TABLE OF CONTENTS

PURPOSE OF AND NEED FOR ACTION

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

AFFECTED ENVIRONMENT

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

CONSULTATION AND COORDINATION

TABLE OF CONTENTS (Continued)

REFERENCES

GLOSSARY OF TERMS

INDEX

APPENDIXES

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

National Park Service
U.S. Department of the Interior

Final Environmental Impact Statement

December 2007

Elk and Vegetation Management Plan
Rocky Mountain National Park • Colorado

Cover art by David Dillon, Parsons

Final Environmental Impact Statement

Elk and Vegetation Management Plan

Rocky Mountain
National Park・Colorado

Summary

This Final Elk and Vegetation Management Plan/Environmental Impact Statement (plan/EIS) analyzes five alternatives to manage elk and vegetation within Rocky Mountain National Park in Colorado. The purpose of this plan/EIS is to guide management actions in Rocky Mountain National Park to reduce the impacts of elk on vegetation and restore, to the extent possible, the natural range of variability in the elk population and affected plant and animal communities.

Alternative 1 would continue to manage elk and the vegetative resources associated with elk as they are currently managed. No specific management actions would be taken to address the large population size and high densities of elk or the resultant adverse vegetative conditions and trends in aspen and willow communities on the winter elk range.

All action alternatives (Alternatives 2 through 5) would incorporate adaptive management and monitoring to determine the level and intensity of management actions including elk population reductions, fencing, herding, and aversive conditioning. Population numbers would be estimated annually and the number of animals to be removed would be determined based on the most current population estimates. If the elk population is within the defined portion of the range of natural variation and vegetation management objectives are being met, no lethal reduction activities would take place.

Alternative 2 would use NPS staff and authorized agents of the National Park Service in the park to remove elk using lethal means to reach a population target range at the lower end of the natural range of variation, between 1,200 and 1,700 elk (200 to 400 park subpopulation; 1,000 to 1,300 town subpopulation). Reduction targets would be aggressive removing 200 to 700 elk in the first four years to quickly reduce the size of the population, followed by less intensive yearly reductions of 25 to 150 elk each year for 16 years. Use of redistribution techniques and limited aspen fencing would also be required to meet vegetation objectives. Given appropriate interagency cooperation, redistribution techniques could include adaptive use of wolves as a management tool.

Alternative 3, the preferred alternative, would rely on gradual lethal reduction of elk over time by NPS staff and authorized agents of the National Park Service to achieve a high target elk population at the high end of the natural range of variation, between 1,600 and 2,100 animals (600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation). Inside the park, up to 200 elk would be removed annually over 20 years. Fertility control agents could be implemented as an adaptive management tool to control the population size if an effective, logistically feasible agent becomes available. The higher elk population target under this alternative would require additional measures, including aspen and montane riparian willow fences on both the primary summer and winter ranges and redistribution techniques, to meet vegetation objectives. Given appropriate interagency cooperation, redistribution techniques could include adaptive use of wolves as a management tool.

Alternative 4 would use fertility control agents on elk inside the park to achieve a target elk population at the higher end of the natural range of variation (1,600 to 2,100: 600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation). Lethal reduction of 80 to150 elk each year by NPS staff and authorized agents of the National Park Service would supplement fertility control. The higher elk population target under this alternative would require additional measures, including aspen fences on the primary winter

and summer ranges and montane riparian willow fences on the primary winter range and redistribution techniques, to meet vegetation objectives.

Alternative 5 would release a limited number of gray wolves in Rocky Mountain National Park to be intensively managed and allowed to increase to a maximum of 14 in a phased approach. Lethal reduction activities by NPS staff and authorized agents of the National Park Service would reduce the elk population to the higher end of the natural range of variation, 1,600 to 2,100 animals, in the first four years. Up to 100 elk would be lethally removed annually over the next 16 years to meet population targets. Later in the plan, the target elk population would be allowed to fluctuate within the natural range of variation between 1,200 to 2,100 elk, depending on wolves' effectiveness in redistributing elk. Wolf activity would be the primary redistribution tool. Wolves would be intensively monitored and their movements and activities restricted to the park. A limited amount of aspen fencing may also be required to meet vegetation objectives.

The potential environmental consequences of the actions are evaluated for each alternative, including impacts on natural resources, cultural resources, visitor use and experience, public health and safety, socioeconomic resources, and park operations.

Superintendent
Rocky Mountain National Park
Attn: Elk and Vegetation Management Plan
Estes Park, Colorado 80517

For further information about this document, write the above address or call 970-586-1206.

United States Department of the Interior • National Park Service • Rocky Mountain National Park

EXECUTIVE SUMMARY

This Final Elk and Vegetation Management Plan/Environmental Impact Statement (plan/EIS) analyzes a range of alternatives and management actions for elk and vegetation within Rocky Mountain National Park in Colorado. The analysis includes the elk population that primarily winters in the eastern part of the park and in the Estes Valley and primarily summers in the Kawuneeche Valley and alpine areas of the park and the vegetation resources on the elk's primary winter and summer ranges inside the park. This plan/EIS assesses the impacts that could result from continuation of the current management framework (alternative 1) or implementation of the four action alternatives.

Development of this plan/EIS involved the cooperation of multiple agencies at various levels of participation. The National Park Service is the lead agency and is responsible for all aspects of developing the plan and environmental impact statement, including selection of a preferred alternative and preparing a record of decision. This plan will be implemented by the National Park Service inside Rocky Mountain National Park. Cooperating agencies include the Town of Estes Park, the Estes Valley Recreation and Parks District, Colorado Division of Wildlife, Grand County, Larimer County, Town of Grand Lake, U.S. Bureau of Reclamation, and the U.S. Forest Service.

PURPOSE OF AND NEED FOR ACTION

This section explains what the plan/EIS would accomplish and why action is necessary at this time. Summaries of both the purpose and the need appear here, with more detailed information available in the "Background" section of this document.

The National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units. The Rocky Mountain National Park / Estes Valley elk population is larger, less migratory, and more concentrated than it would be under natural conditions. Elk heavily use the habitats in aspen and montane riparian willow communities, which support high levels of biodiversity; as a result, these communities may be declining in areas on the elk range where elk concentrate. The high concentrations of elk and levels of herbivory have degraded the vegetation in communities that support large numbers of bird, butterfly, and plant species in comparison to other habitat types in the park and in the Rocky Mountains (Connor 1993, Mueggler 1985, Simonson et al. 2001, Turchi et al. 1994).

NPS management policies (NPS 2006b) direct managers to strive to maintain the components and processes of naturally evolving park ecosystems. These policies also recognize that if biological or physical processes were altered in the past by human activities, they may need to be actively managed to restore them to a natural condition or to maintain the closest possible approximation of the natural condition. Natural conditions are defined as the condition of resources that would occur in the absence of human dominance over the landscape. Natural conditions occur when the components and processes of the natural system are intact. Natural change is recognized as an integral part of the functioning of natural systems; that is, resource conditions are not static, but fluctuate in response to natural processes, such as weather conditions. Recognizing such fluctuations, this document bases its descriptions and analysis on the natural range of variation in resource conditions. A key element in determining the need for action was the comparison between existing conditions and the estimates for the natural range of variation that would be expected under natural conditions.

Elk are a natural component of the Rocky Mountain National Park ecosystem and are expected to affect native vegetation communities that occur in the park. The natural range of variation for elk populations and associated vegetation conditions in the park were estimated based on research and ecosystem modeling specific to Rocky Mountain National Park, as well as related research and experiences in other locations.

Under natural conditions, the elk population size and distribution would be controlled by a number of factors, including predators such as wolves and grizzly bears, hunting by American Indians, and the presence of competitors such as bison. Ecosystem modeling predicted that the elk population under natural conditions, given the current amount of available habitat, would fluctuate between 1,200 and 2,100 elk (Coughenour 2002) with 200 to 800 in the subpopulation that winters inside the park and 1,000 to 1,300 in the subpopulation that winters outside the park. These subpopulations are referred to as the park and town subpopulations, respectively, throughout the text. With an intact predator base, elk would be less sedentary and more wary, resulting in lower concentrations of elk on the elk range. With elk less concentrated and less sedentary, montane riparian willow and aspen would be more abundant with increased stand size and complexity; that is, stands would have a variety of age classes and stems of differing sizes. Under natural conditions with suitable levels of montane riparian willow habitat available, beaver would be more abundant on the elk range and as a result, water levels on the primary elk winter and summer ranges would be higher, further encouraging the establishment and growth of willows. These natural conditions represent the overall desired future condition for elk and vegetation on the elk range, as presented in detail in the "Alternatives" chapter, and are what the National Park Service strives to achieve.

The purpose of this plan/EIS is to guide management actions in Rocky Mountain National Park to achieve these desired conditions by reducing the impacts of elk on vegetation and by restoring, to the extent possible, the natural range of variability in the elk population and affected plant communities. A successful plan would realize these purposes while providing continued elk viewing opportunities for visitors.

Although the overall desired elk population size and distribution could be achieved within the 20-year life of this plan, achieving the desired future conditions for aspen and montane riparian willow on the elk range would take longer. However, strides would be made toward reaching that overall goal.

Several features of the elk population are considered to be outside the natural range of variation, such as its density in some parts of the park (particularly in the core winter range), its overall size, and its behavior (Monello et al. 2005). The absence of an intact predator base is a key reason the elk population size, density and behavior is considered to be outside the natural range of variation. The gray wolf, which was extirpated from the Rocky Mountain National Park area before the park was established, represented a key component in the food chain and in defining the natural condition. Ecosystem simulation modeling indicates that fewer elk would likely be present if wolves lived in the Rocky Mountain National Park area (Coughenour 2002). Empirical evidence from areas with intact wolf populations, such as Yellowstone and Banff National Parks, indicates that elk would be more wary and less sedentary, resulting in lower densities. Grizzly bears, which were native to the park but also extirpated, would also probably contribute to reducing elk numbers; research shows that wolves more effectively limit elk populations in the presence of multiple predators (Gasaway et al. 1992 and Orians et al. 1997, cited in Monello et al.

2005). Other factors that likely contributed to a lower elk population under natural conditions are the effects of American Indian hunters and the presence of bison (reviewed in Monello et al. 2005). The prohibition of hunting inside the park and the town of Estes Park while adjacent areas outside the park are open to hunting has created a "sanctuary" that has contributed to the high elk concentrations and more sedentary behavior.

Elk are gregarious animals, meaning that they tend to form groups with other elk, unlike other wildlife species that are intolerant of high densities. Because elk can congregate in high densities, especially during the winter, an overabundant or over-concentrated population could have a large and detrimental effect on vegetation conditions, in particular aspen and montane riparian willow communities in the core winter range, and on the wildlife that depend on these areas as habitat (Monello et al. 2005). Such effects are becoming increasingly evident in the park.

The elk population reached a high point between 1997 and 2001, with annual estimates ranging from about 2,800 to 3,500 (Lubow et al. 2002). Since 2002, winter estimates in the park and Estes Valley area outside the park have declined, ranging from about 1,700 to 2,200. The dynamic nature of wildlife populations makes population estimates of a wide-ranging, mobile species such as elk variable. Because of these uncertainties, elk population size estimates in the research and in this document use ranges rather than exact numbers. However, the general ranges of population estimates reflect important trends relevant to the analyses of elk population effects on resources.

The elk population includes three subpopulations that exhibit different population dynamics and migration patters (Larkins 1997, Lubow et al. 2002): 1) Moraine Park / Beaver Meadows (referred to as Moraine Park), 2) Horseshoe Park, and 3) the Town of Estes Park. The Moraine Park and Horseshoe Park subpopulations exhibit the same population dynamics and will be collectively referred to here as the park subpopulation. The Town of Estes Park population exhibits different dynamics and is referred to as the town subpopulation.

The elk in the park subpopulation are estimated to be at the food-limited carrying capacity (Coughenour 2002, Singer et al. 2002). The food-limited carrying capacity is the average maximum number of elk that the primary winter range forage base can support (also referred to as ecological carrying capacity). Assuming existing habitat and continuation of weather patterns that occurred in the second half of the 20th century, the park subpopulation is expected to continue to fluctuate between 800 and 1,100 animals (Coughenour 2002). The town subpopulation is variously estimated to be at or below carrying capacity, based on different researchers' results (Coughenour 2002, Lubow et al. 2002). Population estimates for the town subpopulation from 2001 to 2005 have ranged between about 1,000 and 1,400 elk in the Estes Valley area.

If the elk population is at or within the carrying capacity of its habitat, it does not necessarily mean that the elk-to-habitat relationship is balanced or within the natural range of variation. Factors affected by humans such as elk distribution over time and area, a missing predator (i.e., gray wolf), and a refuge effect (i.e., no hunting in the park and in much of the Estes Valley) can have a large influence on habitat conditions even though the ecological carrying capacity may be adequate to support the elk population. Ecosystem simulation modeling indicates that with wolves present, the elk population was 15% to 40% below the food-limited carrying capacity (Coughenour 2002).

Elk densities are variable in the park, with high (76 to 170 elk/mile^2) to very high (171 to 285 elk/mile^2) concentrations on about 7% of the primary winter range, centered in Moraine Park / Beaver Meadows (Singer et al. 2002). The remainder of the primary winter range generally has moderate (26 to 75 elk/mile^2 on 11% of the primary winter range) to low (less than 26 elk/mile^2 on 82% of the primary winter range) densities (Singer et al. 2002). Although elk use lower-density areas of the primary winter range to rest or as they move between areas, most of their foraging time is highly concentrated on a small percentage of the primary winter range. Elk densities on core winter range areas greater than 260 elk/mile^2 are the highest concentrations ever documented for a free-ranging population in the Rocky Mountains (Monello et al. 2005, Singer et al. 2002). Evidence from various research conducted in the park indicates that the high densities of elk in specific areas on the core winter range are as significant as the total population size in terms of causing adverse impacts on vegetation.

Increased concentrations of elk could potentially increase the risk of spreading chronic wasting disease in the elk population. Chronic wasting disease is a transmissible spongioform encephalopathy that primarily occurs in free ranging deer and elk in northeastern Colorado and southeastern Wyoming (Miller et al. 2000). Elk and deer in the park have tested positive for this disease. Based on modeling predictions, chronic wasting disease has the potential to severely affect deer populations (Miller et al. 2000, Gross and Miller 2001).

The elk population, over the years, has also become less migratory, with 10% to 15% of the elk remaining on the primary winter range during the summer. Under natural conditions, all of the elk in the population would seasonally migrate from the primary winter range to the primary summer range. These non-migratory elk can severely inhibit the growth of plants as high levels of herbivory are taking place during the growing season (Augustine and McNaughton 1998).

Changes in migration patterns have also resulted in increasing numbers of elk that spend the entire year on what traditionally was only winter range in both the park and town areas. Over the years, more elk are calving near areas where the public recreates in the Estes Valley, which increases the risk of human-elk conflicts. In addition, increased concentrations of elk in developed areas inside and outside the park also increase the potential for human-elk conflict as elk become more habituated and less fearful of humans. This may result in increased safety risks and property damage.

Research consistently indicates that a continuation of the high elk densities in Rocky Mountain National Park would result in the complete loss of aspen trees or, at best, existence in a shrub-like state on core winter range areas (W. L. Baker et al. 1997, Olmsted 1997, Suzuki et al. 1999, Coughenour 2002, Weisberg and Coughenour 2003). Elk browsing currently stunts the growth or kills all young aspen trees (i.e., less than 8 feet in height, also called suckers or shoots) on the core elk winter range and in some parts of the Kawuneeche Valley (W. L. Baker et al. 1997; Olmsted 1979, 1997). Accordingly, aspen regeneration is suppressed, resulting in overmature, deteriorating aspen stands with no small or mid-size trees. These stands will likely be permanently lost if the current level of elk herbivory continues, although it is difficult to predict when this would happen.

Elk are severely inhibiting the ability of montane riparian willow to reproduce, as few willow plants on the primary winter range produce seed, and seedling survival is almost non-existent (Cooper et al. 2003). Elk are also suppressing the growth of willow plants, so that few plants can attain a height greater than the herbaceous layer, which is the layer of non-woody plants such as grasses, forbs, and herbs (Peinetti et al. 2002, Zeigenfuss et al. 2002). Willow is the dominant woody shrub on almost all wet meadow or riparian areas in Rocky Mountain National Park. It is an important food source for elk (Hobbs et al. 1981, Singer et al. 2002) and provides wildlife habitat for a large number of bird, butterfly, and plant species (Connor 1993, Simonson et al. 2001). Elk herbivory has contributed to a transition of tall willow areas to short willow areas over the last 60 years in Moraine Park and Horseshoe Park (Peinetti et al. 2002, Zeigenfuss et al. 2002, B. W. Baker et al. 2005). Declines in montane riparian willow over the last 50 to 60 years are attributed to various factors, but the current condition and trend of montane riparian willow communities is primarily due to the effects of elk.

Another factor contributing to the decline in montane riparian willow on the elk range is a decrease in surface water, which is believed to be a consequence of reduced beaver activity. Beaver are a critical component of the primary winter range in the park. Under natural conditions, they would be present in higher numbers; currently very few beaver are found on the elk primary winter range. In 1939 and 1940, it was estimated that more than 300 beavers occupied Moraine Park (Packard 1947). Since then, beaver on the primary winter range have declined by more than 90%, with a resultant decline of surface water in the area by nearly 70%, which has led to a decline in montane riparian willow (Packard 1947, Peinetti et al. 2002, Zeigenfuss et al. 2002). The lack of beaver is accelerating montane riparian willow declines by inhibiting the development of appropriate sites for willow seedling establishment and limiting recharge of the shallow aquifers in Moraine Park and Horseshoe Park (Cooper et al. 2003). Recovery of beaver on the primary winter range is unlikely, as suitable habitat for beaver is currently lacking there due to the poor condition of the montane riparian willow communities (B.W. Baker et al. 2005).

Elk consumption at extremely high rates may result in the alteration of herbaceous plant communities on the elk range. Annual herbaceous consumption rates in montane riparian willow and upland shrub communities on the primary winter range have occurred at a high level, on average 55% to 60%, respectively. The majority of offtake in willow and upland areas occurred during the summer and winter periods, respectively (Singer et al. 2002). Herbaceous plants in willow communities may be particularly vulnerable because the majority of grazing occurs during the growing season (Augustine and McNaughton 1998).

Objectives

Objectives are specific statements of purpose that describe what should be accomplished, to a large degree, for the plan to be considered a success. Development of the objectives was done with legal and regulatory mandates in mind and with an awareness of the complexity of relationships between the numerous species, ecosystems, and ecological processes that future management actions would affect. The objectives for the Rocky Mountain National Park elk and vegetation management plan are to

1. Restore and/or maintain the elk population to what would be expected under natural conditions to the extent possible.

    Maintain a free-roaming elk population.

    Decrease the level of habituation to humans exhibited by elk.

    Restore the elk population size to a level allowing it to fluctuate within the natural range of variation, between 1,200 and 2,100 elk with 200 to 800 wintering inside the park and 1,000 to 1,300 outside the park.

    Redistribute elk to disperse high densities of elk.

2. Restore and/or maintain the natural range of variation in vegetation conditions on the elk range, to the extent possible.

    Prevent loss of aspen clones within high elk use areas.

    Restore and maintain sustainable montane riparian willow.

Increase montane riparian willow cover within suitable willow habitat on the primary winter range.

Maintain or improve the condition of riparian and upland willow on the primary summer range.

Reduce the level of elk grazing on herbaceous vegetation.

3. Opportunistically collect information to understand chronic wasting disease prevalence in the park within the framework of the alternative.
4. Ensure that strategies and objectives of this plan/EIS do not conflict with those of chronic wasting disease management.
5. Continue to provide elk viewing opportunities.
6. Recognize the natural, social, cultural, and economic significance of the elk population.

IMPACT TOPICS ANALYZED

Individual impact topics, or subject resources, were analyzed in this environmental impact statement to determine the potential effects that would occur as a result of implementation of any one, or a combination of, the alternatives presented in this elk and vegetation management plan. The impact topics and the rationale for fully evaluating the particular topic are presented below.

Elk population: Retained as one of the primary resources to be managed by this plan.

Endangered or threatened species and critical habitats: Retained because actions taken by the plan could have effects on several listed species and on compliance with the Endangered Species Act.

Soils: Retained because of the impacts that existing elk populations have on soils in areas where elk congregate in high densities.

Natural soundscape: Retained because it could be affected by several of the potential management tools that could be used to manage the elk population. These include, but are not limited to, shooting and the use of vehicles and aircraft.

Vegetation: Retained as one of the primary resources to be managed by this plan. This impact topic will include analyses of effects on wetland vegetation.

