Management Alternatives for Natural Communities and Imperiled Butterflies at Horsetooth Mountain Park, Larimer County, Colorado

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TABLE OF CONTENTS

TABLES

FIGURES

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EXECUTIVE SUMMARY

Larimer County Parks and Open Lands is currently in the process of revising the management plan for Horsetooth Mountain Park. As part of that management plan, the Colorado Natural Heritage Program (CNHP) was contracted to identify potential management strategies for improving the health of the shrubland and grassland plant communities, and for protecting imperiled butterflies which are known to be closely associated with these communities. This was done by identifying the goals for these plant communities and species, evaluating pertinent ecological information, identifying stresses to these natural resources, and identifying strategies to address these stresses.

Obviously, management decisions will need to be made by Larimer County in the context of multiple use as well as financial, social, and practical constraints. By identifying a wide variety of possible management practices the feasibility of implementing these practices can be addressed by the land managers. Implementation of some management strategies may require changes in funding, public education, or partnerships with other agencies or individuals.

Recommendations

- Use prescribed burning and grazing to reduce the abundance of non-native species (concentrating on cheatgrass and Canada bluegrass) in the grassland and shrublands.

- Use application of herbicides or physical removal to reduce the abundance of non-native species in gulches and ravines (concentrating on Canada thistle and musk thistle).

- Use prescribed burning and grazing to reduce fuel loads and reduce the risk of wildfire in grasslands and shrublands.

- Use prescribed burning and/or cutting to reduce the invasion of grasslands by ponderosa pine and mountain mahogany, and shrublands by ponderosa pine.

- Consult with knowledgeable butterfly experts before doing management prescriptions to insure that significant numbers of nectar and host plants, and additional butterfly habitat is available outside of the area to be treated.

- Minimize new trail construction and reduce the extent of social trails.

- Consider options for revegetating treated areas, including planting or seeding with a native species mixture approved for the area. Natural Resources Conservation Service or Colorado State University staff could suggest recommended seed mixtures.

- Continue periodic surveys to identify and map new occurrences of non-native species throughout the Park. Control potentially widespread and problematic non-native species (e.g., knapweed) as soon as possible after they are detected to avoid more costly efforts after these species are established.

- Recruit volunteers and encourage researchers (especially at Colorado State University) to assist with and establish monitoring programs to assess the effectiveness of various management activities.

- Continue surveys for imperiled species including butterflies and plants.

INTRODUCTION

Previously the Colorado Natural Heritage Program (CNHP) had identified Horsetooth Mountain Park (Park) as a site important for the protection of biodiversity (Kettler et al. 1996). This recommendation was based on the presence of several imperiled butterfly species known to exist at the Park. Larimer County Parks and Open Lands is currently in the process of revising the management plan for the Park. As part of that management plan, Larimer County Parks contracted CNHP to identify possible ways to improve the health of the shrubland and grassland plant communities and protect imperiled butterflies present within the Park. This project was accomplished in the following steps:

- Identify the goals for the natural heritage resources (shrubland and grassland plant communities and imperiled butterflies) at the Park.
- Assemble ecological information on the life history of the natural heritage resources and major ecological processes influencing the resources.
- Identify and prioritize the stresses to natural heritage resources and the Park.
- Identify and prioritize methods to mitigate these stresses.
- Make recommendations on the most appropriate methods to achieve the goals.

Goals

The overall goals of this plan are 1) to identify ways to manage and protect shrublands and grasslands at Horsetooth Mountain Park, including restoring the vegetation to a more natural condition, and 2) protect imperiled butterfly species known in the Park. These goals are somewhat overlapping. Managing natural communities[1] to reduce abundance of non-native species, restore natural species composition, and lower fire fuel loads would also be beneficial to the imperiled butterflies in most cases.

The mission of CNHP is to preserve the natural diversity of life by contributing the essential scientific foundation that leads to lasting conservation of Colorado's biological wealth (see Appendix A for more information). Restoring natural ecosystems and protecting sensitive species that inhabit them will also contribute to CNHP's mission. The Larimer County Parks and Open Lands Department is in a strong position to accomplish this.

Obviously, management decisions will need to be made by Larimer County in the context of multiple use as well as financial, social, and practical constraints. By identifying a wide variety of possible management practices designed to meet the goals stated above, the feasibility of implementing these practices can be addressed by the land managers. Implementation of some management strategies may require changes in funding, public education, or partnerships with other agencies or individuals.

[1] The term natural community as used by CNHP refers to and is used interchangeably with the term plant community and plant association.

Natural Communities and Imperiled Butterflies Present in Horsetooth Mountain Park

Butterfly Diversity of the Colorado Front Range

*** Horsetooth Mountain Park contains habitat supporting several imperiled butterfly species**.

The Colorado Front Range and its eastern foothills are well known for their biological diversity (Opler 1994, Whitney 1983, Armstrong 1972). The convergence of the Rocky Mountains' interface with the Great Plains provides an unusual variety of environmental conditions, supporting moist and arid zones, mountain and plain habitats, forest and grassland communities. This provides for a diverse group of organisms representing the biogeographic elements of northern arctic and boreal biomes, Rocky Mountains, southwestern deserts, and grasslands of the Great Plains.

Butterfly and skipper species are particularly numerous on the Front Range of Colorado. Approximately 176 of 750 North American (north of Mexico) species of butterflies are resident or regular colonists on the Colorado Front Range, making it the fourth richest (number of species) butterfly region in the United States (Opler 1994, Opler and Krizek 1984). At the highest elevations, butterflies of arctic affinities occur at their southern limits. Species typical of the Rocky Mountain boreal forests are found at middle elevations and reach their eastern limits here. The lowest elevations of the foothills and adjacent plains support Great Plains species at the western limits of their range, and those of the southwestern mountains and deserts occur near their northern limits. **The highest species richness in butterflies occurs in the low foothills and foothill canyons (Opler 1994),** an area rich in other taxa as well (Weber 1995, Jones 1987, Armstrong 1972). Horsetooth Mountain Park, located in this foothill zone, provides habitat for several imperiled butterfly and skipper species (species underlined in the following text, also see Table 1).

While the high diversity of species of this area is largely due to the mixing of these distinctive flora and faunas, several taxa are endemic to the Front Range foothills and adjacent plains (Opler 1994, Armstrong 1972). Such regional endemics are considered by CNHP as high priorities for conservation efforts and have importance on an evolutionary scale as well. The Hops blue (*Celastrina humulus*) and Schryver's elfin (*Callophrys mossii schryveri*) are two such examples.

Species of the eastern Great Plains occurring in disjunct populations along the Colorado Front Range are also of high conservation priority. Such species include the Ottoe skipper (*Hesperia ottoe*), the Arogos skipper (*Atrytone arogos*), the Dusted skipper (*Atrytonopsis hianna*), and the Crossline skipper (*Polites origenes*). Such disjunct populations are often of conservation significance (Lesica and Allendorf 1995) because genetic diversity and adaptation of the species can be greatly affected by habitat fragmentation. The results of preserving genetic diversity and intact habitat can protect species from local catastrophic events. Furthermore, many of these species are associated with xeric or mesic tallgrass prairies (*Andropogon gerardii-Schizachyrium scoparium* or *Andropogon gerardii-Sorghastrum nutans* plant communities) which have similar

disjunct distributions and are increasingly threatened by land conversion. High rates of habitat destruction throughout the Great Plains region may increase the importance of these disjunct populations. The Ottoe skipper and Arogos skipper are vulnerable throughout their range demonstrating the conservation importance of Colorado populations.

Other species of the Front Range are distinctly characteristic of the Southern Rocky Mountains. While many of these still find ample habitat throughout the mountainous areas of Colorado, Snow's skipper (*Paratrytone snowi*) is of conservation concern because of its possible dependency on late successional forests (Opler, personal communication).

Butterfly and skipper species whose ranges are centered in the deserts of southwest North America are also found on the Front Range. Of these, the Arrowhead skipper (*Stinga morrisoni*) and the Simius roadside skipper (*Amblyscirtes simius*) are of some conservation concern due to localized distributions and specific habitat preferences.

TABLE 1. IMPERILED BUTTERFLY AND SKIPPER SPECIES OCCURRING IN HORSETOOTH MOUNTAIN PARK

Element	Common name	Global Rank	State Rank	Federal Sens.	Federal Status	State Status
Celastrina humulus	Hop-feeding azure	G2	S2			
Hesperia ottoe	Ottoe skipper	G3G4	S2			
Erynnis martialis	Mottled dusky wing	G4	S2S3			
Amblyscirtes simius	Simius roadside skipper	G4	S3			
Paratrytone snowi	Snow's skipper	G4	S3			

See Appendix A for a description of Heritage Program global and state ranks.

Major Plant Communities Present in Horsetooth Mountain Park

*** Horsetooth Mountain Park encompasses a variety of habitats including grasslands, shrublands, and forests.**

Open grasslands are common along the lower elevations, and to a lesser extent on steep dry slopes and in forest openings at higher elevations at the Park. Historically, at the higher elevations of the Park, these grasslands were thought to be dominated by Arizona fescue (*Festuca arizonica*), mountain muhly (*Muhlenbergia montana*), and Parry's oatgrass (*Danthonia parryi*). At relatively lower elevations warm-season grass species (completing much of their growth in the summer) such as big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and sideoats grama (*Bouteloua curtipendula*), and the cool-season species (completing much of their growth in the spring or fall) western wheatgrass (*Pascopyrum smithii*) and needle-and-threadgrass (*Stipa comata*) were common. Many of these native grasses have been reduced in abundance by historic livestock grazing practices and probably by competition from invasive non-native species. For example, the non-native grass smooth brome (*Bromus inermis*) dominates many areas along moist drainages and cheatgrass (*Bromus tectorum*) and Canada bluegrass (*Poa compressa)* are abundant on dry slopes at the lower

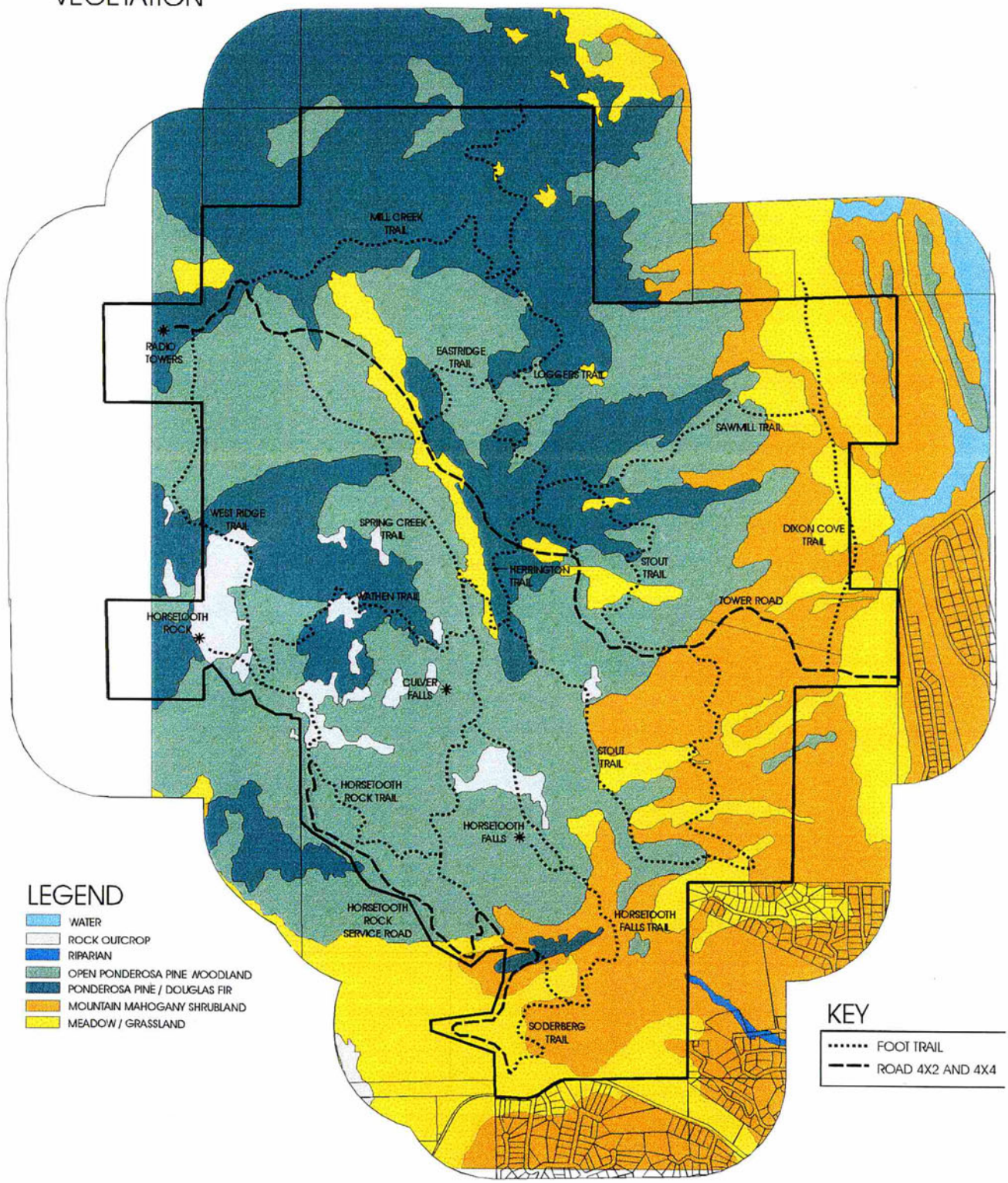
elevations within the Park. **Several of the native warm-season species, which have been reduced in abundance, are needed for some part of the life cycle of the imperiled butterflies known at the Park (see Table 3).**

Mountain mahogany (*Cercocarpus montanus*) shrublands are very common on rocky slopes at the lower elevations of the Park. Grass species thought to be historically common within these shrublands are needle-and-threadgrass, big bluestem, little bluestem, and blue grama. Cheatgrass has invaded many of the shrublands, reducing the abundance of the native grasses and creating heavy fuel loads that could result in catastrophic wildfire. Buckbrush (*Ceanothus fendleri*) is common in mountain mahogany stands and is the host plant and nectar (food) source for one of the imperiled butterflies.

Ponderosa pine (*Pinus ponderosa*) forests are common at the higher elevations of the Park with some Douglas-fir (*Pseudotsuga menziesii*) on cooler slopes. Currently, ponderosa pine occurs in stands that are more dense and at lower elevations than was thought to be the case before European settlement. This has resulted in displacement of shrub and grass species that are adapted to open habitats.

Figure 1. Grassland, shrubland, and forest habitats at Horsetooth Mountain Park.

MAP 2.3
VEGETATION



HORSETOOTH MOUNTAIN PARK

bha design

0 200 400 800 1200 ft. NORTH

MAY1998

Map limits illustrated are representational only a
are approximate based on information provide

Source: Colorado Natural Heritage Program

Stresses to the Natural Communities and Imperiled Butterflies in Horsetooth Mountain Park

* **Alteration of natural ecological processes, invasion of non-native species, habitat loss, fragmentation, and construction of trails and roads can negatively impact natural communities and populations of imperiled butterflies.**

Altered Ecological Processes

In general, most of the ecosystems along the Front Range of Colorado have evolved with natural disturbances such as grazing and fire. Alteration of these natural disturbances can alter ecological functions such as plant succession, and nutrient and energy cycles (Lauenroth and Milchunas 1991), that in turn can impact other parts of the ecosystem. While it is probably not possible to completely return to pre-settlement conditions, more closely mimicking these conditions should be a positive step in protection of imperiled butterflies, restoration of the natural plant communities, and preserving natural biodiversity.

