grading into mixed evergreen - aspen forest at lower elevations. In this high-gradient area in the upper montane zone the drainage pattern is complex. There are a series of channels that are variously active and inactive over the years; some years the perennial flow follows one branch, the next year it follows another leaving the first channel a dry bed of exposed cobbles. There is abundant evidence of high-energy flooding. Quaking aspen (*Populus tremuloides*) is the dominant canopy species in the riparian corridor at this elevation zone although conifers like white fir (*Abies concolor*) and Douglas-fir (*Pseudotsuga menziesii*) are common. Large, multi-stemmed specimens of river birch (*Betula occidentalis*) form discontinuous patches along the reach with other diverse shrub species. The ground layer is comprised of moss-covered boulders and downed wood interspersed with lush and diverse forbs. At lower elevations, the tree canopy shifts to narrowleaf cottonwood (*Populus angustifolia*).

Key Environmental Factors: Subalpine, upper montane elevations; high to moderate gradient; perennial flow.

Biodiversity Significance Rank Comments (B3): This site is drawn for an excellent (A-ranked) occurrence of a globally vulnerable (G3/S2) riparian natural community,

quaking aspen / river birch (*Populus tremuloides / Betula occidentalis*) woodland. Additionally, there are excellent (A-ranked) occurrences of an apparently globally secure (G4/S4) natural community, planeleaf willow / mesic forb (*Salix planifolia* / mesic forb) shrubland and a globally secure (G5/S5) riparian natural community, subalpine fir / tall fringed bluebells (*Abies lasiocarpa / Mertensia ciliata*) forest.

Natural Heritage element occurrences at the Stout Creek PCA.

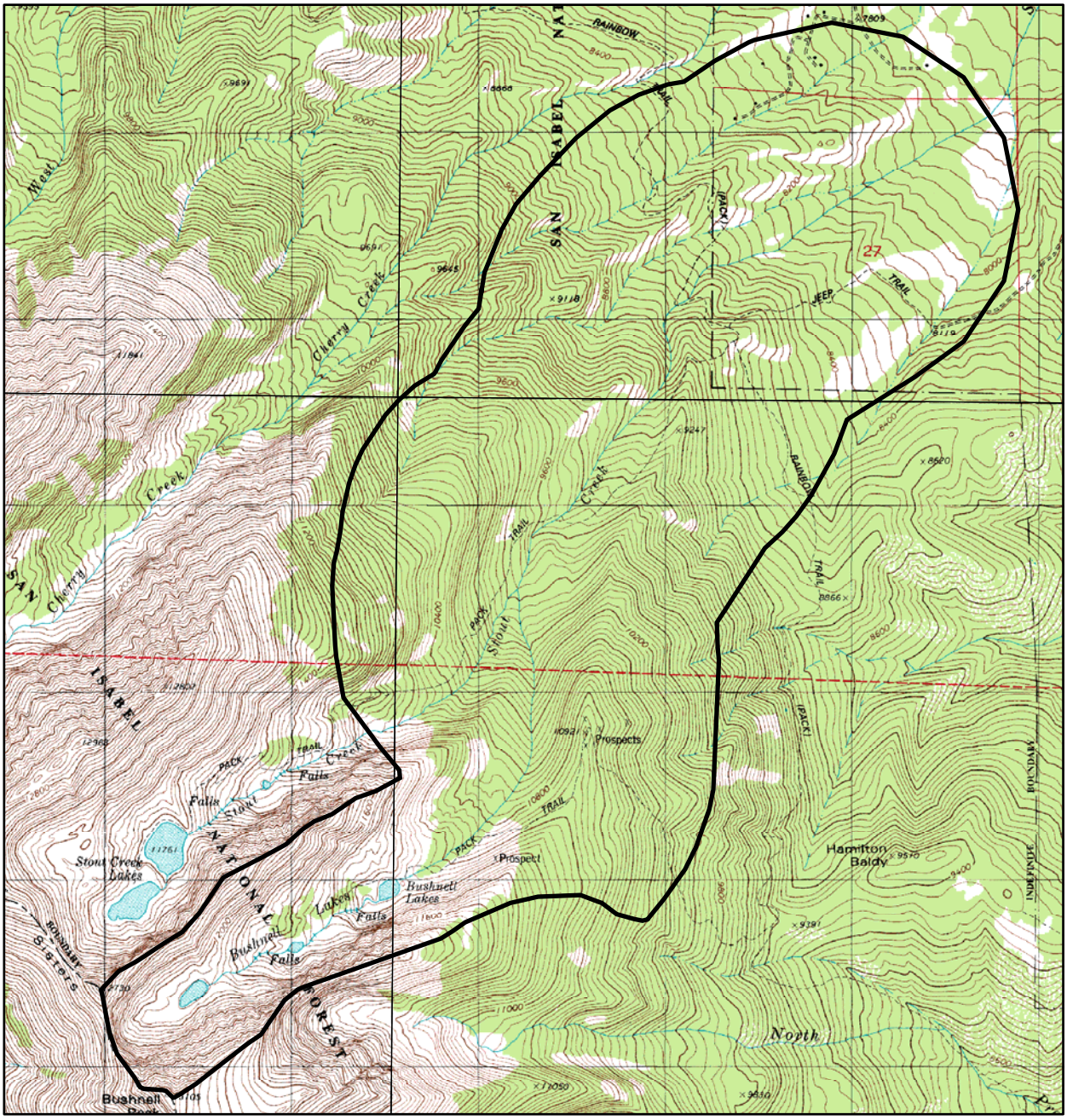
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Populus tremuloides / Betula occidentalis Forest		G3	S2				A	2005-09-30
Natural Communities	Salix planifolia / Mesic Forbs Shrubland [Provisional]	Planeleaf Willow / Mesic Forbs	G4	S4				A	2005-08-03
Natural Communities	Abies lasiocarpa / Mertensia ciliata Forest	Montane Riparian Forests	G5	S5				A	2005-08-03

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary is drawn along the watershed boundary to south and east and along a sharp ridge defining a glaciated valley to southwest for immediate watershed protection in upper portion. The lower portion is buffered to 1 km.

Protection Urgency Rank Comments (P4): The majority of the site is on the San Isabel National Forest and on BLM lands. The downstream end is in private ownership.

Management Urgency Rank Comments (M4): An evaluation of the use of logging roads may be beneficial to the landscape. If roads are not used or needed, closing them would reduce fragmentation in the landscape. Evaluating the function of culverts may be beneficial as well; repairing or removing culverts would potentially restore natural hydrology in the area.



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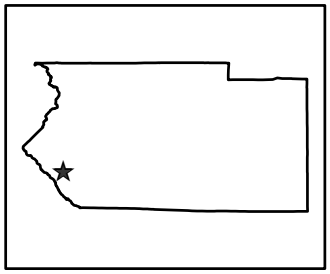
Legend

PCA Boundary

Coaldale, 38105-C7
Bushnell Peak, 38105-C8
Howard, 38105-D7

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 24. Stout Creek Potential Conservation Area, B3: High Biodiversity Significance

Mill Gulch Tributary

Biodiversity Rank - B4: Moderate Biodiversity Significance

Protection Urgency Rank - P4: No Threat or Special Opportunity

Management Urgency Rank - M3: Needed within 5 Years to Maintain Quality

U.S.G.S. 7.5-minute quadrangles: Thirtyone Mile Mountain

Size: 241 acres (98 ha) **Elevation:** 8,200 - 8,900 ft (2,499 - 2,713 m)

General Description: This site encompasses a spring-fed riparian area that occupies a downcut tributary drainage above a sand wash (Mill Gulch). The spring creates mesic conditions along an intermittent stream that is an unusual feature on south-facing, low elevation hills in this area. The small riparian tributary has an interrupted shrub canopy that is strongly dominated by water birch (*Betula occidentalis*) that alternates with mesic meadow vegetation. The drainage is embedded within a landscape mosaic of pinon - juniper (*Pinus edulis - Juniperus* spp.) woodlands, Gambel oak (*Quercus gambelii*) shrublands, and montane grasslands that blanket low hills near the southeastern extent of South Park. In contrast to the mesic tributary, Mill Gulch is downstream and is a dry, sandy wash with scattered pockets of narrowleaf cottonwood (*Populus angustifolia*). Past grazing practices have severely eroded portions of the channel, leaving them severely downcut. Current grazing practices are addressing the prior damage.

Key Environmental Factors: Spring-fed wetland and riparian tributary; lower montane elevations.

Biodiversity Significance Rank Comments (B4): This site is drawn for a fair (C-ranked) occurrence of a globally vulnerable (G3/S2) riparian natural community, water birch / mesic graminoids (*Betula occidentalis* / mesic graminoids) shrubland.

Natural Heritage element occurrences at the Mill Gulch Tributary PCA.

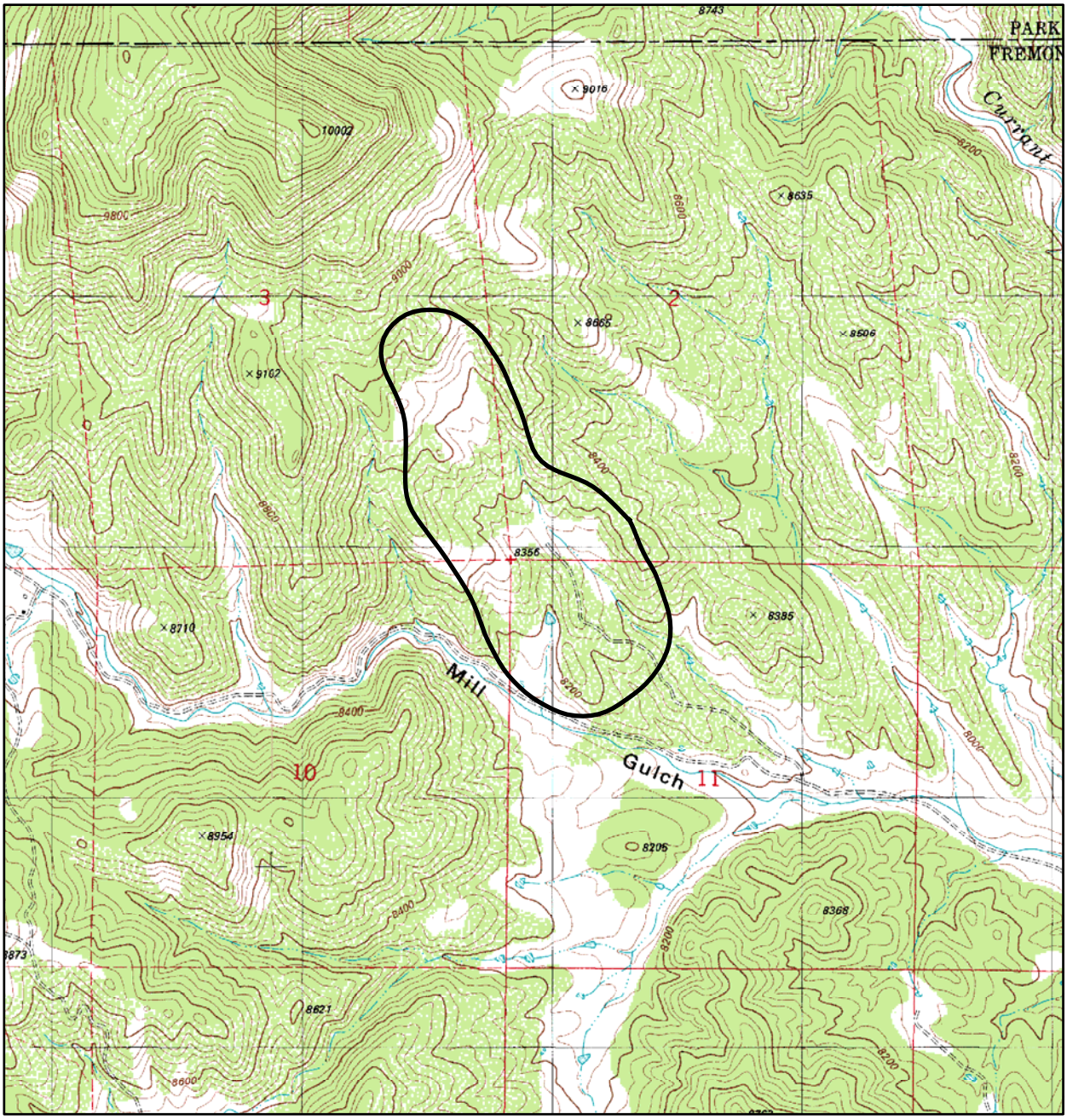
Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Betula occidentalis / Mesic Graminoids Shrubland	Lower Montane Riparian Shrublands	G3	S2				C	2005-08-11

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary drawn along adjacent ridgelines for immediate watershed protection. Boundary includes approximately 500 m buffer uphill from spring.