Water resources: Retained because of the relationships between vegetation (especially willow), water resources, wetlands, and elk in the park's winter range. Wetland issues associated with hydrology will be addressed in this section.

Wetlands: Although this topic was retained because much preferred elk habitat is in riparian willow wetlands in the eastern portion of the park and the Kawuneeche Valley, wetlands were not addressed as a stand-alone impact topic. The hydrologic and vegetative wetland components and issues are fully evaluated in the "Water Resources" and "Vegetation" sections, respectively.

Wildlife: Retained for the potential of the plan to affect other species of wildlife and their habitats.

Wilderness: Retained because of the potential for management actions to affect designated and recommended wilderness in the park.

Socioeconomics: Retained because elk viewing contributes substantially to the Estes Park economy. Changes in the elk herd's size, location, or behavior could affect these factors.

Park operations: Retained because the implementation of management actions in association with this plan would require changes in how the park is operated.

Public health and safety: Retained because of concerns associated with elements of the alternatives such use of firearms, and the consumption of elk meat.

Visitor use and experience: Retained because elk are integral to the expectations and activities of visitors to the park. The actions implemented by the plan could affect how visitors would use and experience the park.

PURPOSE AND SIGNIFICANCE OF ROCKY MOUNTAIN NATIONAL PARK

National park system units are established by Congress to fulfill specific purposes, based on the unit's unique and "significant" resources. A unit's purpose, as established by Congress, is the foundation on which later management decisions are based to conserve resources while providing "for the enjoyment of future generations."

Establishment

Congress established Rocky Mountain National Park on January 26, 1915. The enabling legislation states:

> said area is dedicated and set apart as a public park for the benefit and enjoyment of people of the United States…with regulations being primarily aimed at the freest use of the said park for recreation purposes by the public and for the preservation of the natural conditions and scenic beauties thereof. (38 Stat. 798)

Significance of Rocky Mountain National Park

The significance of Rocky Mountain National Park and its broad mission goals are derived from its enabling legislation and are summarized in the park's strategic plan (NPS 2005j).

As stated in excerpts from the park's 2005-2008 strategic plan (NPS 2005j) that are relevant to the management of elk and vegetation, Rocky Mountain National Park is significant because

> Rocky Mountain National Park provides exceptional accessibility to a wild landscape with dramatic scenery, opportunities for solitude and tranquility, wildlife viewing, and a variety of recreational opportunities.
>
> The fragile alpine tundra encompasses one third of the park and is one of the main scenic and scientific features for which the park was established. This is one of the largest examples of alpine tundra ecosystems preserved in the national park system in the lower 48 states.
>
> The park, which straddles the Continental Divide, preserves some of the finest examples of physiographic, biologic, and scenic features of the Southern Rocky Mountains. The park contains the headwaters of several river systems, including the Colorado River. Geologic processes, including glaciation, have resulted in varied and dramatic landscape. Elevations span from 7,630 feet to 14,259 feet atop Longs Peak, a landmark feature.

> The park's varied elevations encompass diverse ecosystems where wilderness qualities dominate. Varied plant and animal communities and a variety of ecological processes prevail.

In October 1976, Rocky Mountain National Park was recognized as an International Biosphere Reserve. This recognition highlights the significance of the park's natural ecosystems, which represent the Rocky Mountain Biogeographic Province. As an element of the Biosphere Reserve, Rocky Mountain National Park is part of a network of protected samples of the world's major ecosystem types, devoted to conservation of nature and genetic material and to scientific research in service of man.

During the winter months, visitors can enjoy the spectacular landscape while snowshoeing or cross-country skiing. Summer activities at the park include hiking, camping, climbing, fishing, horseback riding, bird watching, and mountaineering. Wildlife viewing is an important activity at the park during all seasons, with the large population of resident elk drawing many visitors.

ALTERNATIVES

This environmental impact statement evaluates five alternatives that could be implemented to manage elk and vegetation in Rocky Mountain National Park. All actions defined in the alternatives would be carried out within the boundaries of the park. The four action alternatives involve the following elements in common:

1. **Population numbers**. All action alternatives are designed to maintain a viable elk population within the natural range of variation as determined from park specific research and ecosystem simulation modeling. Each action alternative would maintain the population between 1,200 and 2,100 elk with 200 to 800 wintering inside the park and 1,000 to 1,300 outside the park; however, they vary in defining where within this range the population would fluctuate, such as the high or low end. The alternatives also vary in the time it would take to achieve the population target.
2. **Vegetation management**. Once aspen and montane riparian willow on the elk range are adequately protected from elk herbivory, vegetation restoration methods would be employed as needed to facilitate faster regeneration of aspen and willow. These methods include prescribed fire, mechanical thinning of vegetation and debris, planting willow cuttings, and reintroduction of beaver if natural recolonization is not occurring.
3. **Adaptive management**. The action alternatives would incorporate the principle of adaptive management using monitoring and evaluation to determine if management actions were achieving objectives and adjusting actions accordingly.
4. **Monitoring and data collection**. The action alternatives would incorporate a monitoring and evaluation program. The monitoring program would consist of collecting data, summarizing data into useful information, and interpreting the data to advance manager's understanding and knowledge for improved decision-making. The National Park Service or contractors would collect monitoring data regarding elk population size, composition, and distribution; vegetative structure, regeneration, and cover; beaver populations; natural wolf recolonization; and visitor response to management actions. In addition to other federal contracting requirements, for the purposes of implementing this plan, a contractor is a fully-insured business entity, nonprofit group, or other government agency engaged in wildlife management activities that include trapping, immobilization and lethal removal, chemical euthanasia, and monitoring. The contractor must possess all necessary permits.

5. **Humane treatment**. All action alternatives involve the direct management of individual animals, ranging from remote delivery of control agents to live capture and lethal removal. These management activities would be conducted in a manner that minimizes stress, pain, and suffering.
6. **Distribution of carcasses**. To the extent possible the National Park Service would donate carcasses and/or meat from elk in which chronic wasting disease is not detected and that were not killed using sedative agents or euthanasia drugs through an organized program to eligible recipients, including members of tribes, based on informed consent and pursuant to applicable public health guidelines. The National Park Service would identify interested organizations, agencies, and /or tribes with whom to partner in a meat donation program in order to defer the high cost of processing and packaging the meat. All adult elk carcasses would be tested for chronic wasting disease. All other carcasses would be disposed of in accordance with federal and state policies.
7. **Wilderness**. All action alternatives would involve management activities in designated or recommended wilderness areas within the park. As such, in accordance with the Wilderness Act and NPS policies, the National Park Service is required to complete a minimum requirement and minimum tool analysis before taking management actions.
8. **Research Study**. Within the framework of an action alternative, the National Park Service would opportunistically conduct a study to evaluate procedures for testing for chronic wasting disease in live elk and the effectiveness of a multi-year fertility control agent in wild, free-ranging elk.
9. **Education**. The National Park Service would establish a long-term public education program to inform the public about the selected alternative and results.

The following alternatives are proposed for managing elk and vegetation in Rocky Mountain National Park:

Alternative 1

This alternative would continue the existing management framework. Under this alternative, no new management actions would be applied. This alternative assumes that the existing management decisions, without any new criteria or factors, would continue. Since NPS lethal reduction was discontinued in 1968, there has been no active management of elk within the park. The elk population size in the park under this alternative would be regulated primarily by forage availability and weather conditions, and outside the park it would continue to be additionally regulated by hunter harvests. Under this alternative, ecosystem modeling predicts that the elk population would continue to fluctuate within 2,200 and 3,100 animals. The population size could rise above or drop below this range due to variables such as weather, emigration, or immigration of elk either permanently or temporarily. In addition, elk would continue to concentrate at high densities in localized areas of the elk range and would continue to be less migratory. No formal vegetation resource management program in the park to address elk-caused effects on vegetative cover, and dominant plant species composition on the elk range would be developed.

Alternative 2

This alternative would involve the lethal removal (culling) of elk by NPS staff and authorized agents of the National Park Service (see Appendix H for further discussion of culling and authorized agents) to reach and maintain an elk population size at the lower end of the natural range of variation (1,200 to 1,700 total elk: 200 to 400 park subpopulation; 1,000 to 1,300 town subpopulation). In the first four years of the plan, between 200 and 700 elk would be lethally removed annually inside the park to bring the population to the target size. To maintain the target population range, 25 to 150 elk would be removed annually over the remaining 16 years of the plan. To reduce elk densities on the elk range, redistribution of the population would occur using herding (for directed movement of a group of elk), aversive conditioning (to locally distribute elk and result in avoidance of areas), and unsuppressed (noisy) weapons. Given appropriate interagency cooperation, adaptive management could also include wolves as a redistribution tool. Aspen stands (up to 160 acres) on the elk range would be fenced to exclude elk herbivory. These temporary fences would be installed adaptively, based on vegetation response to elk management actions as indicated through the monitoring program. Suitable willow habitat on the elk range would not require protection using fences because of the lower target elk population and the use of redistribution methods to disperse high concentrations of elk.

Alternative 3

This alternative, the preferred alternative, would involve the gradual lethal removal of elk by NPS staff and authorized agents of the National Park Service to reach and maintain an elk population size at the higher end of the natural range of variation (1,600 to 2,100 total elk: 600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation). Inside the park, up to 200 elk would be removed annually over 20 years. Fertility control would be considered as an adaptive management tool if an agent that is logistically feasible to implement and is safe and effective becomes available. Aspen stands (up to 160 acres) on the elk range would be fenced to exclude elk herbivory. Because this alternative would result in a target population at the high end of the natural range, up to 440 acres of suitable willow habitat could be fenced in the high elk-use areas of the primary summer and winter ranges. These temporary fences would be installed adaptively, based on vegetation response to elk management actions as indicated through the monitoring program. To reduce elk densities on the elk range outside of fenced areas, redistribution of the population would occur using herding, aversive conditioning, and unsuppressed (noisy) weapons. Given appropriate interagency cooperation, adaptive management could also include wolves as a redistribution tool.

Alternative 4

This alternative involves the use of a single-year, multi-year, or life-time fertility control agent on elk inside the park to achieve a target elk population at the higher end of the natural range of variation (1,600 to 2,100 total elk: 600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation). Using a single-year agent logistically up to 400 elk could be treated annually during the first four years of the plan and 200 for each of the remaining 16 years. Lethal reduction methods to supplement the fertility control actions would also be needed due to logistical constraints on using fertility control agents to reduce the population size to within management objectives (i.e., not enough elk could be treated efficiently). In addition to a single-year fertility control agent, 80 to 150 elk would be lethally removed each year. Aspen stands (up to 160 acres) on the elk range would be fenced to exclude elk herbivory. Because this alternative would result in a target population at the high end of the natural range, up to 260 acres of suitable willow habitat could be fenced in the high elk-use areas of the primary winter range inside the park. These temporary fences would be installed adaptively, based on vegetation response to elk management actions as indicated through the monitoring program. To reduce elk densities on the elk range outside of fenced areas, redistribution of the population would occur using herding, aversive conditioning, and unsuppressed (noisy) weapons.

Alternative 5

This alternative would involve lethal reduction of elk in combination with the release and intensive management of a limited number of gray wolves within Rocky Mountain National Park in a phased approach to achieve an elk population that would fluctuate within the natural range of variation between 1,200 to 2,100 total elk (200 to 800 park subpopulation; 1,000 to 1,300 town subpopulation). In the first four years of the plan, NPS staff and authorized agents of the National Park Service would reduce the elk population by lethal reduction to bring the population within the high end of the natural range of variation (1,600 to 2,100: 600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation) by removing 50 to 500 elk annually. Up to 100 elk could be lethally removed over the remaining 16 years to meet that target population range. At the same time, two pairs of wolves would be released and allowed to gradually increase to a maximum of 14 over the life of the plan. The number of wolves would be increased after determining through monitoring that the National Park Service could effectively manage the size and activities of the wolf population inside the park and that wolves would contribute to accomplishing the plan's management objectives. Due to the presence of wolves and the high level of redistribution of elk expected under this alternative, temporary fences to protect aspen (up to 160 acres) would be installed adaptively based on vegetation response, as indicated through the monitoring program; suitable willow habitat on the elk range would not require protection using fences.

Environmentally Preferred Alternative

The environmentally preferred alternative is the alternative that will promote the National Environmental Policy Act, as expressed in Section 101 of the act. The environmentally preferred alternative is Alternative 5. This best protects the biological and physical environment by effectively reducing the densities and abundance of the elk population to levels that would allow for recovery of vegetation on the elk range most reflective of natural conditions.

ENVIRONMENTAL CONSEQUENCES

Impacts of the five alternatives were assessed and are presented in chapter 4 of the plan/EIS and are summarized in Table 2-3 in Chapter 2.

This page intentionally left blank

Purpose of and Need for Action

PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

This chapter explains why the National Park Service (NPS) is taking action at this time to evaluate a range of alternatives for the management of elk (*Cervus elaphus*) and vegetation in Rocky Mountain National Park. This elk and vegetation management plan and environmental impact statement (plan/EIS) presents four action alternatives for managing elk and vegetation within the park and assesses the impacts that could result from continuation of the current management strategies or from implementation of any of the four action alternatives. On completion of the plan/EIS and decision-making process, one of the five alternatives would become the park's elk and vegetation plan and guide future actions over a 20-year period.

The focus of this plan/EIS is the elk population that winters on the eastern side of Rocky Mountain National Park, the geographic areas used by that population throughout the year, and the vegetation associated with the population. This elk population is known as the Rocky Mountain National Park / Estes Valley population. Estes Valley in this plan/EIS refers to a geographic area. It is not a formal name and is used here to differentiate the larger valley (which covers portions of the park and Estes Park) from the Town of Estes Park (see Figure 1.1). The area of effect for the plan includes the primary winter and summer ranges and transitional areas, plus the area east of the primary winter range where potential changes in elk distribution have been observed, although the causes of these potential changes are uncertain.

The Rocky Mountain National Park / Estes Valley Elk population migrates seasonally between the primary winter range and primary summer range. Figure 1.1 shows the approximate bounds of these ranges. Elk use the primary summer range – which includes the Kawuneeche Valley and subalpine and alpine areas within the park as well as areas outside the park – primarily during June, July, and August. From October through April, most elk use the primary winter range, which is on the eastern portion of the park and extends outside the park to the Estes Valley and eastward. Within this primary winter range, some elk concentrate in areas within the park in the vicinity of Moraine Park / Beaver Meadows and Horseshoe Park, referred to as the core winter range (Figure 1.2). In May and September, elk begin to migrate between these two ranges. These ranges represent the primary areas that elk frequent seasonally, although elk from this population use areas outside these ranges to a limited extent. The "Affected Environment" chapter includes a detailed discussion of elk movements within the range.

Elk are native to the Rocky Mountain National Park area, having lived in the vicinity for thousands of years. By the 1870s, heavy, unregulated hunting had eliminated elk in the area. Around 1900, the gray wolf, the only significant predator of elk in the area, had also disappeared. Elk were reintroduced to the area in 1913 and 1914, shortly before Rocky Mountain National Park was established in 1915.

Elk feed on a wide variety of plant species in a wide variety of habitats. Grasses usually make up most of the diet, followed by woody shrub species such as willow (*Salix spp*.), with aspen (*Populus tremuloides*) and forbs making up a small portion. In the absence of significant predation and hunting, and with the presence of abundant forage, the elk population in the park flourished. By the early 1930s, elk numbers had increased to the point that National Park Service (NPS) managers expressed concern about deteriorating vegetation conditions due to elk herbivory in aspen stands associated with grassland areas and in montane riparian willow communities on the primary winter range. Starting in 1944, rangers used lethal reduction (killing elk by shooting) to control the elk population in the park. To a lesser degree, they also used trapping and transplanting to control elk numbers. For the next 25 years, the number of elk using Rocky Mountain National Park was maintained between 350 and 800 animals. *Note to the reader: Aspen in the park grow in association with pine trees (conifers) such as lodgepole pine (Pinus contorta) and in grassland areas. This plan/EIS focuses on aspen in grassland areas of the elk range, and throughout the text, "aspen" refers only to these non-conifer-associated aspen. The plan/EIS also considers willow types affected by elk herbivory, which include montane riparian willow found on the primary winter and summer ranges and subalpine and alpine riparian and upland willow found on the primary summer range.*

In 1969, a management era marked by little to no intervention on elk populations began. Park staff believed that hunting in adjacent areas would control the elk population in and near the park. Since then, the size of the elk population has more than tripled. Elk population studies conducted in the mid- to late-1990s showed that generally about 1,000 elk wintered in low-elevation areas inside park boundaries on the east side of Rocky Mountain National Park, and another 2,000 elk wintered outside park boundaries in the Town of Estes Park and on adjacent private and U.S. Forest Service lands (Lubow et al. 2002).

Research conducted in the park indicates that the Rocky Mountain National Park / Estes Valley elk population is larger, less migratory, and more concentrated than it would be under natural conditions and has created a host of problems in the area. The most prominent is the alteration of plant communities in the core winter range and the potential for substantial declines in biodiversity within aspen and montane riparian willow communities. Other problems include property damage, safety issues associated with human-elk interactions, and traffic problems.

PURPOSE OF AND NEED FOR ACTION

This section explains what the plan/EIS would accomplish and why action is necessary at this time. Summaries of both the purpose and the need appear here, with more detailed information available in the "Background" section of this chapter.

The National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units. The Rocky Mountain National Park / Estes Valley elk population is larger, less migratory, and more concentrated than it would be under natural conditions. Elk heavily use the habitats in aspen and montane riparian willow communities, which support high levels of biodiversity; as a result, these communities may be declining in areas on the elk range where elk concentrate. The high concentrations of elk and levels of herbivory have degraded the vegetation in communities that support large numbers of bird, butterfly, and plant species in comparison to other habitat types in the park and in the Rocky Mountains (Connor 1993, Mueggler 1985, Simonson et al. 2001, Turchi et al. 1994).