Natural Fire Regimes

* **Alteration of natural fire regimes in natural habitats can allow certain species to invade sites where they otherwise wouldn't occur and can allow fire fuels to build up to dangerous levels.**

Fires in pre-settlement times along the Colorado Front Range are thought to have been fairly frequent and therefore, of low intensity. Suppression of fires, due to settlement, has altered vegetation structure and composition and increased fuel loads. This could result in fires that are more severe than they were historically (Hobbs 1987), especially in areas heavily invaded by cheatgrass and smooth brome.

Grasslands - Little data are available detailing the natural fire regimes of the grasslands along the Colorado Front Range. Fire regimes in the tallgrass prairies of the Midwestern U.S. have been extensively studied and fires were thought to occur naturally as often as every 3 to 5 years (Steinauer and Collins 1996). Fires in tallgrass prairies play a more important role in maintaining the tallgrass prairie (reducing tree and shrub invasion) than in the drier prairies to the west (Anderson 1990). Fire frequency data from the Midwestern U.S. probably do not accurately characterize conditions along the Colorado Front Range because environmental factors (especially climate), and species composition and production are quite different. Nevertheless, fires are still considered an important factor in the shortgrass and mixedgrass prairie common in the area. Wright and Bailey (1980) suggested that fire frequencies in the shortgrass and mixedgrass prairie may have been between 5 to 10 years on average on level topography to 20 to 30 years on dissected topography.

Shrublands - Fires frequencies in mountain mahogany shrublands have not been thoroughly documented. The fire frequency in these shrublands would probably be less

than that of the ponderosa pine communities because of the decreased flammability (at times) of mountain mahogany and reduced frequency of lightning strikes in the lower stature community (R. Laven personal communication). Data from Colorado are lacking, but 40 to 60 years intervals might be expected. Gruell et al. (1986) found the average fire interval to range between 5 and 40 years in mountain mahogany stands in the Intermountain West. A detailed fire scar study in a mountain mahogany chaparral community (mixed with shrub live oak) surrounding a ponderosa pine stand in Arizona showed that the vegetation burned on an average frequency of about 25 years (Dieterich and Hibbert 1988). The absence of oak in the communities along the northern Colorado Front Range might be expected to result in the slower buildup of fuels and decreased fire frequency.

Forests - Historically, fires in ponderosa pine forests were frequent and of low intensity. On the Colorado Front Range, researchers have determined that fire occurred in ponderosa pine forests on average from every 8 to15 years (Mehl 1992) to around every 45 years (Laven et al. 1980). The increased density and spread of ponderosa pine to lower elevations from fire suppression has been well documented (Veblen and Lorenz 1991). This may impact grassland and shrubland communities by altering the environment so that certain shrubs and herbaceous plants, and the animals associated with those species can no longer survive.

Natural Grazing Regimes

* **Plant communities along the Colorado Front Range have evolved with, and adapted to grazing. Certain grazing patterns utilizing domestic livestock may be used to mimic that of native herbivores.**

Plant communities along the Colorado Front Range have evolved with disturbance from native herbivores and are well adapted to grazing. On the prairies of the Great Plains, bison and other large ungulates, and numerous smaller animals were known to remove a large proportion of the above ground and below ground biomass produced by plants (Lauenroth and Milchunas 1991). These herbivores undoubtedly were present at the Park and affected that vegetation. Elimination of many of the native herbivores and replacement with domestic livestock has altered this natural process. While domestic livestock often mimic the grazing of native herbivores, certain differences do affect the plant communities (Lauenroth and Milchunas 1991).

Certain grazing practices, such as continuous grazing for the entire growing season, can alter the plant communities over time. The presence of Arizona fescue, mountain muhly, Parry's oatgrass, western wheatgrass, green needlegrass, and big bluestem in this area is considered an indication of good condition vegetation. Many of these species have been removed or reduced in abundance in the Park. These species are very palatable to livestock and may have been removed from most of the area by past grazing practices (H. Sprock personal communication) and from competition from non-native species.

Invasion of Non-native Species

* **Invasion of non-native species can result in the widespread replacement of native species (often greatly altering ecosystem functions) and is probably the biggest threat to the natural resources at Horsetooth Mountain Park.**

Settlement of the area by European Americans resulted in the introduction of numerous plant species not native to the area. Some species were intentionally introduced as hay or pasture grasses (such as smooth brome), while others were accidentally introduced as contaminants in hay or grain crops. Regardless of the source, the introduction of non-native species has significant impacts on natural communities. For example, cheatgrass competes with native species for water and negatively affects their water status and productivity (Melgoza et al., 1990). Numerous studies have shown that areas invaded by non-native species have reduced populations of native plant and animal species (Bedunah 1992, Bock and Bock 1988). Belcher and Wilson (1989) also found that native species abundance was decreased by the abundance of leafy spurge (*Euphorbia esula*).

The species listed in Table 2 are known to occur within the park, near the park, or in similar habitats along the Front Range. Although some of these species may not currently occur in the Park, they have the potential to seriously disrupt natural processes and communities should they invade the area. Because extensive surveys of non-native species were not done for this project this list should not be considered exhaustive. Regular, periodic surveys are recommended to monitor the presence of non-native species. This may aid in identifying problematic species while they are still easily controlled and prevent the need for more costly control in the future. Neighboring (private and public lands including Lory State Park and City of Fort Collins Open Space) lands need to also address management of non-native species for control efforts to be effective. Table 2 below lists the non-native species that are currently considered the most problematic in the area. Summaries of known control measures are detailed in Appendix D. One point is continuously repeated in the literature on control of non-native species: **to be effective, non-native species management involves not only removal of those species, but also replacement with desirable species.**

TABLE 2. POTENTIALLY PROBLEMATIC NON-NATIVE SPECIES PRESENT AT HORSETOOTH MOUNTAIN PARK OR ADJACENT AREAS

Smooth brome (*Bromus inermis*)
Japanese brome (*Bromus japonicus*)
Cheatgrass (*Bromus tectorum*)
Musk thistle *(Carduus nutans)*
Diffuse knapweed (*Centaurea diffusa*)
Spotted knapweed (*Centaurea maculosa*)
Canada thistle *(Cirsium arvense)*
Field bindweed (*Convolvulus arvensis*)
Leafy spurge (*Euphorbia esula*)
Toadflax *(Linaria dalmatica)*
Canada bluegrass *(Poa compressa)*
Kentucky bluegrass *(Poa pratensis)*

Species in bold are known to occur within the park.

Invasion of non-native species appears to be the biggest threat to the natural communities and the imperiled butterflies at the Park. Managing non-native species can be expensive, labor intensive, and a long-term commitment. Concerns with the level of impact non-natives have on the ecosystem must be balanced with the impact of removing the non-native species. Additional disturbance or removal could provide habitat for non-native species, and with most control methods there is some impact on native species (Hiebert and Stubbendieck 1993).

Rocky Mountain National Park uses a system to prioritize control efforts on non-native species (Hiebert and Stubbendieck 1993). The first phase of the system uses literature reviews to determine potential distributions and impacts. The second phase identifies those species that have high potential distribution and high ecological impacts. This system allows decision making processes that consider those species which may substantially impact resources, those that can be easily managed, those that are not a major problem but have the characteristics that indicate they may become so, or those that are known to impact similar ecosystems. The system considers: 1) the significance of impact including the current level of impact and the ability of the species to become a pest, 2) the feasibility of control or management including the abundance within the parcel, the ease of control, the side effects of control methods, the effectiveness of community management, and the possibility of biological control (Hiebert and Stubbendieck 1993). This system also requires interpretation of biological information and an intensive survey of the parcel to document the location and extent of non-native species.

Figure 3. Meadow dominated by smooth brome in upper Spring Canyon.

Habitat Loss, Edge Effects and Fragmentation

*** Habitat loss, creation of edge habitats, and fragmentation can be detrimental to many animal populations, including the imperiled butterflies known from Horsetooth Mountain Park.**

Since colonial times, human settlement has had a drastic effect on large landscape features, including the Great Plains tall and shortgrass prairies and the Front Range of Colorado. It is estimated that between 95 and 99 percent of all tallgrass prairie in the United States, some of which has a disjunct distribution along the Colorado Front Range corridor, has been eliminated (Swengel and Swengel 1995, Moffat and McPhillips 1993). Elimination of this habitat has been mainly through the conversion of native prairie to agricultural fields. In Colorado, housing and urban development, mining, water development, industry, and recreation have impacted these natural communities.

The unique features of the Colorado Front Range attract developers and real estate interests. These features not only provide habitat for formerly wide-spread prairie specialist butterflies (species restricted to limited habitats or dependent on a few plant species), but also provide unique habitat for species and subspecies of butterflies found to occur only on the Front Range and nowhere else to date (Opler 1994). This is the case with several of the imperiled species known from the Park.

"Edge" areas are zones of sharply contrasting habitats or landscapes (Schwarz et al. 1993). Edges are often created by naturally occurring processes such as floods or fires and will recover naturally over time. Edges can also be created by human activities, such as a grassland and an agricultural field or a grassland and a road. This type of edge is often dominated by plant species that are adapted to disturbance and are more common and widespread. These areas often attract high numbers of generalist butterfly species (species that are able to adapt to plant species that are commonly found in disturbed area) (Rathcke and Jules 1993). As our landscape is increasingly fragmented by large-scale, rapid anthropogenic conversion, these edges become increasingly abundant in the remaining open space areas. As a result, many generalist species of butterflies have become increasingly common in these areas, and compete, either directly or indirectly, for food sources with the specialist species (Rathcke and Jules 1993). The specialists, meanwhile, have become increasingly less common as the overall structure of their habitat landscape is dramatically altered, and interspecies competition has increased. Furthermore, the overall reduction of large landscapes jeopardizes the existence of the specialists further. Specialists that occur in small, patchy populations (like many of the Front Range butterflies) are more likely to be excluded from small fragments or be affected by local disturbance events that could cause the extinction of the entire population. Specialists that exploit sparse and/or scattered plant species could be threatened by fragmentation (Rathcke and Jules 1993). Should a large-scale disturbance such as fire, flood, or disease occur, populations that would normally colonize after landscape recovery may actually be extirpated if they exist in an isolated fragment. They may not be able to travel the distance necessary to colonize suitable habitat (Moffat and McPhillips 1993).

Effects of Roads and Trails

* **Roads and trails create barriers to species movement and corridors for invasion of non-native species. The use of roads and trails increases the chances for human interference of animal life cycles.**

Increased recreation in open space areas has created a demand for trails and trail management. It is generally believed that pedestrian and bike trails do not substantially fragment the natural landscapes. However, any disturbance to a natural landscape can create fragmentation and edges.

In light of the edge affect discussed earlier, there are concerns regarding trail construction and placement. Trails may be viewed as breaks or barriers in otherwise natural habitat. Such breaks may impede or eliminate movement by animals. For example, rodents may avoid trail openings because of exposure to predation (Harker et al. 1993). The same impact holds true for insects. Habitat specialists are very exacting in environmental requirements, obligated to conditions of habitat continuity. They often cannot survive for extended periods of time in small patches and fragments, and cannot exist, as plants occasionally do, in dormant states during intervals of habitat unsuitability (Oates *in* Pullin 1995).

Trails are ideal places for early successional species to grow because the disturbance is continuous and regular. With the arrival of early successional vegetation there are edges, and consequently, a preponderance of generalist species. It is known that with every edge habitat created, interior or undisturbed habitat is lost (Schwarz et al. 1993). **If the impact of additional formal and social trails is considered, the habitat and landscape is increasingly fragmented**, with much additional edge habitat being created, and increasing amounts of natural habitat is being displaced (Harker et al. 1993).

In addition to providing conditions for early successional species, trails and roads may act as corridors for the spread of non-native and invasive plants. Many of these species are tolerant of or rely on continuous disturbance from use and maintenance of the trails to become established. Belcher and Wilson (1989) observed that most leafy spurge infestations were associated with areas that had been disturbed by human activities such as vehicle tracks, road construction, and fire guards. Even in areas that seem relatively free of non-native species, seeds of non-native species often occur in the seed bank and may be viable for many years. With trail construction and use, the soil is disturbed, increasing the opportunity for aggressive non-native species to spread *via* trail corridors. Trail related erosion could increase the habitat available for non-native species and spread seeds further downstream. When the eroded trail becomes too difficult for use, constructing an additional trail or to going off trail can create additional negative impacts on the natural landscape.

Trails also create disturbance in a way not generally realized, such as nest abandonment. Insects may also be disturbed by activities along trails. This may be observed in gulches or ravines where trails follow closely the meandering of a creek. The plants occurring in the gulches in ravines provide larval and adult food sources for butterflies. Narrow trails in these areas may not disturb this vegetation to any great degree, as these areas are areas of frequent disturbance due to floods, erosion, etc.

However, a nectaring butterfly trying to obtain a meal, or a pair of butterflies attempting courtship and mating, can be disturbed by movement on trails. When an adult butterfly has possibly only two weeks during the warm season to complete its life cycle, this may be seen as a significant impact. The degree of impact is unknown, but may be something to bear in mind when considering placement of new trails, or closure of social trails.

Trail construction and management are obviously important and difficult concerns for land managers. In terms of habitat conservation and preservation, trails should be planned to have as little impact as possible on the surrounding habitat. In some cases, the only way to lessen impacts to natural resources is to minimize the number of trails in the area and to hope that user education will help reduce creation of social trails. This will become more difficult as the demands for recreation increase.

Managing for Natural Ecological Conditions and Landscape Diversity

* **Managing for natural ecological conditions and natural landscape diversity is vital for protection of biodiversity, including imperiled butterflies known from the Park.**

Variation in the overall landscape helps create microhabitats that support a variety of butterfly species. Some species may need the dry, southerly exposures dominated by shrubs and grasses for their survival, while others need cool, moist ravines or gulches. A diverse landscape is also very important in maintaining sub-populations of the same species over time. Extensive studies of one rare butterfly have shown that survival of the butterfly colony is facilitated by its association with a landscape containing a variety of topographic relief and slope directions (Opler *in* Collins and Thomas 1991). This diversity in landscape provides a variety of microhabitats enabling survival of the butterfly. This particular butterfly is susceptible to drought, because its hostplant is susceptible to drought. During drought the hostplant survives in places where the topographic relief allows residual moisture to remain. The butterfly can only survive in the places where the hostplant remains. When favorable conditions return both the hostplant and butterfly will disperse to colonize areas previously affected by the drought. Survival of the smaller subpopulations is important for the continued survival of the species as a whole. Keeping this in mind, it is easier to understand the importance of maintaining large, unfragmented pieces of landscape.

One of the most fascinating realities about the Colorado Front Range is that the relief of the landscape is so diverse, the biological diversity of butterflies, skippers, plants and plant communities is unique for such a temperate climate. Of the some 290 butterflies known to occur within the entire state of Colorado, approximately 176, or about 60% occur along this narrow strip known as the Front Range corridor. It is ranked fourth in terms of species richness (number of species) in the United States (Opler 1994, Opler and Krizek 1984).

Presently, however, with disappearance and alteration in habitat occurring at such a rapid pace, these butterflies are unable to move to and colonize other habitat. The effect of disappearing habitat on butterflies is obvious; they simply have no place to go. In

similar context, growth of dense forests has occurred with fire suppression. Open savannas and sunny openings are reduced. This has also altered the ecological processes; litter from trees is not allowed to burn, nutrients are not recycled, very little sunlight reaches the soils, and flowers and grasses formerly occurring no longer have ample sources of sunlight to survive. With this disappearance of sunlight and some plant species, the butterflies have suffered as well.