Protection Urgency Rank Comments (P4): The majority of this site was recently acquired by the BLM.

Management Urgency Rank Comments (M3): Continuing the current grazing regime will maintain the positive recovery of wetland vegetation. Assess any spread of noxious weeds at spring; eradication of noxious weeds at the spring would help protect the species diversity.



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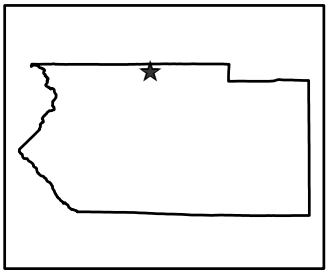
PCA Boundary

Thirtyone Mile Mtn, 38105-F5

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 25. Mill Gulch Tributary Potential Conservation Area, B4: Moderate Biodiversity Significance

Brush Hollow Reservoir

Biodiversity Rank - B5: General Biodiversity Interest

Protection Urgency Rank - P3: Definable Threat/Opportunity but not within 5 Years

Management Urgency Rank - M3: Needed within 5 Years to Maintain Quality

U.S.G.S. 7.5-minute quadrangles: Florence

Size: 1,236 acres (500 ha) **Elevation:** 5,500 - 5,700 ft (1,676 - 1,737 m)

General Description: This sparse, dry greasewood shrubland occurs on silty, alkaline soils of a low, flat valley north of Brush Hollow Reservoir. The valley is carved by shallow ephemeral drainages that flow down to the reservoir, which has backed water up into these drainages and allowed plains cottonwood (*Populus deltoides*), willow (*Salix*) species, and tamarisk (*Tamarix ramosissimum*) to establish nearby. Pinon - juniper (*Pinus edulis - Juniperus* spp.) woodland surrounds the valley, especially on the sandstone and shale hogbacks and valley sides. There is low intensity residential development on several sides of the state land surrounding the reservoir. As a state reservoir, there is a network of roads supporting recreation facilities.

Key Environmental Factors: Silty, alkaline soils of a low, flat valley

Biodiversity Significance Rank Comments (B5): This site is drawn for a fair (C-ranked) occurrence of a natural community, greasewood / inland saltgrass (*Sarcobatus vermiculatus / Distichlis spicata*) shrubland that is globally apparently secure and rare in the state (G4/S2).

Natural Heritage element occurrences at the Brush Hollow Reservoir PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Sarcobatus vermiculatus / Distichlis spicata Shrubland	Saline Bottomland Shrublands	G4	S2				C	2005-06-21

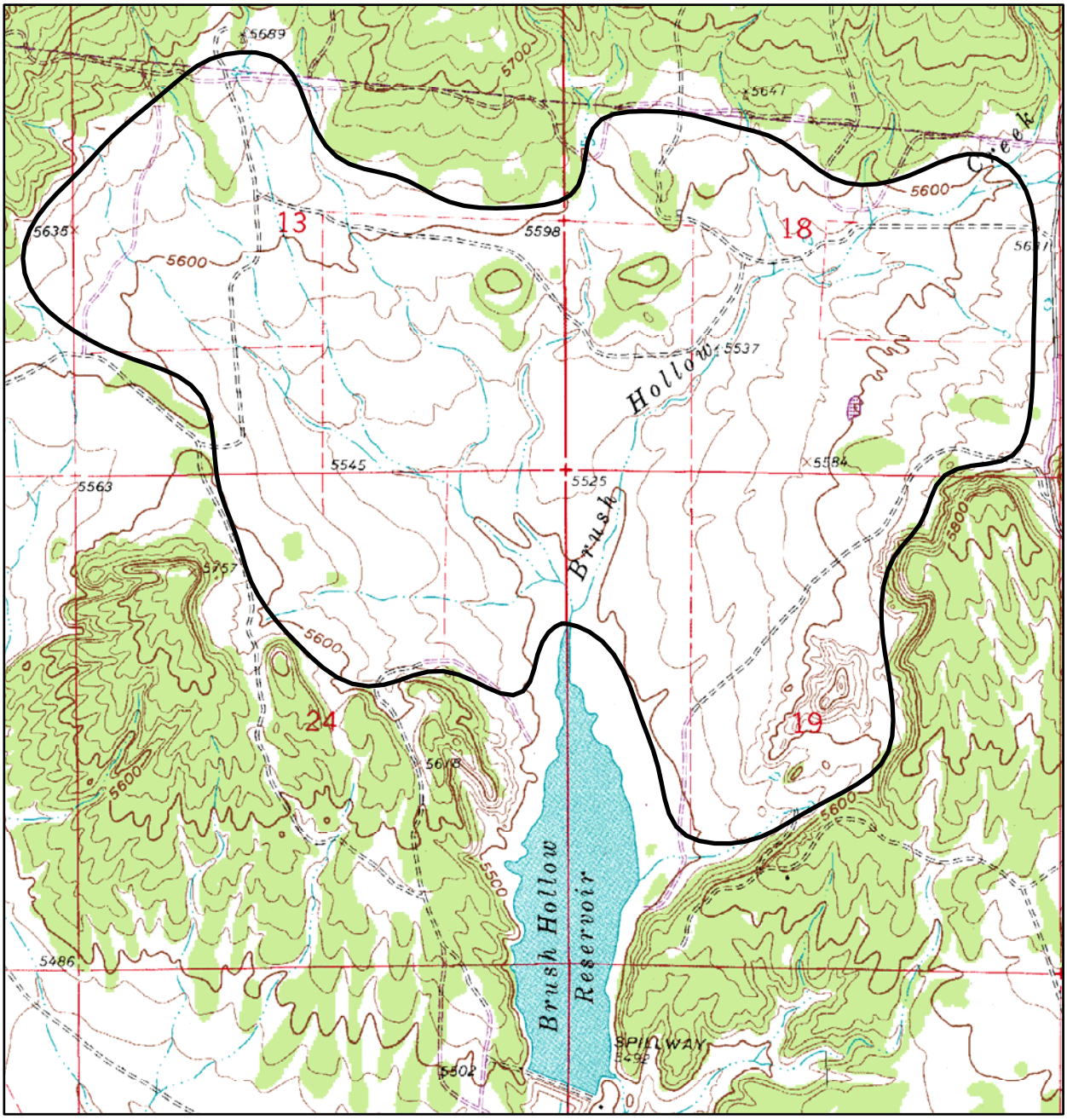
** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: Boundary includes low relief area of similar soils surrounding element occurrence that corresponds to bedrock geology data layer.

Protection Urgency Rank Comments (P3): This recreation and state wildlife area is a patchwork of land parcels next to a reservoir. Expansion of the reservoir would eliminate the wildlife habitat provided by the greasewood upstream. Continued

residential development may encroach upon the habitat as well.

Management Urgency Rank Comments (M3): Eradication of nearby tamarisk and closing of some duplicate roads would reduce the threat of invasive weeds and reduce fragmentation of wildlife habitat.



Colorado Natural Heritage Program
Colorado State University
254 General Services Building
8002 Campus Delivery
Fort Collins, CO 80523-8002

Ph (970) 491-1309
Fax (970) 491-3349
www.cnhp.colostate.edu

Map Date: 03/13/2006

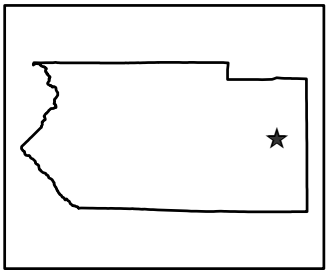
Legend

PCA Boundary

Florence, 38105-D1

7.5 Minute Digital Raster Graphic produced by the U.S. Geological Survey

Location in Fremont County



Map 26. Brush Hollow Reservoir Potential Conservation Area, B5: General Biodiversity Interest

SITES OF LOCAL SIGNIFICANCE

There are nine Sites of Local Significance documented from the 2005 field survey of Fremont County wetlands and riparian areas (see Table 11). They are as follows:

11 Road Wet Meadow

This site represents a common wet meadow shrubland in the northwest corner of Fremont County, Shrubby cinquefoil / Tufted hairgrass (*Dasiphora fruticosa / Deschampsia flexuosa*) Shrubland (G4 S3S4). These occupy moist hillsides and along small streams in the area.

Arkansas River

The Arkansas River is the only major river in Fremont County. It flows through the entire length of the county and has a long history of use and impacts (Cooley et al. 2001). It has been extensively surveyed and analyzed (Cooley et al. 2001, Colorado Natural Areas Program 1995). The impacts from the adjacent roads, railroad, mining operations, irrigation, grazing, recreation, and residential and municipal developments are extensive. However, the riparian vegetation along the reach is well-developed and diverse for many miles. (See report text for additional information.)

Badger Creek

This site contains an element occurrence record of Narrowleaf cottonwood / Coyote willow (*Populus angustifolia / Salix exigua*) Woodland (G4 S4). Badger Creek experienced catastrophic flood in July 16, 2004 from a localized thunderstorm downburst higher in the watershed. Sparse groves of narrowleaf cottonwood (*Populus angustifolia*) and willow (*Salix*) species are re-establishing. Areas of the reach are re-wetting to the surface and being colonized by annuals, like spikerushes (*Eleocharis* spp.) and speedwell (*Veronica catenata*). Tamarisk is present in the shrub layer. Huge bed load from the flood has buried the channel and wiped out all the beaver ponds leaving an unsorted jumble of boulders, cobbles, gravel, and sand interspersed with woody debris of all sizes. The flood stripped much of the riparian vegetation away. Badger Creek will be an excellent research site for documenting succession following this natural disturbance.

Cottonwood Creek

There is an extensive wet meadow along the upper reach of Cottonwood Creek that is dominated by common herbaceous wetland species, especially Baltic rush (*Juncus balticus*). There are also scattered copses of coyote willow (*Salix exigua*). A county road (2 Road) follows the reach along this site. It is surrounded by montane grasslands.

East Badger Creek

This site contains an element occurrence record of Thinleaf alder / Mesic forbs (*Alnus incana* / Mesic forbs) Shrubland that is based on a riparian classification plot from 1997. This site was not revisited in 2005; thus the full extent of the occurrence of the plant association and any impacts from the 2004 flood are unknown.

Five Point Gulch

Five Point Gulch is a sand wash drainage flowing north to its confluence with the Arkansas River. It is generally a dry drainage with scattered pockets of narrowleaf cottonwood (*Populus angustifolia*) and Nebraska sedge (*Carex nebrascensis*). The extents of narrowleaf cottonwood and Nebraska sedge were not large enough to warrant processing as an element occurrence record. Additionally, there are limited areas with willow shrubs that have been heavily grazed. There is some tamarisk (*Tamarix ramosissima*) beginning to establish in the drainage. This drainage is similar to that in the Unnamed Tributary of Badger Creek at Howard PCA.

Fourmile Creek

Fourmile Creek is a perennial drainage that flows from the foothills of Pikes Peak south through the northern arm of the Canon City Embayment. It is generally a relatively wide stream valley, although there are areas where it is constricted by canyon walls and hogbacks. The dominant plant association is Plains cottonwood – (peachleaf willow) / Coyote willow (*Populus deltoides – (Salix amygdaloides) / Salix exigua*) Woodland (G3G4 S3). This association forms an extensive stand along the creek, but this common riparian woodland is represented in Fremont County by an element occurrence along Beaver Creek (Beaver Creek at Sugar Loaf PCA). Further, Fourmile Creek is paralleled and crossed by a county road and the area has been historically impacted by extensive excavations of fossils.