NPS management policies (NPS 2006b) direct managers to strive to maintain the components and processes of naturally evolving park ecosystems. These policies also recognize that if biological or physical processes were altered in the past by human activities, they may need to be actively managed to restore them to a natural condition or to maintain the closest possible approximation of the natural condition. Natural conditions are defined as the condition of resources that would

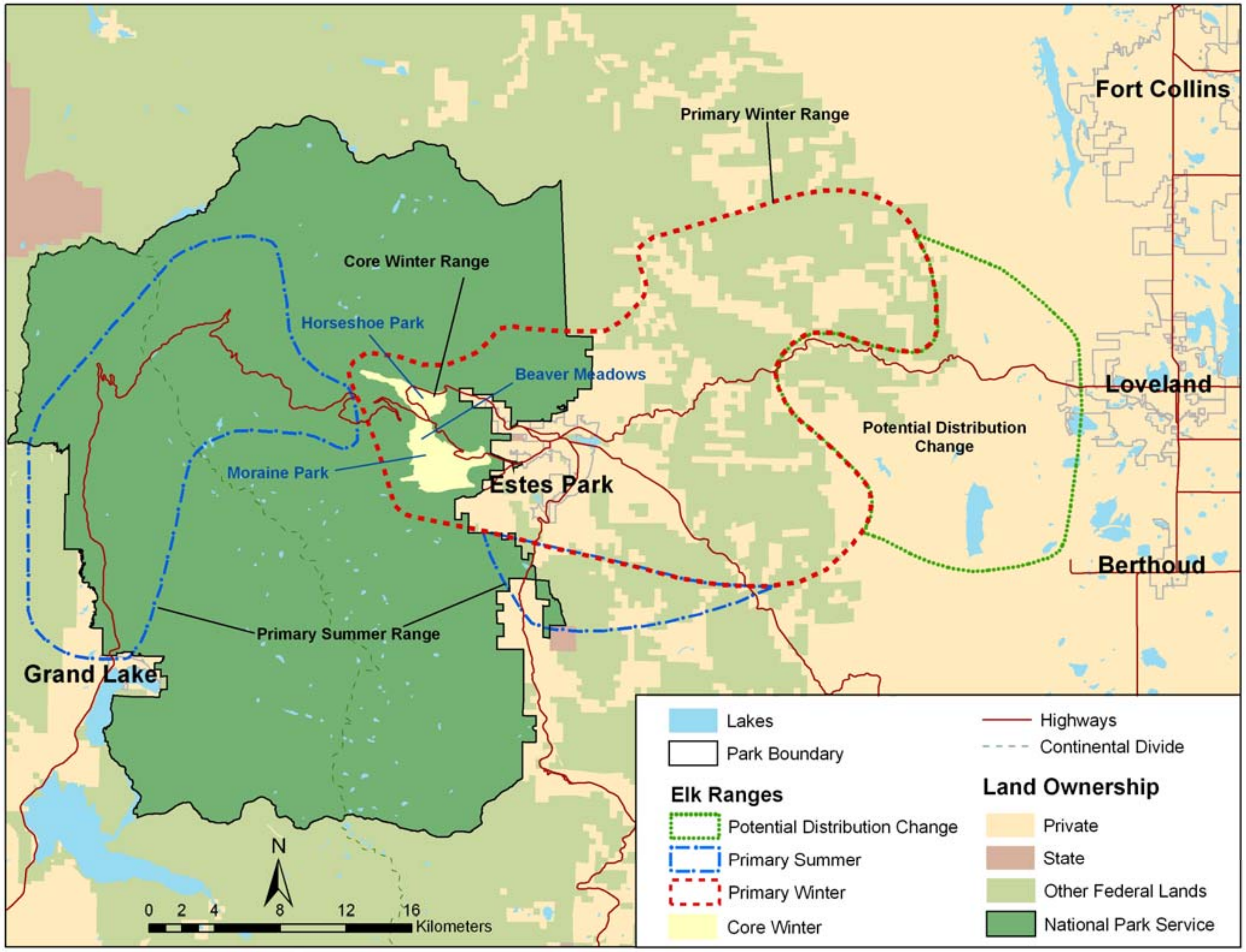


FIGURE 1.1: ELK RANGES ADDRESSED BY THIS PLAN IN ROCKY MOUNTAIN NATIONAL PARK, ESTES PARK, AND VICINITY

This page intentionally left blank

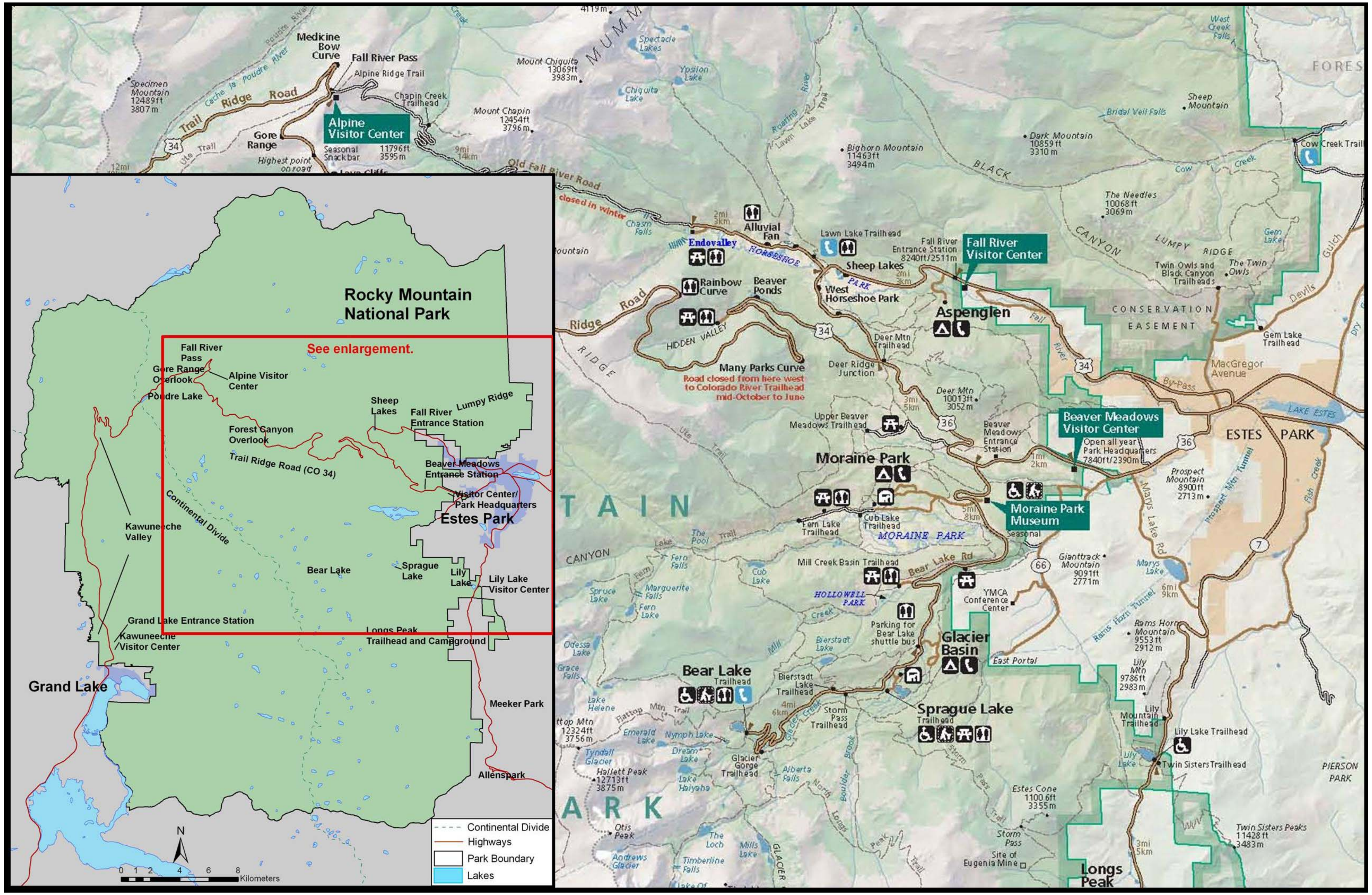


FIGURE 1.2: MAP OF ROCKY MOUNTAIN NATIONAL PARK

This page intentionally left blank

occur in the absence of human dominance over the landscape. Natural conditions occur when the components and processes of the natural system are intact. Natural change is recognized as an integral part of the functioning of natural systems; that is, resource conditions are not static, but fluctuate in response to natural processes, such as weather conditions. Recognizing such fluctuations, this document bases its descriptions and analysis on the natural range of variation in resource conditions. A key element in determining the need for action was the comparison between existing conditions and the estimates for the natural range of variation that would be expected under natural conditions. Elk are a natural component of the Rocky Mountain National Park ecosystem and are expected to affect native vegetation communities that occur in the park. The natural range of variation for elk populations and associated vegetation conditions in the park were estimated based on research and ecosystem modeling specific to Rocky Mountain National Park, as well as related research and experiences in other locations.

Under natural conditions, the elk population size and distribution would be controlled by a number of factors, including predators such as wolves and grizzly bears, hunting by American Indians, and the presence of competitors such as bison. Ecosystem modeling predicted that the elk population under natural conditions, given the current amount of available habitat, would fluctuate between 1,200 and 2,100 elk (Coughenour 2002). With an intact predator base, elk would be less sedentary and more wary, resulting in lower concentrations of elk on the elk range. With elk less concentrated and less sedentary, montane riparian willow and aspen would be more abundant with increased stand size and complexity; that is, stands would have a variety of age classes and stems of differing sizes. Under natural conditions with suitable levels of montane riparian willow habitat available, beaver would be more abundant on the elk range and as a result, water levels on the primary elk winter and summer ranges would be higher, further encouraging the establishment and growth of willows. These natural conditions represent the overall desired future condition for elk and vegetation on the elk range, as presented in detail in the "Alternatives" chapter, and are what the National Park Service strives to achieve.

The purpose of this plan/EIS is to guide management actions in Rocky Mountain National Park to achieve these desired conditions by reducing the impacts of elk on vegetation and by restoring, to the extent possible, the natural range of variability in the elk population and affected plant communities. A successful plan would realize these purposes while providing continued elk viewing opportunities for visitors.

Although the overall desired elk population size and distribution could be achieved within the 20-year life of this plan, achieving the desired future conditions for aspen and montane riparian willow on the elk range would take longer. However, strides would be made toward reaching that overall goal.

Several features of the elk population are considered to be outside the natural range of variation, such as its density in some parts of the park (particularly in the core winter range), its overall size, and its behavior (Monello et al. 2005). The absence of an intact predator base is a key reason the elk population size, density and behavior is considered to be outside the natural range of variation. The gray wolf, which was extirpated from the Rocky Mountain National Park area before the park was established, represented a key component in the food chain and in defining the natural condition. Ecosystem simulation modeling indicates that fewer elk would likely be present if wolves lived in the Rocky Mountain National Park area (Coughenour 2002). Empirical evidence from areas with intact wolf populations, such as Yellowstone and Banff National Parks, indicates that elk would be more wary and less sedentary, resulting in lower densities. Grizzly bears, which were native to the park but also extirpated, would also probably contribute to reducing elk numbers; research shows that wolves more effectively limit elk populations in the presence of multiple predators (Gasaway et al. 1992 and Orians et al. 1997, cited in Monello et al. 2005). Other factors that likely contributed to a lower elk population under natural conditions are the effects of American Indians hunters and the presence of bison (reviewed in Monello et al. 2005). The prohibition of hunting inside the park and the town of Estes Park while adjacent areas outside the park are open to hunting has created a "sanctuary" that has contributed to the high elk concentrations and more sedentary behavior.

Elk are gregarious animals, meaning that they tend to form groups with other elk, unlike other wildlife species that are intolerant of high densities. Because elk can congregate in high densities, especially during the winter, an overabundant or over-concentrated population could have a large and detrimental effect on vegetation conditions, in particular aspen and montane riparian willow communities in the core winter range, and on the wildlife that depend on these areas as habitat (Monello et al. 2005). Such effects are becoming increasingly evident in the park.

The elk population reached a high point between 1997 and 2001, with annual estimates ranging from about 2,800 to 3,500 (Lubow et al. 2002). Since 2002, winter estimates in the park and Estes Valley area outside the park have declined, ranging from about 1,700 to 2,200. The dynamic nature of wildlife populations makes population estimates of a wide-ranging, mobile species such as elk variable. Because of these uncertainties, elk population size estimates in the research and in this document use ranges rather than exact numbers. However, the general ranges of population estimates reflect important trends relevant to the analyses of elk population effects on resources.

The elk population includes three subpopulations that exhibit different population dynamics and migration patters (Larkins 1997, Lubow et al. 2002): 1) Moraine Park / Beaver Meadows (referred to as Moraine Park), 2) Horseshoe Park, and 3) the Town of Estes Park. The Moraine Park and Horseshoe Park subpopulations exhibit the same population dynamics and will be collectively referred to here as the park subpopulation. The Town of Estes Park population exhibits different dynamics and is referred to as the town subpopulation.

The elk in the park subpopulation are estimated to be at the food-limited carrying capacity (Coughenour 2002, Singer et al. 2002). The food-limited carrying capacity is the average maximum number of elk that the primary winter range forage base can support (also referred to as ecological carrying capacity). Assuming existing habitat and continuation of weather patterns that occurred in the second half of the 20th century, the park subpopulation is expected to continue to fluctuate between 800 and 1,100 animals (Coughenour 2002). The town subpopulation is variously estimated to be at or below carrying capacity, based on different researchers' results (Coughenour 2002, Lubow et al. 2002). Population estimates for the town subpopulation from 2001 to 2005 have ranged between about 1,000 and 1,400 elk in the Estes Valley area.

If the elk population is at or within the carrying capacity of its habitat, it does not necessarily mean that the elk-to-habitat relationship is balanced or within the natural range of variation. Factors affected by humans such as elk distribution over time and area, a missing predator (i.e., gray wolf), and a refuge effect (i.e., no hunting in the park and in much of the Estes Valley) can have a large influence on habitat conditions even though the ecological carrying capacity may be adequate to support the elk population. Ecosystem simulation modeling indicates that with wolves present, the elk population was 15% to 40% below the food-limited carrying capacity (Coughenour 2002).

Elk densities are variable in the park, with high (76 to 170 elk/mile^2) to very high (171 to 285 elk/mile^2) concentrations on about 7% of the primary winter range, centered in Moraine Park /

Beaver Meadows (Singer et al. 2002). The remainder of the primary winter range generally has moderate (26 to 75 elk/mile^2 on 11% of the primary winter range) to low (less than 26 elk/mile^2 on 82% of the primary winter range) densities (Singer et al. 2002). Although elk use lower-density areas of the primary winter range to rest or as they move between areas, most of their foraging time is highly concentrated on a small percentage of the primary winter range. Elk densities on core winter range areas greater than 260 elk/mile^2 are the highest concentrations ever documented for a free-ranging population in the Rocky Mountains (Monello et al. 2005, Singer et al. 2002). Evidence from various research conducted in the park indicates that the high densities of elk in specific areas on the core winter range are as significant as the total population size in terms of causing adverse impacts on vegetation.

Increased concentrations of elk could potentially increase the risk of spreading chronic wasting disease in the elk population. Chronic wasting disease is a transmissible spongioform encephalopathy that primarily occurs in free ranging deer and elk in northeastern Colorado and southeastern Wyoming (Miller et al. 2000). Elk and deer in the park have tested positive for this disease. Based on modeling predictions, chronic wasting disease has the potential to severely affect deer populations (Miller et al. 2000, Gross and Miller 2001).

The elk population, over the years, has also become less migratory, with 10% to 15% of the elk remaining on the primary winter range during the summer. Under natural conditions, all of the elk in the population would seasonally migrate from the primary winter range to the primary summer range. These non-migratory elk can severely inhibit the growth of plants, as high levels of herbivory are taking place during the growing season (Augustine and McNaughton 1998).

FIGURE 1.3: ASPEN STAND EXHIBITING EFFECTS OF ELK HERBIVORY

Changes in migration patterns have also resulted in increasing numbers of elk that spend the entire year on what traditionally was only winter range in both the park and town areas. Over the years, more elk are calving near areas where the public recreates in the Estes Valley, which increases the risk of human-elk conflicts. In addition, increased concentrations of elk in developed areas inside and outside the park also increase the potential for human-elk conflict as elk become more habituated and less fearful of humans. This may result in increased safety risks and property damage.

Research consistently indicates that a continuation of the high elk densities in Rocky Mountain National Park would result in the complete loss of aspen trees or, at best, existence in a shrub-like state on core winter range areas (W.L. Baker et al. 1997, Olmsted 1997, Suzuki et al. 1999, Coughenour 2002, Weisberg and Coughenour 2003). Elk browsing currently stunts the growth or kills all young aspen trees (i.e., less than eight feet in height, also called suckers or shoots) on the core elk winter range and in some parts of the Kawuneeche Valley (W.L. Baker et al. 1997; Olmsted 1979, 1997). Accordingly, aspen regeneration is suppressed, resulting in overmature, deteriorating aspen stands with no small or mid-size trees. These stands will likely be permanently lost if the current level of elk herbivory continues, although it is difficult to predict when this would happen.

Elk are severely inhibiting the ability of montane riparian willow to reproduce, as few willow plants on the primary winter range produce seed, and seedling survival is almost non-existent (Cooper et al. 2003). Elk are also suppressing the growth of willow plants, so that few plants can attain a height greater than the herbaceous layer, which is the layer of non-woody plants such as grasses, forbs, and herbs (Peinetti et al. 2002, Zeigenfuss et al. 2002). Willow is the dominant woody shrub on almost all wet meadow or riparian areas in Rocky Mountain National Park.

FIGURE 1.4: HEAVILY BROWSED WILLOW ON THE ELK WINTER RANGE

FIGURE 1.5: RESEARCH EXCLOSURE SHOWING THE DIFFERENCE BETWEEN BROWSED AND UNBROWSED WILLOW

It is an important food source for elk (Hobbs et al. 1981, Singer et al. 2002) and provides wildlife habitat for a large number of bird, butterfly, and plant species (Connor 1993, Simonson et al. 2001). Elk herbivory has contributed to a transition of tall willow areas to short willow areas over the last 60 years in Moraine Park and Horseshoe Park (Peinetti et al. 2002, Zeigenfuss et al. 2002, B. W. Baker et al. 2005). Figures 1.4 and 1.5 show the effects of heavy browsing on montane riparian willow. Declines in montane riparian willow over the last 50 to 60 years are attributed to various factors, but the current condition and trend of montane riparian willow communities is primarily due to the effects of elk.

Another factor contributing to the decline in montane riparian willow on the elk range is a decrease in surface water, which is believed to be a consequence of reduced beaver activity. Beaver are a critical component of the primary winter range in the park. Under natural conditions, they would be present in higher numbers; currently very few beaver are found on the elk primary winter range. In 1939 and 1940, it was estimated that more than 300 beavers occupied Moraine Park (Packard 1947). Since then, beaver on the primary winter range have declined by more than 90%, with a resultant decline of surface water in the area has by nearly 70%, which has led to a decline in montane riparian willow (Packard 1947, Peinetti et al. 2002, Zeigenfuss et al. 2002). The lack of beaver is accelerating montane riparian willow declines by inhibiting the development of appropriate sites for willow seedling establishment and limiting recharge of the shallow aquifers in Moraine Park and Horseshoe Park (Cooper et al. 2003). Recovery of beaver on the primary winter range is unlikely, as suitable habitat for beaver is currently lacking there due to the poor condition of the montane riparian willow communities (B.W. Baker et al. 2005).

Elk herbaceous consumption at extremely high rates may also result in the alteration of herbaceous plant communities on the elk range. Annual consumption rates in montane riparian willow and upland shrub communities on the primary winter range have occurred at a high level, on average 55% to 60%, respectively. Most offtake in willow and upland areas occurred during the summer and winter periods, respectively (Singer et al. 2002). Herbaceous plants in willow communities may be particularly vulnerable because most grazing occurs during the growing season (Augustine and McNaughton 1998).

OBJECTIVES

Objectives are specific statements of purpose that describe what should be accomplished, to a large degree, for the plan to be considered a success. Development of the objectives was done with legal and regulatory mandates in mind and with an awareness of the complexity of relationships between the numerous species, ecosystems, and ecological processes that future management actions would affect. Several objectives refer to the "natural range of variation" or "natural conditions." The concept of natural range of variation in resource conditions was discussed earlier in the "Purpose of and Need for Action" section of this chapter, along with the reasons why the elk population and vegetative conditions on the primary winter range are thought to be outside the natural range of variation. Based on these objectives, the "Adaptive Management" section of Chapter 2 presents specific desired future conditions for elk and vegetation on the elk range to be achieved over the next 20 to 50 years. The objectives for the Rocky Mountain National Park elk and vegetation management plan are to

1. Restore and/or maintain the elk population to what would be expected under natural conditions to the extent possible.

    Maintain a free-roaming elk population.

    Decrease the level of habituation to humans exhibited by elk.

    Restore the elk population size to a level allowing it to fluctuate within the natural range of variation, between 1,200 and 2,100 elk with 200 to 800 wintering inside the park and 1,000 to 1,300 outside the park.

    Redistribute elk to disperse high densities of elk.

2. Restore and/or maintain the natural range of variation in vegetation conditions on the elk range, to the extent possible.

    Prevent loss of aspen clones within high elk use areas.

    Restore and maintain sustainable montane riparian willow.

        Increase montane riparian willow cover within suitable willow habitat on the primary winter range.

        Maintain or improve the condition of riparian and upland willow on the primary summer range.

    Reduce the level of elk grazing on herbaceous vegetation.

3. Opportunistically collect information to understand chronic wasting disease prevalence in the park within the framework of the alternative.

4. Ensure that strategies and objectives of this plan/EIS do not conflict with those of chronic wasting disease management.

5. Continue to provide elk viewing opportunities.

6. Recognize the natural, social, cultural, and economic significance of the elk population.

PARTICIPATING AGENCIES

Figure 1.1 shows the approximate bounds of the primary summer range and primary winter range of the elk population addressed by this plan. As shown in the figure, elk move outside the park onto other federal, state, and private lands.

Because of the migratory nature of the elk population, a regional approach is essential to develop a meaningful, long-term plan. Therefore, the National Park Service is committed to working in partnership with nearby land managers and other federal, state, and local agencies to effectively manage elk and vegetation in and near the park.

Development of this plan and environmental impact statement involved the cooperation of multiple agencies at various levels of participation. The National Park Service is the lead agency and is responsible for all aspects of developing the plan/EIS, including selecting a preferred alternative and preparing a record of decision.

Cooperating agencies on the core planning team participate in all aspects of developing the plan/EIS. These agencies include the Town of Estes Park and the Estes Valley Recreation and Parks District.

Cooperating agencies on the extended planning team have agreed to provide expertise and data on pertinent topics and to review appropriate portions of the plan and environmental impact statement. These agencies include the Colorado Division of Wildlife, Grand County, Larimer County, the Town of Grand Lake, the U.S. Bureau of Reclamation, and the U.S. Forest Service.