Management to Restore Plant Communities and Imperiled Butterfly Species

The following recommendations are based on goals identified for grassland, shrubland, and ravine and gulch habitats. Non-native species have seriously invaded the grassland and shrubland communities in the Park. The imperiled butterflies known from the Park often rely on a few plant species for some part of their life cycle (see Table 3), some of which were important components of these communities. Several of these butterfly species depend on warm-season grasses during the larval stage. These grasses have been impacted and reduced in abundance by invasion of non-native species (especially the cool-season grasses smooth brome, Canada bluegrass, and cheatgrass) and past livestock grazing practices. Management options and recommendations for imperiled butterflies are primarily adapted from Moffat and McPhillips (1993), Murphy et al. (1990), Rathcke and Jules (1993), and Swengel and Swengel (1995). Management options and recommendations for non-native species are summarized from information in Appendix D (Specific Control Methods for Non-Native Species).

TABLE 3. IMPERILED BUTTERFLIES KNOWN TO OCCUR WITHIN HORSETOOTH MOUNTAIN PARK AND PLANTS NEEDED FOR SOME PART OF THEIR LIFE CYCLE

Element	Common name	Larval Hostplant	Adult Nectaring Sources
Celastrina humulus	Hop-feeding azure	Hops (*Humulus lupulus)*	Flowers of the waxflower (*Jamesia americana*), among others; adult males sip mud (Scott and Wright 1998).
Hesperia ottoe	Ottoe skipper	Big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and side oats grama (*Bouteloua curtipendula*) (Scott 1986).	Yellow prickly pear (*Opuntia* sp.), milkweeds (*Asclepias* sp.), coneflower (*Ratibida* sp.) and *Rudbeckia* sp.), wavy-leafed thistle (*Cirsium undulatum)*
Erynnis martialis	Mottled dusky wing	Buckbrush (*Ceanothus fendleri*), red root (*C. herbaceus)*	Buckbrush (*Ceanothus fendleri*) and red root (*C. herbaceus)*
Amblyscirtes simius	Simius roadside skipper	Blue grama (*Bouteloua gracilis)*	Blue beardstongue (*Penstemon* sp.) (Scott 1986), possibly prickly pear cactus (*Opuntia* sp.)
Paratrytone snowi	Snow's skipper	Not well known, possibly pine dropseed (*Blepharoneuron tricholepis*) or mountain muhly (*Muhlenbergia montana*)	Horsemint (*Monarda fistulosa*) (Ferris and Brown 1981).

Figure 4. Hops – a host plant for an imperiled butterfly at Horsetooth Mountain Park.

Prescribed burning

*** Small-scale (30-40 acre or less) cool-season or dormant season prescribed burns may be one way to reduce the abundance of widespread non-native species (cheatgrass, Canada bluegrass, smooth brome) which impact the natural communities and butterfly populations, and to control the buildup of fire fuels.**

Dormant season burns for the warm-season species (late fall or early spring) would probably be most beneficial. Late fall and early spring burns may help reduce cheatgrass and Canada bluegrass abundance but could potentially impact native cool-season grasses (needle-and-threadgrass, green needlegrass, western wheatgrass). Species that are very habitat specific and rare (such as some of the imperiled butterflies known from the Park) can be extirpated by fires that affect their entire habitat. Care needs to be taken to avoid impacting a large proportion of their habitat in any one year. Fires should probably be limited to 30-40 acres or less each year.

Grasslands:

Prescribed burns during the dormant season are known to be effective in reducing some non-native species and allowing an increase in the abundance of desirable warm-season grasses. Burning would also reduce the invasion of ponderosa pine and mountain mahogany into the grasslands. However, burning (especially with heavy fuel loads) can impact several native cool-season grasses. Needle-and-threadgrass, green needlegrass, and western wheatgrass can be harmed by spring or fall burning (FEIS 1998). Timing may be very difficult because several of these species may be growing at nearly the same time in the spring. **Impacts can be minimized by burning while the desirable grasses are dormant but undesirable species (cheatgrass, Japanese brome, Canada bluegrass) are actively growing.** Fall burning may be possible because fuel loads are adequate to carry a fire and conditions are dry enough. This may not be the case in the spring. **Repeated cool-season or dormant season burning may allow warm-season species to compete more effectively, but could be harmful to butterfly populations (by not allowing them to recolonize an area) and is not recommended.** In general, burning during drought can be harmful to many grass species even with dormant season burns (Culver 1997).

Short duration, high intensity management often used in grassland reclamation may involve management practices that are detrimental to sensitive butterfly populations (Oates 1995). Only a small proportion of the habitat should be burned in any one year (possibly 30-40 acres) and the same area should not be burned more than once every 5-10 years. Trails and roads exist which could be used as fire breaks for small prescribed burns. Vegetation management for butterflies should consider the availability of microhabitats, some of which provide refuges during certain weather cycles (Murphy et al., 1990). Understanding butterfly habitats based on their needs of plants, solar radiation, etc., is important when planning management activities so that not all of the habitat is affected at one time. **A review of prescribed burning plans by knowledgeable lepidopterists is advised.**

Shrublands

In the absence of fire, ponderosa pine has invaded mountain mahogany communities. Ponderosa pine seedlings are often killed by fire and mountain mahogany is usually only temporarily damaged by fire. Seedling establishment of mountain mahogany is slow but the species sprouts vigorously from root crowns after most fires (FEIS 1998). Fires in pre-settlement times may have been fairly frequent and therefore of low intensity. Fuel build-up may cause fires to be more severe than they were historically. Although no specific fire effects information was available for buckbrush (*Ceanothus fendleri),* other *Ceanothus* species are known to respond favorably to fire (FEIS 1998).

Most desirable warm-season grasses in the understory respond well, or at least are not severely impacted by dormant season burning. However, burning can impact several native cool-season grasses. Needle-and-threadgrass, green needlegrass, and western wheatgrass can be impacted by spring or fall burning (FEIS 1998). Timing may be very difficult because several of these species begin growth simultaneously. **Impacts can be minimized by burning while the desirable grasses are dormant but undesirable grasses (cheatgrass, Japanese brome, bluegrasses) are actively growing.** In general, burning during drought can be harmful to many grass species even with dormant season burns (Culver 1997).

Again, similar to the grasslands, only a small proportion of the habitat should be burned in any one year (possibly 30-40 acres or less) and we recommend that the same area not be burned more than once every 30-40 years. Trails and roads exist which could be used as fire breaks for small prescribed burns. Vegetation management for butterflies should consider the availability of microhabitats, some of which provide refuges during certain weather cycles (Murphy et al. 1990). **A review of prescribed burning plans by knowledgeable lepidopterists is recommended.**

Gulches and Ravines

Wild hops, the host plant for the hop-feeding azure butterfly, commonly grows in narrow gulches and ravines. No data are available to suggest how the hops would be affected by prescribed burning. Fire may not be an effective method for controlling non-native species in this type of habitat.

Grazing

*** Grazing during the cool-season or dormant season would be effective in reducing cool-season, non-native species (cheatgrass, Canada bluegrass, smooth brome) and reducing fire fuel buildup in grassland and shrubland communities.**

Dormant season grazing would aid in reducing the buildup of fire fuels. Grazing in the spring to target cool-season species may allow the warm-season species to more effectively compete. Livestock should be periodically excluded from known locations of imperiled butterflies during the growing season to allow plant communities to recover.

The use of grazing as a management tool at the Park has its difficulties. Steep terrain and limited water distribution currently available at the Park may make it difficult to get livestock to utilize the areas where the non-natives species are most abundant (i.e., cheatgrass on dry, steep slopes) and may result in livestock loitering around water sources. Concentration areas for livestock often are invaded by non-native species, especially in moist areas. Spring grazing, which would most benefit desirable warm-season grasses, may impact native cool-season grasses that are important components of the plant communities. Additionally, several plants poisonous to livestock are present such as locoweed (*Oxytropis* spp.) and larkspur (*Delphinium* spp.), and toxic during the spring. Grazing by other non-native herbivores, such as llamas, may be effective as they do not require as much water as cattle, will utilize a variety of species, and are adapted to the steep topography (Stan Ebel - personal communication). Because a llama eats only 5-10% as much as a cow, it would take many animals to achieve the necessary utilization of the non-native species.

Application of Herbicides

*** Application of herbicides may be effective for controlling non-native species which occur in small isolated populations (dalmatian toadflax, Canada thistle, musk thistle, and leafy spurge) or for those species difficult to control with burning or grazing (Canada thistle, smooth brome, and musk thistle).**

The extensive size of the areas infested with non-native species may make application of herbicides impractical as a control for widespread non-natives species such as cheatgrass and Canada bluegrass. Boulder County Parks and Open Space has had some success in controlling cheatgrass by applying herbicide early in the spring when cheatgrass is first developing leaves (but before native species do so). As is the case with prescribed burning, only a small proportion of the butterfly habitat should have herbicides applied in any one year.

Spot application of herbicides is highly recommended as a control option for some non-native species that are only abundant in small patches (dalmatian toadflax, Canada thistle, and musk thistle). This prevents negative effects of repeated, annual, broad-scale herbicide applications, such as the elimination of native broad-leaved flora. It is highly recommended that staff working with herbicides be familiar with identification of both native and non-native species, especially thistles. Note that one of the host plants for the Ottoe skipper is the native wavy-leafed thistle (*Cirsium undulatum*).

Biological control (insects)

* **Biological controls should only be used for non-native species that greatly impact the native plants and animals and are very difficult to control with other methods (e.g. knapweeds and leafy spurge). This management tool should only be used as a last resort and should be carefully planned.**

Biological control has proven to be effective against some non-native species, often those that resist other control methods. Special care is necessary when importing non-native insects species (Lattin et al. 1994). Generally experiments are conducted to insure that the introduced insects do not impact desirable species but some insect species do not differentiate between related native and non-native plants (such as Canada thistle and native thistles). Many insect species can shift and adapt to differences in their environment in a short time. This phenomenon is referred to as "microevolution," and is usually in response to short-term selection pressures such as insecticides, pollution, or availability of a different host plant (B. Kondratieff personal communication). Introducing non-native insects as biological controls may have similar consequences to past introductions of non-native plants. A species formerly thought to be beneficial could become a pest in the future.

Mowing or Physical Removal

* **Mowing or physical removal (cutting) may be effective in controlling non-native species where infestations are small or easily accessed. Cutting of ponderosa pine would help reduce the invasion of this species into grassland and shrubland habitats.**

Mowing or "weed-whacking" may be viable alternatives in some cases where infestations are small, areas are difficult to access, or rugged terrain exists. This method obviously can be very labor intensive. Large scale mowing could be possible in some areas (such as the large smooth brome fields between Dixon Cove and Quarry Cove or along upper Spring Creek Trail). This method would not be effective in reducing fire fuel loads and should be avoided when butterfly nectar plants are flowering.

In some cases where populations of non-native species are small, physically cutting or removing the non-native plants may be successful. Generally, this would be very labor intensive and therefore may only be possible on small infestations. This may be one method to control small infestations by species that may have not yet become widespread and problematic.

Controlling the invasion of ponderosa pine into grassland and shrubland communities will help protect those habitats for imperiled butterflies. The forest management plan being developed for the Park should be consulted for more detail on management of ponderosa pine but additional control may be necessary in non-forested areas of the Park.

Priority Management Areas

The areas described in the section below are listed in order of priority of the greatest urgency for management actions. The map following this section depicts these areas. Boundaries for these areas are not exact but indicate general areas needing management.

Area 1.
The grasslands and shrublands on the south side of the Park provide significant habitat for several of the imperiled butterflies. The non-natives cheatgrass and Canada bluegrass have heavily invaded parts of this area. Control of these non-native species would benefit the plant communities as well as the imperiled butterflies.

Area 2.
The meadows along upper Spring Creek Trail had been planted to smooth brome in the past and are still heavily dominated by that species. Restoration of the meadow is needed. As a result of the nearly complete dominance of the area by smooth brome the butterfly species of concern probably do not inhabit this area. In this area mowing, burning, and/or application of herbicides in consecutive years would probably have little impact on butterfly species of concern.

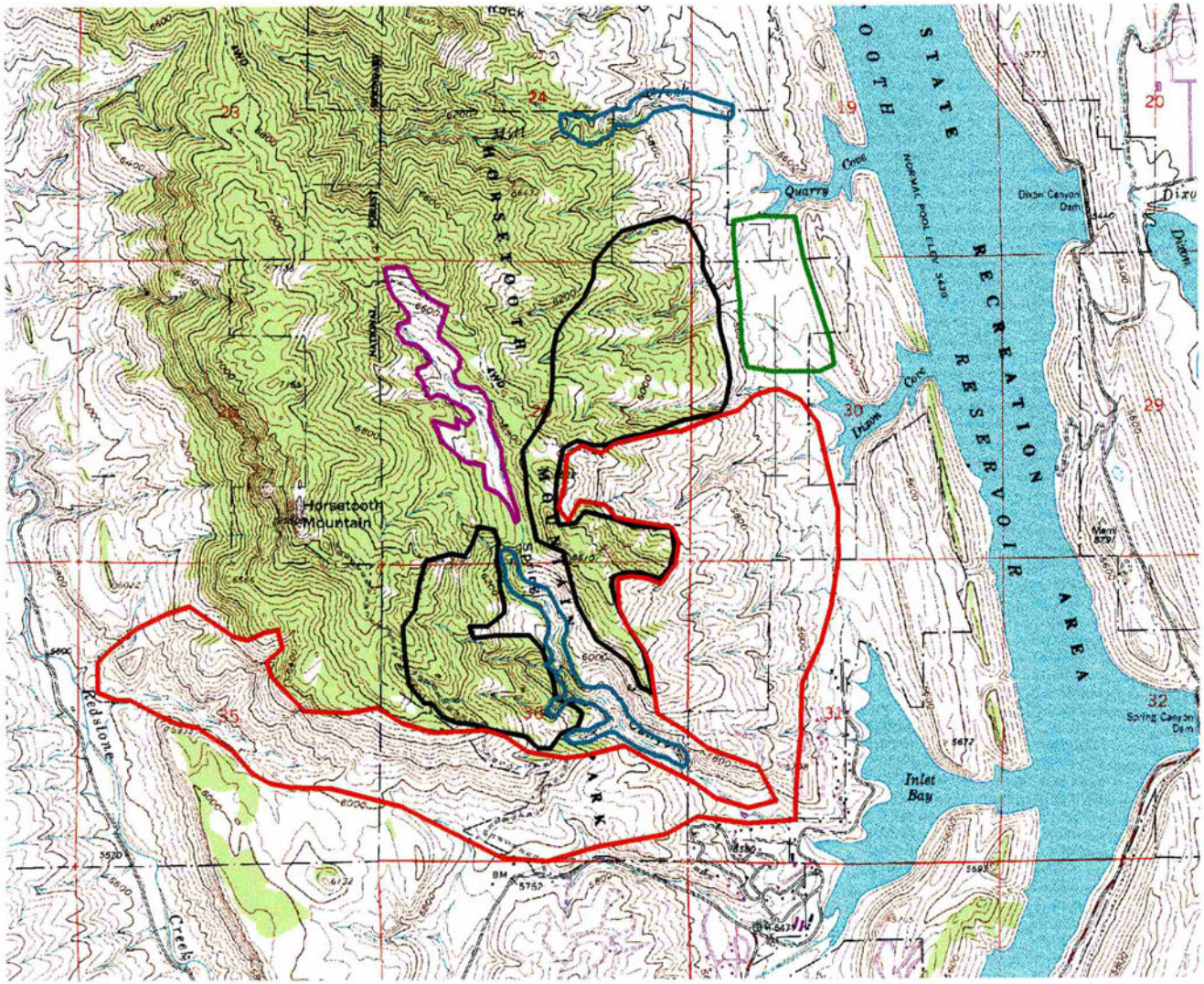
Area 3.
A large parcel of land between Dixon Cove and Quarry Cove had been planted to smooth brome in the past. As a result of the nearly complete dominance of the area by smooth brome the butterfly species of concern probably do not inhabit this area. Mowing, burning, and/or application of herbicides in consecutive years would probably have little impact on butterfly species of concern.