Highway 120 Wetland

This wetland is arguably among the largest jurisdictional wetlands in Fremont County. It is dominated by common wetland species like cattail (*Typha latifolia*) and hardstem bulrush (*Schoenoplectus acutus*) ringing open water. The wetland is impacted by roads and adjacent commercial development (Penrose Auto Salvage).

Tunnel Trail

This site contains a sparse hanging garden of golden columbine (*Aquilegia chrysantha* var. *rydbergii*; G4T1Q S1) on a waterfall. It is a small oasis in an otherwise dry and rugged drainage (Kelso 2004).

Wilson Creek

Wilson Creek is an intermittent tributary of Fourmile Creek that winds between Rice and Thompson mountains before flowing through Webster Park. It supports an extensive stand of the common riparian community, Narrowleaf cottonwood / Coyote willow (*Populus angustifolia / Salix exigua*) Woodland (G4 S4). This plant association is contained in the Bull Gulch at East Gulch PCA.

PLANT CHARACTERIZATION ABSTRACT

Sisyrinchium pallidum (Pale Blue-Eyed Grass)

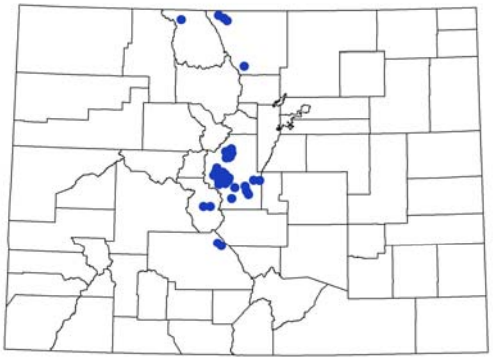
photo by S. Spackman

Taxonomy
Class: Monocotyledoneae
Order: Liliales
Family: Iridaceae
Genus: *Sisyrinchium*

Taxonomic comments: Impossible to distinguish from other species of *Sisyrinchium* except in flower.

CNHP Ranking: G2G3 S2

State/Federal Status: BLM sensitive.



Colorado Distribution

July and likely depends on annual growing conditions, especially the availability of water. Mature fruits are present from near the end of June into early August.

A perennial herb with pale-blue flowers that occurs in montane, wetland communities.

Habitat Comments: Wet, poorly drained meadows, streambanks, roadside ditches, and irrigated hay meadows where standing water is available through the early growing season.

Global Range: Regional endemic of central Colorado and southeastern Wyoming.

State Range: Chaffee, Jackson, Larimer, Park, Saguache counties.

Distribution/Abundance: There are 66 known occurrences. Estimates of number of individuals are about 10,000 for Colorado and 300,000 for Wyoming. Locally abundant within this relatively small geographic area and is actually increasing in Wyoming due to the creation of suitable habitat from flood-irrigation of hay meadows.

Known Threats and Management Issues: The majority of occurrences are located on private lands. The plant is vulnerable based on its limited global distribution and the fragility of the wetland habitats in which it occurs. Threats include road improvement, changes in irrigation practices, residential development, cattle grazing, peat mining, and recreational activities, as well as activities that drain wetlands.

Potential Conservation Areas that support *Sisyrinchium pallidum* :

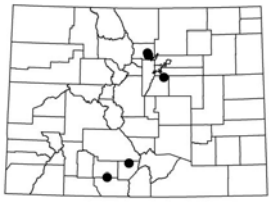
Unnamed Tributary of Badger Creek at Howard

NATURAL COMMUNITY CHARACTERIZATION ABSTRACT

Excerts from Carsey et al. 2003.

American mannagrass Herbaceous Vegetation

Glyceria grandis



Global rank/State rank:
G2? / S2
HGM subclass: D2/3, D4/5
Colorado elevation range:
5,200-8,900 ft (1,580-2,700 m)

General Description

This tall grass plant association occurs in small depressions along the edges of ditches, small streams, or sloughs. It may develop where a gentle current occurs, or in the wet sands on the edge of the active channel. Stands are seasonally or permanently flooded (Depressional 2/3) or occasionally flooded (Depressional 4/5).

This association occurs in wet areas along the Front Range in the transition zone between the foothills and the plains and in valleys in the mountains at low to moderate elevations, often associated with beaver ponds. Soils are generally coarse, but may be fine, usually sedimentary and alluvial. Soils vary from mineral to organic; mineral soils may have a thick layer of muck-like organic material.

Vegetation Description

Glyceria grandis (American mannagrass) is generally the most abundant species, with cover values up to 90%. Occasionally it may be the only species present. More often a variety of forbs and graminoids, usually with fairly low cover and constancy occur with the *Glyceria grandis.* Forbs that may occur include *Bidens cernua* (nodding beggartick), *Mentha arvensis* (wild mint), *Solidago* spp. (goldenrod), and *Persicaria* spp. (smartweed). Graminoid species typically provide greater cover than forbs and may include *Eleocharis palustris* (common spikerush), *Phalaris arundinacea* (reed canarygrass), *Agrostis gigantea* (redtop), *Beckmannia syzigachne* (American sloughgrass) and *Leersia oryzoides* (rice cutgrass). *Carex nebrascensis* (Nebraska sedge) was present in one stand in the San Luis Valley.

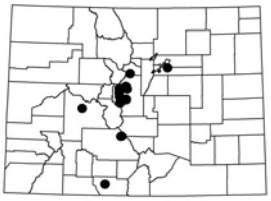
Ecological Processes

This plant association is usually an indicator of stable water table levels. A drop in water table will eliminate this association. Saturated soils are highly susceptible to damage by livestock.

Analogue sedge Herbaceous Vegetation

Carex simulata

Global rank/State rank:
G4 / S3
HGM subclass: S1/2
Colorado elevation range:
5,600-11,700 ft (1,700-3,560 m)



General Description

Carex simulata (analogue sedge) is found only on quaking fens in Colorado (occasionally may persist on drying fens). It is commonly found with many other sedge species, but its presence is associated with deep organic soils and a perennially high water table. *Carex simulata* (analogue sedge) fens are known from Larimer County south to the San Luis Valley, and are more or less restricted to the high mountain valleys in the central part of the state.

This community is located on saturated organic soils in moderate to wide valleys. The surface of the ground is hummocky, and "quakes" when walked or jumped on. Streams are low gradient and highly sinuous to broader and slightly steeper. Soils are deep, dark brown to black, 100% peat, saturated to the surface.

Vegetation Description

Graminoids dominate this meadow association with 90-100% vegetative cover. *Carex simulata* (analogue sedge) may not be the most abundant species, but it is always present, and serves as the indicator species for this association. A variety of other *Carex* (sedge) species may be present, and even more abundant, including *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), and *Carex nebrascensis* (Nebraska sedge). *Juncus balticus* var. *montanus* (mountain rush) and other graminoids may also be present. A variety of forbs may be inconspicuously present (total cover <10%). A few scattered shrubs, usually in stunted form, contribute little cover when present. They may include *Salix geyeriana* (Geyer willow), *Salix monticola* (mountain willow), and *Dasiphora floribunda* (shrubby cinqefoil).

Concentric rings or a mosaic of patches of other herbaceous wetland types can be adjacent and intermixed with *Carex simulata* (analogue sedge) fens. Herbaceous wetland plants include *Carex nebrascensis* (Nebraska sedge), *Carex utriculata* (beaked sedge) and *Juncus balticus* var. *montanus* (mountain rush).

Ecological Processes

Little is known about the successional processes of this plant association. Deep accumulations of peat suggest long-term stability. Changes in the natural hydrological regime have the potential to greatly affect the composition of this association.

Black greasewood / Inland saltgrass Shrubland

Sarcobatus vermiculatus / Distichlis spicata

Global rank/State rank:
G4 / S2
HGM subclass: F1
Colorado elevation range:
5,500-7,650 ft (1,700-2,300 m)

General Description

Sarcobatus vermiculatus (black greasewood) forms expansive shrublands on alkaline soils with a perennial high water table in southern and western Colorado. In the San Luis valley, it grows between playa lakes on sandy hummocks. The shrubs are 2-4 ft (0.6-1.2 m) tall and usually have non-overlapping canopies. The understory is sparse, open herbaceous cover of *Distichlis spicata* (inland saltgrass) and other salt tolerant species.

This community occurs on the highest ground between salt flat depressions called playa lakes in the northern part of the San Luis Valley. The shrubs occur on hummocks, approximately 4 ft (1.2 m) above the lake bed. Soils are deep, fine-textured sandy loams to clay loams. The surface soil is very hard when dry, but the subsurface soils, below 12 in (30 cm), are of a friable loamy texture.

Vegetation Description

The shrub canopy is fairly open with 18-30% cover of *Sarcobatus vermiculatus* (black greasewood). *Ericameria nauseosa* ssp. *nauseosa* var. *glabrata* (rubber rabbitbrush) may also occur. The herbaceous understory is a dry carpet of *Distichlis spicata* (inland saltgrass) with up to 40% cover. Other graminoid species which may be present are *Juncus balticus* var. *montanus* (mountain rush) and *Spartina gracilis* (alkali cordgrass). Forb cover is minimal.

Ecological Processes

Sarcobatus vermiculatus (black greasewood) and other salt flat vegetation often occur as bands or rings of species around a salt flat or depression. This visible zonation is caused by the change in dominant species and their relative tolerances to soil salinity and depth to groundwater. Soil characteristics may also play a role in the mosaic of shrub species on the landscape.

In the San Luis Valley, a large playa lake ecosystem supports the largest and most pristine example of *Sarcobatus vermiculatus* (black greasewood) shrublands in the state. The playas are ephemeral to perennial shallow lakes, depending on the variation in the annual precipitation.

Sarcobatus vermiculatus (black greasewood) shrublands are long-lived, self-perpetuating communities. Seedlings can survive under parent shrubs, where salinity is the highest. Seeds germinate in spring when surface soils are wet with spring runoff, and the salinity is most diluted. Although characteristic of desert climates, greasewood cannot tolerate droughts and grows only at the edges of lakes or arroyos or in sites with at high water table. Greasewood has salt glands adapted for excreting excess salts, often increasing the soil salinity over time.

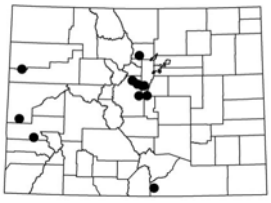
Blue spruce / River birch Woodland

Picea pungens / Betula occidentalis

Global rank/State rank:
G2 / S2

HGM subclass: R2

Colorado elevation range:
6,160-8,860 ft (1,870-2,700 m)



General Description

The *Picea pungens/Betula occidentalis* (blue spruce/river birch) plant association is a cool, moist riparian woodland occurring in deep, narrow canyons in the foothills and at

lower montane elevations. *Betula occidentalis* (river birch) forms a thick band along the stream banks with branches overhanging the stream. Mature *Picea pungens* (blue spruce) shade the *Betula occidentalis* along narrow floodplains.

This association is limited to deep, 100-600 ft (30-180 m), narrow canyons where it occurs on terraces, stream banks, and narrow floodplains. Stream channels are steep (6-10% gradient) and narrow or moderately wide with a moderate gradient (1-2%). Soils are generally sandy loams to clay loams with mottling 15-45 inches (35-110 cm) deep.

Vegetation Description

Picea pungens (blue spruce) dominates the canopy. *Populus tremuloides* (quaking aspen) may also be present. The shrub canopy is dominated by *Betula occidentalis* (river birch). Other shrubs that may be present include *Alnus incana* ssp. *tenuifolia* (thinleaf alder), *Salix exigua* (sandbar willow), *Salix bebbiana* (Bebb willow), and *Cornus sericea* (red-osier dogwood). The herbaceous undergrowth can be dense to open. Forb species that may be present include *Rudbeckia laciniata* var. *ampla* (cutleaf coneflower), *Heracleum maximum* (common cowparsnip), *Fragaria virginiana* (strawberry), and *Mertensia ciliata* (tall fringed bluebells). Graminoid species that may be present include *Calamagrostis canadensis* (bluejoint reedgrass) and *Agrostis stolonifera* (creeping bentgrass). *Equisetum arvense* (field horsetail) may be sparse to dense.