The National Park Service and the cooperating agencies have signed a memorandum of agreement to establish how the plan and environmental impact statement would be prepared. The memorandum, which is included in Appendix A, delineates the roles and responsibilities of each agency. The National Park Service will be responsible for publishing and distributing the draft and final plan/EIS and the record of decision.

The National Park Service is solely responsible for managing elk inside park boundaries according to federal laws and policies. Outside the park, wildlife-management and wildlife-damage cases are supervised by the Colorado Division of Wildlife. This authority extends onto Arapaho-Roosevelt National Forest on the east and northern boundaries of the park. The U.S. Forest Service has the authority to manage wildlife habitat on the national forest, but the management of the wildlife itself is the responsibility of the Colorado Division of Wildlife.

BACKGROUND

Elk in the Rocky Mountain National Park Region

Prior to colonial westward expansion, elk inhabited the area that became the Rocky Mountain National Park and the Estes Valley. There is no historic information on the range of variability in elk numbers prior to the era of European settlement. Estimates based on the SAVANNA ecosystem simulation model (Coughenour 2002) indicate that the historic elk population during winter in the Estes Valley probably fluctuated between 1,500 and 3,500 animals, depending on factors such as available food resources, weather, and wolf predation.

The gray wolf, which was extirpated from the Rocky Mountain National Park area before the park was established, represented a key component in the food chain and in defining the natural condition. Ecosystem simulation modeling indicates that wolves would have helped limit elk numbers (Coughenour 2002), and empirical evidence from areas that currently have intact wolf populations indicates that elk would have been more wary and less sedentary, resulting in lower densities. Grizzly bears, which were native to the park but also extirpated, would also probably also have contributed to reducing elk numbers and research shows that multiple predators more effectively limit elk populations (Gasaway et al. 1992 and Orians et al. 1997, cited in Monello et al. 2005). American Indian hunters and the presence of bison would probably have also helped limit elk numbers (Monello et al. 2005).

There is little information on where elk spent summer and winter prior to settlement of the Estes Valley. Some have suggested that elk spent summers in and around the park and migrated to the plains during the winter (Clarke et al. 1994). However, Estes (1939), in referring to animal migrations during the 1860s, stated "winter drove all the game down to the foothills, except the elk, they would remain in the park [referring to the Estes Valley] until summer, then they went up over the range or mountains." While this suggests that elk stayed in the Estes Valley throughout the winter, there is no definitive evidence either way. Within Rocky Mountain National Park, the comparison of historic game drives and current elk migration patterns suggests that elk use the same routes today as they did historically (Benedict 1996; Larkins 1997).

After European settlement of the Estes Valley in the mid-1800s, the elk population was rapidly reduced by market hunting. Abner Sprague, one of the first settlers in Moraine Park, described the decline (1925):

> Our [elk] only lasted about three years. They came down from their high range just before Christmas, 1875, by the thousands and were met by hunters with repeating rifles and four horse teams; hauled to Denver for three or four cents per pound. In 1876 fewer came down; in '77 very few were seen on [the east] side of the divide. In 1878 I killed my last elk, and to get him had to go over Flat Top [Mountain].

Although claims of "thousands" of elk cannot be verified, it is clear that elk were extirpated (or nearly so) from the Estes Valley by 1880. No viable population existed again until elk were reintroduced in 1913-14.

Elk Reintroduction and Management from 1913 through 1968

The U.S. Forest Service and Estes Valley Improvement Association reintroduced 28 elk into the Estes Valley in 1913-14. These elk were heavily protected by prohibiting hunting (i.e., no hunting was allowed in or near the Estes Valley until 1939). Under this protection, along with the creation of the park in 1915, the population grew from 30 animals in 1915 to approximately 350 animals by 1930 (Stevens 1980a).

Concern about the size of the elk population first arose in the early 1930s because elk started eating the bark of live aspen trees (McLaughlin 1931 cited in Guse 1966). G. Wright et al. (1933) suggested that this indicated that "the elk population was reaching the limit of its food supply and that range abuse and starvation were in the offing." This was likely one of the first indications that elk were approaching the park's carrying capacity.

G. Wright et al. (1933) suggested that a major cause of poor range conditions was that the most important elk winter range areas, such as Beaver Meadows, were privately owned. These areas were heavily grazed by cattle and horses during the summer, leaving little forage for elk in the winter. To remedy the situation, in 1932 the United States government purchased about five square miles of private land in core elk winter range areas and added them to the national park.

These areas included Moraine Park, Beaver Meadows, and Horseshoe Park (Ratcliff 1941): the areas referred to as the core winter range.

An elk and deer management plan written in 1943 (Condon 1943 cited in Guse 1966) was prepared in response to continuing increases in the elk population and the belief that range conditions were deteriorating (Dixon 1939, Ratcliff 1941). The plan stated, "300 elk and 200 deer should be removed from the actual populations of 705 elk and 717 deer counted in April 1943." Direct reductions (shooting) carried out in December 1944 and January 1945 removed 301 elk and 113 deer from the park winter range areas (Grater 1945). The goal of the reductions was to reduce the grazing and browsing effects on native vegetation.

The 1943 management plan and subsequent reductions produced controversy. Grater (1945) stated that the population reductions were not necessary because browse plants such as montane riparian willow were not seriously damaged except in localized areas where elk concentrated to feed. Additionally, the Assistant Director of the National Park Service, Hillary A. Tolson, wrote to the park in 1946, stating that the Director's office had a "strong dislike" for reduction programs either inside or adjacent to NPS units. Accordingly, further reductions were halted until 1949.

A report by Fred Packard, the park's full time wildlife technician, was based entirely on work done prior to the initial reduction programs in 1944 and 1945 (Packard 1947). The park's annual reports from 1945 to 1947 generally remained optimistic about range conditions. However, in a 1949 report, the park again focused on reducing the number of elk and deer to improve range conditions: "The major wildlife problem at this time is the overused condition of winter range by deer and elk. It is anticipated that a reduction of elk and deer will be effected during the winter of 1949-50." Such conclusions were generally based on personal, subjective observations; quantitative data on range conditions were not collected again until 1954 by Buttery (1955).

Direct reductions resumed in 1949-50, removing 340 elk and 100 deer from Rocky Mountain National Park. Annual removal of on average 60 elk and 40 deer continued until 1962 and 1959, respectively. Population estimates during this period indicated that 350 to 800 elk and 300 to 700 deer remained in the park during the winters between 1950 and 1962 (Stevens 1980a).

The National Park Service discontinued direct elk population reductions in the park in 1962 for several reasons. Researchers provided evidence that upland shrubs and willow were displaying signs of recovery and overall primary winter range conditions were improving (Buttery 1955, R. Wright 1992). More importantly, a memorandum of understanding in 1962 among Rocky Mountain National Park, the Colorado Department of Game and Fish (now known as the Colorado Division of Wildlife), and the U.S. Forest Service set the framework for a cooperative elk study program that would determine the distribution and migration routes of elk in and around Rocky Mountain National Park. The control program ended as a result. Additionally, the state initiated a hunt in January and February 1963. The goal of these cooperative research efforts was to determine if there was any time of year when large numbers of elk from the park were outside park boundaries to allow hunters (rather than park rangers) to harvest park population surpluses (Denney et al. 1967).

Large numbers of elk were documented to move east of the park boundary once during a five-year cooperative study in the early 1960s (Denney et al. 1967). Several factors likely contributed to this unusual elk migration out of the park, including significant snowfall during January to March 1963 and avoidance of the park's primary winter range by elk as a result of lethal control actions during the previous 10 to 15 winters. (Elk avoid areas where they are disturbed or hunted [Altmann 1956].) This single large migration also coincided with the first January and February 1963 hunt, which removed more elk (more than 500) from the hunt units adjacent to and surrounding Rocky Mountain National Park than any previous National Park Service control effort (Stevens 1980a). However, many of these animals were harvested at sites more than 20 miles from the park border, and the National Park Service trapping report from 1967-68 suggested they were not part of the Rocky Mountain National Park elk population. Harvests throughout the rest of the study (Denney et al. 1967) were markedly reduced, averaging fewer than 75 animals per year (Stevens 1980a). Nevertheless, the agencies moved ahead with a long-term management plan to control elk numbers with public harvests outside Rocky Mountain National Park boundaries.

The long-term elk management plan (1967 supplement to the 1962 memorandum of understanding) agreed to:

Dispose of surplus elk by public hunting outside of the park,

Establish a hunt in January and February adjacent to park boundaries, and

Trap and transplant animals if the public hunt was not effective.

The park used trapping and transplanting to supplement hunting harvests outside the park in efforts to reduce the elk population. However, even with relatively high harvests and trapping (268 and 175 elk, respectively) in 1967-68, elk numbers appeared to nearly double in size the following year (Stevens 1980a). January and February hunts outside the park continue today, but the 1967-68 transplants were the last time Rocky Mountain National Park directly reduced the population. This marked the beginning of a management era that has become known as “natural regulation.”

Natural Regulation (1969 to Present)

The management era from 1969 to the present, marked by little to no management intervention on ungulate populations, has become widely known in the media and scientific literature as "natural regulation" (Huff and Varley 1999). The concept implies that a population will self-regulate, which means that population growth tends to slow as the population fills the available habitat and to increase if their numbers decline. Natural regulation in Rocky Mountain National Park always included the provision that hunting adjacent to the park or some other type of control was necessary to help control the elk population and to fulfill the role of extirpated predators (Stevens 1980a).

The elk population in the park was never greatly influenced by public hunting outside the park. Instead, population growth only slowed as it approached the food-limited carrying capacity in the 1980s (Lubow et al. 2002).

Extensive development in and around Estes Park has decreased hunting opportunities there, and elk have increasingly concentrated in Rocky Mountain National Park and Estes Park, where hunting and/or the discharge of firearms is not allowed. Despite this concentration in areas where hunting is prohibited, the total number of elk harvested in Game Management Unit 20 (mostly east of the park) has generally not declined. In fact, in recent years, harvest numbers have been at their highest historic levels.

Over time, the elk population has become less migratory, as recent surveys indicate that 10% to 15% of the elk population in the Rocky Mountain National Park area spend the summer on the primary winter range. During summer, at least 100 to 200 animals stay on the primary winter range in the park and as many as 550 animals stay on the primary winter range areas in town. Under natural conditions, all of the elk would migrate from the primary winter range to the primary summer range. These elk cause concern because non-migratory elk can severely inhibit the regrowth capabilities of important winter forage species (Augustine and McNaughton 1998).

The only large group of elk (more than 300 animals) that do not migrate tend to use the Meadowdale Ranch and 18-hole golf course on the east end of Estes Park. This herd has stayed in this area since at least the 1970s (Stevens 1980a), although their numbers appear to have increased over the last 30 years.

Aspen Community

Aspen occupies less than 5% of the habitat within Rocky Mountain National Park. However, it is ecologically important because it supports a large number of plant and animal species compared to other plant communities in the park (Mueggler 1985; Simonson et al. 2001; Turchi et al. 1994). Aspen is a preferred browse species for elk, and regeneration of aspen shoots is being suppressed as a result of elk herbivory (Olmsted 1979 and 1997).

Park-wide, aspen are present in numerous, healthy stands and are not overly affected by elk herbivory (Suzuki et al. 1999). However, there are severe problems with the condition of aspen stands on the core winter range and in the Kawuneeche Valley, where elk densities are high. Continuation of the current "natural regulation" management approach for elk in Rocky Mountain National Park could result in the complete loss of aspen trees or their existence in a shrub-like state on core winter range areas (W.L. Baker et al. 1997, Olmsted 1997; Suzuki et al. 1999, Coughenour 2002, Weisberg and Coughenour 2003).

Throughout the western United States, aspen reproduction is almost always vegetative (through suckers) rather than by seeds. Vegetative reproduction occurs when interconnected roots give rise to an adventitious sucker that eventually becomes an aspen tree. Aspen trees that are connected by their roots are referred to as a clone. Almost all aspen stands that have been studied in the western United States are made up of a single clone or mosaic of clones. Few individual aspen trees live more than 200 years (Jones and Schier 1985), but aspen clones often are hundreds or thousands of years old (Kay 1997a). Aspen suckers are vulnerable to elk and mule deer browsing, which can result in the death or stunted growth of the aspen clone if the rate of browsing exceeds the rate of sprout survival over a long period. When browsing is intense enough, no aspen suckers within a clone can reach tree size. This could eventually result in the loss of the clone because photosynthesis will cease as the older trees die, and the root systems become malnourished. Death of aspen clones in localized areas may indicate that the supporting ecological system is experiencing conditions outside its range of normal variability.

In the core winter range on the east side of Rocky Mountain National Park, researchers have not documented unprotected aspen suckers that have matured into trees with a height greater than 8 feet since 1970 (W. L. Baker et al. 1997, Olmsted 1997, Suzuki et al. 1999). Olmsted (1979) and W. L. Baker et al. (1997) found inverse correlations between aspen regeneration on the core winter range and elk population size. The latter study concluded that aspen stands only produced a new cohort of trees when the elk population was less than 600 animals.

Research almost two decades apart (Olmsted 1979 and 1997, W. L. Baker et al. 1997) suggested that elk population size is the primary factor controlling aspen regeneration and cohort establishment on the core elk winter range in and near Rocky Mountain National Park. However, other research suggests that elk distribution (density) may be equally or even more important for successful aspen regeneration than overall population size (Stevens 1980a, Weisberg and Coughenour 2003).

Elk also can damage aspen by stripping the bark off live trees (see Figure 1.6). Because elk prefer more nourishing grasses, twigs, and leaves, this occurs most often when other vegetation in an area has already been eaten or is buried by deep snow. Bark stripping does not usually kill aspen, but it can create inoculation sites for pathogens that lead to aspen mortality (Hinds 1985).

FIGURE 1.6: ELK HERBIVORY DAMAGE ON AN ASPEN TRUNK

Montane Riparian Willow Community

Willow is the dominant woody shrub on almost all wet meadow or riparian areas in Rocky Mountain National Park. It is an important food source for elk (Hobbs et al. 1981, Singer et al. 2002) and provides wildlife habitat for a large number of wildlife species (Connor 1993, Simonson et al. 2001). Montane riparian willow declines in Moraine Park are visibly correlated to a large reduction (69%) in surface water that has been attributed to an almost complete loss (greater than 90% decline) of the area's beaver population since 1940 (Packard 1947, Peinetti et al. 2002, Zeigenfuss et al. 2002). Beaver are highly effective at building dams that create ponds and additional stream channels.

The relationships between montane riparian willow, beaver, and elk are complex. Under natural conditions, with an intact predator base, beaver and elk establish a competitive balance in which each species' willow herbivory does not ultimately exclude each other or annual regeneration of montane riparian willow (B.W. Baker et al. 2005). However, because most of the beaver population was trapped from the park in the 1940s (B.W. Baker et al. 2004), hydrological support for montane riparian willow declined (i.e., less surface water and lower water table). In turn, the increasing numbers and concentrations of the elk population produced higher rates of willow herbivory on the core winter range. Because montane riparian willow growth and survival in Rocky Mountain National Park primarily depend on ground water from streams and snowmelt instead of rainfall (Alstad et al. 1999), it is not surprising that large expanses of montane riparian willow have died where streams have become totally dry and water tables have apparently experienced dramatic decreases. Many stream channels in Moraine Park that were filled with water and bordered by live willow in 1937 are now dry, with large, dead willow on the old stream banks. Continued high rates of elk herbivory and the absence of beaver and their associated habitats are decreasing the available suitable sites for willow seed germination and associated montane riparian willow reproduction (Cooper et al. 2003).

Herbaceous Vegetation

Herbaceous vegetation (grasses) make up a large component of the elk diet, between 58% and 76% (Monello et al. 2005). Herbivory of herbaceous vegetation in montane riparian willow and upland shrub communities on the elk range occurs at a high level. Annual herbaceous consumption rates in montane riparian willow and upland shrub communities on the primary winter range in the park averaged 55% to 60%, respectively. Most offtake in willow and upland areas occurred during the summer and winter periods, respectively (Singer et al. 2002). These herbaceous consumption rates by elk in the park are extremely high, exceeding most areas in North America. This has not altered herbaceous coverage, but comparison with consumption rates in similar type ecosystems indicates that herbaceous communities on the primary winter range may not be able to be maintained under such grazing pressures (Singer et al. 2002).

Socioeconomic Importance of Elk to the Area

Elk are an important part of the socioeconomics of the Estes Park area. Their importance derives from three primary contributions:

> Many visitors come to the park and valley hoping to see elk.
>
> Many area residents feel that the presence of the elk enhances their personal quality of life. In some cases, it contributed to their decision to live or work in the area.
>
> Recreationists appreciate the presence of elk in the forests and parks of the region and some, such as elk hunters and wildlife photographers, base their experience on the existence of elk.

Elk contribute to the economy of the Estes Valley by attracting visitors to the park and the Town of Estes Park. Visitors enjoy viewing and photographing elk, especially during the autumn elk rutting season. While a few visitors come primarily to see elk, most consider the elk as part of the overall experience of the area. The visitors contribute to the economy through expenditures on lodging, food, entertainment, gifts, souvenirs, and other items, all of which contribute to the local sales tax base. They also often pay entrance fees to Rocky Mountain National Park, increasing National Park Service revenues.

Elk play a role in the economy of the area by contributing to its overall attractiveness to new and existing residents and employees. Quality of life is difficult to quantify but is important in the economic vitality of a region. The aesthetic perceptions associated with the presence of elk may enhance property values in the town, and the presence of elk may play a role in encouraging some people to live and work in the area. On the other hand, some consider elk a nuisance. They can damage landscaping and hinder traffic or impede the ability to use golf courses or participate in other recreational activities such as walking, running, or biking on the Lake Estes Trail or Fish Creek Trail which may discourage visitors use of the area.

Elk contribute to the economy around the park by providing a focal point for hunters and other recreationists in the region. Hunting elk, especially mature bull elk, is an important activity for many Colorado residents and out-of-state visitors. Hunting license fees contribute to the state coffer, and hunters' purchases of lodging, food, sporting goods, and other supplies contribute to the local economy. Recreationists, who sometimes make similar local expenditures, may have an enhanced enjoyment of their hiking, biking, and other recreational activities because of the presence of elk in the area.

Chronic Wasting Disease and Elk

Chronic wasting disease first appeared in cervids over 30 years ago. In elk, it first appeared in 1979 (Williams and Young 1982). Chronic wasting disease occurs in free-ranging deer and elk in northeastern Colorado and southeastern Wyoming (Miller et al. 2000), and has recently been detected in moose (CDNR 2005). It also has been documented in deer and/or elk in other western, Midwestern, and eastern states as well as in Saskatchewan and Alberta, Canada. Elk and deer in the populations in Rocky Mountain National Park have tested positive for chronic wasting disease. No other wildlife species or domestic animals are known to be susceptible to the disease, under natural conditions.

Chronic wasting disease causes behavioral changes, emaciation, excessive salivation, weakness, and death in infected animals. The disease can remain latent (i.e., no symptoms are apparent) for months and potentially years, and it is fatal in all cases. It is unknown how the disease originated; but knowledge of its presence in Colorado began about 35 years ago (Miller et al. 2000). Although the origin of the disease is unknown, it is believed to be an exotic disease that is the result of human influences, such as loss of habitat from encroaching development and extirpation of predators, that has resulted from concentrated ungulate populations.

Prevalence estimates for chronic wasting disease for elk inside Rocky Mountain National Park have not been determined. In the late 1990s, chronic wasting disease prevalence in elk in adjacent areas was estimated to be less than 1%, based on surveillance from mandatory elk head submission from hunters (Miller et al. 2000). More recent estimates taken from Colorado Division of Wildlife data analysis units adjacent to the park range between 0 and 2.8% (Miller 2006).

Recent research indicates that chronic wasting disease can be contracted through environmental contamination with excreta or carcasses and directly through animal-to-animal contact (Miller et al. 2004). In captive situations, up to 71% (five of seven) of adult elk deaths were due to the disease (Miller et al. 1998), and simulation modeling predicts that chronic wasting disease has the potential to cause drastic population reductions in deer (Miller et al. 2000; Gross and Miller 2001).

ISSUES AND IMPACT TOPICS

According to the guidance provided in Director's Order #12 (NPS 2001c), an "issue" under the National Environmental Policy Act describes the relationship between actions (proposed, connected, cumulative, similar) and environmental resources, including natural, cultural, and socioeconomic resources. Issues are usually problems that the current management practices have caused or that any of the proposed alternatives might cause. They also may be questions, concerns, problems, or other relationships, including beneficial ones.