Area 4.
The ravines and gulches running east from the Park (e.g. Spring Canyon, Mill Creek) have been somewhat invaded by Canada thistle and musk thistle. Control of these species will allow native nectar plants such as horsemint and wavyleaf thistle to thrive and will benefit the imperiled butterfly that occurs in this habitat.

Area 5.
While not as obvious as the invasion of non-native species, the east facing slopes of the Park often have ponderosa pine invading grasslands and shrublands. This may be a relatively slow process but in the long-term may be impacting butterfly species by making the habitat unsuitable or eliminating plant species necessary for their life cycles.

Figure 5.

Priority Management Areas



Currently, butterfly species of concern are known to occur in areas 1 and 4.

Implementation Steps

In order to address the biological needs of, and provide potential benefits to the natural communities and imperiled butterflies, the priority of overall management steps are as follows:

1. Use prescribed burning and grazing to reduce the abundance of non-native species (concentrating on cheatgrass and Canada bluegrass) in the grassland and shrubland habitats (Priority Management Areas 1, 2, 3).

2. Use application of herbicides or physical removal to reduce the abundance of non-native species in gulches and ravines (concentrating on Canada thistle and musk thistle) (Priority Management Area 4).

3. Use prescribed burning and grazing to reduce fuel loads and reduce the risk of wildfire in grasslands and shrublands (Priority Management Areas 1, 2, 3).

4. Use prescribed burning and/or cutting to reduce the invasion of grasslands by ponderosa pine and mountain mahogany, and invasion shrublands by ponderosa pine (Priority Management Area 5).

5. Minimize new trail construction and reduce the extent of social trails in those areas identified as Priority Management Areas.

Specific implementation steps are provided below.

Prescribed Burning and/or Grazing

- Research specific growing seasons and rare butterfly host plants and critical time of use by the butterflies (see Table 3). Develop consolidated seasonal charts showing the relationship of growing season and butterfly use. This would be an excellent project for a CSU student.
- Inventory and map concentrations of butterfly host plants to determine the extent of current butterfly habitat.
- Inventory and map locations of invasions of non-native species (such as cheatgrass and Canada bluegrass) which would be the target of fall or early spring burning.
- With assistance from knowledgeable lepidopterists, develop a prescribed burning and/or grazing strategy that will control non-native species while considering growing season and times that the butterflies use specific host plants. Prescribed burns should be in sections of 30-40 acres or less.
- Implement prescribed burning and/or grazing strategies that consider the Priority Management Areas.
- Revegetate treated areas through planting or seeding with appropriate native seed

mixtures approved for the area. Consult with the Natural Resources Conservation Service or Colorado State University (CSU) to provide recommended seed mixtures.
- Engage volunteers such as CSU students, Volunteers for Outdoor Colorado, Student Conservation Association, and researchers to monitor the results of prescribed burns and/or grazing strategies.

Note that the development, implementation, and monitoring of results of prescribed burning or grazing that focuses on eliminating non-native species and enhancing rare butterfly populations would be an excellent research project for a CSU graduate student. This type of research would also be of interest to other land management agencies along the Colorado Front Range (such as Boulder and Jefferson County Open Space Departments).

Use of herbicides or physical removal of non-native species

- Map locations of non-native species such as Canada thistle and musk thistle.
- Develop an Integrated Pest Control Management Plan that will address the use of herbicides to control these species. A knowledgeable lepidopterist should be consulted to assure the plan would not adversely impact rare butterflies.
- Implement the Integrated Pest Control Management Plan. Care should be taken to avoid impacting native thistles.
- Revegetate treated areas through planting or seeding with appropriate native seed mixtures approved for the area. Consult with the Natural Resources Conservation Service or Colorado State University to provide recommended seed mixtures.
- Monitor results of treatments on an ongoing basis.
- Monitor the Park for future invasions of problematic non-native species and eradicate these species as soon as possible.
- Engage CSU researchers to implement monitoring programs to assess the effectiveness of management treatments.

Thinning of ponderosa pine within grassland and shrubland habitats

- Identify and map specific area where ponderosa pine is invading grassland and shrubland habitats.
- Coordinate thinning of ponderosa pine either through burning or cutting with the forest health management plan.

Reduction of social trails

- Identify specific social trails within the butterfly habitat and take steps to close these trails.
- Revegetate closed trails with the appropriate native seed mixtures.
- Post education signage explaining the purpose of the closure and providing information on the resources being protected.

General

- Continue regular surveys to determine the existence and locations of rare butterflies, butterfly host plants, and general butterfly habitat.
- Continue to survey for problematic non-native species on a regular basis.

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APPENDICES

Appendix A - Biodiversity and the Colorado Natural Heritage Program

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 Colorado for 14 years, the Program was relocated from the State Division of Parks and Outdoor Recreation to the University of Colorado Museum in 1992, and more recently to the College of Natural Resources at Colorado State University.

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

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

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

The Natural Heritage Network and Biodiversity

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

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

Recognizing that rare and specialist species are more likely to become extinct than common and generalist species, the Natural Heritage Methodology ranks species according to their rarity or degree of imperilment. The ranking system is scientifically based upon the number of known locations of the species as well as its biology. 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 prioritizing conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community began to realize that plant communities are as equally important as individual entities, this methodology has also been applied to ranking and preserving significant natural plant communities. By protecting and managing aggregate units, associated species that we do not track can be included and protected.

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

What is Biological Diversity?

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

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

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

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

3. **Community Diversity**. The variety of natural communities or ecosystems within that area. These communities may be diagnostic or even endemic to an area. It is within these ecosystems that all life dwells.

4. **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 may also 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 lost of biological diversity for a region. Humans and the results of their activities are integral parts of most landscapes.

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

The Natural Heritage Ranking System

Information is gathered by CNHP on Colorado's plants, animals, and natural communities. Each of these species and natural communities is considered an **element of natural diversity**, or simply an **element**. Each element is assigned a rank that indicates its relative degree of imperilment on a five-point scale (i.e., 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (i.e., the number of known distinct localities or populations). This factor is weighted more heavily because an element found in one place is more imperiled than

something found in twenty-one places. Other important factors are: size of the geographic range, number of individuals, trends in both population and distribution, identifiable threats, and number of already protected occurrences.

Element rarity ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State or S-rank) and the element's imperilment over its entire range (its Global or G-rank). Taken together, these two ranks give an instant picture of the degree of imperilment of an element. CNHP actively collects, maps, and electronically processes specific occurrence information for elements considered extremely imperiled to imperiled (S1 - S3). Those with a ranking of S3S4 are "watchlisted," meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. Watchlisted species are noted in the lists by an asterisk (*) next to the species name.

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 4, ranks followed by a "B" (i.e., S1B) indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N" (i.e., 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.

TABLE 4. DEFINITION OF COLORADO NATURAL HERITAGE IMPERILMENT RANKS

Global imperilment ranks are based on the range-wide status of a species. State rarity ranks are based on the status of a species in an individual state. State and Global ranks are denoted, respectively, with an "S"

G/S1	Critically imperiled globally/state because of rarity (five or fewer occurrences in the world/state; or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (six to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range.
G/S3	Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences).
G/S4	Apparently secure globally/state, though it might be quite rare in parts of its range, especially at the periphery.
G/S5	Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
GX	Presumed extinct.
G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but not verified for an extended period.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not permanent residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used
SZ	Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.
SA	Accidental in the state.
SR	Reported to occur in the state, but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

Note: Where two numbers appear in a state or global rank (e.g., S2S3), the actual rank of the element falls between the two numbers.

Appendix B - Site Profile

Horsetooth Reservoir Hogbacks Site Profile

Size: 9,000 acres.
(Note that the potential conservation site also includes land outside of Horsetooth Mountain Park and therefore may address additional species which are not known from the Park)

Biodiversity Rank: **B2** (Very high biodiversity significance)

Comments: The Horsetooth Reservoir Hogbacks site is an area of very high biodiversity significance. This site contains a concentration of good to fair quality occurrences of globally vulnerable to globally imperiled plants, animals, and plant communities. The Bell's twinpod (*Physaria bellii*) is found on sandstones with intermixed shales south of Horsetooth Reservoir. This occurrence is somewhat small, but is of interest because it is one of the few occurring on sandstone instead of the typical Niobrara shales.

The ponderosa pine/mountain mahogany/big bluestem (*Pinus ponderosa/Cercocarpus montanus/Andropogon gerardii*) foothills woodland is known only from the northern Colorado Front Range. Most occurrences have been destroyed or degraded by development, overgrazing, or mining. This site has been impacted to some extent by these activities and the occurrence is degraded, but probably still viable. The big bluestem-little bluestem (*Andropogon gerardii-Schizachyrium scoparium*) xeric tallgrass prairie has been documented only from the Colorado Front Range as well. Most occurrences are severely degraded. This occurrence is in fair condition and is relatively small, but is one of the best remaining in Larimer County. The mountain mahogany-skunkbrush/big bluestem (*Cercocarpus montanus-Rhus trilobata/Andropogon gerardii*) foothills shrubland has been documented from few locations. This plant community occurs in patches throughout the site near Horsetooth Reservoir. Although much of the area to the south of Horsetooth Reservoir was not ground checked, roadside observations indicate that this plant community is also extensive on hogback slopes there. The mountain mahogany/New Mexican feathergrass (*Cercocarpus montanus/Stipa neomexicana*) foothills shrubland is known only from Colorado and Wyoming. The occurrence as this site is relatively small.

This site includes such invertebrate species as the Ottoe skipper butterfly (*Hesperia ottoe*) and the Arogos skipper butterfly (*Atrytone arogos iowa*). These species are vulnerable to habitat disturbance and conversion, and have declined throughout their range. These species rely on the tallgrass prairie remnants that occur along the hogbacks of the Front Range, and are important ecological indicators of prairie remnant viability. This site also supports colonies of a globally rare butterfly, the hops azure (*Celastrina humulus*). This species is known to occur only on the Colorado Front Range from El Paso County north to Larimer County within canyon and ravine habitats. This is a good occurrence with consistent sightings since it was first documented at the site in the 1980's. Additionally, Schryver's elfin (*Callophrys mossii schryveri*) occupies similar habitat as the hops azure. It maintains a subspecific status and is only known from the Rocky Mountain Foothills in Colorado and southern Wyoming. The site also supports a good occurrence of the mottled duskywing skipper (*Erynnis martialis*), which is common

globally, but imperiled to vulnerable in Colorado. This species is found in shrubby habitats containing its hostplant buckbrush (*Ceanothus* sp.). These upper slope, somewhat xeric habitats are in relatively natural condition. The dusted skipper butterfly (*Atrytonopsis hianna*) is common globally, but rare to imperiled in Colorado. This species prefers very open pine woodlands and relies on big bluestem and little bluestem as hostplants for larval development. These four butterfly and skipper species (Ottoe, Arogos, mottled duskywing, and Schryver's elfin) have a disjunct species distribution in Colorado in relation to their overall North American distribution.

Several other elements are documented from the area, but precise locations are not known. These include: prairie goldenrod (*Solidago ptarmicoides* = *Unamia alba*), and the forktip three-awn grass (*Aristida basiramea*).

Protection Urgency: **P2** (Threats expected within five years)

Comments: Threats from expanding residential development, additional fragmentation through the building or widening of roads and trails, and increased recreational use are expected within five years.

Management Urgency: **M3** (New management action needed within five years)

Comments: Management of non-native plant species is needed in the future to maintain the current quality of element occurrences. Severe trail erosion within Horsetooth Mountain Park may call for trail closures, improved trail placement, and closely managed rehabilitation of closed trails. Areas of grassland that were formerly managed for livestock need concerted reclamation efforts to recover native grasses and flora, and to prevent the increase of the non-native flora into adjacent areas. The increased canopy due to higher tree density (attributed to fire suppression) may need to be mitigated through controlled burns, girdling of trees, or selective cutting.

Location: The Horsetooth Reservoir Hogbacks site is located in Larimer County, west of Fort Collins. It includes the area surrounding Horsetooth Reservoir, the hogbacks east and west of the reservoir, from the north end of the reservoir near Bellvue continuing south and terminating just north of the Devil's Backbone near Loveland.

Legal Description: Horsetooth Reservoir Quadrangle and Masonville Quadrangle:

Township and Range	Section
008N 069W	31
008N 070W	36
007N 069W	6,7,17,18,19,20,29,30
007N 070W	1,10,11,12,13,14,15,22,23,24
006N 069W	5,6,7,8,16,17,18,20
005N 069W	5,6
006N 070W	1,2

General Description: The elevation of this site ranges from 5430 feet at Horsetooth Dam to 7200 at Horsetooth Mountain (1655m to 2198m). This site occurs on the hogback ridges just east and west of Horsetooth Reservoir and on the ridges just

southwest of the Horsetooth Mountain, and continuing west to near the US Forest Service Boundary.

The key environmental factors in this area are precipitation, grazing, and probably fire, as the plant associations in this site reflect fire as one of the prominent ecological processes.

Within this site, the mean annual air temperature is about 42 to 46 degrees Fahrenheit (5.6 to 7.8C), and annual precipitation ranges from 13 to 18 inches (33 to 48cm).

Several geological formations are exposed on the hogbacks, mostly sandstone, or sandstone/limestone formations. Lower slopes are composed of faulted sedimentary substrates which give way to granitic formations as elevation increases. In some areas, the sandstone forms a "pavement" and the vegetation is confined to cracks in the rock.

The vegetation is dominated by mountain mahogany (*Cercocarpus montanus*) and small grassland openings with ponderosa pine (*Pinus ponderosa*) woodlands higher on the slopes. Some parts of the valleys between the hogbacks have undergone agricultural conversion to hay meadows or pastures, and are generally dominated by non-native species of grass.

Residential development has occurred at a rapid pace, houses have been built are built or are being built within the site. Some past mining and quarrying is evident. Numerous picnic grounds, recreational and social trails (hiking and cycling) exist both in the park and in the general area.

Historical Perspective: Historical Perspective: (Extrapolated from Hendon 1984). The known history of the area dates back as far as 10,000 BC. Indigenous peoples used the area as a hunting and gathering ground. Much archeological evidence exists from the Horsetooth and Lory Park areas, both in the forms of arrowhead artifacts, and teepee rings known to be extant on what was formerly known as the Soderberg Ranch. The foothills later were used intermittently by both the Apache and the Ute tribes; however, the area was predominantly Ute territory. According to one of their legends, Horsetooth Mountain is the body of a giant slain by a native warrior who slashed the giant's heart, now known as Horsetooth Rock. The death of the giant brought peace and tranquillity to the Valley of Contentment, now known as Spring Canyon.

European settlement into the area began as early as 1825, with the arrival of fur trappers and traders. Other European settlers arrived later with the discovery of nearby gold in 1858. By the 1870's, Horsetooth Mountain had become a popular area for recreation. During the 1880's, sandstone quarrying in Spring Canyon had created a demand for lumber which was harvested from the nearby mountain slopes. Land use practices later expanded to include livestock grazing, timber harvesting, quarrying, and farming.

During the early 1980's, it became apparent that increased and impending residential development was threatening the area now known as Horsetooth Mountain Park. In response to this threat, several concerned students from Colorado State University began a petition to purchase the Soderberg Ranch for a county park. Extending an existing one-cent sales tax for six months provided funding. The issue was place on the April 28, 1981 ballot and passed. By 1982, Larimer County came into ownership possession of Horsetooth Mountain Park. In the following years, the park has

acquired a trailhead with parking, picnic, restroom and drinking water facilities. The trailhead provides access to approximately 27 miles of trails that have been developed for recreation within the park.