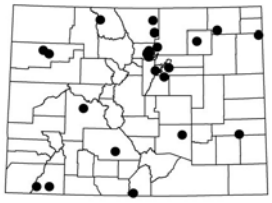
Ecological Processes

This association appears to be stable and late-seral. In deep, narrow canyons with swift-moving streams and narrow floodplains and benches, *Picea pungens* (blue spruce) appears to be a climax riparian species and will remain until removed or damaged by a catastrophic flood.

Picea pungens (blue spruce) is a slow-growing, long-lived tree which regenerates from seed. 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). *Betula occidentalis* (river birch) can tolerate flooding but not permanent inundation. Fire disturbance results in *Betula occidentalis* (river birch) resprouting and the replacement of this type with an early-seral plant association such as *Populus tremuloides/Betula occidentalis* (quaking aspen/river birch).

Cattail Herbaceous Vegetation

Typha angustifolia - Typha latifolia - (Typha domingensis)



Global rank/State rank:
G5 / S4
HGM subclass: D2/3, D4/5?
Colorado elevation range:
3,900-8,900 ft (1,530-3,500 m)

General Description

The *Typha angustifolia-Typha latifolia-(Typha domingensis)* (cattail) plant association is a commonly seen tall, dark green community growing in 2-4 feet of standing water. It is found in the shallow edges of ponds and lakes, and can occur in backwaters of larger river floodplains. This association is a common wetland community occurring throughout the western and midwestern states.

This plant association occurs in standing water at least 1 foot (0.3 m) in depth, although it will persist during drier periods. It is found along the margins of beaver ponds, overflow channels, backwater sloughs, floodplain swales, drainage ditches, behind railroad embankments, and any place where water collects and remains for two-thirds of the growing season. This association can be found on nearly every type of stream channel, but typically along meandering, low gradient streams. Soils are deep, heavy silty clay loam and organic mucks. Some profiles have 10-30% coarse material and are fairly well drained, others remain anoxic throughout most of the year.

Vegetation Description

Typha angustifolia (narrowleaf cattail) and/or *Typha latifolia* (broadleaf cattail) forms near-monotypic (70-85%) stands between 3 and 6 feet tall (1-2 m). *Typha domingensis* (southern cattail) is much less common than the other two species. It may or may not be present and is restricted to Western Slope stands. *Schoenoplectus acutus* and *Schoenoplectus tabernaemontani* are common associates. Other species which may be present include *Potamogeton* (pondweed) spp., *Spartina pectinata* (prairie cordgrass), and *Veronica* (speedwell) spp.

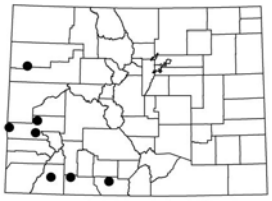
Ecological Processes

Typha angustifolia (narrowleaf cattail) occupies inundated and disturbed grounds and can tolerate deeper water and higher alkalinity levels than *T. latifolia* (broadleaf cattail). *Typha* species are prolific seed producers, spreading rapidly to become the early colonizers of wet mineral soil, and will persist under wet conditions. The roots and lower stems are well adapted to prolonged submergence but germination and establishment require periods of drawdown to expose bare soil.

This association may be declining in Colorado. It is threatened by development, wetland draining, and stream flow alterations. However it is also a natural invader to newly created wetlands, and will appear in newly ponded areas on its own.

Douglas-fir / Red-osier dogwood Woodland

Pseudotsuga menziesii / Cornus sericea



Global rank/State rank:
G4 / S2
HGM subclass: R3/4
Colorado elevation range:
5,600-8,500 ft (1,700-2,400 m)

General Description

In Colorado, this is an uncommon association that naturally occurs in small patches. It occurs in the San Juan and Rio Grande National Forests, the San Miguel and Dolores River Basins, Gunnison River Basin, and White River Basin.

This plant association occurs in narrow valleys with variable stream gradients (5-25%) on narrow floodplains and elevated benches. Stands occur well above the stream channel bankfull height, 1-10 ft (0.16-3 m). Stream channels are steep and narrow. The soils are generally well-drained, well-developed colluvial clay loams to sandy loams. Coarse fragments range from 0 to 25%. The water table is at least one meter below the surface.

Vegetation Description

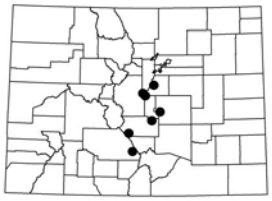
Pseudotsuga menziesii (Douglas-fir) dominates the overstory with 10-60% cover. Other tree species that may be present include *Populus angustifolia* (narrowleaf cottonwood), *Populus tremuloides* (quaking aspen), *Abies concolor* (white fir), *Acer negundo* (boxelder), and *Picea pungens* (blue spruce). *Cornus sericea* (red-osier dogwood) forms a dense shrub layer with 20-75% cover. Other shrub species that may be present include *Acer glabrum* (mountain maple), *Quercus gambelii* (Gambel oak), *Alnus incana* (thinleaf alder), *Ribes* (currant), and *Prunus virginiana* (chokecherry). The ground is covered with a thick layer of duff and few herbaceous plants. This association is often the only type within a narrow valley profile. Adjacent riparian areas may have *Cornus sericea* (red-osier dogwood) and *Acer glabrum* (Rocky Mountain maple) shrubland communities.

Ecological Processes

Pseudotsuga menziesii (Douglas-fir) is a non-obligate riparian species. This plant association is limited to narrow canyon bottoms where upland *Pseudotsuga menziesii* forests on north-facing slopes grade into riparian corridors. Narrow canyons with steep slopes create pockets of moist, cool air by funneling cold-air drainage and providing a microsite for *Pseudotsuga menziesii*. *Cornus sericea* (red-osier dogwood) is more abundant on level sites where water tables are periodically high. At lower elevations, *Pseudotsuga menziesi* can occur in cool valley bottoms where it cannot survive on warmer and drier valley slopes. Well drained colluvial soils also favor *Pseudotsuga menziesii* establishment.

Douglas-fir / River birch Woodland

Pseudotsuga menziesii / Betula occidentalis



Global rank/State rank:
G3? / S3
HGM subclass: R3/4
Colorado elevation range:
6,600-8,400 ft (2,000-2,560 m)

General Description

The *Pseudotsuga menziesii/Betula occidentalis* (Douglas-fir/river birch) association occurs in narrow foothill canyons of the Colorado Front Range in the upper Arkansas and South Platte River Basins and in the Rio Grande National Forest. This plant association occurs in narrow canyons with small streams and is limited to a narrow band along stream banks. Stream channels are steep and narrow with mostly rocky beds.

The soils, derived from alluvial and colluvial deposits, are fairly shallow (60-135 in, 25-55 cm) and 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 appears to be concentrated in the upper layers.

Vegetation Description

This association is characterized by a dominance of *Pseudotsuga menziesii* (Douglas-fir) and *Betula occidentalis* (river birch), which are key indicators for this type, even if other tree and shrub species present are abundant. The overstory canopy of this plant association is dominated by 25-50% cover of *Pseudotsuga menziesii* (Douglas-fir). Other tree species that may be present include *Populus angustifolia* (narrowleaf cottonwood), *Juniperus scopulorum* (Rocky Mountain juniper), *Pinus ponderosa* (ponderosa pine), *Abies concolor* (white fir), *Abies lasiocarpa* (subalpine fir), *Picea pungens* (blue spruce), and *Populus tremuloides* (quaking aspen).

The shrub canopy is fairly thick and diverse with 20-80% cover of *Betula occidentalis* (river birch). Other shrubs that may be present include *Alnus incana* ssp. *tenuifolia* (thinleaf alder), *Acer glabrum* (Rocky Mountain maple), *Rosa woodsii* (Woods rose), *Jamesia americana* (wax flower), *Cornus sericea* (red-osier dogwood), *Quercus gambelii* (Gambel oak), *Salix bebbiana* (Bebb willow), *Salix ligulifolia* (strapleaf willow), *Salix monticola* (mountain willow), and *Salix irrorata* (bluestem willow).

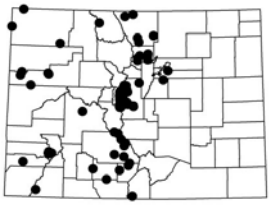
The herbaceous undergrowth is sparse and limited by heavy shade. Some of the more abundant species that may be present include *Maianthemum stellatum* (starry false Solomon seal), *Equisetum arvense* (field horsetail), *Carex disperma* (softleaf sedge), and *Melilotus officinalis* (yellow sweetclover).

Ecological Processes

The *Pseudotsuga menziesii/Betula occidentalis* (Douglas-fir/river birch) plant association appears to be in a late-seral stage since *Pseudotsuga menziesii* is successfully reproducing. It also appears that this association is limited to perennial streams where the cold-air drainage and perennial stream flow provide a cool and moist environment to support a diverse shrub canopy.

Mountain rush Herbaceous Vegetation

Juncus balticus var. *montanus*



Global rank/State rank:
G5 / S5
HGM subclass: D2/3, D4/5, S3/4, R3/4
Colorado elevation range:
4,900-10,000 ft (1,500-3,050 m)

General Description

This plant association occurs as small, dense patches on flat stream benches, along overflow channels, near springs, and around ponds. It is characterized by a dense sward of *Juncus balticus* var. *montanus* (mountain rush) and often minor cover of *Carex* (sedge) species. Forb cover is generally low. This association is often considered to be a grazing-induced community since it is not palatable to livestock and increases with grazing.

Adjacent stream channels are highly variable and can be narrow and deeply entrenched, moderately wide and moderately sinuous, moderately wide and very sinuous, narrow and very sinuous, or braided. Soil textures are also variable. They range from sandy and well drained, to silty clay loams, to pure organic matter, however most stands occur on coarse-textured sandy loams with a high percentage of cobbles and gravel. Mottles or gleyed horizons are often present.

Vegetation Description

This plant association is very easy to recognize with its band of dark green following the channel path or surrounding depressions. *Juncus balticus* var. *montanus* (mountain rush) is the dominant and indicator species for this community. Because it occurs over a broad elevational and latitudinal range in Colorado, associated species are variable. Some of the more frequently encountered species include *Carex aquatilis* (water sedge), *Carex praegracilis* (clustered field sedge), *Carex utriculata* (beaked sedge), *Glyceria striata* (fowl mannagrass), *Distichlis spicata* (inland saltgrass) and *Eleocharis palustris* (common spikerush).

Forb cover is usually minor, and may include *Argentina anserina* (silverweed cinquefoil), *Achillea millefolium* var. *occidentalis* (western yarrow), *Mentha arvensis* (wild mint) or

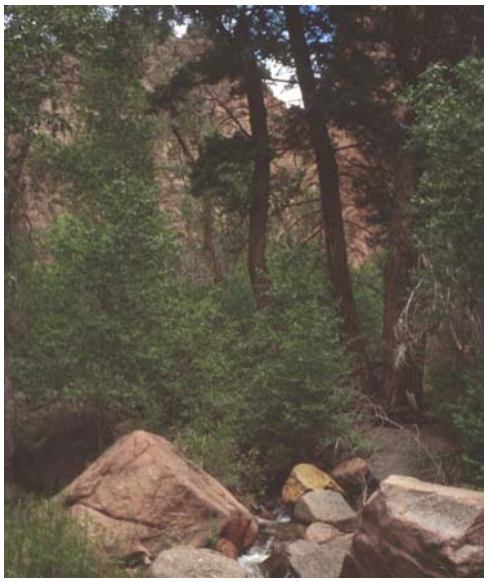
Trifolium spp.(clover). Degraded stands and grazing-induced stands of *Juncus balticus* var. *montanus* (mountain rush) can have high abundance of *Agrostis gigantea* (redtop), *Poa pratensis* (Kentucky bluegrass), *Phleum pratense* (timothy), and *Taraxacum officinale* (dandelion). Occasionally, a few tree or shrub seedlings may be present with 3-15% cover, including *Populus angustifolia* (narrowleaf cottonwood), *Dasiphora floribunda* (shrubby cinquefoil), and *Salix exigua* (sandbar willow).