Issues need to be addressed in the analysis of the proposed management actions and alternatives. The following issues were identified by the Environmental Impact Statement Team and by the public during the public scoping period. Initial analysis showed that some of these issues were not problematic; the section "Issues Considered but Not Evaluated Further" at the end of this chapter explains why each was dismissed. In addition, research and analysis raised further problems, questions, or concerns related to some of these issues. Relevant aspects of those issues that were retained are discussed in detail under the appropriate impact topics in Chapter 3 "Affected Environment" and Chapter 4 "Environmental Consequences." See Chapter 5

"Consultation and Coordination" for a description of public and agency involvement that took place during the development of this plan.

Effects of Existing Elk Population

Elk Population and Density: Effects on Vegetation, Wildlife, Population Health, and Biodiversity

Since active management of elk within Rocky Mountain National park ended in 1969, the increased abundance and densities of elk has placed stress on the local ecosystem:

> Research in Rocky Mountain National Park indicates that, without an intact predator base, the elk population size is larger and the population is more concentrated, more sedentary (i.e., less mobile), and less migratory (i.e., remaining on primary winter range in summer). As a result, some plant species, particularly montane riparian willow and aspen, are browsed to the point that they cannot regenerate. This has altered aspen and montane riparian willow plant communities in the park, primarily in the core winter range, which has potential to reduce the biodiversity of plants and animals in those communities. The vegetation community-level changes are exacerbated by reduced water levels and the significant decrease in the beaver population in the park, which contribute to changes in water levels. High elk populations and densities may contribute to an increase in erosion, water quality degradation, and an increase in exotic plant establishment.
>
> The public identified a need to address restoration of an intact ecosystem in addition to focusing on elk and vegetation. Within this context, the issue of habitat restoration to benefit all species rather than just elk was recognized. By considering ecosystem restoration as a goal rather than a species- or community-specific approach, biodiversity would be bettered served.
>
> Although there is no direct evidence to suggest that elk in Rocky Mountain National Park are negatively affecting native biodiversity on a landscape scale, there is indirect evidence to support such a concern. Aspen and montane riparian willow communities support a diversity and abundance of wildlife not seen in other habitat types in Rocky Mountain National Park. Further declines of the montane riparian willow and aspen communities on the core winter range would likely result in localized declines or losses of bird, butterfly, and plant species in Rocky Mountain National Park.
>
> Montane riparian willow declines over the last 50 to 60 years are attributed to a variety of factors, but the current condition and trend of montane riparian willow communities is primarily due to the effects of elk. Elk are severely inhibiting the ability of montane riparian willow to reproduce, for few willow plants on the primary winter range are able to produce seed, and seedling survival is almost non-existent. Elk are also suppressing the growth of willow plants, so that few plants can attain a height greater than the herbaceous layer. Montane riparian willow communities on the core winter range are expected to continue to decline under current browsing levels.
>
> The localized decline or loss of aspen stands may indicate an ecosystem that is outside its natural range of variability. Elk are the proximate factor in aspen declines, as elk browsing severely inhibits aspen reproduction and growth on the primary winter range.
>
> Herbaceous consumption rates by elk in the park are extremely high and comparison with consumption rates in similar type ecosystems indicates that herbaceous communities on the primary winter range may not be able to be maintained under such grazing pressures.

Recent surveys indicate that up to 25% of the elk population remains on primary winter range areas year-round and nonmigratory elk can severely inhibit the regrowth capabilities of important winter forage species.

High levels of elk herbivory in upland shrub areas have inhibited the ability of fire resource managers in the park to use prescribed fire to reduce fuel levels. High levels of herbivory by elk and mule deer following a fire can result in the permanent loss of shrubs.

The elk population has increased over the past 30 years to a high ranging from 2,800 to 3,500 animals between 1996 and 2001. There have been concerns that the town subpopulation would continue to grow as some estimates showed it to be below carrying capacity. Recent estimates, however, indicate that the town subpopulation may be at or within the carrying capacity of the habitat, although this does not necessarily mean that the elk and the habitat are in balance or that the population is within the natural range of variation. Other factors such as elk distribution, a lack of natural predators, and hunting prohibitions in the park or Estes Park can have a large affect on habitat conditions although the carrying capacity is adequate to support the population. Research indicates that as a result, the elk population is now limited primarily by density-dependent factors. The large and highly dense elk population may affect elk behavior during the breeding season, when energy expenditures, particularly for bulls, may affect survival and fitness (i.e., ability to reproduce).

Effects on Property and Safety

Increasing elk numbers and concentrations have the potential to increase health and safety risks for humans as well as for elk:

Elk have concentrated in "safe zones" where they cannot be hunted, including Rocky Mountain National Park and the Town of Estes Park. As a result, property damage from elk in the Town of Estes Park has increased. Elk eat shrubbery, gardens, and lawns on private and public property, including the town golf course, its parks, and school grounds.

Migratory and calving patterns have changed, with more elk calving in town. This has resulted in an increased safety risk for people in town who inadvertently or intentionally disturb cows or their calves. Increased elk concentrations may also increase risk of human contact with bull elk or other dangerous individuals outside calving season.

It is believed that increased concentrations of elk can increase the rate of transmission of chronic wasting disease in the elk population.

Increased abundance and concentrations of elk in the park and town cause visitors driving automobiles to slow down or stop as they seek to view elk, which increases traffic congestion and accidents.

Habitat Conflicts

Estes Park and the region around the park are being increasingly developed for summer and year-round homes. Both the human population and the elk population have increased over recent years. This has displaced elk onto open areas in the town, and has increased elk-human contact in the town and entire project area. This increase in contact can result in the following problems:

Elk may have become more habituated to humans and be less fearful of them. This can mean not only safety risks and property damage, as described in the preceding issue, but also the perception of elk as pests. The requirement that dogs be leashed has helped habituate elk to humans.

New residents may not be as tolerant of elk as those who have lived with them for many years. Some citizens want elk removed or the population reduced or restrained and others want to keep them as they are now. This reflects a difference in social values.

Effects on the Local Economy

Changes in the size and density of the elk population in the park and the Estes Valley could impact various sectors of the area economy.

Elk are a major visitor draw for Estes Park and Rocky Mountain National Park. Town business owners depend in large part on the money spent by visitors who come to view elk to support their business.

Local employment can be directly affected by elk management strategies. Hunting contributes substantially to the Estes Valley economy, and changes in elk population management strategies could affect hunting.

The overpopulation of elk has potential effects on agricultural operations in the Estes Valley as a result of competition between livestock and elk for natural vegetation and supplementary feedstocks (i.e., hay).

Effects on Visitors

Because some people visit the park to view elk, the increase in visitors can impact the experience for all visitors. In some cases, the large number of visitors who come to the park to view elk can cause traffic congestion and noise in popular elk-viewing areas. This can detract from the values typically associated with the national park experience, such as solitude and quiet.

Effects of Potential Management Actions

Lethal Reduction Management Actions

The use of park staff or personnel assisting the National Park Service to remove elk using lethal means such as firearms or injection raised the following issues:

Lethal reduction could be an effective population control measure with substantial support, but a segment of the public does not want to see a lethal management tool employed in a national park. Opposition to lethal reduction could adversely affect tourism. This issue is distinct from hunting in a national park because the lethal reduction would be done under controlled circumstances by agency or contracted personnel and would not allow for the “fair chase” ethic associated with hunting.

There are concerns that lethal reduction activities, including an elk-capture facility, use of equipment and personnel to access backcountry or wilderness areas of the park, and removal of elk carcasses, could affect vegetation as well as other wildlife species, their habitats, or their behavior.

Lethal reduction activities could pose safety risks to the public and staff implementing the actions.

Hunting of Elk Outside the Park as a Population Control Measure

Although hunting is illegal in the park, hunting outside the park has traditionally been used to manage elk populations. However, there are concerns associated with hunting as a means of population control for the Rocky Mountain National Park / Estes Valley population:

Colorado Division of Wildlife hunting harvest objectives may not have the same goals as the National Park Service with respect to the size and distribution of the elk population.

Hunting has the potential to reduce localized populations; however, because of limitations on hunter access to the elk population of concern, hunting may not be effective in controlling the population in areas where impacts are taking place (e.g., Estes Park).

Redistribution Methods

Concerns were raised that methods used to redistribute the elk population such as aversive conditioning and the use of unsuppressed (noisy) weapons may result in more elk movements outside the park that may exacerbate problems in areas adjacent to the park such as Estes Park.

Chronic Wasting Disease

There is concern that high concentrations of elk may be associated with increases in the rate of transmission of chronic wasting disease in the elk population. The presence of chronic wasting disease has numerous ramifications. Some of these include questions about the safety of consuming elk meat and the long-term effects of the disease on the elk population. This plan will be limited to assisting in determining the prevalence of chronic wasting disease in Rocky Mountain National Park elk; actions will not conflict with chronic wasting disease management.

Education

Education of the public about elk, their habits, and how people can learn to adapt and share the environment with elk was identified as an issue. The plan will incorporate educational components to help deal with this issue.

Release of Wolves

Releasing an experimental gray wolf population in Rocky Mountain National Park is a controversial issue. Some people argue that it is the most effective way to manage the elk population, while others argue that conditions in the region make this approach infeasible:

Proponents of wolf release maintain that wolves would control elk populations and return a missing predator to the ecosystem.

Opponents posit that the region is too developed and that the wolf no longer has a suitable niche within this human-dominated system. Others question whether a plan to release wolves in the park could occur without cooperation from other agencies or if it would be consistent with the Colorado Wildlife Commission draft Wolf Management Plan. There is also concern that release of wolves in the park would result in depredation of livestock and/or domestic animals.

Fertility Control

Issues relating to use of fertility control as a management tool include ethical concerns as well as concerns about the biological effects of fertility control agents.

> There are concerns that the use of fertility control to manage elk populations would be artificial and that humans do not have the right to interfere with the reproductive processes of wild animals.
>
> There is also a concern that not enough is known about the long-term effects of fertility control agents on elk and other species that could be exposed to the control agent or its derivatives.
>
> Concern was also raised regarding the consumption of elk meat that has been exposed to fertility control agents.

Fences

The use of fences to restrict elk access to vegetation and allow restoration of fenced vegetative communities is a polarizing issue. Some people feel that fences would have an adverse effect on the park visitor experience while others view fences as the solution to protecting and restoring degraded vegetative communities. Fencing in the park raises the concern that elk fenced out of preferred foraging habitat in the park would disperse to habitats in town and exacerbate existing problems. Concerns were also raised regarding the effects that fences would have on the movements of other wildlife.

Effects on Hydrology

Various management actions such as construction of fences, active replanting of montane riparian willow, or the recovery or reintroduction of beaver could affect water quality and hydrology on the elk range.

Effects on Soils

Soil resources could be affected by excess concentration of elk or by the actions taken to manage the elk population as a result of erosion, exposure of bare ground, compaction, changes in fertility and nutrients, and long-term sustainability and productivity.

Effects on Wilderness

Because 95% of Rocky Mountain National Park is managed as wilderness, elk and vegetation management actions could affect wilderness or wilderness values. Actions such as the transport and installation of fences and capture facilities, the use of helicopters, removal of carcasses, and use of firearms could degrade the wilderness within the park.

Effects on Natural Soundscapes

Natural soundscapes within the park could be disturbed by elk and vegetation management actions such as fence construction and the use of machinery, including helicopters, motorized vehicles, and firearms.

Effects on Public Health and Safety

Issues identified during scoping include potential safety risks for the public or personnel associated with elk and vegetation management actions such as darting, prescribed fire, and fence construction and maintenance.

Effects on Visitors

Some scoping participants expressed concerns that prescribed fire could generate smoke and odors or could close portions of the park, which could detract from the park experience.

Effects on Park Operations

The elk and vegetation management actions could have a substantial effect on the ability of the park staff to perform their duties.

ISSUES CONSIDERED BUT NOT EVALUATED FURTHER

Chronic Wasting Disease Management

Some members of the public requested that this management plan specifically address chronic wasting disease and focus on finding a solution for the problems associated with the disease. This plan/EIS does evaluate the effects that changes in the elk population size and distribution may have on chronic wasting disease in the population. Moreover, the National Park Service recognizes that management of elk populations requiring population reductions would present an opportunity for the park to gain knowledge on the prevalence of chronic wasting disease within the park, and under this plan, that information will be collected within the framework of the alternative chosen. In conjunction with the proposed elk management actions, the National Park Service would collect data regarding a field procedure that can serve as a diagnostic test for chronic wasting disease in live elk. However, this plan/EIS will not address efforts to manage chronic wasting disease, which is beyond the scope of this plan. If information collected through this plan shows that there is a need to manage the disease in elk, that need would be addressed by a separate chronic wasting disease management plan.

Mule Deer and Moose Management

During scoping, concerns were raised about the response of mule deer and moose populations as a result of changes in elk populations, the effects that such responses would subsequently have on sensitive upland shrub and willow habitat, and whether the park should also take action to control these other ungulate populations. This plan/EIS evaluates the indirect effects on moose and mule deer populations and the effects on vegetation; however, management of these other ungulates is beyond the scope of this plan. If monitoring of upland shrubs, which would be separate from elk and vegetation monitoring associated with this plan/EIS, and monitoring of willow as part of this plan/EIS indicate that mule deer populations and/or in moose populations are degrading vegetation, the park would develop separate management plans to address these concerns.

IMPACT TOPICS

Discussions during scoping examined the range of potential natural and cultural resources and elements of the human environment that might be of concern or might be affected by the implementation of an elk and vegetation management plan. This review led to the selection of impact topics to be analyzed in the environmental impact statement. The impact topics examined, along with rationales for their retention or dismissal, are presented in the following paragraphs. Relevant laws, regulations, and policies specific to given impact topics retained are described in Chapter 4, "Environmental Consequences." Those relevant to all topics are discussed in "Laws, Regulations, and Policies" later in this chapter.

The natural resource topics that were retained for detailed analysis follow:

Elk population: Retained as one of the primary resources to be managed by this plan.

Vegetation: Retained as one of the primary resources to be managed by this plan. This impact topic will include analyses of effects on wetland vegetation.

Special status species: Retained because actions taken by the plan could have effects on several listed species and on compliance with the Endangered Species Act.

Other wildlife species: Retained because of the potential of the plan to affect other species of wildlife and their habitats.

Water resources: Retained because of the relationships among vegetation (especially montane riparian willow), water resources, wetlands, and elk in the park's primary winter range. This topic also addresses wetland issues associated with hydrology.

Wetlands: Retained because much of the elk-preferred habitat is in montane riparian willow wetlands in the eastern portion of the park and the Kawuneeche Valley, but not addressed as a stand-alone impact topic. The hydrological and vegetative wetland components and issues are fully evaluated in the "Water Resources" and "Vegetation" sections, respectively.

Soils and nutrient cycling: Retained because of the impacts that existing elk populations have on soils in areas where elk congregate in high densities. Continuing current management could result in continued or increased soil erosion. Management actions to control elk and protect vegetation could also result in increased soil erosion. Alternatives that altered vegetative cover and hydrology by reducing elk numbers or restoring montane riparian willow, aspen, and other plant communities could improve soils and reduce erosion.

Natural soundscape: Retained because it could be affected by several of the potential management tools that could be used to manage the elk population. These include, but are not limited to, shooting and the use of vehicles and aircraft.

Wilderness: Retained because of the potential for management actions to affect designated and recommended wilderness in the park.

Socioeconomics: Retained because elk viewing contributes substantially to the Estes Park economy. Changes in the elk population's size, location, or behavior could affect these factors.

Public health and safety: Retained because of concerns associated with shooting, the consumption of elk meat, and human-elk interactions.

Visitor use and experience: Retained because elk are integral to the expectations and activities of visitors to the park. The actions implemented by the plan could affect how visitors would use and experience the park.

Park operations: Retained because the implementation of management actions in association with this plan would require changes in how the park is operated.

IMPACT TOPICS CONSIDERED BUT DISMISSED

A brief rationale is provided for each impact topic that was dismissed from further evaluation in this environmental impact statement.

Air quality: Under the alternatives considered, there would be short-term, transportation-related effects. Surface disturbance from transportation actions would be minimal, and fugitive dust would not likely affect visitors and staff. Emissions from vehicles would be minimized by best management practices such as restricting idling time. Therefore, there would be no appreciable impacts on air quality related to transportation.

The action alternatives could include prescribed fire activities, which emit smoke. As stated in the Rocky Mountain National Park Fire Management Plan, the intent of the Clean Air Act is not to manage the impacts of natural resources management activities or of singular events such as wildland or ecologically beneficial prescribed fires that would occur in Rocky Mountain National Park (NPS 2004a). Thus, temporary impacts on air quality and visibility in the park during ecologically essential fires are anticipated and managed for. Implementation of small-scale burns would be conducted according to specifications in the fire management plan incorporating best management practices and mitigation measures to reduce air quality effects. All necessary permits would be obtained to conduct any beneficial burn activities. As a result of the small-scale nature of burns that would occur with implementation of mitigations, the effects on air quality would be short-term and would not exceed a minor level. Therefore, air quality is not considered for further consideration.

Cultural resources: No fences or temporary capture facilities would be located near existing structures or built in National Register Historic Districts, cultural landscapes, or campgrounds. The park archeologist would be contacted prior to the construction of any proposed fences or capture facilities to ensure that work would not disturb historic or prehistoric archeological sites. Should any artifacts or bone be encountered in the construction of the fences, work would cease and the park archeologist would be contacted. There are no identified ethnographic resources in the park that would be affected by elk management activities. In addition, none of the park's museum collections would be affected by any of the alternatives under evaluation. It is possible that the presence of elk, particularly when they congregate, may expose archeological resources; however, this possibility is considered to be remote and would be difficult to detect, and the impact would be negligible. Therefore, cultural resources are dismissed from further consideration.

Ecologically critical areas or other unique natural resources: The alternatives being considered would not affect any designated ecologically critical areas, wild and scenic rivers, or other unique natural resources, as referenced in the Wild and Scenic Rivers Act, *Management Policies*, 40 *Code of Federal Regulations* 1508.27, or the 62 criteria for national natural landmarks.

Energy efficiency and conservation potential: Under any alternative, the National Park Service would continue to implement its policies of reducing costs, eliminating waste, and conserving resources by using energy-efficient and cost-effective technology (NPS 2006b). The National Park Service would continue to look for energy-saving opportunities in all aspects of park operations. Refer to the "Sustainability and Long-term Management" section in Chapter 4 "Environmental Consequences" for additional details regarding the dismissal of this impact topic.

Environmental justice: Executive Order 12898, General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that all federal agencies address environmental and human health conditions in minority and low-income communities to avoid disproportionate placement of any adverse effects from federal policies and actions on these populations. Residents within the surrounding communities of the park are not disproportionately minority or low-income. Changes in elk and vegetation management within the park would not disproportionately affect low-income or minority populations. NPS policy (NPS 2006a) and the need for informed consent of individuals who would consume elk meat resulting from management actions prohibits the donation of meat to groups or organizations that support individuals of low-income; see "Distribution of Carcasses" in the "Actions Common to All Action Alternatives" section of Chapter 2 for more detail. Minority and low-income individuals would not be prohibited from receiving meat if available. Therefore, this topic has been dismissed from further consideration.

Floodplains: Executive Order 11988 instructs federal agencies to avoid, to the extent possible, the long- and short-term, adverse impacts associated with the occupancy and modification of floodplains and wetlands, and to avoid direct or indirect support of development in floodplains and wetlands wherever there is a practicable alternative. Director's Order # 77-2 addresses development in floodplains. None of the alternatives proposed in this plan would develop lands within any floodplain; actions taken in floodplains would be short term and support vegetation restoration objectives. As a result, floodplains were not retained for further analysis.

Indian trust resources: Indian trust assets are owned by American Indians but are held in trust by the United States. Requirements are included in the Secretary of the Interior's Secretarial Order 3206, American Indian Tribal Rites, Federal–Tribal Trust Responsibilities, the Endangered Species Act, and Secretarial Order 3175, Departmental Responsibilities for Indian Trust Resources. No Indian trust assets occur within Rocky Mountain National Park. Therefore, there would be no effects on Indian trust resources resulting from any of the alternatives.

Natural or depletable resource requirements and conservation potential: As directed by *Management Policies* (NPS 2006b), the National Park Service strives to minimize the short- and long-term environmental impacts of development and other activities through resource conservation, recycling, waste minimization, and the use of energy-efficient and ecologically responsible materials and techniques. Each of the action alternatives requires energy and materials for day-to-day operations. The use of energy is analyzed under the impact topic dismissed from further analysis "Energy efficiency and conservation potential." Specific impacts on the natural environment are addressed by impact topic.

Prime and unique farmland: The Council on Environmental Quality 1980 memorandum on prime and unique farmlands states that prime farmlands have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. Unique agricultural land is land other than prime farmland that is used for production of specific high-value food and fiber crops. Both categories require that the land be available for farming uses. Lands within Rocky Mountain National Park are not available for farming and therefore do not meet the definitions.