Natural Heritage Resource Significance: Biological assessments of the Horsetooth Reservoir Hogbacks site were done extensively in 1996 by the Colorado Natural Heritage Program, with follow-up summaries done during the early spring of 1998 within Horsetooth Mountain Park. Based on the findings during these surveys, this site is considered to have very high significance in its biodiversity.

Elements of Interest within the Horsetooth Hogback Site:

Animals (Invertebrates)

Celastrina humulus	Hops azure	G2S2
Atrytone arogos	Arogos skipper	G3G4S2
Hesperia ottoe	Ottoe skipper	G3G4S2
Erynnis martialis	Mottled duskywing	G4S2S3
Callophrys mossii schryveri	Schryver's elfin	G4T3S2S3
Amblyscirtes simius	Simius roadside skipper	G4S3
Paratrytone snowi	Snow's skipper	G4S3
Stinga morrisoni *	Morrison's skipper	G4S3S4
Atrytonopsis hianna	Dusted skipper	G4G5S2
Archilestes grandis	Great spreadwing	G5S3
Polites origenes	Crossline skipper	G5S3

* = Watchlisted species

Animals (Vertebrates)

Sorex merriami	Merriam's shrew	G5S3

Plants

Physaria bellii	Bell's twinpod	G2S2
Carex saximontana	Rocky Mountain sedge	G5S1

Natural Communities/Plant Associations

Andropogon gerardii-Schizachyrium scoparium	Xeric tallgrass prairie	G2S2
Cercocarpus montanus -Rhus trilobata/Andropogon gerardii	Mixed foothill shrubland	G2G3S2S3
Cercocarpus montanus/Stipa neomexicana	Foothills shrubland	G2G3S2S3
Pinus ponderosa/Cercocarpus montanus/Andropogon gerardii	Foothills ponderosa pine woodland	G2S2

Current Status: Much of the land adjacent to Horsetooth Reservoir is owned by the public, but significant portions within the site are owned by private landowners. Several landowners in the area appear to be willing to work with the county. Horsetooth

Mountain Park is owned by Larimer County. Small parcels of private land occur southeast and southwest of the park.

Boundary Justification: The site includes most of the hogback complex east and west of the Horsetooth Reservoir, continuing south to the Devil's Backbone near Loveland. Most of the land south of Horsetooth Reservoir was not field surveyed, but roadsides surveys and aerial photo interpretation indicate that habitat similar to that supporting the known occurrences continues to the south. The boundary is intended to protect the community occurrences and habitat for the butterflies, several of which are dependent on remnant tallgrass prairies containing big bluestem and little bluestem for their life cycles. Host species of grass are present throughout the length of the hogbacks included in the site. Spring Canyon is included for the hop azure butterfly along with much of the mountain mahogany dominated slopes to the south which provides habitat for the mottled duskywing butterfly. These species are known to have very limited dispersal rates, so as much continuous habitat as possible is included for protection of these species.

Protection Consideration: Much of this land is very valuable for residential development, which is occurring at an alarming rate in this area. Numerous tracts have been developed and it may be necessary to protect any large parcels which are still intact. This site is somewhat isolated from other natural areas. Both residential development and agricultural conversion have altered lands surrounding the site. Protecting large tracts may help insure the viability of the site by allowing some natural ecological processes to function. Horsetooth Mountain Park is owned by Larimer County and managed as a park. Protection of the small, privately owned parcels abutting the southern park boundary would help insure the viability of the butterflies. Several of the owners have expressed interest in working with Larimer County Parks to preserve these areas.

Management Considerations: Recreation activities are common at the site, impact the land in many places, and may need to be managed in the future to avoid excessive disturbance of the habitat. Fire pits are common and many social trails have been created, contributing to the spread of non-native plant species. Current and future residential and recreational development may preclude natural fires (which may be an integral part of this ecosystem), fragment the landscape, and introduce domestic pets and garden flora into the area which can impact native wildlife and native floral populations.

Livestock grazing has been a prominent land use factor since European settlement. The valley bottoms in the site are degraded from years of heavy grazing and should be restored, if possible. Non-native or native weedy species are very common and dominant in some places. These species include cheatgrass, Japanese brome and smooth brome, crested wheatgrass, leafy spurge, dalmatian toadflax, and ragweed. Further increase of non-native species may decrease the biodiversity significance of the site by altering the native floral and faunal species compositions (Bock and Bock 1988).

Control of non-native species may also be necessary so that the hostplants and nectaring sources for the butterflies are able to compete and remain as an important component of the plant communities. Grazing or fire management could be used as tools to reduce the dominance of these species and increase the proportion of native species. With both of these tools, special attention would need to be given at the time of

implementation. Goals for management, especially species-specific goals, should be developed before a fire management plan is implemented. Disturbance from fires may provide the opportunity for non-native species to increase in dominance. Additionally, eastern tallgrass prairie which have been managed by frequent fires are known to have experienced a reduction butterfly diversity (Swengel and Swengel 1995). Burning all of the butterfly habitat in one year or frequent fires could potentially extirpate populations (Moffat and McPhillips 1993). We recommend that management goals be designed to include a mosaic of vegetation types as naturally connected as possible.

Additional Information Needs: Further field surveys may be necessary to document presence or absence of prairie goldenrod (*Solidago ptarmicoides* = *Unamia alba*), and the forktip three-awn grass (*Aristida basiramea*). These species are documented from the area, but their precise location is unknown. Knowledge of presence or absence, exact location, and habitat condition of these species may affect or augment any management plans designed for this site.

Ecological processes are not specifically understood for the Colorado Front Range; much literature exists for woodlands and for prairies, but these are treated as separate entities. The unique ecological processes that dominate the Colorado Front Range should be studied in depth.

Appendix C - Invertebrate Characterization Abstracts

This appendix will provide background information regarding those species of concern targeted for the Horsetooth Mountain Park. It may be useful to incorporate some of this information as management plans or actions are taken by open space personnel.

The characterization abstracts for each species known from Horsetooth Mountain Park and the surrounding area are given in taxonomic order. Each abstract gives information with respect to taxonomy, global and state distribution, habitat, phenologies, and management issues. These are intended to be a guide for basic information regarding these species. More detailed information can be found in Scott (1986) and Ferris and Brown (1981).

Invertebrate Characterization Abstract
Erynnis martialis
Mottled dusky wing

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Hesperiidae Genus: *Erynnis*

Taxonomic Comments: No subspecies are listed for this species (Miller and Brown 1981). The second phenotype of the Afranius duskywing (*Erynnis afranius*) is often mistaken for *E. martialis*; fortunately, the two almost never occupy the same habitat simultaneously (Ferris and Brown 1981).

CNHP Ranking: G4S2S3

Distribution: Global range: Eastern United States from Massachusetts and New York west across Ontario and the Great Lakes states to Minnesota and western Iowa, then south to Georgia, the Gulf states, and central Texas (Opler and Krizek 1984). West to eastern Nebraska, eastern Kansas, the Ozarks, and disjunct isolated populations in the eastern foothills of the Rocky Mountains in central Colorado, and in the Black Hills (Opler 1994, Stanford and Opler 1993, Opler and Krizek 1984, Ferris And Brown 1981). State range: Front Range foothills from to 3000m (8200 feet) (Ferris and Brown 1981). Reported from nine counties (Stanford and Opler 1993): Boulder, Clear Creek, Custer, Douglas, Fremont, Huerfano, Jefferson, Larimer, Pueblo.

Habitat Comments: The mottled duskywing colonies are closely associated with the distribution of buckbrush (*Ceanothus* sp.) This species is usually confined to hilly country, often near wooded areas or open shrubby areas with stands of mahogany (*Cercocarpus* sp.) and buckbrush (*Ceanothus* sp.) at an elevational range of 1371 to 3000m (4500 to 8200 feet) (Opler and Krizek 1984, Ferris and Brown 1981).

Phenology: ***Adult stage.*** The mottled duskywing adult flight occurs from April to mid-June along the Colorado Front Range. Adult males may be encountered on hilltops or along ridges during the daylight hours, either perched on the ground or on low vegetation to await females. ***Early stages.*** Eggs are laid on hostplant leaves, and the larvae live in leaf shelters. The mature larvae overwinters in a leaf shelter, and pupates with the following spring. Emergence of the adult follows in April to mid-June (Opler and Krizek 1984).

Larval Hostplants: The selected hostplant for this species is various types of wild lilac (*Ceanothus* sp.), including buckbrush (*Ceanothus fendleri*) and red root (*C. herbaceus*).

Adult Food Plants: The adults have been observed nectaring on the white flowers of the hostplant (Scott 1986).

Known Threats and Management Issues: Foothills habitats at risk of loss by anthropogenic alteration, including: fire suppression, habitat fragmentation, and agricultural and urban development.

Invertebrate Characterization Abstract
Stinga morrisoni
Morrison's skipper

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Hesperiidae Genus: *Stinga*

Taxonomic Comments: A monotypic genus.

CNHP Ranking: G4S3S4

Distribution: Global range: Along the Colorado Front Range from the Wyoming border south through Colorado, into New Mexico, Arizona, and Texas. State range: From Larimer County southward. Known from 15 counties in Colorado: Alamosa**,** Boulder, Clear Creek, Custer, Douglas, El Paso, Fremont, Gilpin, Huerfano, Jefferson, Larimer, Las Animas, Park, Saguache, Teller (Pineda and Ellingson 1998, Stanford and Opler 1993)..

Habitat Comments: This desert species of skipper occupies open pinyon and ponderosa pine foothills in the upper Sonoran, below 2926m (9600 feet) (Scott 1986), with a variety of grasses and flowers in the understory. Areas of encounter are open, sunny, often south-facing, and dry, and well-drained. The species appears to associate with habitat containing a substrate of crumbly granitic soils (R. Stanford personal communication).

Phenology: ***Adult stage.*** The adults of this species may be encountered from May through Mid-June in the Colorado Foothills (Scott 1986). It is usually uncommon in most years, but may be locally common during other years (Ferris and Brown 1981). The adult males will perch during the day on hilltops, usually next to shrubs or trees, to await females. ***Early stages.*** Very little documentation was found for the early stages of this species.

Larval Hostplant: The hostplant for this species is not well known; blue grama (*Bouteloua gracilis*) or little blue stem (*Schizachyrium scoparium*) is suspected by habitat association (Ferris and Brown 1981).

Adult Food Sources: Adults are known to sip mud for nourishment (Scott 1986).

Known Threats and Management Issues: Species' habitat is rapidly being developed from Colorado Springs to Fort Collins; low elevations along the Colorado Front Range Foothills are especially favored for development. Fire suppression, habitat fragmentation, and weedy invasions also affect quality of habitat. Historically threatened by logging.

Invertebrate Characterization Abstract
Hesperia ottoe
Ottoe Skipper

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Hesperiidae Genus: *Hesperia*

Taxonomic Comments: No subspecies reported (Miller and Brown 1981). Western populations of this species average paler in color on the upperside compared to more eastern populations, but this coloring can be variable (Scott 1986).

CNHP Ranking: G3S2

Distribution: Global range: Great Plains range extends from southern Manitoba south to northern Texas, and northeastward to the Great Lakes Regions (Scott 1984, Ferris and Brown 1981). State range: Base of the Front Range from El Paso County north to the Wyoming state line, and a few records from the eastern plains of Colorado. Apparently a Front Range disjunct restricted to mid- and tallgrass prairies. Known from nine counties in Colorado: Arapahoe, Boulder, Douglas, Elbert, El Paso, Jefferson, Larimer, Phillips, Yuma (Stanford and Opler 1993).

Habitat Comments: In Colorado, this species occupies mid- to tallgrass undisturbed prairies or high quality grazed prairie on the plains and Front Range foothills, especially hills and gentle slopes below 1920m in elevation (6300 feet) (Opler and Krizek 1984, Ferris and Brown 1981). It prefers to occupy open areas of grassland with favored nectar sources, and where the habitat supplies ample hostplant for larval reproduction. Areas containing disturbance or an abundance of exotic flora are avoided by this species (Scott 1986, Ferris and Brown 1981, Pyle 1981), except in gulch or low lying areas were exotic thistles provide nectar.

Phenology: ***Adult stage***. The Ottoe skipper has one brood per year, with adults flying from mid-June through early August, reaching peak abundance in early to mid-July (Sedman and Hess 1985, Opler and Krizek 1984). The adult males begin to emerge before the females. Emergence is extended over a two-week period in late-June through mid-July, with females offset by about a week. Life span for adults is about 19 days in nature. ***Early stages.*** The eggs are laid on or near the host grasses. The young larvae eat the leaves of the host, and live in tied-leaf nests near the base of the hostplant. The fourth or fifth-stage larvae hibernate until the following summer (Scott 1986).

Larval Hostplants: The preferred larval hostplants for the Ottoe skipper are big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and side oats grama (*Bouteloua curtipendula*) (Scott 1986).

Adult Food Plants: The Ottoe skipper relies on a mixture of summer blooming flowers to provide ample nectar as energy during their flight and mating season. Such favorites

include yellow prickly pear (*Opuntia* sp.), milkweeds (*Asclepias* sp.), coneflower (*Ratibida* sp. and *Rudbeckia* sp.), wavy-leaved thistle (*Cirsium undulatum*), and such exotics as alfalfa (*Medicago sativa*), musk thistle *(Carduus nutans*) and Canada thistle (*Cirsium arvense*) (Opler and Krizek 1984). The adult males often perch on these flowers or low plants during warm daylight hours when seeking mates (Dana 1981).

Known Threats and Management Issues: Declines are likely due to continued destruction of prairie habitat by conversion to cropland and urban developments. Additionally, along the Colorado Front Range, increased loss of its disjunct habitat may be attributed to increased tree density into former prairie habitat, due in part to fire suppression.

Invertebrate Characterization Abstract
Atrytone arogos iowa
Arogos skipper

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Hesperiidae Genus: *Atrytone*

Taxonomic Comments: Most authors recognize two subspecies: *arogos* formerly Atlantic and Gulf coastal plains from New York to Florida and Louisiana and *iowa* of the Great Plains, with subspecies *iowa* demonstrating reduced dark markings (Ferris and Brown 1981). Colorado populations are subspecies *iowa.*

CNHP Ranking: G3G4S2

Distribution: Global range: The Arogos skipper occupies a patchy range from Long Island south along the Piedmont and coastal plain to peninsular Florida and west along the Gulf to eastern Texas. A separate group of populations occurs on the prairies from southern Minnesota and adjacent Wisconsin west to eastern Wyoming and south to Missouri, Oklahoma, and northeastern Colorado (Opler and Krizek 1984). State range: Known only from northern lower Front Range and extreme northeastern Colorado in five counties (Stanford and Opler 1993): Arapahoe, Boulder, Jefferson, Larimer, Yuma.

Habitat Comments: The Arogos skipper is almost always found on relatively undisturbed sloping mixed- and tallgrass prairie meadows at a maximum elevation of 1890m (6200 feet) (Opler and Krizek 1984, Ferris and Brown 1981). During the its adult life span, it can be found flying simultaneously with the Ottoe skipper, as they occupy the same habitat (Ferris and Brown 1981). Often, these skippers may be found within gulches or low lying areas sipping mud, nectaring on flowers, or the males may be perched on tall grass blades or flowers awaiting females for courtship.

Phenology: ***Adult stage***. The Arogos skipper has a short flight with emergence of adults beginning in late-June through mid-July near the foothills, a week or two earlier eastward on the plains. Males perch on flowers and tall grass blades to await females, mainly in the afternoon when thunderclouds have developed. In sunny morning hours when most butterflies are active, Arogos skipper individuals are difficult to find except on flowers (Ferris and Brown 1981). ***Early stages***. Eggs are laid on the underside of the hostplant leaves; the larvae eat the leaves of the hostplant, and live in a tent made of two leaves at the base of the hostplants. They complete the fourth larval stage in the first season, hibernate, and complete larval development the following spring. Pupation follows, and the adult emerges in late-June through mid-July (Opler and Krizek 1984).