Ecological Processes

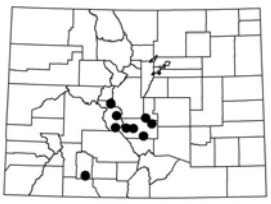
In low-disturbance areas, this plant association appears to be a stable, climax community, often persisting in the absence of wetland conditions. It occupies frequently inundated swales and wet, low- to mid-elevation sites. However, in some areas, this association is considered to be grazing-induced. *Juncus balticus* var. *montanus* (mountain rush) is considered an increaser due to its low forage value and high tolerance to grazing. It usually increases in abundance on sites formerly dominated by *Deschampsia caespitosa* (tufted hairgrass) or *Calamagrostis canadensis* (bluejoint reedgrass). Nearly pure stands of *Juncus balticus* var. *montanus* (mountain rush) indicate that the site may have been heavily grazed in the past.

Narrowleaf cottonwood – Douglas fir Woodland

Populus angustifolia - Pseudotsuga menziesii



Global rank/State rank:
G3 / S2
HGM subclass: R3/4
Colorado elevation range:
7,100-8,700 ft (2,150-2,700 m)



General Description

This plant association occurs in the San Juan National Forest and in parts of the upper Arkansas River Basin. It is also expected to occur in narrow foothill canyons of the Colorado Front Range. 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-environments.

This association represents a transition from lower montane to upper montane habitats. Nearly all stands observed have an adjacent north-facing slope with *Pseudotsuga menziesii* (Douglas-fir) forests.

The association grows in wash bottoms and on immediate stream banks, cobble bars, and terraces. Stream channels are steep and narrow with streambeds of bedrock, sand, or silt. This association also occurs on slightly meandering floodplains of broad reaches with coarse channel bed material. 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 Description

The upper canopy of this plant association is dominated by *Pseudotsuga menziesii* (Douglas-fir) and *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. *Juniperus scopulorum* (Rocky Mountain juniper) or *Abies concolor* (white fir) may also be present. Several other conifer tree species may be present, but with less than 1% cover. Shrub cover is typically low, but is highly variable and diverse. No single species was present in all stands sampled. Shrub species include *Acer glabrum* (Rocky Mountain maple), *Salix exigua* (sandbar willow), *Betula occidentalis* (river birch), *Alnus incana* (thinleaf alder), *Quercus gambelii* (Gambel oak), *Salix lucida* ssp. *caudata* (shining willow), *Clematis ligusticifolia* (western white clematis), and *Ribes cereum* (wax currant).

The herbaceous undergrowth can be sparse and is usually limited by heavy shade and dry soil conditions. Herbaceous species include *Poa pratensis* (Kentucky bluegrass), *Taraxacum officinale* (dandelion), *Achillea millefolium* var. *occidentalis* (western yarrow), *Trifolium repens* (white clover), and *Agrostis stolonifera* (creeping bentgrass).

Ecological Processes

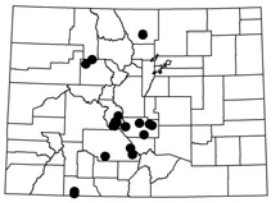
Pseudotsuga menziesii (Douglas-fir) is a non-obligate riparian species and in Colorado riparian communities dominated by this species are uncommon. Observed stands of the *Populus angustifolia-Pseudotsuga menziesii* plant association were composed of mature trees, appear to be late-seral, and were limited 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.

Narrowleaf cottonwood - Rocky Mountain juniper Woodland

Populus angustifolia - Juniperus scopulorum



Global rank/State rank:
G2G3 / S3
HGM subclass: R3/4
Colorado elevation range:
6,000-8,600 ft (1,800-2,600 m)

General Description

Populus angustifolia (narrowleaf cottonwood) and *Juniperus scopulorum* (Rocky Mountain juniper) dominated riparian areas are uncommon. The community occurs along lower foothill streams with perennial to intermittent stream flows. Total biomass and canopy cover are often low. The association is characterized by an open canopy of *Populus angustifolia* (narrowleaf cottonwood) and *Juniperus scopulorum* (Rocky Mountain juniper), often with little else growing in the understory. The species composition and percent cover is variable and depends on aspect, elevation, and stream flow, in addition to the degree of disturbance by recreational use and livestock grazing.

Stream channels are steep and narrow with rocky to sandy bottoms. This association can also occur on upper terraces and elevated islands of wide, meandering river reaches such as those found along the Arkansas and Colorado Rivers. Valley widths are typically 700 ft (200 m) or less and stream gradients are generally low to moderate (0.5-2.5%). *Juniperus scopulorum* (Rocky Mountain juniper) is situated at the high water line and above, while the *Populus angustifolia* (narrowleaf cottonwood) grades into the active floodplain area. Soils of this plant association are derived from alluvial deposits. The surface soils consist of loamy sand, clay loams, silty clays or organic matter. Subsurface layers range from sandy loams and loamy sands to clay loams and sandy clay loams with 20-50% gravel and cobbles. Soil depth ranges from 15-25 inches (40 to 65 cm).

Vegetation Description

This plant association is characterized by an open to closed canopy of 20-100% cover of *Populus angustifolia* (narrowleaf cottonwood) and scattered to abundant *Juniperus scopulorum* (Rocky Mountain juniper) with 5-85% cover. Stands with northern aspects may include *Pseudotsuga menziesii* (Douglas-fir) or *Populus tremuloides* (quaking aspen). Two stands in the lower San Juan watershed with *Juniperus osteosperma* (Utah juniper), rather than *J. scopulorum* (Rocky Mountain juniper), are included in this type.

There is very little shrub canopy and little to no herbaceous undergrowth due to dry conditions. If present, the shrub canopy may include a wide variety of species, although

none is present in every stand. Shrub species may include *Clematis ligusticifolia* (western white clematis), *Acer glabrum* (Rocky Mountain maple), *Rhus trilobata* (skunkbush sumac), *Symphoricarpos oreophilus* (mountain snowberry), *Quercus gambelii* (Gamble oak), and *Berberis fendleri* (Colorado barberry).

Non-native species are some of the more commonly encountered herbaceous components of this association, and generally occur in disturbed stands. Species include *Poa pratensis* (Kentucky bluegrass), *Taraxacum officinale* (dandelion), *Agrostis stolonifera* (creeping bentgrass), and *Melilotus officinalis* (sweet clover).

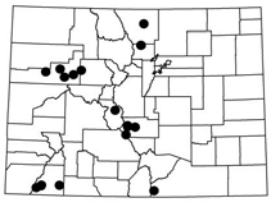
Ecological Processes

As with all cottonwood woodlands, this association is found within a continually changing alluvial environment where riparian vegetation is constantly being "re-set" by flooding disturbance. 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. Natural river processes of bank erosion, deposition and channel migration result in a dynamic patchwork of different age classes, plant associations and habitats.

Narrowleaf cottonwood / River birch Woodland

Populus angustifolia / Betula occidentalis

Global rank/State rank:
G3 / S2
HGM subclass: R3/4
Colorado elevation range:
6,000-8,400 ft (1,830-2,600 m)



General Description

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.

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. Stream channels are steep and narrow with rocky beds or broad and meandering. 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.

Vegetation Description

This plant association is characterized by an overstory of 5-80% cover of *Populus angustifolia* (narrowleaf cottonwood) and a thick shrub understory of *Betula occidentalis* (river birch). Other tree species that can be present include *Pseudotsuga menziesii* (Douglas-fir) and *Juniperus scopulorum* (Rocky Mountain juniper). Other shrubs that can be abundant, but never more than birch include *Alnus incana* (thinleaf alder), *Acer glabrum* (mountain maple), *Cornus sericea* (red-osier dogwood), *Salix bebbiana* (Bebb willow), *Crataegus rivularis* (river hawthorn), *Ribes inerme* (whitestem gooseberry), *Salix ligulifolia* (strapleaf willow), *Rhus trilobata* (skunkbush sumac), *Salix irrorata* (bluestem willow), *Rubus parviflorus* (thimbleberry), and *Prunus virginiana* (chokecherry).

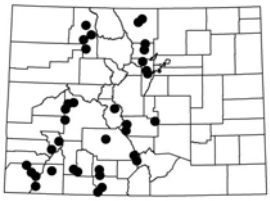
Graminoid and forb cover is minor, except in degraded stands, where introduced, non-native species can be abundant. These include *Poa pratensis* (Kentucky bluegrass), *Taraxacum officinale* (dandelion), *Melilotus* spp. (sweetclover). Native herbaceous species include *Maianthemum stellatum* (starry false Solomon seal), *Rudbeckia laciniata* var. *ampla* (cutleaf coneflower), *Carex utriculata* (beaked sedge), and *Angelica ampla* (giant angelica).

Ecological Processes

The *Populus angustifolia/Betula occidentalis* (narrowleaf cottonwood/river birch) plant association is considered to be early- to mid-seral. *Betula occidentalis* 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* reproduction may cease and the stand may become a *Betula occidentalis* dominated shrubland with a graminoid understory. *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.

Narrowleaf cottonwood / Thinleaf alder Woodland

Populus angustifolia / Alnus incana



Global rank/State rank:
G3 / S3
HGM subclass: R3/4
Colorado elevation range:
6,000-9,600 ft (1,830-2,930 m)

General Description

The *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) plant association is characterized by a dense stand of *Alnus incana* lining the stream bank and an open to nearly closed canopy of *Populus angustifolia*. Other shrubs may occur but *Alnus incana* (thinleaf alder) usually has at least 10-20% cover and is the most abundant of all other shrubs within the stand. It occurs along narrow, fast-moving stream reaches in montane areas.

This plant association occurs on active floodplains in narrow to broad valleys. It forms a narrow, dense band along stream banks and benches. Some of the stands have signs of recent flooding. Stream gradient and channel width are highly variable. Some sites occur along steep, narrow reaches with little sinuosity. Other sites occur along low gradient, moderately sinuous, broad channel reaches, low gradient, highly sinuous reaches, or very narrow and highly sinuous stream sections. Soils are mostly coarse textured ranging from deep sands to shallow sandy loams. Some profiles show stratification with loams to clay loams alternating with sands. Most profiles become skeletal at an average depth of 12 inches (30 cm).

Vegetation Description

The dominance of *Populus angustifolia* (narrowleaf cottonwood) and *Alnus incana* (thinleaf alder) are the key diagnostic characteristics of this association. Several other tree and shrub species may be present, but they rarely equal the abundance of the diagnostic species. The overstory is an open to dense canopy of *Populus angustifolia*, which is always present, if sometimes only as sapling-sized individuals. Other tree species that may be present include *Pseudotsuga menziesii* (Douglas-fir), *Juniperus scopulorum* (Rocky Mountain juniper), *Populus tremuloides* (quaking aspen), *Pinus ponderosa* (ponderosa pine), *Populus* x *acuminata* (lanceleaf cottonwood), *Abies concolor* (white fir), or *Picea pungens* (blue spruce). The shrub understory is dominated by a dense band of *Alnus incana* (thinleaf alder) lining the stream bank. A variety of other shrubs may be present, intermingling with the alder but usually providing less than the total alder cover. Other shrub species include *Salix bebbiana* (Bebb willow), *Salix monticola* (mountain willow), *Salix drummondiana* (Drummond willow), *Salix ligulifolia* (strapleaf willow), *Salix lucida* ssp. *caudata* (shining willow), *Salix exigua* (sandbar willow), *Cornus sericea* (red-osier dogwood), *Rosa woodsii* (Woods rose), *Acer glabrum* (Rocky Mountain maple), and *Betula occidentalis* (river birch).