LAWS, REGULATIONS, AND POLICIES

Numerous laws, regulations, policies, and planning documents at the federal, state, and local levels of jurisdiction guide the decisions and actions that can be taken under the elk and vegetation management plan. The following provides a summary of the laws, regulations, and policies that provide the authority and basis for this plan and that affect the alternatives that were considered.

NPS Organic Act of 1916 and the Requirement to Avoid Impairment

In the Organic Act of 1916, which established the National Park Service, Congress directed the Department of the Interior and the National Park Service to manage units "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (Title 16 United States Code, section 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that the National Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically directed by Congress" (Title 16 United States Code, Section 1a-1).

Within these mandates, the Organic Act and its amendments afford the National Park Service latitude when making resource decisions that balance visitor recreation and resource preservation. By these acts, Congress "empowered [the National Park Service] with the authority to determine what uses of park resources are proper and what proportion of the parks resources are available for each use" (Bicycle Trails Council of Marin v. Babbitt, 82 F.3d 1445, 1453 [9th Cir. 1996]).

Courts have consistently interpreted the Organic Act and its amendments to elevate resource conservation above visitor recreation. For example, Michigan United Conservation Clubs v. Lujan, 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation." The National Rifle Association of America v. Potter, 628 F. Supp. 903, 909 (D.D.C. 1986) states, "In the Organic Act Congress speaks of but a single purpose, namely, conservation." *Management Policies* also recognizes that resource conservation takes precedence over visitor recreation. Section 1.4.3 states that "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant" (NPS 2006b).

Because conservation remains predominant, the National Park Service seeks to avoid or minimize adverse impacts on park resources and values; however, the National Park Service has discretion to allow negative impacts when necessary to fulfill park purposes (NPS 2006b, 1.4.3).

While some actions and activities cause impacts, the National Park Service cannot allow an adverse impact that constitutes resource impairment (NPS 2006b, 1.4.3). The Organic Act prohibits actions that impair park resources unless a law directly and specifically allows the acts (16 USC 1a-1). An action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2006b, 1.4.5). To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected, the severity, duration, and timing of the impact, the direct and indirect effects of the impact, and the cumulative effects of the impact in question and other impacts" (NPS 2006b, 1.4.5). This plan/EIS, therefore, assesses the effects of the management alternatives on park resources and values and determines if these effects would cause impairment.

NPS management policies require an analysis of potential effects to determine whether or not actions would impair park resources (NPS 2006b). The fundamental purpose of the national park system is to conserve park resources and values for the use and enjoyment of future generations. NPS managers have the discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. That discretion to allow certain impacts within the park is limited by the statutory requirement that the National Park Service must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible manager, would harm the integrity of park resources or values. An impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major adverse effect on a resource or value whose conservation is

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park
- Key to the natural or cultural integrity of the park
- Identified as a goal in the park's general management plan or other relevant NPS planning documents

Management Policies

Management Policies (NPS 2006b) establishes service-wide policies for the preservation, management, and use of park resources and facilities. These policies provide guidelines and direction for management of elk and vegetation within the park.

Section 4.4.1.1 requires that the National Park Service "adopt park resource preservation, development, and use management strategies that are intended to maintain the natural population fluctuation and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks" (NPS 2006b).

Section 4.1.5 also directs the National Park Service to reestablish natural functions and processes in human-disturbed components of natural systems in parks (unless otherwise directed by Congress). Impacts on natural systems resulting from human disturbances include the disruption of natural processes. The National Park Service will seek to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated. The National Park Service is to use the best available technology, within available resources, to restore the biological and physical components of these systems, accelerating both their recovery and the recovery of landscape and biological- community structure and function. This includes the restoration of native plants and animals, which Section 4.4.1.3 defines as "all species that have occurred or now occur as a result of natural processes on lands designated as units of the national park system" (NPS 2006b).

Numerous other sections of *Management Policies* are relevant to the elk and vegetation management plan. These sections include, but are not limited to, Section 4.3.6, Biosphere Reserves; 4.4.1, General Principles for Managing Biological Resources; 4.4.1.1, Plant and Animal Population Management Principles; 4.4.1.2, Genetic Resource Management Principles; 4.4.2.1, NPS Actions That Remove Plants and Animals; 4.4.2.2, Restoration of Native Plant and Animal Species; 4.4.3, Harvest of Plants and Animals by the Public; 4.9, Soundscape Management; and 6 Wilderness Preservation and Management. *Management Policies* is incorporated by reference to support the decisions made in association with this plan.

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision-Making

Director's Order #12 and the accompanying handbook (NPS 2001c) lay the groundwork for how the National Park Service complies with the National Environmental Policy Act. Director's Order #12 and the handbook set forth a planning process for incorporating scientific and technical information and establishing a solid administrative record for NPS projects.

Director's Order #12 requires that impacts on park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and in context, based on an understanding and interpretation by resource professionals and specialists. Director's Order #12 also requires that an analysis of impairment to park resources and values be part of the National Environmental Policy Act document.

Purpose and Significance of Rocky Mountain National Park

National park system units are established by Congress to fulfill specific purposes, based on the unit's unique and significant resources. A unit's purpose, as established by Congress, is the foundation on which later management decisions are based to conserve resources while providing "for the enjoyment of future generations."

The purpose and significance of Rocky Mountain National Park and its broad mission goals are derived from its enabling legislation and are summarized in the park's strategic plan (NPS 2005j). The purpose, need, objectives, and range of alternatives presented in this plan/EIS are grounded in the park's purpose and mission.

Excerpts relevant to the management of elk and vegetation in the park are provided below.

Establishment

Congress established Rocky Mountain National Park on January 26, 1915. The enabling legislation states (38 Stat. 798)

> Said area is dedicated and set apart as a public park for the benefit and enjoyment of people of the United States…with regulations being primarily aimed at the freest use of the said park for recreation purposes by the public and for the preservation of the natural conditions and scenic beauties thereof…"

Significance of Rocky Mountain National Park

As stated in the park's 2005-2008 strategic plan (NPS 2005j), Rocky Mountain National Park is significant because

> Rocky Mountain National Park provides exceptional accessibility to a wild landscape with dramatic scenery, opportunities for solitude and tranquility, wildlife viewing, and a variety of recreational opportunities.
>
> The fragile alpine tundra encompasses one third of the park and is one of the main scenic and scientific features for which the park was established. This is one of the largest examples of alpine tundra ecosystems preserved in the national park system in the lower 48 states.
>
> The park, which straddles the Continental Divide, preserves some of the finest examples of physiographic, biologic, and scenic features of the Southern Rocky Mountains. The park contains the headwaters of several river systems, including the Colorado River. Geologic processes, including glaciation, have resulted in varied and dramatic landscape. Elevations span from 7,630 feet to 14,259 feet atop Longs Peak, a landmark feature.
>
> The park's varied elevations encompass diverse ecosystems where wilderness qualities dominate. Varied plant and animal communities and a variety of ecological processes prevail.

In October 1976, Rocky Mountain National Park was recognized as an International Biosphere Reserve. This recognition highlights the significance of the park's natural ecosystems, which represent the Rocky Mountain Biogeographic Province. As an element of the Biosphere Reserve, Rocky Mountain National Park is part of a network of protected samples of the world's major ecosystem types, devoted to conservation of nature and genetic material and to scientific research in service of man.

RELATIONSHIP TO OTHER PLANS AND PROJECTS

Elk and vegetation management is only one of many management issues in Rocky Mountain National Park and the surrounding area. Ongoing planning at the federal, state, and local levels on other management issues may affect or guide NPS decisions made for elk and vegetation management in the park. Efforts were taken to maintain consistency between actions associated with elk and vegetation management and other ongoing planning and resource management efforts. However, the actions associated with this plan would be taken exclusively by the National Park Service. Plans and projects that were considered in the preparation of this plan and environmental impact statement are summarized below.

Rocky Mountain National Park Master Plan, 1976

The most recent master plan for this park was written in 1976 and, for the current analysis, serves as the park's general management plan. The master plan established guidelines for the overall use, preservation, management, and development of the park. It identified the purposes for the various areas of the park, its relationship to regional environs, its resource values, and which human-environment needs should be met, and it set forth park management objectives. This document established three management zones in the park, including the scenic viewing or drive-through zone, the day-use zone, and the primitive or backcountry zone, and established resource management and development standards for each. It also contains a land classification plan and a general development plan.

The 1976 plan included the following management objective, relevant to the goals of elk and vegetation management:

> To provide management for the soil, water, flora, and fauna, native to this portion of the Rocky Mountains, so as to minimize the impact of man, and where desirable and feasible restore those ecosystems altered by man. Restoration will be aimed at presenting as close an approximation of primitive conditions as possible.

Rocky Mountain National Park Vegetation Restoration Management Plan, 2006

The vegetation restoration management plan provides the guidelines, procedures, and techniques to be applied in vegetation and ecological restoration activities taking place in the park, including classifying areas and determining an approach to treatment. The goals of the plan include using local genotypic plant material for restoration efforts, stabilizing disturbed sites before they deteriorate further, and controlling the establishment and perpetuation of non-native species. It states that each restoration effort should include preserving the genetic integrity of native plants, collection of baseline data, and carrying out a quantitative monitoring program throughout the life of the project.

The elk and vegetation management plan will be consistent with the park's vegetation restoration management plan. Specifically, both will work toward preserving the genetic integrity of native plants, reducing invasive plant species, collecting consistent monitoring data, and restoring native communities within the park. Both plans will work toward collecting consistent monitoring data and restoring native vegetation within the park.

Backcountry Wilderness Management Plan, 2001

This plan addresses the designated or recommended wilderness areas in Rocky Mountain National Park. The plan formalizes the management guidelines for non-developed areas of the park that are defined as backcountry. The plan provides direction for management of natural and cultural resources within the context of wilderness management policies. It also identifies the park's long-range management goals and objectives for backcountry wilderness areas and sets forth actions to meet those objectives. The plan formalizes management practices in the park for the protection of wilderness values and resources, including the requirement that a minimum tool analysis be conducted for management actions that take place in wilderness areas. Activities conducted as part of the elk and vegetation management plan will be consistent with the guidelines set fort in the backcountry wilderness management plan.

Rocky Mountain National Park Fire Management Plan, 2004

This plan is a detailed plan of action for all wildland fire activities, including preparedness, suppression, wildland fire use, fire prevention, fire monitoring, and fuels management activities. Included are the monitoring and evaluation processes, goals of the fire management program, and descriptions of the fire regimes, condition class, and ecosystem processes of the major vegetative associations found within each fire management unit at Rocky Mountain National Park.

The goals in the plan include such concepts as protecting life and property, using a variety of fire management tools, allowing wildland fire to achieve its natural role in the ecosystem, and avoiding unacceptable effects. Each of the eleven fire management units has unique natural attributes and has different objectives established by this plan.

The elk and vegetation management plan will coordinate and be consistent with the fire management plan to provide for vegetation restoration through the use of prescribed fire. These efforts would proceed when the elk population has been reduced to an acceptable level to allow protection of habitat from overuse by elk.

Arapaho and Roosevelt National Forests and Pawnee National Grassland, 1997 Revision of the Land and Resource Management Plan

This plan provides guidance for all resource management activities in the Arapaho and Roosevelt National Forests and Pawnee National Grassland. It establishes forest-wide, multiple-use goals and objectives; management requirements; direction for specific management areas and geographic areas; designation of land uses and management activities; and monitoring and evaluation requirements.

The plan provides for long-term health of the land and restoring of ecosystems. Multiple resource uses, including recreation and commodities, are managed within the capabilities of the ecosystems. The plan specifies that management actions will not result in the loss of any species, and identifies large blocks of land that will remain undeveloped and natural.

A Strategy for Accelerated Watershed/Vegetation Restoration on the Arapaho and Roosevelt National Forests and Pawnee National Grassland, 2004

This plan identifies the need to develop sustainable vegetative communities that fulfill the forest's stated desired future conditions. The goals of this plan are to increase the rate of vegetation management activities, rapidly restore vegetation, and treat areas containing hazardous fuels. The plan prescribes the use of low-intensity fire to treat low-elevation ponderosa pine forests, reduce tree density and fuels build-up, and encourage old-growth trees. Improving ecosystem sustainability through prescribed fire will improve habitat conditions for wildlife, reduce risks to watersheds, and reduce the expansion of noxious weeds. The plan's activities will encourage the restoration of degraded and recovering vegetative areas, strengthen the diversity of the ecosystem, and reduce the risk of future wildland fires. The goals of this plan complement those of the elk and vegetation management plan, as actions taken would result in improving habitat for wildlife species and restoration of native vegetation within the region.

Draft Colorado Wolf Management Plan

In May 2005, the Colorado Wildlife Commission adopted the recommendations of the Colorado Wolf Management Working Group for management of wolves that may migrate to Colorado. The working group's recommendations were in anticipation of the natural return of the wolf to Colorado. Some of the recommendations from the group include:

Wolves should be allowed to live without boundaries in suitable habitat in Colorado.

> The management plan should be implemented within an adaptive management framework that will allow the state the maximum flexibility to manage wolves.
>
> Coordination with other federal and state agencies should occur to determine wolf occurrence, status, and habitat use.
>
> Voluntary non-lethal methods should be encouraged to prevent wolves from causing damage.
>
> Livestock producers should be compensated when wolves kill or injure livestock.
>
> Wildlife managers may control predators if they are inhibiting management of other wildlife populations as directed by a species management plan.
>
> There should be ongoing efforts to assess public attitudes towards wolves and to keep the public informed and involved.

In November 2005, the wolf working group was tasked to continue discussions through 2006, focusing on who should make the decision about potential reintroduction of wolves to Colorado and how a compensation program should be structured. Decisions of the state's management of naturally occurring wolves and any future decisions regarding potential reintroduction of wolves is important to the Rocky Mountain National Park elk and vegetation management plan because one alternative includes using wolves to help manage elk in the park, and two other alternatives retain the potential to use wolves in an adaptive context as needed.

The Wildlife Commission established the wolf working group in anticipation of a change in the legal status of wolves. With the increasing numbers of wolves in Wyoming, Montana, and Idaho, the U.S. Fish and Wildlife Service was in the initial stages of delisting the wolf. This change in legal status would return management authority for wolves to the state wildlife divisions. However, in January 2005, a U.S. District Court judge ruled that the U.S. Fish and Wildlife Service rulemaking to identify the "distinct population segments" of wolves violated the Endangered Species Act (USFWS 2005b). This court ruling kept management of all wolves under the Endangered Species Act and under the authority of the U.S. Fish and Wildlife Service for the time being. As a result, the state's wolf management plan, and any supplementary document that may be generated, would guide the situation "if and when" the federal government turns over management of wolves to the state. While there are uncertainties about the management authority for wolves, for the purposes of this EIS analysis, it is foreseeable that the state wolf management plan would be implemented on land around the park within the 20-year lifespan of the elk and vegetation management plan.

Colorado Wildlife Commission Five-Year Big Game Season Structure, 2005-2009

The Colorado Wildlife Commission approves big game season structures in five-year blocks to guide the development of annual hunting regulations and harvest targets. The Commission provides this guidance for a number of reasons. For wildlife managers, multi-year season structures allow some consistency in the application of wildlife management practices and the opportunity to assess their effectiveness. The Data Analysis Unit and Game Management Unit elk harvest targets are developed by the Wildlife Commission within the season structure set out in the five-year season structure plan. The National Park Service would use the annual elk hunting harvest results in areas adjacent to the park to determine appropriate elk reduction target levels for actions that would be taken in the park.

Estes Valley Comprehensive Plan, 1996

This document provides direction for regional planning in the Estes Valley to accommodate growth and maintain the quality of life known to the valley's inhabitants. The plan addresses housing, the local economy, population growth, traffic, and retaining the overall quality of the town.

In preparing the plan, citizens participated in a lengthy process to decide the direction of the valley's growth. The goals identified in the plan include balancing the needs of visitors with those of full-time residents, encouraging tourism in the valley, accommodating the growing population of retired residents, and preserving natural resources.

The plan consists of five major components: a future land use plan and map, a transportation plan, economic overview, development of community-wide policies, and an action plan. The plan proposes limited development on steep slopes, visually sensitive areas, areas with significant wildfire hazards, wildlife migration routes and habitat, and flood-prone areas.

Estes Park Development Code, 2000

The regulations of this code implement the 1996 Estes Valley comprehensive plan. The code establishes development regulations to preserve the appearance and density of the area, coordinate the actions of other various plans, and encourage development of the downtown area.

In this document, the Town of Estes Park considers the presence of wildlife and the need to preserve their habitat while accommodating growth of the town. In the development of new trails or open space, the code states that priority is to be given to any area with known migration corridors. All residential developments and subdivisions containing five or more units must set aside a pre-set minimum percentage of total gross land area for private open areas for the protection of wildlife habitat.

Larimer County Master Plan, 1997

The Larimer County master plan establishes a long-range framework for decision-making for the unincorporated area of the county. It includes criteria for development decisions, decisions on public services and capital facilities, and decisions on environmental resources protection through its guiding principles and implementing strategies.

In the plan, new development is directed to be compatible with natural systems in the county and existing uses through environmental review and performance standards incorporated into the development review process. Information on wetlands, wildlife habitat, and other sensitive environmental areas will be included in the county's review process by their identification in county maps. New subdivisions will be required to plat houses in clusters, creating up to 80% open space (depending on existing zoning) to allow room for new rural residential areas while maintaining agricultural and natural areas. This document also contains the Larimer County land use code, which implements the directives set forth in the Larimer County master plan.

This page intentionally left blank

Alternatives

This page intentionally left blank

ALTERNATIVES

INTRODUCTION

The *National Environmental Policy Act* (NEPA) requires that federal agencies explore a range of reasonable alternatives and analyze impacts that the alternatives could have on the natural and human environment. The "Environmental Consequences" chapter of this elk and vegetation management plan and environmental impact statement (plan/EIS) presents the results of the analyses. The alternatives under consideration must include a "no-action" alternative as prescribed by 40 CFR 1502.14. Alternative 1 in this plan/EIS is considered to be the "no-action" alternative as it is the continuation of current management of elk and vegetation, and it assumes that the National Park Service (NPS) would not make major changes to the current management program. The four action alternatives presented in this chapter were developed by the interagency planning team, which included federal, state, and local agencies, and through feedback from the public during the public scoping process.

Each of the four action alternatives analyzed in this plan/EIS meets, to a large degree, the management objectives for elk and vegetation and also addresses the purpose of and need for action as expressed in the "Purpose of and Need for Action" chapter. Because each action alternative responds to the objectives and is technically and logistically feasible to implement, all are considered "reasonable."

This chapter describes the development process of the alternative for this plan/EIS. It also describes each alternative, summaries of the important features of the alternatives, their effectiveness in meeting objectives of this plan/EIS, and a summary of the effects of the alternatives on park and regional resources. The chapter also identifies actions or alternatives eliminated from further consideration and discusses the environmentally preferred alternative.

ALTERNATIVE DEVELOPMENT

The alternatives were developed based on an understanding of this plan/EIS's purpose, need, issues, and objectives, as well as from input from the public obtained during the scoping phase of the project. The National Park Service and cooperating agencies conducted numerous internal workshops to define the range of alternatives based on the objectives of the plan. Preliminary alternatives considered actions that other agencies on the planning team might take to address elk-related issues outside the park. After much deliberation, those agencies decided to take no additional actions to reduce the elk population or to redistribute the population outside the park in conjunction with this plan.

The alternatives therefore were structured so that all new actions to manage elk and vegetation would be conducted within the park boundaries. Based on public input and agency needs, the range of alternatives captures the most divergent, yet reasonable, scenarios that could be implemented within the park. Each alternative to a large degree emphasizes a different management technique or a combination of techniques, such as lethal reduction, fertility control, wolf release, or fence installation. After defining the range of alternatives, the National Park

Service held workshops with experts in various disciplines such as fertility control, lethal reduction, and wolves to define and revise the detailed actions within each action alternative.

The National Park Service realized at the onset of the planning process that the alternatives must include a formal monitoring program to adequately assess the effectiveness of the program and its effects on other park resources, and that any plan needed to be based on adaptive management, allowing modification of management actions within the framework of each alternative based on future research and monitoring information.

Method for Arriving at Alternatives

Since elk reductions in the park were eliminated in 1969, elk numbers and densities have increased and vegetation has changed, particularly a decline in montane riparian willow and aspen on the elk range. The appropriate elk population size and distribution and its associated effects on plant communities and biodiversity have been increasingly questioned.