Larval Hostplant: The preferred larval hostplants for the Arogos skipper are: big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and possibly switch grass (*Panicum* sp.) (Scott 1986).

Adult Food Sources: The Arogos skipper relies on a variety of summer blooming composites which provide ample nectar as energy during their flight and mating season. Such favorites include: milkweeds (*Asclepias* sp.), dogbane (*Apocynum* sp.), coneflower (*Ratibida* sp. and *Rudbeckia* sp.), wavy-leaved thistle (*Cirsium undulatum*), horsemint (*Monarda fistulosa*) and such exotics as musk thistle *(Carduus nutans*) and Canada thistle (*Cirsium arvense*) (Opler and Krizek 1984).

Known Threats and Management Issues: Prairie habitats have been severely altered by agricultural conversion, urban development, fire suppression, and mismanagement of livestock grazing. These threats continue to impact prairie habitat fragments (Panzer 1988). Introduced grasses and other forbs, i.e., smooth brome (*Bromus inermis*), cheat grass (*Bromus tectorum*) and knapweed (*Centaurea* spp.) threaten to invade existing prairie habitats. Additionally, increased tree density negatively affects the quality of suitable habitat.

Invertebrate Characterization Abstract
Paratrytone snowi
Snow's skipper

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Hesperiidae Genus: *Paratrytone*

Taxonomic Comments: Burns (1992) moved *snowi* into the genus *Paratrytone* (from the genus *Ochlodes*) based on female and male genitalic characters. Rocky Mountain specimens are typical *snowi*; a subspecies with larger spots occurs in central Mexico (Ferris and Brown 1981).

CNHP Rank: G4S3

Distribution: Global range: Restricted to the central and southern Rocky Mountains south to Pueblo, Mexico, with records from Arizona, New Mexico, Colorado, southeast Wyoming, and two to six (taxonomic question) counties in Mexico (Stanford and Opler 1993, Ferris and Brown 1981). State range: Known from 19 counties in Colorado (Stanford and Opler 1993): Boulder, Chaffee, Conejos, Costilla, Custer, Douglas, El Paso, Gunnison, Hinsdale, Huerfano, Jefferson, Larimer, Las Animas, Mineral, Park, Pueblo, Rio Grande, Saguache, Teller.

Habitat Comments: This montane species inhabits upper Transition to Canadian Zone woodlands within an elevational range of 2072m to 2926m (6800 to 9600 feet). It inhabits the upper edge of ponderosa pine forest (Scott 1986) and riparian habitats in pine forests (Ferris and Brown 1981). In some areas of Colorado, this species is known to frequent wet montane meadows (Emmel et al. 1992). Along the Front Range, this skipper is usually encountered in gulches and ravine bottoms in sunny openings.

Phenology: ***Adult stage.*** The Snow's skipper adults fly from mid-July to early-August in most areas, usually during July in northern Colorado (Scott 1986). The males may be found perching all day in narrow dry gullies, or in open sunny areas within ravines to await females, and court there and elsewhere at flowers (Scott 1986). ***Early stages.*** Very little documentation was encountered with regards to the early stages of this species.

Larval Hostplant: The Snow's skipper has been observed to oviposit on the grass pine dropseed (*Blepharoneuron tricholepis*) (Scott 1986), and J. Scott observed attempted oviposition on mountain muhly (*Muhlenbergia montana*) in southern Colorado (Ferris and Brown 1981).

Adult Food Plants: The adult skippers have been observed nectaring on horsemint (*Monarda* spp. especially *fistulosa*) (Ferris and Brown 1981). Additionally, nectaring has been observed on exotic thistles occurring within the drainages, especially Canada thistle (*Cirsium arvense*). Often, an adult may be observed sipping mud in sunny openings.

Known Threats and Management Issues: This species prefers a high quality, open woodland. Preferred habitats are at risk due to deforestation for timber harvest, or increased tree density. Increased tree density may be attributed to a successional response to fire suppression; this may increase the threat of large scale fires, possibly destroying suitable habitat.

Invertebrate Characterization Abstract
***Amblyscirtes simius* - Simius roadside skipper**

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Hesperiidae Genus: *Amblyscirtes*

Taxonomic Comments: No subspecies reported for this species (Miller and Brown 1981). May belong in a separate genus because of mating habits and genitalic differences uncharacteristic for the genus *Amblyscirtes* (Scott 1986).

CNHP Rank: G4S3

Distribution: Global range: In shortgrass prairie, ranges from southern Saskatchewan south to Sonora, Mexico, through Montana, Wyoming, Colorado, Arizona, New Mexico, and Texas (Scott 1986, Ferris and Brown 1981). State range: Known from 10 counties in Colorado: Baca, Custer, El Paso**,** Fremont, Huerfano, Larimer, Otero, Pueblo, Rio Grande, Saguache (Stanford and Opler 1993).

Habitat Comments: The Simius roadside skipper occupies shortgrass and mixed-grass prairie and open pinyon-juniper or ponderosa pine woodland up to 2800m (9000 feet) (Scott 1986, Ferris and Brown 1981). This species occurs in hilly prairie, and there seems to be a correlation with shaley substrates (Stanford personal communication).

Phenology: ***Adult stage***: In the Rocky Mountain region, the flight period begins in late-May and continues through July, depending on elevation and latitude (Scott 1986, Ferris and Brown 1981). The adult stage occupies from five to seven days in nature, depending on the weather, and current moisture conditions. This species is usually uncommon, but may swarm briefly in wetter years (Ferris and Brown 1981). Males are usually active very early in the day. In sunny, calm weather, males perch on hilltops and small prairie prominence to await females, usually from 7: 30 to 10:30 in the morning (Scott 1986, Ferris and Brown 1981). ***Early stages***: The eggs are laid singly under the leaves of the hostplant (Scott 1986). Very little documentation was encountered regarding the early stages of this species.

Larval Hostplant: The known hostplant is blue grama (*Bouteloua gracilis*) (Scott 1986).

Adult Food Sources: Adults sip nectar of many flowers, including blue beardstongue (*Penstemon* sp.) (Scott 1986), possibly prickly pear cactus (*Opuntia* sp.) (Opler and Krizek 1984).

Known Threats and Management Issues: Existing threats include conversion of habitat for housing developments, mismanagement of grazing regimes, or agricultural use resulting in habitat fragmentation and reduction in good cover of hostplant.

Invertebrate Characterization Abstract
Callophrys mossii schryveri
Schryver's elfin

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Lycaenidae Genus: *Callophrys*

Taxonomic Comments: Formerly in the genus *Incisalia*. The *mossii* complex is separated from the *fotis* complex due to its preference for stonecrop (*Sedum* spp.) as a hostplant. Subspecies *schryveri* occurs in Colorado (Ferris and Brown 1981). *C. mossii schryveri* range is restricted to the Rocky Mountain region. Contrasts with species *C. mossii* in that it is smaller, has a lighter dorsal color in the male; and more contrasting ventral hindwing markings (Scott 1986).

CNHP Rank: G4T3S2S3

Distribution: Global range: The *mossii* complex is confined to the northwestern portion of the United States and southwestern Canada extending south to central California and to east-central Colorado (Stanford and Opler 1993, Ferris and Brown 1981). State range: Foothills and lower montane canyons between 1828 and 2438m (6000 to 8000 feet) (Ferris and Brown 1981). Known from nine counties in the Colorado Rocky Mountain region (Stanford and Opler 1993): Boulder, Clear Creek, Douglas, El Paso, Fremont, Gilpin, Jefferson, Larimer, and Pueblo.

Habitat Comments: This butterfly occupies suitable habitat in Transition to lower Canadian Zone wooded canyons containing the hostplant) within an elevational range of 1828 to 2438m (6000 to 8000 feet) (Scott 1986, Ferris and Brown 1981). Most often encountered in canyons with steep rocky slopes, mossy bare summits and ridges, and in foothill ravines and gulches within brushy hillsides and flats (Pyle 1981).

Phenology: ***Adult stage.*** Adults of this species fly from February to June depending on locality, elevation, and weather conditions (Pyle 1981). Schryver's elfin is one of the first non-hibernating butterflies to appear in the spring (Ferris and Brown 1981). The adults remain near to the hostplant, flying erratically and close to the ground, often in inaccessible areas. The adult males come to damp earth, perching on low shrubs or ground; the females are more reclusive and remain higher up on slopes (Pyle 1981). The adults are local, and disperse an average of only 50m for males and 52m for females over a lifetime (Scott 1986). Males perch all day on shrubs in gulches and on slopes to await females (Scott 1986). ***Early stages.*** The eggs are laid mostly on the underside of the hostplant leaves. The very young larvae eat only the leaves and older larvae prefer the later blooming flowers and subsequent fruits; the larvae do not build nests. Within the same season, a larva will complete its growth, the pupae will hibernate.

Larval Hostplant: The hostplant for those populations occupying the Colorado Front Range is stonecrop (*Sedum lanceolatum*).

Known Threats and Management Issues: The greatest current threats are extensive urbanization and alteration of habitat. Noxious exotic plants, recreational development and water development continue to threaten lower foothill canyons (even on public lands). The absence of fire and increased tree density may negatively impact hostplant.

Invertebrate Characterization Abstract
Celastrina humulus
Hop-feeding azure

Taxonomy:
Class: Insecta Order: Lepidoptera
Family: Lycaenidae Genus: *Celastrina*

Taxonomic Comments: A recently described species (Scott and Wright 1998), that is endemic to the Front Range of Colorado. Apparently there are two races occurring; one race is restricted to wild hops (*Humulus lupulus*) as a larval hostplant and the other to a lupine, *Lupinus argenteus*.

CNHP Rank: G2S2

Distribution: Global range: Known only from the Front Range of Colorado (Scott and Wright 1998). State range: Probably endemic to the Front Range of Colorado (Opler personal communication). Documented from eight Front Range counties in Colorado : Adams, Arapahoe, Boulder, Douglas, El Paso, Elbert, Jefferson, Larimer (Scott and Wright 1998, Stanford and Opler 1996, Ellingson et al. 1996, Stanford and Opler 1993).

Habitat Comments: Typical habitats are mountain canyons and valleys containing permanent water at a minimum elevation of 1615m (5300 feet) (Wright 1995, Fisher 1981). The colonies occur where the hostplant grows, usually at the edges of gulch bottoms, in sunny rocky/steep areas (Scott and Wright 1998).

Larval Hostplant: Most known colonies use wild hops (*Humulus lupulus*) as the larval hostplant; however, a smaller population west of Denver uses a the white variety of a lupine *(Lupinus argenteus*) as the larval hosplant. Wild hops are absent from these locations (Scott and Wright 1998).

Adult Food Sources: The adults of both sexes will visit various flowers, including the creamy flowers of waxflower (*Jamesia americana*). Males have often been observed sipping mud. A female was observed feeding on the honeydew of an aphid on the underside of prickly lettuce (*Lactuca serriola*).

Phenology: ***Adult stage.*** The *C. humulus* hop race flies during June, and may be common anytime during June depending on the year. Peak flight is most often during mid-June. The lupine race also flies during June. Males will patrol the hostplant all day to seek females. The adults are fairly local, preferring close proximity to the hostplant, and rarely fly farther than 100m from the host. ***Early stages***. Depending on the race, eggs are oviposited mostly onto the flower buds of the male hops plant, or on the flower buds of the white variety of the lupine. Maturing larvae eat the male flower buds of the hops hostplant, or the white lupine flowers; older hops race larvae are tended by ants. Pupation occurs in late summer, and the pupae hibernate (Scott and Wright 1998).

Known Threats and Management Issues: Extensive urbanization and alteration of habitat is a major threat. Noxious exotic plants, recreational development and water development also continue to threaten lower foothill canyons (even on public lands). Formal description may increase collecting pressure (Opler personal communication). Management should include control of noxious weeds and control tree density. Hostplant is an early-successional plant requiring open, sunny areas within canyon habitats. There is some concern that collection of the flowers (for beer brewing purposes) may affect larval food supply.

Appendix D - Specific Control Methods for Non-native Species

Smooth brome (*Bromus inermis)*

Smooth brome is common along the lower reaches of the park, especially along roads where it has been seeded for revegetation purposes. It is also common along the creek bottom in Spring Canyon, in open meadow along the upper reaches of Spring Creek Trail, and in what appears to be a planted meadow in the lowland between Dixon Cove and Quarry Cove.

This species often forms dense stands which reduce the diversity of native plant and animal populations. Smooth brome could be out-competing native species that are important components of the natural system and also plants required by native butterflies during some part of their life-cycle.

Numerous herbicides have been shown to be effective but control is difficult if native species are not available to re-colonize the site. Seeding success of native species within smooth brome patches has been low (Willson and Stubbendieck 1996), even with mowing, burning, and application of atrazine. The species is fairly tolerant of fire and reproduces by rhizomes. There is some evidence that repeated spring burning may allow native warm-season species to better compete. Mowing while smooth brome is in the boot stage (flowering head still enclosed within the sheath) may be one of the most effective means of control (TNC - ESA). Repeated mowing of fairly pure patches throughout the summer may help other species compete. Smooth brome patches at the Air Force Academy near Colorado Springs that were frequently mowed (along a bike trail) appeared to have native blue grama (*Bouteloua gracilis*) invading the patches (A. Ellingson - personal communication).

Japanese brome (*Bromus japonicus)*

Japanese brome was not positively documented in the Park, but surveys were done during the winter when identification would have been difficult. This species is usually present in the foothills and is known from nearby areas with similar habitat (S. Kettler personal observation).

Except in wet years fire tends to reduce Japanese brome, but the reduction typically lasts for only one or two years. Frequent fires help reduce litter accumulation and the success of this species, but use of this technique needs to be balanced with the desirable effects of litter buildup (FEIS 1998).

Cheatgrass (*Bromus tectorum)*

Cheatgrass is common in the mountain mahogany shrublands on the Park and is very dense on lower slopes and in ravines near the main entrance to the park. While some consider cheatgrass a minor impact on the plant communities on the Colorado Front Range, numerous studies have shown that areas invaded by non-native species have reduced populations of native species (both plant and animal) (Bedunah 1992, Bock and Bock 1988). This is an even greater concern in areas where sensitive species such as imperiled butterflies occur. Year to year changes in moisture seem to have an effect on

the abundance of cheatgrass. During some years it may appear to be very dense (moist spring) while in other years it may not (dry spring). Complete elimination of this species is probably not possible, but it may be possible to reduce its abundance and allow natives to more effectively compete. Cheatgrass competes with native species for water and negatively affects their water status and productivity (Melgoza et al., 1990). Warm-season grasses may be seriously impacted by cheatgrass, which in turn may impact butterfly populations dependent on these grasses.

Grazing, possibly in combination with fire, may help reduce cheatgrass. It may be difficult to accomplish, as spring is considered the ideal time to graze cheatgrass but several poisonous plant species known to occur in the Park are very toxic at this time (locoweed, larkspur) (personal communication with John Fusaro - NRCS). If abundance of the poisonous species is fairly low they may not be a problem for livestock.

A herbicide known as Plateau® can be used to control some broadleaf and grass weeds and is tolerated by many native warm-season grasses (although with some growth suppression). Boulder County has had some success with using Roundup® early in the spring (generally in March) when cheatgrass has some leaves developed. Timing would be critical as desirable species like western wheatgrass and needle-and-threadgrass green up shortly after cheatgrass and could be impacted by the herbicide. Atrazine applied a 1.1 kg/ha. over one year-old bitterbrush seedling controlled cheatgrass and promoted establishment of big sagebrush and bitterbrush seedling (citation in Rutledge and McLendon - no date). It is unknown if mountain mahogany would respond the same way.