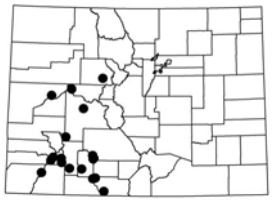
The herbaceous undergrowth is generally sparse. Herbaceous species include *Poa pratensis* (Kentucky bluegrass), *Taraxacum officinale* (dandelion), *Equisetum arvense* (field horsetail), *Rudbeckia laciniata* var. *ampla* (cutleaf coneflower), *Heracleum maximum* (common cowparsnip), *Maianthemum stellatum* (starry false Solomon seal), *Trifolium repens* (white clover), *Calamagrostis canadensis* (bluejoint reedgrass), *Oxypolis fendleri* (Fendler cowbane), and *Cardamine cordifolia* (heartleaf bittercress).

Ecological Processes

The *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) plant association is considered a mid-seral community (not the youngest and not the oldest stands of cottonwoods within a reach). With time and without flooding disturbance, stands may become dominated by invading conifers from adjacent upland communities such as *Pseudotsuga menziesii* (Douglas-fir), *Juniperus* spp. (juniper), or *Picea engelmannii* (Engelmann spruce).

Planeleaf willow / Mesic forb Shrubland

Salix planifolia / Mesic forbs



Global rank/State rank:
G4 / S4
HGM subclass: S1/2, R2
Colorado elevation range:
8,900-12,100 ft (2,700-3,700 m)

General Description

The *Salix planifolia*/mesic forbs (planeleaf willow/mesic forbs) plant association is a low stature (<2 ft, 0.5 m) shrubland with abundant and diverse forbs under the willow canopy. It is a common community of the sublapine and lower alpine areas. It occurs on mesic soils. This plant association typically occurs in wide, glaciated valleys adjacent to streams. It occurs in swales, depressions and on slopes where snow melt runoff saturates soils for much of the growing season. The ground may be flat or uneven with raised hummocks. Stream gradients range from <1% in broad floodplains to 14% in steep snowmelt basins. Stream channels vary. Channels may be steep and narrow, first-order streams in snow melt basins, relatively wide and straight, narrow, relatively deep, and meandering in broad, glaciated valleys or braided, multiple channels below beaver dams.

Soil textures are highly variable. Mineral soils vary along a moisture gradient. Wet sites have soil textures of silty clays and silt loams, while slightly drier sites have loamy sands and sandy loams overlying gravelly alluvium. Some stands occur on well-drained, mineral soils with well-oxygenated water and no mottled or gleyed layers. Other sites have a shallow organic layer overlying a gravel or cobble layer within 10-20 inches (20-50 cm) of the surface. The water table at these sites is usually near the surface

throughout the growing season and may be perched by a clay horizon. Still other stands occur on deep, dark clay loams with high organic content or a fibric or hemic layer on top.

Vegetation Description

Salix planifolia (planeleaf willow) often forms nearly pure stands. Other willows that may be present include *Salix monticola* (mountain willow), *S. brachycarpa* (barrenground willow), *S. boothii* (Booth willow), *S. drummondiana* (Drummond willow), and *S. wolfii* (Wolf willow). *Picea engelmannii* (Engelmann spruce) can occur along the outer edges of the stand.

Typically, the willow canopy is nearly closed and an herbaceous undergrowth occurs only in openings between willow patches. The undergrowth is characterized by an abundance of forbs with few graminoids. Forb species include *Achillea millefolium* var. *occidentalis* (western yarrow), *Mertensia ciliata* (tall fringed bluebells), and *Senecio triangularis* (arrowleaf ragwort).

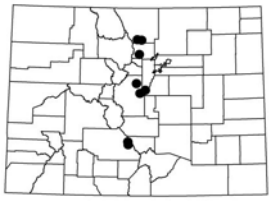
Ecological Processes

Salix planifolia (planeleaf willow), *Salix brachycarpa* (barrenground willow) and *Salix wolfii* (Wolf willow) are abundant low-stature willows of first- and second-order streams of subalpine elevations of Colorado. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix wolfii* grows on deep, undecomposed peat, while *Salix planifolia* tends to grow on more decomposed (humified) organic soils. *Salix planifolia* also grows at elevations below the subalpine, and becomes a much taller willow due to a longer growing season. In montane elevations, *Salix planifolia* is often a co-dominant in *Salix monticola* plant associations.

The *Salix planifolia*/mesic forbs (planeleaf willow/mesic forbs) plant association occurs in wet swales that are saturated throughout most or all of the growing season. It is a long-lived, stable association that changes with fluctuations in the water table and degree of soil saturation. The *Salix planifolia/*mesic forbs association may be a grazing-induced phase of the *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) association. Many stands in the Routt National Forest are heavily grazed and contain a high number of exotic and increaser species such as *Taraxacum officinale* (dandelion) and *Fragaria virginiana* (strawberry). Other stands in Colorado, however, do not show an increase in non-native species.

Quaking aspen / River birch Forest

Populus tremuloides / Betula occidentalis



Global rank/State rank:
G3 / S2
HGM subclass: R3/4
Colorado elevation range:
7,540-10,400 ft (2,300-3,100 m)

General Description

The *Populus tremuloides/Betula occidentalis* (quaking aspen/river birch) plant association is a lush, deciduous riparian woodland with a diverse canopy of aspen and conifer trees. The understory has a high structural diversity of shrubs and an herbaceous undergrowth ranging from a thick carpet of grasses and forbs to a very sparse ground cover in heavily shaded areas. The presence of obligate riparian shrub species distinguish this association from upland *Populus tremuloides* communities. This plant association is known only from foothill streams of the west side of the Sangre de Cristo Mountains and along the Colorado Front Range.

This plant association occurs along stream banks, benches and narrow floodplains in narrow valleys, 40-200 ft (130-660 m) wide, and steep, first-order gulches. Stream channels are steep and narrow or moderately steep and slightly meandering. The soils are uniformly sandy loams becoming skeletal at a 3 ft (1 m) depth. A sandy clay layer consistently appears at an average depth of 5 inches.

Vegetation Description

This plant association is characterized by an open to dense canopy of *Populus tremuloides* (quaking aspen). *Betula occidentalis* (river birch) forms a thick band along the stream banks. Associated tree species vary with elevation. *Pinus ponderosa* (ponderosa pine) and *Populus* x *acuminata* (lanceleaf cottonwood) occur at lower elevations, while *Abies lasiocarpa* (subalpine fir) and *Pseudotsuga menziesii* (Douglas-fir) occur at higher elevations. Other shrub species that may be present include *Rosa woodsii* (Woods rose), *Salix bebbiana* (Bebb willow), *S. monticola* (mountain willow), *S. planifolia* (planeleaf willow), *Acer glabrum* (Rocky Mountain maple), *Alnus incana* ssp. *tenuifolia* (thinleaf alder), and *Cornus sericea* (red-osier dogwood).
The herbaceous undergrowth is sparse to thick, depending on local site conditions. Species include *Maianthemum stellatum* (starry false Solomon seal), *Equisetum arvense* (field horsetail), *Heracleum maximum* (common cowparsnip), *Aconitum columbianum* (Columbian monkshood), and *Dactylis glomerata* (orchardgrass).

Ecological Processes

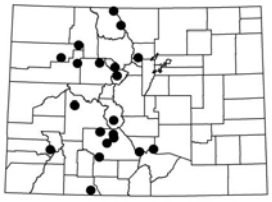
Populus tremuloides (quaking aspen) forests and woodlands can be self perpetuating climax plant associations or early-seral stages of coniferous types. *Populus tremuloides* is a non-obligate riparian species and often occurs in upland communities. Where valley

bottoms are moist and stable, *Populus tremuloides* can dominate the riparian area, while also occurring on adjacent mesic hillslopes.

Betula occidentalis (river birch) becomes abundant along stream banks with perennial stream flow and well-aerated soils. The presence of seedling and sapling conifers in some stands of this plant association indicates the potential to become a conifer/*Betula occidentalis* type. The suppression of fire in this plant association may allow conifer species to gain dominance since *Populus tremuloides* and *Betula occidentalis* sprout following fires.

Quaking aspen / Thinleaf alder Forest

Populus tremuloides / Alnus incana ssp. Tenuifolia



Global rank/State rank:
G3 / S3
HGM subclass: R3/4
Colorado elevation range:
7,850-9,700 ft (2,400-2,950 m)

General Description

The *Populus tremuloides/Alnus incana* ssp. *tenuifolia* (quaking aspen/thinleaf alder) plant association is located in narrow ravines and along first- and second-order streams where upland *Populus tremuloides* forests intermix with riparian shrub vegetation and at lower elevations where *Populus tremuloides* persists only in the riparian zone. The presence of obligate riparian species distinguish this association from upland *Populus tremuloides* communities. This plant association is known from throughout the Western Slope.

This plant association occurs in narrow, 25-225 ft (10-70 m) wide, valleys along stream banks of first- and second-order streams. Stream channels are steep and narrow and occasionally, of moderate gradient and width. Stream gradients range from 1-30%. Soils are generally skeletal, shallow, sandy and sandy clay loams or deeper sandy clay loams.

Vegetation Description

This plant association has a tall, 20-40 ft (6-12 m), overstory of *Populus tremuloides* (quaking aspen). Several conifer species can occur, but aspen is clearly the dominant canopy tree, at least along the streambanks. Other tree species that may be present include *Pinus contorta* (lodgepole pine), *Abies lasiocarpa* (subalpine fir), *Picea pungens* (blue spruce), and *Pseudotsuga menziesii* (Douglas-fir).

The shrub and forb canopy along the immediate stream bank distinguish this riparian plant association from the adjacent forests. The shrub layer is dominated by *Alnus incana* ssp. *tenuifolia* (thinleaf alder). Other shrubs that may be present in this association include *Salix drummondiana* (Drummond willow), *Lonicera involucrata* (twinberry honeysuckle), *Rosa woodsii* (Woods rose), *Salix bebbiana* (Bebb willow), and

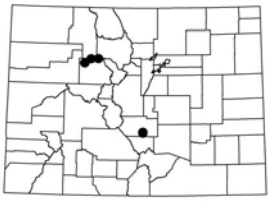
Cornus sericea (red-osier dogwood). The forb undergrowth can be dense and includes *Cardamine cordifolia* (heartleaf bittercress), *Mertensia ciliata* (tall fringed bluebells), *Osmorhiza depauperata* (bluntseed sweetroot) and *Senecio triangularis* (arrowleaf ragwort). Graminoid cover includes *Calamagrostis canadensis* (bluejoint reedgrass), *Equisetum arvense* (field horsetail) and *Carex disperma* (softleaf sedge).

Ecological Processes

Populus tremuloides (quaking aspen) forests and woodlands can be self-perpetuating climax plant associations or early-seral stages of coniferous types. *Populus tremuloides* (quaking aspen) is a non-obligate riparian species and often occurs in upland communities. Where valley bottoms are moist and stable, *Populus tremuloides* can dominate the riparian area, while also occurring on adjacent mesic hillslopes. *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining. 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.

Rocky Mountain juniper / Red-osier dogwood Woodland

Juniperus scopulorum / Cornus sericea



Global rank/State rank:
G4 / S2
HGM subclass: R3/4
Colorado elevation range:
6,400-6,900 ft (2,000-2,100 m)

General Description

This association has an open canopy of *Juniperus scopulorum* (Rocky Mountain juniper) and an occasional upland species, such as *Juniperus osteosperma* or *J. monosperma* (Utah or one-seed juniper). The understory contains few shrubs and little herbaceous growth. This plant association is common along desert streams and arroyos and can occur on upper terraces with *Populus angustifolia-Juniperus scopulorum* (narrowleaf cottonwood-Rocky Mountain juniper) on the lower floodplain. Although *Cornus sericea* (red-osier dogwood) was present in fewer than half of the plots sampled, the overall species composition closely matches the *Juniperus scopulorum*/*Cornus sericea* (Rocky Mountain juniper/red-osier dogwood) type described from Montana.

This plant association appears to be limited to a distinct band at the high water mark of gently meandering, moderate-gradient stream channels having little to moderate floodplain development. Stands sampled along the Colorado River appeared to be

mature, relic stands surviving only on upper stream banks and terraces approximately 7 ft (2 meters) above the active stream channel. Only a few stands of this community have been documented in Colorado.

The shallow soils are derived from coarse alluvial substrates. Soil textures are sandy clay loams to sandy loams with a high percentage of coarse fragments.