In 1994, a research initiative by the National Park Service and the U.S. Geological Survey (USGS) began gathering critical scientific information needed to develop a management plan (Singer and Zeigenfuss 2002). In addition, the park began synthesizing the historical information and research on the Rocky Mountain National Park / Estes Valley elk population dynamics and their effects on vegetation conditions and animal populations in and around the park (Monello et al. 2005). This synthesis also discussed the major findings from Rocky Mountain National Park in the context of similar scientific studies that have been conducted elsewhere.

Part of the research initiative involved an ecosystem simulation model, SAVANNA, (Coughenour 2002) to evaluate the population dynamics and ecological effects of elk and to predict the effects over time of different management strategies on vegetation on the primary winter range. This computer model was customized for Rocky Mountain National Park to provide an objective tool to evaluate past, present, and future elk and vegetation conditions under different management scenarios.

The model incorporated herbivore numbers, willow sizes and densities, and hydrologic conditions at the time the model was run to predict plant responses to varying levels of herbivory, fences, and predation across a 50-year period beginning in 1999. Modeling conducted by Coughenour (2002) predicts how vegetation within the primary winter range would respond to different target elk population levels. Three elk management scenarios simulated never reducing the elk population size, reducing it to 1,600 to 2,100 animals (mid-to-high end of the natural range) with 600 to 800 wintering in the park and 1,000 to 1,300 wintering outside the park, and reducing it to 1,200 to 1,700 animals (low-to-mid end of the natural range) with 200 to 400 wintering in the park and 1,000 to 1,300 wintering outside the park. The ranges of elk in the two reduction scenarios represent two historic periods in the park, the lower range representing the historic elk population prior to establishment of the park, and the second, or higher, range representing the size of the population when it was managed prior to 1968. The three elk reduction scenarios were repeated with and without fencing of all willow and aspen on the elk primary winter range inside the park. In the simulations, beaver were assumed to start at existing levels and then gradually restored to natural levels over a 25-year period.

Based on recent elk population monitoring data, the town subpopulation may be within the natural range of variation, with estimates ranging between 1,000 and 1,400. Recent declines in the subpopulation estimates have coincided with drought, several significant snowfall events, and a potential change in distribution of elk eastward. It is uncertain whether any shifts in distribution are temporary or long-term. The park subpopulation is expected to continue to fluctuate outside the natural range of variation between 800 and 1,100 animals (Coughenour 2002). To allow management of both subpopulations, lethal reduction actions could occur any time of year inside the park. However, to allow for the greatest opportunity to reduce the park subpopulation, most lethal reductions would likely take place between November and February.

Using the large body of ecological knowledge gathered in the park as well as similar scientific information from other areas and model predictions, the National Park Service developed alternatives that combined different management tools with differing elk population levels to achieve to the greatest extent the management objectives of this plan/EIS. Based on this information, the National Park Service and cooperating agencies agreed that to best protect park resources, the elk population would need to be brought down to a level within the natural range of variation. Therefore, each alternative achieves to the extent practicable a population size that fluctuates within the natural range of variation: 1,200 to 2,100 elk with 200 to 800 wintering inside the park and 1,000 to 1,300 wintering outside the park.

Elk Population

The team used results of elk population modeling (Hobbs and Bradford 2003, Bradford and Hobbs 2006) to estimate the number of animals that would need to be removed or controlled annually over the 20-year timeframe of the plan to achieve and maintain the target elk population size under each action alternative. This allowed the team to assess the effort required to stabilize the elk population at target population sizes and to quantify some of the risks involved in achieving those targets, including having an overabundant elk population or a population so small that extirpation (loss of a population) becomes possible. For example, modeling showed that removing a large number of animals in a single year coincident with high levels of natural mortality brought on by some unusual event (an extreme snowstorm or catastrophic wildfire) could reduce elk numbers to unacceptably low levels (Hobbs and Bradford 2003). By reducing the population size over a slightly longer period and at lower rates of reduction, the National Park Service could account for these unusual events and their effects on population and could compensate by varying elk reduction levels annually to achieve the overall target population range.

The population model incorporates mortality from all sources, including hunter harvest outside the park. Hunter harvest outside the park is an important variable. The Colorado Division of Wildlife manages the elk population outside the park consistent with population management objectives specified in individual population management plans, primarily through hunter harvest. Hunting is expected to continue to contribute to management of the population under all alternatives. Since 1999 annual hunter harvest levels in the Estes Park area (Game Management Unit 20) have typically increased, ranging from 343 elk in 1999 to over 700 elk in 2006, as hunter numbers have increased.

As the elk population fluctuates due to variables such as immigration or emigration, environmental conditions, and hunter harvest, the number of elk lethally removed or controlled would vary from year to year. The numbers of elk to be lethally removed or controlled under each action alternative is therefore presented as a range to take into account uncertainty and interaction of these variables as park staff determine the number of elk to be managed each year. The range of elk to be lethally removed is based on current modeling and monitoring information and the best professional judgment of NPS staff and scientists. It is a representation of what is most likely to occur under each action alternative, however, as information on the population and modeling is improved or refined over time, the minimum and maximum of the range may change. If more elk need to be removed under the selected alternative, an evaluation of the effects of that number would be undertaken to ensure that the level of impact on park and regional resources as presented in the plan/EIS are not exceeded.

The strategies to regulate the population size that the team felt were most effective and efficient in meeting objectives were lethal removal, fertility control supplemented by lethal removal, and/or release of wolves supplemented by lethal removal.

Vegetation

Aspen

The ecosystem simulation model was used to simulate aspen cover on the core elk winter range. In all model runs, aspen cover on the core winter range declined from current levels under all elk population scenarios. Only when elk were removed could aspen persist or increase on the core winter range (Coughenour 2002). However, these runs did not include changes in elk densities or distribution, which could alter the effect of elk on aspen conditions (e.g., W. Baker et al. 1997). A follow-up ecosystem modeling effort to more intensively examine the effects of elk density on aspen regeneration indicated that aspen were able to regenerate and produce new cohorts in the presence of lower elk densities (less than 26 elk/mile^2), depending on the amount of time elk spent feeding in aspen stands (Weisberg and Coughenour 2003).

It is uncertain when aspen established in the area that is now Rocky Mountain National Park, how its distribution fluctuated, and whether aspen found in the grassland areas of the primary winter range was present prior to elk extirpation by 1880 (Monello et al. 2005). Until obtaining more information on the establishment of these aspen clones, the National Park Service would take action to preserve the aspen on the elk range. Due to the highly degraded condition of the aspen on the elk range and the uncertainty of success that could be achieved with elk redistribution techniques, to prevent the loss of the aspen clones on the elk range, all of the action alternatives incorporate the option to fence aspen to facilitate achieving the management objectives.

Montane Riparian Willow

Ecosystem modeling predicted that willow would respond positively to lower elk numbers, with the degree of response related to the amount of population reduction. When the elk population size was reduced and maintained at the lower end of the natural range of variation, willow conditions improved markedly, whereas when the population was maintained at the higher end of the natural range of variation, willow cover only slightly increased. Therefore, those alternatives that maintain a higher target elk population would require the use of fences and redistribution methods (e.g., herding, aversive conditioning, or lethal reduction with unsuppressed (noisy) weapons) to achieve willow recovery objectives due to the degraded condition of willow on the elk range. Alternatives that aggressively reduce the population early in the plan and either maintain a target population size at the low end of the range of variation or use wolves to redistribute elk would require no fencing of willow to meet the objectives.

Based on consideration of the costs to install large amounts of fences and of the impacts that fences may have on wilderness and the park visitor experience, alternatives were developed that involved minimal use of fences to protect montane riparian willow (Alternative 2 and 5). In these alternatives, the elk population would need to be reduced quickly to allow vegetation recovery that meets objectives within the life of the plan. Alternatives that result in a more gradual reduction of the elk population to a higher population level that allows maximum viewing opportunity of elk in the park would therefore require the use of fences to protect montane riparian willow to meet vegetation management objectives (Alternatives 3 and 4).

To estimate the expected fencing requirements needed to meet the aspen and willow restoration objectives, the total acreage of these vegetation types was considered in relation to use of various redistribution techniques that the action alternatives would employ to achieve local elk densities that allow establishment and growth of new plants. The amount of fence proposed in the action alternatives to protect vegetation is based on current park vegetation maps and GIS analysis, park specific scientific research (e.g. Cooper et al. 2003 and Peinetti 2002), vegetation and hydrologic site-specific conditions, and best professional judgment where data on vegetation condition is not available. The amount of fencing needed to restore riparian willow habitat includes areas determined to be suitable willow habitat as defined by Cooper et al. 2003. These areas currently fall within the "meadow" habitat type, but are places where willow would be expected to occur because current water tables are adequate. For aspen, the current vegetation map of the park was used to select categories that include *Populus tremuloides*, but have no or only a limited conifer component.

The action alternatives present the best estimate for expected amount of fencing at this time. However based on monitoring and on ground surveys to confirm acreages (ground-truthing) the amount of fencing needed may be adjusted in the future to achieve vegetation management objectives.

The National Park Service recognizes that the management alternatives were developed with scientific information and data, including models, that are provisional and possibly imprecise. In light of this uncertainty, the alternatives include the principal of adaptive management, which approaches management as a learning process or continuous experiment in which incorporating the results of prior actions allows managers to remain flexible and adapt to uncertainty. Therefore, the National Park Service would continue to incorporate annual elk and vegetation monitoring data, including results of the previous year's hunter harvest, and the best available science to guide management actions, ensuring progress toward meeting the plan's objectives. See "Adaptive Management" in the section "Elements Common to All Action Alternatives" for a more detailed explanation of monitoring and adaptive management.

ELEMENTS COMMON TO ALL ALTERNATIVES

The following actions to manage elk and vegetation within the park would be common to all alternatives, including Alternative 1, which would continue current management.

Elk Management

Under all alternatives, the park staff could use some aversive conditioning methods to move individual elk exhibiting aggressive behavior. This may involve a variety of methods, including noise, visual stimuli, rubber bullets, cracker shells, or other non-lethal projectile rounds. If the threat is deemed great enough, individual elk could be lethally removed.

Chronic Wasting Disease Prevalence Testing

Opportunistic testing for chronic wasting disease would continue under all alternatives inside the park. Alternatives differ in their ability to facilitate testing and to increase the agencies' knowledge of prevalence within the park, depending on the availability and number of carcasses, development of a live test for chronic wasting disease in elk, and capturing elk as part of the alternatives. Each alternative provides a more detailed description of how samples would be collected and the degree of testing that would occur to estimate prevalence within the park. Park staff would continue under all alternatives to manage elk inside the park in accordance with NPS chronic wasting disease policy and established park protocols. Elk suspected of having chronic wasting disease would be lethally removed and tested. Elk targeted for lethal removal because of suspected chronic wasting disease would be disposed of appropriately (i.e., incinerated or chemically digested). When possible, elk carcasses found within the park would be removed and tested for chronic wasting disease and those that test positive for the disease would be disposed of appropriately.

Vegetation Protection

The park currently uses limited fencing for localized plant protection in areas where landscape plants used for revegetating areas require protection from elk foraging. Within the park, fences that were established for research purposes would continue to be maintained as long as needed for research or monitoring purposes. These research exclosures exclude large ungulates from foraging on approximately 12 acres of willow, aspen, grassland, and upland shrub vegetation in Beaver Meadows, Horseshoe Park, Tuxedo Park, Moraine Park, and Buck Creek on the primary winter range, and in the Kawuneeche Valley on the primary summer range. Research conducted in a number of these plots contributed to the knowledge of the effects that ungulate grazing has on park vegetation, such as willows and aspens, which led to the initiation of this plan/EIS (e.g., Singer et al. 2002; Olmsted 1997).

Wilderness Minimum Requirement / Minimum Tool Analysis

All alternatives would involve activities, in designated or recommended wilderness areas within the park. As such, in accordance with the Wilderness Act and NPS policies, the National Park Service must complete a minimum requirement analysis before taking management actions. This analysis documents whether administrative activities affecting wilderness resources or the visitor experience are necessary, and how to best minimize impacts. The minimum requirement analysis is a two-step process. The first step determines whether the proposed action is appropriate or necessary for administration of the area as wilderness and whether it poses significant impact on wilderness resources and character. The second step analyzes the techniques and types of equipment needed for the action to minimize impact on wilderness resources and character. The alternatives for elk and vegetation management include activities or the use of tools that would be subject to a minimum requirement analysis. Each alternative description discusses the specific activities and/or tools that would be subject to a minimum requirement analysis. A programmatic analysis has been completed evaluating the elements associated with the action alternatives and is appended to this final plan/EIS in Appendix G. Final determination of what methods would be used for site-specific actions to manage elk and vegetation will be further evaluated and determined when the National Park Service completes the minimum tool analysis prior to implementation of actions of this plan/EIS.

Natural Wolf Recolonization

Colorado is part of the gray wolf's native range, but wolves were eradicated from the state by 1930. Over the past decade, the U.S. Fish and Wildlife Service has reintroduced gray wolves into Wyoming, Idaho, Montana, New Mexico, and Arizona. Currently the gray wolf is listed as a federally endangered species. To prepare for future natural migrations of wolves into Colorado, the Colorado Division of Wildlife formed a multi-disciplinary working group, which includes the National Park Service, that developed a wolf management plan adopted by the Colorado Wildlife Commission in June 2005. In November 2005, the wolf working group was tasked to continue discussions through 2006, focusing on who should decide on potential reintroduction of wolves to Colorado and how to structure a compensation program. The park would continue to work with the wolf working group and other federal, state, and local agencies on regional wolf issues such as natural wolf recolonization or a regional restoration effort. The park would also continue to monitor for natural wolf recolonization within its boundaries and would manage adaptively (see "Monitoring and Data Collection" section for more details on adaptive management).

ALTERNATIVE 1

Alternative 1 would involve the continuation of current management of elk and vegetation within the park. Because Alternative 1 represents current management, it is also the baseline condition against which the action alternatives are compared.

Elk Population Reduction

This alternative includes no actions to specifically control elk population numbers or actively manage the elk population within Rocky Mountain National Park. Instead, this alternative relies on forage availability, which is driven by weather, supplemented by hunting outside the park to control population size.

Ecosystem simulation modeling (Coughenour 2002) predicts that by continuing current management under this alternative, the population would range between 2,200 to 3,100 elk. This modeling assumed no significant development in the area and that all elk remain in study area. It also did not incorporate the potential for weather events that could affect the populations. As such, the population size could rise above or drop below this range due to variables such as weather and emigration or immigration of elk, either permanently or temporarily.

Elk Distribution

Under Alternative 1, no management actions would be taken to redistribute elk from areas where they concentrate on the elk range or to encourage migration to the primary summer range by elk that stay on the core winter range in the park during the summer. Under this alternative, without management actions to redistribute elk, the densities of elk, described in the "Purpose and Need for Action" chapter of this plan/EIS, are not expected to change over time.

Vegetation Management

Under this alternative, vegetation on the elk range, particularly willow and aspen, would not be protected from elk herbivory, and no measures would be employed to maintain or restore areas. Herbivory of aspen, willow, and upland herbaceous (grassland) communities would be expected to continue at a high level in localized areas of the elk range where elk would continue to concentrate at high densities and would continue to be less migratory.

Current Monitoring

The National Park Service currently monitors the elk population size, sex and age structure, and general distribution in the park. The Colorado Division of Wildlife monitors these same factors outside the park. Over the past decade, studies conducted in the park have assessed the status of vegetation conditions, beaver populations, and visitor attitudes and beliefs, but no routine monitoring is conducted.

One annual survey is conducted each winter over several days to count and classify elk, which provides information on the sex and age of the animals in the population by counting the number of calves and adult and yearling males and females. The National Park Service conducts ground surveys for three consecutive days inside the park on five routes and outside the park on seven routes. An aerial survey is conducted concurrently over the park's five routes on the first day. The National Park Service conducts additional classification surveys (ground) several times per winter. Annual population estimates for the park primary winter range are based on total counts using a sightability model that was developed for the park (Lubow et al. 2002). The National Park Service generates population size estimates outside the park using an established correction factor (Lubow et al. 2002).

The Colorado Division of Wildlife conducts winter classification surveys annually outside the park. These data are used in population models to estimate post-hunting season population size and structure in Game Management Unit 20. In recent years, sex and age ratios have been based on a ground survey in the Estes Valley conducted by Colorado Division of Wildlife staff.

Minimum Requirement / Minimum Tool Analysis

Under this alternative, implementation of specific elements of the alternative listed below would require a prior, written minimum tool analysis. Final determination of what methods would be used for site-specific actions to manage elk and vegetation would be further evaluated and determined when the National Park Service completes the minimum tool analysis prior to implementation of actions of this plan/EIS. For a detailed discussion of the minimum requirement process, refer to the "Wilderness Minimum Requirement / Minimum Tool Analysis" section in "Elements Common to All Alternatives."

The following actions of Alternative 1 would be subject to minimum requirement and minimum tool analysis prior to their use in wilderness areas.

The use of firearms to lethally remove elk or dart guns to anesthetize elk suspected of having chronic wasting disease.

The use of helicopters for annual monitoring of the elk population.

Education

The park provides some interpretive programs and literature. Volunteer groups cooperate with the interpretive division to disseminate information regarding the elk population and its role in the environment. Natural resource staff and interpretive staff conduct outreach programs at schools and community meetings, as well as for other groups within the region. Under Alternative 1, the current education program would continue into the future.

ELEMENTS COMMON TO ALL ACTION ALTERNATIVES

Elk Population Management

All action alternatives employ population size targets to guide management actions. Ecosystem simulation modeling predicted that under natural conditions (i.e., with predators present), the elk population size would fluctuate between 1,200 and 2,100 animals with 200 to 800 wintering inside the park and 1,000 to 1,300 wintering outside the park. Therefore, all action alternatives are intended to maintain a viable elk population within this range. The alternatives vary in defining where within this range, such as at the high or low end, the target population would be reduced to and maintained over the life of the plan. The description of each alternative provides the specific target population range and how the target population would be achieved and maintained. It should be noted that based on adaptive management, management actions to control the elk population would not be taken if the elk population size was within the range specified by each action alternative and vegetation objectives were being met.

Lethal reduction (culling) would be conducted in all action alternatives, at least in the early years, using NPS personnel and their authorized agents. See Appendix H for further discussion of culling and authorized agents. Lethal reduction could be conducted under all action alternatives at any time of day using noise suppressed weapons (weapons equipped with a silencing device), unsuppressed weapons, and/or darting with anesthesia followed by lethal injection. To mitigate impacts on visitor use of the park consideration would be given to the type of weapon used and the time of day actions were taken. For example, to reduce or eliminate impacts on visitor use of the park and to reduce elk dispersion, lethal reduction could be conducted by shooting at night from the ground using noise-suppressed weapons. Spotlighting could illuminate target elk. Night vision firearm scopes would be used with rifles, and laser sights would be used with shotguns. If performed during daylight, lethal reduction could be carried out in more remote areas or on a much smaller scale. Reductions of the population by shooting with unsuppressed weapons would be conducted to redistribute the population away from selected areas. Immobilization by dart, followed by lethal injection, could be used when animals are close to structures or other areas used by people and where the discharge of a shotgun or rifle would not be prudent.

Lethal reduction activities could occur at any time of year and it could vary by alternative dependent upon the number of elk that may need to be removed annually. However, most lethal reductions would likely occur between November and February to allow the greatest opportunity to reduce the park subpopulation. Lethal reductions would be performed to minimize the likelihood of ophan calves and to minimize visitor impacts.

The National Park Service would use specially trained National Park Service staff and their authorized agents to perform reduction activities under the alternatives. See Appendix H for further discussion of culling and authorized agents. NPS personnel and authorized agents would be certified in firearms training, specially trained in wildlife culling, and be required to pass a proficiency test in order to qualify to participate in lethal reduction (culling) activities. To mitigate or eliminate a risk to public health and safety during lethal reduction actions, highly trained personnel would make decisions based on an understanding of the capability and characteristics of various firearms and ammunition that could be used. Decisions for type of firearm and ammunition to be used would be made on a case-by-case basis in terms of the backdrop, how far the round might carry, and the type and extent of visitor use in each particular area. Further mitigations and area closures would be employed as determined based on this evaluation. Mitigation could also include use of subsonic ammunition, which has a shorter range than conventional rounds, and shooting from elevated stands, which can establish shooting lanes and reduce the distance bullets could travel via backstops. Spotters could be used to help ensure that the area is clear of people and to prevent individuals from entering the area during lethal reduction activities.