There is little or no published literature and a variety of opinions on the effectiveness of prescribed fire as a control method for cheatgrass on the Colorado Front Range. Studies indicate that in the Great Basin control of this species may be almost impossible. Differences in climate between the Great Basin and the Great Plains, specifically between summer and winter precipitation, have been shown to strongly influence the flora (Cook and Irwin 1992) and may allow for different results on the Colorado Front Range. Rutledge and McLendon (no date) reported that prescribed burns early in the spring would kill seedlings and possibly reduce the seed bank but the remaining plants became more vigorous. Undoubtedly, the seed source for cheatgrass will be present for many years even with some removal of the plants themselves.

At The Nature Conservancy's (TNC) Phantom Canyon Preserve north of Fort Collins, spring burning is planned with the idea that it will reduce cheatgrass production and seedset (personal communication Terri Schulz - The Nature Conservancy). TNC, in consultation with Rangeland Ecosystem Science staff from Colorado State University, is also considering a fall burn which would be designed to kill cheatgrass seeds and reduce the litter layer thought to be important for cheatgrass germination. The goal is to increase the native species (which are still present at some level) competitiveness (personal communication Terri Schulz - The Nature Conservancy).

Boulder County has attempted to burn cheatgrass in April or early May, but moisture levels at that time in combination with matted down thatch have made it difficult to carry a fire. Other prescribed fires employed by Boulder County appear to have had reduced the abundance of cheatgrass (personal communication Cindy Owsley - Boulder County).

In general, control efforts may be difficult. Timing of spring grazing or burning may be critical as desirable cool-season grasses such as needle-and-threadgrass and western wheatgrass may be beginning development at approximately the same time and could be impacted by these activities. Needle-and-thread grass and other needlegrasses (*Stipa* spp.) can be heavily impacted by burning. As with other weedy species it seems important that desirable natives be established in the area so that the short-term reduced competition after a burn would allow native species to flourish. Burning in the same area during consecutive years could reduce cheatgrass, but could negatively impact butterfly communities. Burning followed by grazing or possibly herbiciding may allow some management and reduction of cheatgrass in multiple years while not negatively impacting the butterflies.

Musk thistle *(Carduus nutans)*

Mush thistle was observed in low abundance at the lower end of Spring Canyon (within the Park). Generally this species is not considered to be as threatening as others to native species because of low levels of infestation.

Fire and biological control alone are not effective in reducing the species. Manual cutting is labor intensive but can be effective. Spot control with herbicides may be effective but care should be taken to avoid other thistles. Grazing is not an effective method of control because livestock usually eat only the flowers (FEIS 1998, Northern Prairie Wildlife Research Center 1998, Rutledge and McLendon - no date, TNC 1995).

Diffuse knapweed (*Centaurea diffusa)*

While diffuse knapweed is not currently known to occur in the Park, the species is common in Boulder County in similar habitat. This species can be very difficult to control once populations are established. Control efforts are generally not effective unless native species are able to re-colonize the site. If the species does appear at the Park immediate control could help avoid the more costly control efforts associated with heavy invasion. CNHP would recommend that special efforts are undertaken to monitor for the presence of this species.

Fire probably only kills the tops of diffuse knapweed and is not suggested as an effective control method (FEIS 1998). Various herbicides are effective in controlling knapweed but also are harmful to non-target vegetation. Biological controls have been shown to be effective in various ways (Northern Prairie Wildlife Research Center 1998, Story 1992) but numerous insects may need to be used collectively to control the species (Rutledge and McLendon - no date).

Spotted knapweed (*Centaurea maculosa)*

While spotted knapweed is not currently known to occur in the Park, the species is common in Boulder County in similar habitat. This species has invaded and altered community composition even in areas not disturbed by livestock in Montana (Bedunah 1992). As with diffuse knapweed, this species can also be very difficult to control once populations are established. If the species does appear at the Park immediate control could help avoid the more costly control efforts associated with heavy invasion. CNHP recommends that special efforts be undertaken to monitor for the presence of this species.

Herbicides can be used to easily and effectively control spotted knapweed but may impact non-target species. Smaller infestations may be controlled by hand pulling (while wearing gloves!) or cutting after flowering but before seed set. This may be effective in drier climates because little moisture would be available for regrowth. Several insect species have shown promise in control efforts (Story 1992). Sheep have been used in Montana to reduce knapweed and release grasses from competition with some success (Rutledge and McLendon - no date). Fire alone may actually increase abundance of spotted knapweed but may be more effective when used in conjunction with herbicides (FEIS 1998). This species also has been documented to invade sites that have experienced wildfires in the last three to five years.

Canada thistle *(Cirsium arvense)*

Canada thistle was observed in low abundance along the creek bottoms in Spring Canyon. It is also common in patches with snowberry (*Symphoricarpos* sp.) in the valley bottom near Quarry Cove. This species is capable of invading and replacing native grasses and forbs, decreasing species diversity, and changing the structure and composition of some habitats. Canada thistle may produce allelopathic substances which inhibit the growth of other species in the area.

This species survives fire because of its extensive underground root system and may invade recently burned sites (FEIS 1998). Prescribed fire can be effective if done annually in late spring for several years (White et al. 1993). Burning for four consecutive years in the spring in Minnesota did reduce Canada thistle (FEIS 1998). Control will not be effective unless desirable plants are present to re-colonize the site (Northern Prairie Wildlife Research Center 1998). Mowing several times per season over several years has shown promising results. Several herbicides are effective in controlling the species and biological controls have been moderately successful (Northern Prairie Wildlife Research Center 1998). An introduced weevil has been effective in reducing overwintering survival of the plant (Story 1992). Research at Colorado State University indicates that control with herbicides is most effective when combined with cultural or mechanical methods (Rutledge and McLendon - no date). Several herbicides have been shown to be effective controlling the plant. Picloran destroys the root system, 2,4-D kills the above-ground parts of the plant, and glyphosate destroys the entire plant. If herbicides are used caution should be exercised to avoid native thistles which are often used by butterflies as nectar sources. Canada thistle is often restricted to areas where there is additional soil moisture such as stream bottoms or overflow areas. Other native thistles and nectaring plants (horsemint) for the butterflies grow in similar habitats.

Field bindweed (*Convolvulus arvensis*)

This species was not observed at the Park but it can be very difficult to control once established. Infestations should be controlled at the earliest possible time because of the plant's ability to regenerate from other plant parts (TNC 1988).

Mechanical control is not effective. Herbicides are effective but require high application rates and repeated applications that damage other plant populations (TNC 1988). Fire is not an effective control method because of the deep rhizomes and long term viability of seeds (FEIS 1998).

Leafy spurge (*Euphorbia esula)*

Leafy spurge is reported to occur in the Park and is common in nearby areas. Belcher and Wilson (1989) found that common native species abundance in Canada was negatively correlated with the abundance of leafy spurge. They also observed that most leafy spurge infestations were associated with areas that had been disturbed by human activities such as vehicle tracks, road construction, and fire guards. Avoiding soil disturbance may help reduce the chance of infestation by leafy spurge (White et al. 1993).

Several insects have been used to successfully reduce densities of leafy spurge (Story 1992, White et al. 1993). Some reports indicate that chemical control is difficult because of the extensive root system (Story 1992), while others indicate that chemical control is the best method for control of the species (TNC 1992). Adequate control is possible if invasions are treated in the early stage including herbiciding in association with prescribed burning (TNC 1992). Fall burning may be somewhat successful in controlling leafy spurge (FEIS 1998). Sheep grazing has been used effectively to control the species, but once grazing is stopped it is suspected that the spurge will return.

Toadflax *(Linaria dalmatica)*

Toadflax was observed along the service road near the main park entrance and has been observed to invade similar habitat in Boulder County.

Several herbicides are described as being effective in controlling the species (Rutledge and McLendon - no date). Other control methods do not appear to have been successful.

Kentucky bluegrass, Canada bluegrass *(Poa pratensis, Poa compressa)*

Some large patches of Canada bluegrass were observed at the southern end of the park, usually in grassland openings between mountain mahogany stands. This grass may be competing with native warm-season grasses which also occur in the area. Control of this species may favor help the warm-season grasses, reduce fuel loads, and be beneficial for many of the prairie butterflies.

Intensive early season grazing or other management that allows native warm-season species to flourish helps control Kentucky bluegrass (TNC 1987). Spring burning at the boot stage (with the flowering head still enclosed within the sheath) can reduce these species. Fires need to be timed precisely in some areas to avoid damage to desirable cool-season plants such as needle-and-threadgrass. In Kansas and Nebraska three consecutive years of spring burning are considered sufficient to convert from *Poa pratensis* to native warm-season grasses. Late spring burning may be the most effective control method although this may not be as effective in controlling *Poa compressa* as it is *Poa pratensis* (Rutledge and McLendon - no date). Spring grazing can have a similar effect but also needs to be monitored to avoid the impact to desirable cool-season plants. Herbicides, mowing, and biological controls are generally considered ineffective or not possible.

Appendix E - Community Characterization Abstracts

The following community characterization abstracts are for those imperiled plant communities (monitored by CNHP) which potentially occur in or near the Park.

Andropogon gerardii - Schizachyrium scoparium Herbaceous Vegetation

Common Name: Big bluestem - little bluestem xeric tallgrass prairie

Synonym: *Andropogon gerardii-Bouteloua curtipendula-Bouteloua gracilis-Schizachyrium scoparium* xeric tallgrass prairie

Range: This plant association occurs along the eastern foothills of the Rocky Mountains in Colorado and occasionally on basalt outcrops on the Great Plains in southeastern Colorado. Stands with similar dominant species are reported from the Ashland Division of the Custer National Forest in Montana (Taylor and Holst 1976), although similar types are not reported in the habitat type classification completed for the area by Hansen and Hoffman (1988). The relationship of these stands to the *Andropogon gerardii-Schizachyrium scoparium* plant association described here is not clear from the data presented in those reports.

Johnston (1987) includes similar grassland types from the Dakotas, Montana, Nebraska, and Kansas in his *Andropogon gerardii/Schizachyrium scoparium* plant association. In Colorado, this plant association lacks many of the midwestern plant species and also exhibits significantly different structural characteristics. For these reasons it is considered a different plant association from that described by Johnston.

Environmental Description: This association occurs at elevations between 5400 and 7600 feet. It is found along the margins or in openings of ponderosa pine (*Pinus ponderosa*) woodlands (Bichel 1959) and along steep "hogback" slopes in the foothills (Buckner 1994, CNHP 1996). It also occurs in flat meadows or on mesa tops extending onto the Great Plains (CNHP 1996, Robbins 1917, Branson et al. 1965). The occurrences in pine openings are relatively small, generally from 3-100 acres. The occurrences on mesas can be quite large - the occurrence at Rocky Flats covers nearly 2000 acres. Stands found on slopes, mesas, and ridges usually occur on soils that have rock and gravel in the upper profile. This may allow for quick infiltration of precipitation and more available soil moisture and nutrients when compared to adjacent finer textured soils (Branson et al. 1965). These coarse materials near the surface may act to reduce evaporation. Stands found in flat meadows and at the base of slopes usually occur on finer textured and deeper soils (Johnston 1987, Hanson and Dahl 1957, CNHP 1996). Lichen crusts on soils are reported from three sites (CNHP 1996, Branson et al. 1965).

Climate on the eastern mountain front of Colorado is strongly continental in character with sudden extreme changes possible at any time. Temperatures are warm in summer and cool in winter. Along the mountain front from Fort Collins to Colorado Springs

average annual precipitation ranges from 13 to 19 inches. On average, at least 60 percent of the precipitation falls during the growing season (May - September) (Doesken 1984).

Most Abundant Species: *Andropogon gerardii, Schizachyrium scoparium, Poa compressa, Liatris punctata*

Diagnostic Species: *Andropogon gerardii, Schizachyrium scoparium*

Vegetation Description: This is a grassland association dominated by the perennial bunch grasses, *Andropogon gerardii* (3-75%) and *Schizachyrium scoparium* (10-40%) (CNHP 1996). Other common graminoids include *Stipa comata*, *Sorghastrum nutans*, *Panicum virgatum, Muhlenbergia montana, Bouteloua curtipendula, B. gracilis*, and the exotic species *Poa compressa* (CNHP 1996). Other associated species commonly include the forbs *Heterotheca villosa, Liatris punctata, Thelesperma megapotamicum*, *Aster porteri*, *Psoralea tenuiflora*, *Eriogonum alatum*, *Artemisia ludoviciana*, and the dwarf shrub *Artemisia frigida* (CNHP 1996, Buckner 1994). Johnston (1987) includes similar grassland types from the Dakotas, Montana, Nebraska, and Kansas in his *Andropogon gerardii/Schizachyrium scoparium* plant association. While the dominant species in the Colorado association are similar to those in the midwestern and Great Plains association, the communities in Colorado lack many species common in midwestern tallgrass prairies and also exhibit significantly different structural characteristics.

The forb component of this plant association is very diverse but contributes a lesser amount of the vegetative cover than do the graminoids (Moir 1969, Mutel and Emerick 1984, Buckner 1994).

Exotic weeds are common in this plant association. *Bromus tectorum* and *Bromus japonicus* are common in most stands. Knapweed (*Centaurea*) species seem to be invading sites that are disturbed.

Conservation Rank: G2

Rank Justification: This plant association is documented by few occurrences, many of which are degraded by anthropogenic activities (gravel mining, overgrazing, urban development). Less than 4000 acres are documented. Historically, this association was thought to have been wide spread along the eastern Rocky Mountain front of Colorado. Much of the known habitat for this association has been surveyed.

Comments: Years of fire suppression have resulted in the spread of ponderosa pine stands (Branson et al. 1965), possibly occupying potential habitat for the *Andropogon gerardii-Schizachyrium scoparium* association. Overgrazing, mining, and urbanization have altered or destroyed many stands.

The Soil Conservation Service (SCS) reports that overgrazing by cattle on a plant community similar to the *Andropogon gerardii-Schizachyrium scoparium* association will result in reduction or elimination of *Andropogon gerardii*, *Sorghastrum nutans*, *Bouteloua curtipendula*, *Muhlenbergia montana*, and *Panicum virgatum* (SCS 1975, SCS 1984). This is especially true of summer grazing, which can heavily impact late season (C4) grasses. This association seems to have the ability to recover from moderate disturbance as evidenced by the grassland at Rocky Flats near Boulder, Colorado (CNHP 1996).

In Colorado this plant association is habitat for several state rare and at least one globally rare butterfly.

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Cercocarpus montanus-Rhus trilobata/Andropogon gerardii plant association

Common Name: Mountain mahogany-skunkbush/big bluestem shrubland

Range: This association occurs in large stands along the northern Front Range of Colorado, mainly in Larimer County but also in Boulder County. The NRCS range site descriptions suggest this association may occur south of Denver, but the dominance of *Quercus gambelii* in that region makes this suspect.

Environmental Description: This association occurs on rock outcrops on hogbacks from about 5000-7000 feet elevation. Parent material includes igneous and metamorphic racks and colluvium derived from these rocks. Most stands are on moderately steep slopes up to 20-30%. Soils are primarily shallow loams, and often have limited water-holding capacity. Up to 75% of the ground surface may consist of bare exposed rock and weathered debris.

Climate on the eastern mountain front of Colorado is strongly continental in character with sudden extreme changes possible at any time. Temperatures are warm in summer and cool in winter. Along the mountain front from Fort Collins to Colorado Springs average annual precipitation ranges from 13 to 19 inches. On average, at least 60 percent of the precipitation falls during the growing season (May - September) (Doesken 1984).