Vegetation Description

The upper canopy is dominated by *Juniperus scopulorum* (Rocky Mountain juniper) (30-80% cover) with a few scattered *Populus angustifolia* (narrowleaf cottonwood) (<10%) individuals. The shrub layer is very patchy along the streambank. *Cornus sericea* (red-osier dogwood) is the most frequently present shrub species (40% constancy). Other infrequently encountered shrubs, with an average of about 1% cover, include *Quercus gambelii* (Gambel oak), *Rhus trilobata* (skunkbush sumac), *Rosa woodsii* (Woods rose), *Salix exigua* (sandbar willow), *S. monticola* (mountain willow), and *Symphoricarpos oreophilus* (mountain snowberry).

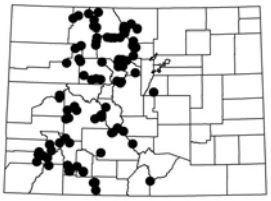
The herbaceous undergrowth occurs within the shade of the tree canopy as well as on exposed point bars. No species were consistently present, but commonly encountered native species ranging from 1-8% cover include *Panicum virgatum* (switchgrass), *Equisetum hyemale* (scouringrush horsetail), and *Equisetum arvense* (field horsetail). Commonly present non-native grasses include *Agrostis stolonifera* (creeping bentgrass), *Poa pratensis* (Kentucky bluegrass), and *Elytrigia repens* (quackgrass). Forb cover is sparse and consists of only a few scattered individuals.

Ecological Processes

In riparian areas, *Juniperus scopulorum* (Rocky Mountain juniper) generally occurs with *Populus angustifolia* (narrowleaf cottonwood). However, in narrow, V-shaped canyons and at the margins of older terraces in wider valleys, *Juniperus scopulorum* can occur as the single dominant tree species. The *Populus angustifolia-Juniperus scopulorum* (narrowleaf cottonwood-Rocky Mountain juniper) plant association may convert to *Juniperus scopulorum* as *Populus angustifolia* dies and does not regenerate. Therefore, the dominance of *Juniperus scopulorum* indicates a late seral stage of a riparian community.

Subalpine fir - Engelmann spruce / Tall fringed bluebells Forest

Abies lasiocarpa - Picea engelmannii / Mertensia ciliata



Global rank/State rank:
G5 / S5
HGM subclass: S1/2?, R2, R3/4
Colorado elevation range:
8,200-11,500 ft (2,500-3,500 m)

General Description

This association is a heavily shaded forest with no shrubs and a thick line of wildflowers lining the stream edge. It is a common community in the subalpine zone along first- and second-order streams. *Mertensia ciliata* (tall fringed bluebells) is nearly always present but can be absent. Other forbs consistently present include *Cardamine cordifolia* (heartleaf bittercress), *Saxifraga odontoloma* (brook saxifrage) and *Senecio triangularis* (arrowleaf ragwort). *Salix drummondiana* (Drummond willow), *Lonicera involucrata* (twinberry honeysuckle), and *Ribes* (currant) species can be present, but with less than 10% cover. At high elevations, *Vaccinium myrtillus* (whortleberry), typically an upland species, can intergrade with this riparian plant association on the stream banks. This is a common plant association throughout the southern Rocky Mountains of Colorado and occurs in all mountain ranges and National Forests in Colorado, comprising approximately 2,000+ miles of stream habitat in Colorado alone.

This association occurs in narrow to wide valleys, 35-350 feet (10-100 m) wide, and is limited to the immediate stream channel edge and overflow areas. It usually establishes within 15 feet (5 m) of the channel and within 2 feet (0.5 m) of channel bankfull height. Typically this association occurs along steep (2-15% gradient), narrow streams, but can also be found along moderate gradient stretches. Soils range from a thin layer of skeletal sandy loams to somewhat deep, mottled loamy sands over colluvial boulders. Total soil depth is never more than 7 feet (2 m), and is typically less than 3 feet (1 m). Consistent to all profiles is a deep, dark brown color and high organic content.

Vegetation Description

Either *Picea engelmannii* (Engelmann spruce) or *Abies lasiocarpa* (subalpine fir) is present, although they are not always present together. The tree canopy can be very thick, completely overhanging the stream, or it can be quite open, with a wide gap over the stream. There is generally very little shrub cover. *Vaccinium myrtillus* (whortleberry), can be abundant, but it was present in only a third of the stands sampled. Other shrub species that may be present include *Salix drummondiana* (Drummond willow), *S. planifolia* (planeleaf willow), *S. monticola* (mountain willow), *Alnus incana* ssp. *tenuifolia* (thinleaf alder), *Lonicera involucrata* (twinberry honeysuckle), and several *Ribes* (currant) species.

The dense, mossy forb layer is the diagnostic part of this vegetation type. The forb layer is usually very narrow, often well under 3 ft (1 m) wide, clinging to and undulating with the side of the narrow stream channel. It is species-rich with 20-80% total combined forb

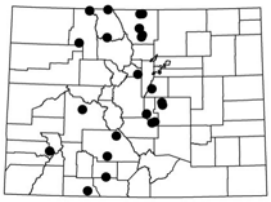
cover. No single forb species is consistently present in every stand, however, a distinct suite of species is present in varying combinations.

Ecological Processes

Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number of riparian *Abies lasiocarpa - Picea engelmannii* (subalpine fir-Engelmann spruce) plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

Thinleaf alder / Mesic forb Shrubland

Alnus incana / Mesic forbs



Global rank/State rank:
G3 / S3
HGM subclass: R2, R3/4
Colorado elevation range:
5,800-9,600 ft (1,750-2,930 m)

General Description

This association is characterized by stands of medium-tall, deciduous shrubs and a thick, herbaceous undergrowth of forbs and wetland 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* (creeping bentgrass). Large stands (>0.5 acre, 0.2 ha) with the native herbaceous undergrowth intact are uncommon.

This plant association occurs along narrow, 130-230 ft (40-70 m) wide, alluvial benches and terraces of canyons and valleys. It also occurs as narrow bands in wider valleys and occasionally forms a wide band on the floodplain. Stream channels are highly variable. They can be steep (3-12%) gradient and narrow or wider, rocky, and moderately sinuous. Occasionally, stream channels are low gradient and highly sinuous, narrow and highly sinuous, or braided. 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.

Vegetation Description

Alnus incana (thinleaf alder) creates a dense, tall shrub canopy. Other shrubs occasionally present include *Lonicera involucrata* (twinberry honeysuckle), *Ribes inerme* (whitestem gooseberry), *R. montigenum* (gooseberry currant) *Rosa woodsii* (Woods rose), *Salix bebbiana* (Bebb willow), *S. drummondiana* (Drummond willow), *S. geyeriana*

(Geyer willow), *S. lucida* ssp. *caudata* (shining willow) and *S. monticola* (mountain willow). A few trees, including *Picea engelmannii* (Engelmann spruce), *Populus tremuloides* (quaking aspen), and *Populus angustifolia* (narrowleaf cottonwood) may be present along the edges of the stand.

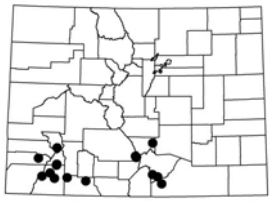
The ground is generally very wet and covered with tall, 3-7 ft (1-2 m), forbs and graminoids. Forb cover is high in undisturbed stands, with total cover often exceeding 60%. Dominant forb species include *Heracleum maximum* (common cowparsnip), *Angelica ampla* (giant angelica), *Aconitum columbianum* (Columbian monkshood), *Mertensia ciliata* (tall fringed bluebells), *Rudbeckia laciniata* var. *ampla* (cutleaf coneflower), *Viola canadensis* var. *scopulorum* (Canada white violet) and *Streptopus amplexifolius* (claspleaf twistedstalk). Graminoid species include *Glyceria striata* (fowl mannagrass), *Calamagrostis canadensis* (bluejoint reedgrass), *Carex microptera* (smallwing sedge), and *C. utriculata* (beaked sedge) A dense ground cover also includes *Equisetum arvense* (field horsetail), *Equisetum hyemale* (scouringrush horsetail) and *Equisetum pratense* (meadow horsetail).

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. 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.

White fir - (Blue spruce) - Narrowleaf cottonwood / Rocky Mountain maple Forest

Abies concolor - (Picea pungens) - Populus angustifolia / Acer glabrum



Global rank/State rank:
G2 / S2
HGM subclass: R3/4
Colorado elevation range:
7,200-9,100 ft (2,200-2,770 m)

General Description

The *Abies concolor-(Picea pungens)-Populus angustifolia/Acer glabrum* (white fir-blue spruce-narrowleaf cottonwood/Rocky Mountain maple) plant association is a diverse, mixed conifer-deciduous forest occurring on active floodplains and stream banks of montane valley floors. The presence of *Abies concolor* distinguishes this community from the more common *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-blue spruce/thinleaf alder) plant association, and is indicative of the southern-most mountains in Colorado. *Picea pungens* (blue spruce) is often an upper

canopy component but is not present in all stands. This is reflected in the association name by placing *Picea pungens* in parentheses.

This community is located in narrow to moderately wide valleys, 50-300 ft (17-100 m) on immediate stream banks, floodplains and upper terraces, 1-6.5 ft, 1.5 ft avg. (0.3-2.0 m, 0.35 avg. m), above the channel high-water level. Streams are steep to moderately steep, straight to moderately sinuous (2-6%, average 4% gradient). The soils are well drained and poorly developed mineral soils with shallow sandy loams over coarse alluvial materials.

Vegetation Description

The upper canopy is diverse, dominated by *Populus angustifolia* (narrowleaf cottonwood) and *Abies concolor* (white fir) and usually including several other tree species such as *Picea pungens* (blue spruce), *Abies lasiocarpa* (subalpine fir), and *Pseudotsuga menziesii* (Douglas-fir). Shrubs are thickest near the stream channel with *Acer glabrum* (Rocky Mountain maple) being the most commonly encountered and abundant species. Other shrubs often present include *Alnus incana* ssp. *tenuifolia* (thinleaf alder), *Betula occidentalis* (river birch), *Cornus sericea* (red-osier dogwood), *Amelanchier utahensis* (Utah serviceberry), *Jamesia americana* (wax flower), *Lonicera involucrata* (twinberry honeysuckle), *Mahonia repens* (Oregon grape), *Salix bebbiana* (Bebb willow), *S. drummondiana* (Drummond willow), *S. monticola* (mountain willow), *Symphoricarpos* spp. (snowberry), *Ribes* spp. (current), and *Rosa woodsii* (Woods rose).

The herbaceous undergrowth is variable, depending on site conditions, but is generally sparse, with less than 20% total cover. No one species is present in all stands. Common forb species include *Heracleum maximum* (common cowparsnip), *Geranium richardsonii* (Richardson geranium), *Vicia americana* (American vetch), *Viola* spp. (violet), *Osmorhiza berteroi* (sweet cicely), *Maianthemum stellatum* (starry false Solomon seal), *Mertensia ciliata* (tall fringed bluebells). Graminoid species include *Elymus glaucus* (blue wildrye), *Bromus inermis* (smooth brome), and *Poa pratensis* (Kentucky bluegrass).

Ecological Processes

This plant association is a mid- to late-seral community. High elevations and cool, shaded canyon bottoms create an environment for *Abies concolor* (white fir) and *Picea pungens* (blue spruce). The active channel flooding and sediment deposition along the reach allows *Populus angustifolia* (narrowleaf cottonwood) to persist. On higher terraces that no longer experience flooding, *Abies* and *Picea* may become the climax tree species.

REFERENCES

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, W. 2006. Sangre de Cristo Natural History. http://www.uni.edu/~andersow/ index. html. Accessed May 12, 2006.

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. and Walford, G.M. 1995. Multiple stable states and models of riparian vegetation succession on the Animas River, Colorado. Annals of the Association of American Geographers 85: 320-338.

Beach, B.W. 1982. Florence City quadrangle geologic maps. Colorado Geological Survey, Dept. of Natural Resources, Denver, CO.

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.

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.

Campbell, C.J. and Green, W. 1968. Perpetual succession of stream-channel vegetation in a semiarid region. Journal of the Arizona Academy of Science 5: 86-98.

Campbell, R.W. 1972. From Trappers to Tourists, Fremont County, Colorado, 1830-1950. The Filter Press, Palmer Lake, CO.

Carsey, K., Kittel, G., Decker, K., Cooper, D.J., and Culver, D. 2003. Field Guide to the Wetland and Riparian Plant Associations of Colorado. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Carter, V. and R.P. Novitzki. 1988. The Ecology and Management of Wetlands Vol. 1. Timber Press, Portland, OR.

Central Shortgrass Prairie Ecoregional Planning Team 1998. Ecoregion-based conservation in the Central Shortgrass Prairie. The Nature Conservancy, Boulder, CO.

Chien, N. 1985. Changes in river regime after the construction of upstream reservoirs. Earth Surface Processes 10, 143-159.

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 Department of Natural Resources. 1998. Planning trails with wildlife in mind. Colorado Department of Natural Resources, Trails Program. Denver, CO

Colorado Division of Wildlife 2006. Colorado Division of Wildlife Wetland and Riparian Mapping. http://ndis1.nrel.colostate.edu/riparian/riparian.htm. Accessed January 11, 2006.

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 Geological Survey 2003. Messages in Stone. Colorado Geological Survey, Denver, CO.

Colorado Natural Areas Program. 1995. Wetland resources of Arkansas Headwaters State Park. Unpublished report to the U.S. Environmental Protection Agency. 53pp.

Colorado Natural Heritage Program 2005. Ecological System Descriptions and Viability Guidelines for Colorado . Colorado Natural Heritage Program, Fort Collins, CO (http://www.cnhp.colostate.edu/projects/eco_systems/eco_systems.html).

Cooley, C., Gilbert, D., and Backstrand, J. 2001. Riparian analysis of the Arkansas River from Leadville Junction to Pueblo Reservoir. Bureau of Land Management, Canon City, 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.

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.

Doesken, N.J., Pielke, R.A., and Bliss, O.A.P. 2003. Climate of Colorado. Climatography of the United States No. 60, Colorado Climate Center, Colorado State University, Ft. Collins, CO.

Douhovnikoff, V., McBride, J.R., and Dodd, R.S. 2005. Salix exigua clonal growth and population dynamics in relation to disturbance regime variation. Ecology 86: 446-452.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Environmental Protection Agency 2006. Wetlands Definitions. U.S. Environmental Protection Agency. http://www.epa.gov/owow/wetlands/what/definitions.html. Accessed January 11, 2006.

Epis, R.C., Wobus, R.A., and Scott, G.R. 1979. Geologic map of the Black Mountain quadrangle, Fremont and Park Counties, Colorado. U.S. Geological Survey, Open-File Report 79-652, Washington, DC.

Fennessy, M. S., A. D. Jacobs, and M. E. Kentula. 2004. Review of Rapid Methods for Assessing Wetland Condition. EPA/620/R-04/009. U.S. Environmental Protection Agency, Washington, D.C.

Forman, R. T. T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge Press, Cambridge, UK.

Forman, R. T. T., and M. Godron. 1986. Landscape Ecology, John Wiley & Sons, New York, New York.

Forman, R. T. T., and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Reviews of Ecological Systems. pp. 207-226.

Friedman, J.M., W.R. Osterkamp, M.L. Scott, and G.T. Auble. 1998. Downstream effects of dams on channel geometry and bottomland vegetation: regional patterns in the Great Plains. Wetlands 18:619-633.

Friedman, J.M. and Lee, V.J. 2002. Extreme floods, channel change, and riparian forests along ephemeral streams. Ecological Monographs 72: 409-425.

Gerhard, L.C. 1967. Paleozoic geologic development of Canon City Embayment, Colorado. American Association of Petroleum Geologists Bulletin 51: 2260-2280.

Gillihan, S.W., D.J. Hanni, S.W. Hutchings, T. Toombs, and T. VerCauteren. 2001. Sharing your Land with Shortgrass Prairie Birds. Rocky Mountain Bird Observatory, Brighton, CO.

Henry, T.W., Evanoff, E., Grenard, D.A., Meyer, H.W., and Vardiman, D.M. 2004. Geologic Guidebook to the Gold Belt Byway, Colorado. Gold Belt Tour Scenic and Historic Byway Association, Colorado.

Hopkins, R.L. and Hopkins, L.B. 2000. Hiking Colorado's Geology. Mountaineers, Seattle, WA.

Husong, B. and J. Alves. 1998. Boreal toad surveys in the south San Juan mountains of Colorado. Colorado Natural Heritage Program and Colorado Division of Wildlife Report. 5 pp. + appendices.

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.

Kelso, T. 2004. Field visit along Tunnel Trail west of Canon City, April 27, 2004.

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.

Lesica, P. and Miles, S. 2001. Natural history and invasion of Russian Olive along eastern Montana rivers. Western North American Naturalist 6: 1-10.

McClean, S. 2005. Upper Arkansas/South Park Conservation Biologist, Colorado Division of Wildlife. Personal communication.

Miller, S.G., R.L. Knight, and C.K. Miller. 1998. Influence of recreational trails on breeding bird communities. Ecological Applications 8:162-169.

Miller, S.G., R.L. Knight, and C.K. Miller. 2001. Wildlife responses to pedestrians and dogs. Wildlife Society Bulletin 29:124-132.

Mitsch, W. J. and J.G. Gosselink. 1993. Wetlands. Second edition, Van Nostrand Reinhold, New York, NY.

National GAP Analysis Program 2005. SWReGAP Landcover. Department of the Interior, U.S.Geological Survey. http://earth.gis.usu.edu/swgap/. Accessed May 15, 2005.

National Research Council. 1995. Wetlands: Characteristics and Boundaries. National Academy Press, Washington D.C.

National Water and Climate Center 2005. SNOTEL Data and Products. U.S. Department of Agriculture, National Resources Conservation Service. http://www.wcc.nrcs.usda.gov/ snow/. Accessed 2005.

Natural Resources Conservation Service 2005. Soil Survey Geographic (SSURGO) database for Fremont County Area, Colorado. U.S. Department of Agriculture, Natural Resources Conservation Service, Fort Worth, Texas.

NatureServe 2003. A Working Classification of Terrestrial Ecological Systems in the Coterminous United States. International Terrestrial Ecological Systems Classification. NatureServe, Arlington, VA.

Neely, B., P. Comer, C. Moritz, M. Lammert, R. Rondeau, C. Pague, G. Bell, H. Copeland, J. Humke, S. Spackman, T. Schulz, D. Theobald, and L. Valutis. 2001. Southern Rocky Mountains: An Ecoregional Assessment and Conservation Blueprint. Prepared by The Nature Conservancy with support from the U.S.

Forest Service, Rocky Mountain Region, Colorado Division of Wildlife, and Bureau of Land Management.

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.

Osterkamp, W.R. and Friedman, J.M. 2000. The disparity between extreme rainfall events and rare floods-with emphasis on the semiarid American West. Hydrological Processes 14: 2817-2829.

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.

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.

Rocchio, J. 2006. Vegetation Index of Biotic Integrity for Colorado Wetlands: Phase 1. Colorado Natural Heritage Program, Fort Collins, CO.

Rondeau, R. 2005. Director, Colorado Natural Heritage Program. Personal communication.

Rondeau, R. 2001. Ecological system viability specifications for Souther Rocky Mountain ecoregion. Colorado Natural Heritage Program, Fort Collins, 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.

Salotti, C.A. 1961. Geology and petrology of the Cotopaxi - Howard area, Fremont County, Colorado. PhD. dissertation. University of Michigan, Ann Arbor, MI.

Schultze, H.-P. and Enciso, G. 1983. Middle Juirrassic Age of the fishbearing horizon in the Canon City Embayment, Colorado. Journal of Paleontology 57: 1053-1060.

Scott, G.R. 1977. Reconnaissance geologic map of the Canon City quadrangle, Fremont County, Colorado. U.S. Geological Survey, Reston, VA.

Scott, G.R. and Taylor, R.B. 1974. Reconnaissance geologic map of the Rockvale Quadrangle, Custer and Fremont Counties, Colorado. U.S. Geological Survey Miscellaneous Field Studies Map MF-562, Washington, D.C.

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.

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.

Spatial Climate Analysis Service . PRISM Climate Data. http://www.ocs.orst.edu/prism/. Accessed May 26, 2005.

Stromberg, J.C. 1998. Functional equivalency of saltcedar (Tamarix chinensis) and Fremont cottonwood (Populus fremontii) along a free-flowing river. Wetlands 18: 675-686.

Taylor, R.B., Scott, G.R., Wobus, R.A., and Epis, R.C. 1975a. Reconnaissance geologic map of the Cotopaxi 15-minute quadrangle, Fremont and Custer Counties, Colorado. U.S. Geological Survey Miscellaneous Investigations Series, Reston, VA.

Taylor, R.B., Scott, G.R., Wobus, R.A., and Epis, R.C. 1975b. Reconnaissance geologic map of the Royal Gorge quadrangle, Fremont and Custer Counties, Colorado. U.S. Geological Survey, Reston, VA.

Topper, R., Spray, K.L., Bellis, W.H., Hamilton, J.L., and Barkmann, P.E. 2003. Ground Water Atlas of Colorado, Special Publication 53. Colorado Geological Survey, Denver, CO.

Tweto, O. 1979. Geologic Map of Colorado, 1:500,000. Colorado Geological Survey, Denver, CO.

U.S. Census Bureau . Fremont County, Colorado QuickFacts. 2005. http://quickfacts.census.gov/qfd/states/08/08043.html. Accessed April 19, 2005.

U.S. Fish and Wildlife Service 2005. National Wetlands Inventory. U.S. Department of the Interior, U.S. Fish and Wildlife Service. http://www.fws.gov/nwi/. Accessed 2005.

U.S. Fish and Wildlife Service 1998. Regional policy on the protection of fens. Unpublished memo from Mary Gessner, Region 6 Director, sent to project leaders

for ecological services, refuges and wildlife, and fish and wildlife management assistances in Region 6..

U.S. Geological Survey 2005. USGS Real-Time Water Data for the Nation. U.S. Department of the Interior, U.S. Geological Survey. http://waterdata.usgs.gov/nwis/rt. Accessed 2005.

USDA SCS and U.S. Department of Agriculture, S.C.S. 1993. Fremont County Area, Colorado Comprehensive Hydric Soils List. U.S. Department of Agriculture.

Wallace, C.A., Cappa, J.A., and Lawson, A.D. 1999. Geologic map of hte Gribbles Park quadrangle, Park and Fremont Counties, Colorado. Colorado Geological Survey, Denver, CO.

Wallace, C.A. and Lawson, A.D. 1998. Geologic map of the Cameron Mountain quadrangle, Chaffee, Park, and Fremont Counties, Colorado. Colorado Geological Survey, Division of Minerals and Geology, Denver, CO.

Wheeler, T.J., Anderson, D.L., Engel, S., Hogan, A.M., Laresen, L.S., Neve, L.A., and Romano, R.R. 1995. Soil Survey of Fremont County Area, Colorado. United States Department of Agriculture, Natural Resources Conservation Service ; in cooperation with Colorado Agricultural Experiment Station and United States Department of the Interior, Bureau of Land Management., Washington, D.C.

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.

Wobus, R.A., Epis, R.C., and Scott, G.R. 1979. Geologic map of the Cover Mountain quadrangle, Fremont, Park, and Teller counties, Colorado. U.S. Geological Survey, Reston, VA .

Wobus, R.A., Epis, R.C., and Scott, G.R. 1977. Reconnaissance geologic map of the Cripple Creek - Pikes Peak area, Teller, Fremont, and El Paso counties, Colorado. Miscellaneous Field Studies Map MF-805. U.S. Geologic Survey, Reston, VA.

Wynne, M.E. 1962. Geology of a portion of Fremont County, Colorado. M.S. Thesis. University of Kansas, Lawrence, KS.