Most Abundant Species: *Cercocarpus montanus, Rhus trilobata, Andropogon gerardii*

Diagnostic Species: *Cercocarpus montanus, Rhus trilobata, Andropogon gerardii*

Vegetation Description: *Cercocarpus montanus* and *Rhus trilobata* are the dominant species. *Ribes cereum* and *Artemisia frigida* may be present..

Andropogon gerardii is the dominant herbaceous species. Other common species include *Bouteloua gracilis, Bouteloua curtipendula, Schizachyrium scoparium, Stipa scribneri, Muhlenbergia montana, Oryzopsis hymenoides, Koeleria macrantha, and Opuntia polyacantha.*.

Bromus inermis has also been observed to occur within stands along roads where it has been planted after roadwork. The Soil Conservation Service (SCS) reports that overgrazing by cattle will result in reduction or elimination of *Andropogon gerardii*, *Sorghastrum nutans*, *Bouteloua curtipendula*, *Muhlenbergia montana*, and *Panicum virgatum* (SCS 1975, SCS 1984) and increase species such as *Artemisia frigida* and *Opuntia polyacantha.*. This is especially true of summer grazing, which can heavily impact warm-season grasses.

Conservation Rank: G2G3

Rank Justification: This association has only been documented from a few occurrences along the Northern Front Range of Colorado, an area experiencing rapid development pressures which often impact this association.

Comments: This community often intergrades with other *Cercocarpus montanus* communities (*Cercocarpus montanus/Stipa comata, Cercocarpus montanus/Pseudoroegneria spicata* ((or *Elymus lanceolata X Pseudoroegneria spicata*)), *Cercocarpus montanus/Muhlenbergia montana, Cercocarpus montanus/Stipa scribneri)* or grasslands dominated by *Stipa comata, Bouteloua gracilis,* and *Pascopyrum smithii. Cercocarpus montanus* is known to provide winter browse for a variety of native ungulates and may provide habitat for birds.

Fire has probably been suppressed in most stands and would be expected to reduce the canopy cover of the *Cercocarpus montanus* but not totally eliminate it. *Cercocarpus montanus* will resprout following fire (FEIS 1998).

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Soil Conservation Service (SCS). 1984. Range Site Description for Shallow Foothill #204. Soil Conservation Service, Colorado.

Cercocarpus montanus/Stipa comata shrubland

Common Name: Mountain mahogany/needle and threadgrass shrubland

Range: This association occurs in large stands along the northern Front Range of Colorado (mainly Jefferson, Boulder, and Larimer counties), in small patches on the Chalk Bluffs along the Colorado-Wyoming line in Weld County, and on rock outcrops on the Comanche National Grassland in southeastern Colorado.

Environmental Description: This association occurs on rock outcrops of various geologic formations mainly from about 5000-7000 feet elevation. Parent material includes igneous and metamorphic racks and colluvium derived from these rocks. Most stands are on moderately steep slopes up to 20-30%, usually facing from east to south to west. Soils are primarily entisols (Ustorthents) with a shallow A horizon and coarse texture. Surface exposure of bare ground and rock and gravel may be 50%.

Climate on the eastern mountain front of Colorado is strongly continental in character with sudden extreme changes possible at any time. Temperatures are warm in summer and cool in winter. Along the mountain front from Fort Collins to Colorado Springs average annual precipitation ranges from 13 to 19 inches. On average, at least 60 percent of the precipitation falls during the growing season (May - September) (Doesken 1984).

Most Abundant Species: *Cercocarpus montanus, Stipa comata, Bouteloua gracilis, Artemisia frigida, Opuntia polyacantha*

Diagnostic Species: *Cercocarpus montanus, Stipa comata*

Vegetation Description: *Cercocarpus montanus* is the dominant species (around 25-40% canopy cover). *Rhus trilobata, Ribes cereum, Artemisia frigida,* and *Opuntia polyacantha* are common in low abundance.

Stipa comata dominates the understory in good condition stands (with 10-20% cover). *Bouteloua gracilis* is commonly present with 1-5% cover. Other species usually present but in low abundance are *Elymus lanceolata, Oryzopsis hymenoides, Helianthus pumilus, Heterotheca villosa* and *Eriogonum umbellatum.*

Disturbance from livestock grazing would likely reduce *Stipa comata* and increase species such as *Artemisia frigida*, *Opuntia polyacantha*, and *Bromus tectorum*. *Bromus tectorum* has also been observed to invade stands that are lightly grazed or ungrazed in some cases. This species has invaded this community throughout most of its range, probably seriously altering the plant community composition.

Other Noteworthy Species: *Helianthus pumilus*, *Eriogonum umbellatum*

Conservation Rank: G2

Rank Justification: Although numerous large stands exist, almost all are invaded to some extent invaded by *Bromus tectorum*, most very heavily. This is thought to

significantly alter community composition and ecological functions (Bock and Bock. 1988, Bedunah 1992)

Comments: This community often intergrades with other *Cercocarpus montanus* communities (*Cercocarpus montanus/Stipa comata, Cercocarpus montanus/Pseudoroegneria spicata* (or *Elymus lanceolata X Pseudoroegneria spicata*), *Cercocarpus montanus/Muhlenbergia montana, Cercocarpus montanus/Stipa scribneri)* or grasslands dominated by *Stipa comata, Bouteloua gracilis,* and *Pascopyrum smithii.* In northern Larimer County the *Cercocarpus montanus/Stipa comata* association often occurs on warmer slopes (generally south facing) while the *Cercocarpus montanus/ Elymus lanceolata* X *Pseudoroegneria spicata* community often occurs on cooler slopes (generally north facing). *Cercocarpus montanus* is known to provide winter browse for a variety of native ungulates and may provide habitat for birds.

Fire has probably been suppressed in most stands and would be expected to reduce the canopy cover of the *Cercocarpus montanus* but not totally eliminate it. *Cercocarpus montanus* will resprout following fire (FEIS 1998). Many stands invaded by *Bromus tectorum* could burn very hot because of increased fuel loads.

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Cercocarpus montanus/Stipa neomexicana shrubland

Common Name: mountain mahogany/New Mexico feathergrass shrubland

Range: This plant association is known from southeastern Wyoming on the Hartville Uplift, eastern Colorado from Larimer and Boulder counties, and from a few small patches in the Mesa de Maya area in Las Animas County.

Environmental Description: This association occurs on outcrops of various sedimentary geologic formations (Niobrara shale, Lykins sandstone, Fountain formation, others) from about 5000-7000 feet elevation. Most stands are on moderately steep east to south to west facing slopes up to 20-30%. Some occurrences are on nearly flat to shallow slopes where bedrock is exposed as a relatively flat "pavement." The exposure of the sedimentary rock seems to be an important factor in determining the distribution of this community. Other geologic outcrops at the same elevation and general aspects support *Cercocarpus montanus/Stipa comata* or *Cercocarpus montanus/Pseudoroegneria spicata* communities. Soils are shallow and often sandy. Suffice bedrock, boulders and cobbles predominate and cover approximately 50-75% of the surface.

Climate on the eastern mountain front of Colorado is strongly continental in character with sudden extreme changes possible at any time. Temperatures are warm in summer and cool in winter. Along the mountain front from Fort Collins, Colorado to Colorado Springs average annual precipitation ranges from 13 to 19 inches. On average, at least 60 percent of the precipitation falls during the growing season (May - September) (Doesken 1984).

Most Abundant Species: *Cercocarpus montanus, Rhus trilobata, Stipa neomexicana, Schizachyrium scoparium, Bouteloua curtipendula, Schizachyrium scoparium*

Diagnostic Species: *Cercocarpus montanus, Stipa neomexicana*

Vegetation Description: The vegetation in general is sometimes very sparse, mainly growing in cracks in the bedrock, to fairly dense on more moist aspects or deeper soils. *Cercocarpus montanus* is the dominant species but it may be sparse on steep, rocky slopes or shaley outcrops (around 10% canopy cover), and more abundant (around 25-35% canopy cover) on deeper soils and/or more moderate slopes or moist aspects. *Rhus trilobata* is often scattered throughout the stand but contributes little canopy cover. *Juniperus scopulorum* and *Pinus ponderosa* may be present in some stands in low abundance.

The understory may be very sparse on bedrock "pavement" to very dense on sites where soils are deeper. *Stipa neomexicana* is dominant to co-dominant (approximately 3-25%) in most stands in good condition. On red sands derived from Fountain Formation sandstones *Schizachyrium scoparium* and *Bouteloua curtipendula* may be dominant or co-dominant (approximately 5-20%), but *Stipa neomexicana* is present with at least moderate canopy cover. Numerous other grasses occur in most stands consistently but with low abundance (*Oryzopsis hymenoides, Stipa comata, Pseudoroegneria spicata (*or *Elymus lancelolata X Pseudoroegneria spicata), Aristida purpurea, Bouteloua gracilis).*

Numerous forbs are common but present in low abundance (*Hymenoxys acaulis, Paronychia jamesii, Eriogonum spp., Helianthus pumilus, Artemisia frigid, Opuntia polyacantha). Helianthus pumilus, Artemisia frigida,* and *Opuntia polyacantha* may increase with heavy grazing. Fire may reduce the abundance of *Opuntia* (Thomas 1991).

Exotic species do not seem to readily invade most stands, possibly because of the xeric nature of the sites, although *Bromus tectorum* and *Bromus japonicus* were common in one stand that was heavily grazed. *Linaria dalmatica* was observed to heavily invade nearby *Pinus ponderosa* stands on granitic soils but has not been found to invade this the *Cercocarpus montanus/Stipa neomexicana* community.

Other Noteworthy Species: *Schizachyrium scoparium* and *Bouteloua curtipendula* may be co-dominant with *Stipa neomexicana* on red sandstone outcrops of the Fountain Formation. *Muhlenbergia filiculmis* and *Muhlenbergia montana* are occasionally common and *Pinus ponderosa* and *Juniperus scopulorum* may be invading in the stands at higher elevations (near 7000 feet) and at the northern range of the community near Guernsey, Wyoming.

Conservation Rank: G2G3

Rank Justification: Ten to fifteen occurrences have been documented in Colorado with several more thought to exist. At least two or three stands occur in Wyoming. Known occurrences of this community are estimated to cover at least 10,000 acres. Most stands are not highly threatened by grazing activities as the forage is generally sparse and topography is steep in this community. Residential development may become more of a threat in the future in Larimer and Boulder counties, Colorado, as many of the sites are very scenic.

Comments: This community often intergrades with other *Cercocarpus montanus* communities (*Cercocarpus montanus/Stipa comata, Cercocarpus montanus/Pseudoroegneria spicata* ((or *Elymus lanceolata X Pseudoroegneria spicata*)), *Cercocarpus montanus/Muhlenbergia montana, Cercocarpus montanus/Stipa scribneri)* or grasslands dominated by *Stipa comata, Bouteloua gracilis,* and *Pascopyrum smithii. Cercocarpus montanus* is known to provide winter browse for a variety of native ungulates and may provide habitat for birds.

Fire has probably been suppressed in most stands and would be expected to reduce the canopy cover of the *Cercocarpus montanus* but not totally eliminate it. *Cercocarpus montanus* sprouts readily after fire (FEIS 1998). Fire would not be expected to carry through the entire stand in sparsely vegetated stands on bedrock pavements.

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Pinus ponderosa/Cercocarpus montanus/Andropogon gerardii sparse woodland

Common Name: Ponderosa pine/mountain mahogany/big bluestem sparse woodland

Range: This plant association has been documented from the foothills of the northern Front Range, north central Colorado, in Douglas, Jefferson, Larimer, Elbert, and Boulder Counties.

Environmental Description: This plant association occurs in the lower foothills of a mountainous region, on the east side of the Continental Divide in Colorado from approximately 5200 to 6900 feet. The region is characterized by a strongly continental climate, with hot summers and cold winters. In winter, cyclonic storms control the precipitation pattern, occasionally causing deep snows. These storms can occur during spring and fall months as well. In summer, convective rain showers contribute a large amount to the total annual precipitation and generate lightning which is a significant cause of forest fire. Annual precipitation averages 13 to 17 inches, 65% of which falls between May and September. Strong downslope winds can occur any time of the year, but are particularly prevalent in the late winter and spring.

This association is found from 5200 to 6900 feet elevation, on topographic features including hogbacks, ridges, mesas and slopes. Slopes vary from gentle to somewhat steep (up to 45%) and aspects are often easterly, except at the higher elevations, where they are southerly. It occupies the most xeric of the forested sites in the eastern Front Range, a zone between grass- and shrub-dominated vegetation at lower elevations and more densely forested in more mesic areas. Parent materials are primarily sandstones and conglomerates. Most soils are lithic orthents, where bedrock approaches the surface. They are poorly developed, well-drained, very rocky and/or gravely, loam or sandy loam in texture, and with much exposed surface rock. At lower elevations in the Front Range, soil texture and rocky sites are apparently the most important factors in the shift from grassland to vegetation dominated by woody species.

Most Abundant Species: *Pinus ponderosa, Cercocarpus montanus, Rhus trilobata, Opuntia polyacantha, Purshia tridentata, Andropogon gerardii, Stipa comata, Elymus lanceolatus* ssp. *albicans, Schizachyrium scoparium, Artemisia ludoviciana*

Characteristic Species: *Cercocarpus montanus, Andropogon gerardii*

Vegetation: This is an open, shrubby, woodland association. The evergreen, needle-leaved tree *Pinus ponderosa* forms an open tree layer (cover varying from 10% to over 30%) over an understory composed of broad-leaved deciduous shrubs, succulents, suffrutescents and graminoids. *Cercocarpus montanus* dominates the shrub layer, typically with cover values varying from 10% to over 40%, with *Rhus trilobata* always present in lower abundance. Succulent species such as *Opuntia polyacantha*, *Echinocereus viridiflorus*, and *Yucca glauca* are more important in this association than in other foothill woodlands of this region. Suffrutescent species are also common: the most

abundant include *Artemisia frigida*, *A. ludoviciana*, and *Eriogonum umbellatum*. The herbaceous layer is dominated by perennial grasses. *Andropogon gerardii* is always present, varying from 5% to 30% cover. Several other species can be abundant, including *Elymus lanceolatus* ssp *albicans, Schizachyrium scoparium*, *Stipa comata*, *Bouteloua hirsuta*, and *B. curtipendula*. Both perennial and annual forbs occur in the herbaceous layer in low abundance; some of the more important species include *Heterotheca villosa*, *Erigeron pumilis*, *Astragalus* spp., and *Penstemon* spp. Total herbaceous cover is high, usually over 30% and occasionally as high as 60%.

Other Species: Most sampled stands reviewed for this abstract had high cover of the introduced, weedy grass *Bromus tectorum*. This may be a result of cattle and sheep grazing and other physical disturbances (mining, road building, home development), which also results in lower abundance of native perennial grasses.

G Rank: G2

Rank Justification: This association occurs in a region near numerous large metropolitan areas, and is being impacted by housing subdivisions in the foothills. Additionally, much of the foothills region was heavily grazed by livestock (and still is in some locations), and disturbed by mining, road building, and home development, resulting in increased dominance of introduced and weedy species, a loss of the native bunchgrasses, and increased dominance of shrubs. *Cercocarpus montanus* can be severely impacted by sheep browsing, even eliminated in some cases.

Comments: This association occurs north of the *Quercus gambelii* chaparral found at the base of the foothills south of Denver. Many species are shared between these two types.

Episodic regeneration of *Pinus ponderosa* is characteristic of these chronically drought-stressed sites where there is limited potential for seedling establishment and growth (Peet 1981). Only in unusual years are both weather and seed production appropriate for abundant tree regeneration. Additionally, low intensity fires probably maintain an open, woodland character on these sites by causing tree seedling mortality. Most expert consider density of *Pinus ponderosa* to be higher than historical conditions as a result of fire suppression.

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