The alternatives may involve the use of authorized agents to conduct various management actions depending on cost, efficiency, and effectiveness. If contractors are used as authorized agents, in addition to other federal contracting requirements, for implementing this plan, a contractor is recognized as a fully insured business entity, nonprofit group, or other government agency engaged in wildlife management activities that include trapping, immobilization chemical euthanasia, or other lethal removal. The contractor must possess all necessary permits.

To maximize efficiency by removing the fewest animals, the primary target would be adult female elk rather than males because by removing females, the calves that they would produce in the current year and future years would not be recruited into the population. Thus, the population would be reduced by the number of individual females removed plus the offspring that they would have produced during their breeding years.

However, population modeling predicted that removing only females produced population structures with unnaturally large proportions of males and calves. Therefore, under the action alternatives, some calves and male elk would be removed to ensure that a minimum of 15% of the population is adult females to ensure no risk of local population extinction (Hobbs and Bradford 2006) and to prevent the bull to cow ratio from exceeding 80 bulls per 100 cows. Modeled ratios for the park have predicted a population structure as high as 60 bulls to 100 cows, which included some effects of hunting. Therefore, a population structure of 80 bulls to 100 cows is considered reasonable for unhunted populations in national parks (Hobbs 2005).

Based on monitoring data of elk population size and demographics, determination of the number of elk to be removed or controlled each year under each action alternative would use an adaptive management approach. Determining the level of management actions for a particular year would involve analyzing the results on the population of the previous year's management actions in combination with population changes that may have occurred as a result of stochastic events such as a severe winter in areas adjacent to the park. The National Park Service would continue to collaborate with the Colorado Division of Wildlife to monitor the population and to determine annual management activities in terms of the locations, numbers, and timing of elk removal.

Under all action alternatives, the National Park Service would continue to encourage the cooperating agencies to consider taking further actions outside of the park in addition to public hunting to manage the larger town subpopulation that spend most of their time outside of the park. Additional actions outside the park to reduce the elk population size and densities would reduce the need for management actions inside the park or reduce the intensity and frequency at which actions would be taken in the park.

Vegetation Management

Under all action alternatives there may be the use of fences as described in the alternative descriptions. Under all action alternatives, monitoring of vegetation communities would provide the information necessary to determine how many acres of willow or aspen on the primary elk range need to be protected. Similarly, monitoring data would provide the information necessary to determine when fences can be removed once communities are restored.

Aspen in particular could be fenced to maintain the aspen clone on the elk range. Currently there is debate about the historical establishment of aspen on the elk range. There is no sound evidence that aspen were present on the elk winter range prior to elk extirpation by 1880 (Monello et al. 2005), but best available information indicates that aspen have been present in most of their current locations for hundreds of years (Monello et al. 2005). Additionally, studies have documented aspen establishment during periods when large elk populations of over five hundred animals were present (Olmsted 1979, W. Baker et al. 1997), such as before 1880. In addition, modeling predicts that aspen can regenerate, depending on the elk density and amount of time elk spent feeding in the aspen stands (Weisberg and Coughenour 2003). However, there may have been no aspen clones in the park on the elk winter range prior to elk extirpation. Other modeling has indicated that almost any population size of elk in the park can prevent aspen cohort establishment, and that current stands are primarily a result of aspen expansion while elk were extirpated from the area (Coughenour 2002). However, until further research can refute the hypothesis that the presence of aspen is not a result of elk extirpation, the park would manage aspen on the elk range as a natural component in those areas.

Selected fence designs, as determined through continuing coordination with U.S. Department of Agriculture Wildlife Services and the National Wildlife Research Center, would allow the greatest access to fenced areas by species such as deer, black bear, and smaller animals, but would prevent use of the area by larger animals such as elk and moose. Fence options include the use of wooden and/or wire fence in a rail or page-wire fence design with a gap in the bottom. Fences would also be designed with gates to allow for public access to areas to the extent possible. Which fence designs are used would depend on the location and the potential effects on wilderness, the viewshed, and movement of other wildlife species. Informal visitor surveys would assess the effects of fences on the visitor experience, and monitoring would assess the effects on other wildlife species. These factors would be used to evaluate future fencing types and locations and to minimize impacts on other resources. Installation of fences in locations away from roadsides may involve helicopters to transport materials. In wilderness, the locations and type of fence used, the method of transportation to remote locations, and the equipment used to install the fences would be determined based on a minimum requirement and minimum tool analysis. For a detailed discussion of the minimum requirement process, refer to the "Elements Common to All Action Alternatives" section titled, "Wilderness Minimum Requirement / Minimum Tool Analysis."

Once an area of aspen or willow was adequately protected from elk herbivory, (aspen are tall enough to withstand browsing pressures and still reproduce) or when elk density, numbers, and frequency of browsing (offtake) are low enough, as indicated in the "Monitoring and Data Collection" section, willow cuttings, mechanical thinning or removal, or prescribed fire could be used to facilitate regeneration of vegetation on the elk range if needed. Prescribed fire or mechanical methods could remove dead material or stimulate new growth in target aspen and willow communities. Because willow is particularly adept at rooting from cuttings if adequate water is present, planting of willow cuttings could support restoration of willow in areas with suitable hydrologic conditions, as in riparian areas.

Once willow vegetation is restored to an acceptable level, beavers would be expected to increase and recolonize riparian areas on the elk range. Approximately 10 acres or more of tall willow would need to be recovered to support a beaver colony indefinitely (B. Baker et al. 2003). If natural recolonization by beavers does not occur, the National Park Service would reintroduce beavers to main drainages that maintain 10 acres of tall willow for two years.

Adaptive Management

Monitoring and evaluation are crucial in determining whether management actions are achieving objectives. For instance, if elk numbers and distribution continue to show unacceptable effects on vegetation, different management actions may be necessary to further reduce the abundance or density of the population, change the distribution of elk, or protect vegetation. This process of using information as it becomes available to alter management actions is called adaptive management. Adaptive management is an iterative process that requires selecting and implementing management actions, careful monitoring, comparing results with objectives, and using feedback to make future management decisions.

This process recognizes the importance of continually improving management techniques through flexibility and adaptation instead of adhering rigidly to a standard set of management actions. These alterations may include adjusting the number of elk removed, the number of acres fenced or the configuration of the fences, the frequency or location of redistribution activities, or releasing wolves. Any adjustment in management actions would be made within the framework of the alternative. For example, to reduce impacts on visitors and wilderness, Alternatives 2 and 5 focus on reducing the elk population and increasing elk distribution without the use of fences, so the use of willow fences would be an inappropriate adaptive management action within the context of those alternatives. Alternatives 3 and 4, which maintain the elk population at a higher level, involve the use of willow and aspen fences and redistribution techniques to protect vegetation. Adaptive management actions that would be appropriate within the framework of these alternatives would increase redistribution actions, including aversive conditioning, use of unsuppressed (noisy) weapons, and herding. Increased use of fences would also be appropriate within the constraints of the alternatives.

Each action alternative in this plan/EIS employs an adaptive management element involving monitoring and evaluation. Therefore, although each alternative employs a set of specific management techniques, some of those actions may change as a result of adaptive management.

Under this elk and vegetation management plan/EIS, seven steps would be followed when applying an adaptive management approach:

1. Collect baseline data. Existing conditions would be measured to establish a set of baseline conditions. The current conditions are described in the "Affected Environment" chapter.

2. Establish desired future conditions for the elk population. The park would manage for an elk population that is within the plan's target objective for size, density, and distribution. These objectives also define the desired conditions, which in the case of the elk population represent long-range goals.

3. Establish desired future conditions for vegetation. The park would manage the elk population based on the effects elk have on the vegetation, and vegetation would be monitored to determine whether management actions to reduce and distribute elk and to protect vegetation are successful. The effects of actions would be measured against established desired future conditions established for aspen, riparian montane willow, and upland herbaceous vegetation. Desired future conditions for vegetation are those target conditions indicating that the recovery of vegetation has been successfully achieved. The desired future conditions represent long-range goals for vegetation on the elk range that extend beyond the planning period of this plan/EIS.

4. Apply the management action. The elk population size and distribution and the vegetation recovery would be achieved by lethal reduction, fertility control, wolves, fencing, distribution techniques, release of wolves, or a combination of methods within the context of the alternative. To further enhance vegetation recovery, additional methods such as beaver reintroduction, planting of willow cuttings, and prescribed fire or mechanical

thinning of vegetation would be implemented after determining that vegetation was protected sufficiently from the effects of elk herbivory.

5. Monitor the effectiveness of the management actions. Monitoring would determine whether vegetation was recovering to levels defined in the management objectives and in the indicators and thresholds of vegetation conditions defined in "Monitoring and Data Collection" section below; whether the method(s) used were successfully reducing and maintaining the elk population size within the target population range defined under each alternative; and whether distribution objectives were being met. Data collected regarding the elk population size and vegetation response would be incorporated into the ecosystem simulation model to evaluate the progress being made toward meeting the objectives. This ecosystem simulation model and the elk population model would be used throughout the life of the plan to adjust the level of management actions within the framework of each alternative as needed to allow continued progress toward meeting the objectives.

   If progress towards meeting the management objectives does not occur within a reasonable time as indicated by vegetation condition thresholds, then different method(s) would be employed. If the management actions work effectively and meet thresholds, the National Park Service would continue to employ those methods. Each alternative describes what actions may be employed to replace or enhance the initial management actions. For instance, in Alternatives 3 and 4, if distribution techniques do not reduce impacts on vegetation to a level allowing recovery, then additional fencing may be installed.

6. Perform general surveillance for effects of the management actions on other resources in the project area to determine the effects of the methods. Surveys would show whether the management actions were having an unacceptable effect on native vegetation, other wildlife, sensitive species, or visitor use and experience.

7. If surveillance indicates that acceptable levels of impact on other resources have been exceeded, reconsider management actions. For example, if management actions to reduce the elk population have impacts on visitor experience that exceed those predicted in this plan/EIS, additional mitigation measures may minimize the effect or the management action may be changed within the context of the alternative. If dispersion activities in an area adversely affect visitors beyond acceptable levels, those actions may be stopped, the time of day they take place may change, or fencing may instead be installed in these areas to protect vegetation.

Adaptive management combines the advantages of the scientific method with the flexibility to address the human and technical complexities inherent in managing complex environmental issues. The goal is to give policy makers a better framework for applying scientific principles to complex environmental decisions (Wall 2004).

Monitoring and Data Collection

The effectiveness of specific management actions and resource conditions would be monitored through the 20-year life of the plan. This information would be used to adapt management actions as needed to meet plan objectives. Monitoring would be conducted in the short and long term on geographic scales ranging from site-specific to landscape. The frequency of monitoring actions would be high in early years and may decrease later if less frequent data collection is found to be sufficient. Monitoring would be used for several purposes:

1. To determine if management actions need to be altered (Are thresholds being met? Are specific techniques successful?).
2. To gather data needed for population modeling that would guide annual removal or treatment rates.
3. To gather data to improve the predictive capability of the ecosystem simulation model.
4. To determine educational needs based on visitor response to management actions.

The following would be monitored under all action alternatives:

Elk Population Size, Composition, and Distribution

The elk population size, composition, and distribution would be monitored using multiple population surveys each year. Surveys would be conducted on both primary winter and summer ranges to provide information to determine annual reduction and/or treatment targets. A population model would help determine specific targets needed each year to meet the reduction timeframe specified for each alternative. The model would be updated annually to incorporate new data and to account for observed density dependant responses in the population. For alternatives that include a maintenance phase (Alternatives 2 and 5), reduction would be adjusted as needed to maintain a population size within the target range for that alternative. Radio telemetry could be used to improve the efficiency of summer reductions by providing information on subpopulation distribution. Reductions would be distributed between males and females to maintain a gender structure that does not exceed 80 bulls per 100 cows while minimizing the number of animals killed.

The National Park Service would conduct surveys in the park and in the Estes Valley as described in Alternative 1; however, they would be conducted several times per winter. In addition, mark-resight surveys could be conducted to revise the correction factor for ground surveys as needed to incorporate changes in elk distribution.

The Colorado Division of Wildlife would continue to count and classify elk using a combination of aerial and ground surveys, followed by population modeling to estimate the population size for Game Management Unit 20. The Colorado Division of Wildlife would also continue to monitor harvest results for Game Management Unit 20. These data would be incorporated into the process of determining population reduction or treatment needs in the park each year.

On the primary summer range, the National Park Service would conduct a combination of aerial and ground surveys to count and classify elk. Population size could be estimated from a single summer count based on corrections derived from the results of multiple observers (Lubow 2005). This information would be used to fine tune reduction or treatment targets for the summer and fall reduction or treatment time periods.

Elk distribution would be recorded during annual aerial surveys in the park, and population density across the primary winter range would be calculated based on grids with a 100-meter cell size and a 3,000-meter search radius using the ArcGIS density calculation, consistent with methods used to determine baseline conditions (Singer et al. 2002). Ground surveys would be conducted weekly to monthly to ensure that distribution during aerial surveys is consistent with general winter distributions. Target densities in unfenced willow communities would be maintained below about 83 elk/mile^2 to maintain willow growth at about 60% of maximum levels (Singer et al. 2002). If monitoring of vegetation response indicates that this upper threshold is too high, then elk densities would be lowered to meet objectives.

From late June through early August, weekly ground surveys would monitor summer use in the core winter range in the park. Herding during that period would direct elk off the primary winter range toward the primary summer range.

To determine the efficacy of the redistribution methods, elk distribution would be monitored directly both for short-term distribution response at the time of any active elk management (e.g., lethal control, fertility control, herding, aversive conditioning, high wolf use areas) and for longer-term distribution responses in site-specific locations at random times. Vegetation consumption (offtake) would also be measured to indirectly monitor elk use in areas subject to specific management actions (see "Vegetation Structure, Regeneration, and Cover" section below).

The broad extent of the elk distribution across the primary winter and summer ranges would be monitored annually based on a combination of all location data collected during aerial and ground surveys conducted by the National Park Service and Colorado Division of Wildlife inside and outside the park. Outside the currently designated ranges, observations of any marked animals or tracks through snow would be used to indicate any range expansion. Radio telemetry could be used periodically as needed to provide more detailed information on elk movements and distribution.

Vegetation Structure, Regeneration, and Cover

Monitoring of vegetation would be limited to aspen, willow, and herbaceous vegetation types within the park elk range because these are most closely linked with elk herbivory. For example, any monitoring of upland shrubs (which are expected to benefit from lowered elk herbivory but are also browsed by mule deer; see Chapters 3 and 4) would not be associated with this plan.

The monitoring protocols would be designed in an experimental context to yield measurable results to show the level of improvement of vegetation structure, regeneration, or cover. Examples of design considerations are outlined by Zeigenfuss et al. (2001) and Binkley et al. (2001) in the Rocky Mountain National Park long-term monitoring program (Stohlgren et al. 2001b). Collection of baseline data would occur before any management actions are taken.

Table 2.1 describes the indicators that would be monitored for each vegetation category and the thresholds being evaluated to determine if management actions are successful or if actions would need to be altered to meet management objectives and vegetation desired future conditions.

Aspen

As a result of monitoring the indicators defined in Table 2.1, management actions would be adjusted to ensure that progress is made toward achieving desired future conditions. The desired future condition of aspen on the elk range would be a higher diversity of age classes, which would be expressed in two ways:

1. The distribution of stem diameters should reflect many (~75%) small diameters stems, some (~20%) medium diameters stems, and few (~5%) large diameters stems (Dan Binkley, Colorado State University, unpublished data). This would be measured as stems/acre plotted against diameter at breast height.
2. At least 45% of stands on the primary elk winter range and in the Kawuneeche Valley should have developed a regeneration cohort as seen in non-core winter range areas inside the park (Suzuki et al. 1999). This would mean that 45% or more of the stands in these areas should experience 1-2 regeneration events each decade.

TABLE 2.1: VEGETATION INDICATORS AND THRESHOLDS

Vegetation Category	Indicator	Threshold
Aspen	Number of stems/acre	Every 5 years the number of stems/acre reaching 10 years of age would be measured with an increase toward 45% of all winter range stands regenerating within each decade (Binkley et al. 2001 in Stohlgren et al. 2001b, Suzuki et al. 1999).
Riparian Montane Willow	Consumption/offtake	The annual consumption/offtake should not be greater than 27% averaged across all sites using estimation methods consistent with Singer et al. (2002).
	Percent cover	Percent cover increases toward the desired condition throughout the 20 year time period.
	Structure	Willow heights and stem densities on the primary winter range should increase 20% over the 20 years of the plan.
Upland herbaceous	Consumption/offtake	Annual consumption/offtake should not be greater than 59% averaged across sites (Singer et al. 2002), but at no point would more than 1% of sites be consumed at 80 to 100% offtake and no more than 15% of sites would be consumed at 50 to 80% offtake during the first 10 years and no more than 8% of sites thereafter (Coughenour 2002).

Such stand-level regeneration would be measured every 5 years by height (stems/acre between 1.5 and 2.5 m in height), aging of increment cores (stems/acre < 10 years of age), stem diameter at breast height, and stem density (stems/acre). In addition, overstory aspen mortality and diversity of age classes would be monitored.

Riparian Montane Willow

Given complete restoration of willow and hydrologic conditions the desired future condition of riparian montane willow is up to 70% willow cover within suitable riparian habitat on the primary winter range. The long-term desired condition could not be met within the 20-year period of this plan/EIS. However, within the 20-year life of the plan there should be an increase in the number of willow stands that are reaching a height beyond the reach of elk browsing and a progressive increase in percent cover of willow on the elk range to at least 10% greater than current conditions, indicating progress toward the overall desired condition.

Annual measurements of consumption/offtake would be taken. Percent cover and measurements of vegetation structure (height, canopy volume, and stem density) would be measured at least every 5 years. Percent cover would be monitored using a combination of remote sensing (aerial photography and/or satellite imagery) and ground measurements.

Upland Herbaceous

The desired condition for upland herbaceous vegetation (grasses) on the elk range would be an increase in the diversity of grazing levels so that not all areas are heavily grazed, but at no point should there be more than 1% of sites consumed at greater than 80% offtake and no more than 15% of sites consumed at 50 to 80% offtake (Coughenour 2002). Consumption/offtake would be measured annually.

Beaver Populations

In the past, beaver activity helped maintain higher water levels in many of the streams on the elk range, encouraging and nurturing willow growth. Water levels could be returned to their former levels to some degree by the natural colonization or the reintroduction of beavers. Therefore, the status of beaver populations would be monitored in riparian areas on the elk range. Winter ground surveys would help determine presence or absence and trends of current beaver activity (e.g., recently maintained dams or lodges, active bank dens, food caches) throughout the survey area, both inside and outside fences. The influence of beaver on surface water conditions would be determined using aerial photography at five-year intervals in conjunction with plant cover surveys.

Under the action alternatives, if beaver have not naturally recolonized areas on the elk range after sufficient willow recovery has occurred, beavers would be reintroduced to these areas. Based on findings that approximately 10 acres of tall willow could sustain one beaver colony on the primary winter range indefinitely Baker et al. 2003), at least 10 acres of restored willow sustained for two seasons would be needed prior to a reintroduction. Any reintroduced beavers would be monitored using radio telemetry to determine distribution, movements, habitat use, survival, and reproduction.

Natural Wolf Recolonization

As mentioned in "Elements Common to All Alternatives," park staff would consult with other federal and state agencies to keep apprised of any wolf activity in southern Wyoming, northeastern Utah, or northern Colorado and monitor the situation appropriately. In addition, management activities under the action alternatives would be altered if monitoring detected changes in the elk population size, composition, and distribution or in vegetation structure, regeneration, and cover as a result of wolf recolonization. For example, if elk were being effectively distributed by naturally recolonized wolves, aversive conditioning of elk would cease.

Visitor Response to Management Actions

Visitor response to management actions would be monitored informally by park staff who have regular contact with visitors as well as through general written comments from visitors. If appropriate approvals are obtained, formal visitor surveys asking opinions of elk and vegetation management activities would also be conducted periodically over the life of the 20-year plan, depending on funding availability. This information would help identify educational needs of the public to further understand the elk and vegetation management plan.

Humane Treatment

All action alternatives involve the direct management of individual animals, ranging from remote delivery of fertility control agents to live capture and lethal removal. These management activities would be conducted in a manner that minimizes stress, pain, and suffering. Lethal removals using firearms would be conducted by NPS personnel and authorized agents that would be certified in firearms training, specially trained in wildlife culling, and be required to pass a proficiency test in order to qualify to participate in lethal reduction (culling) activities. Use of remote delivery systems for fertility control or anesthetizing (e.g., dart guns, Biobullet® guns) would also be conducted by trained personnel under Director's Order 77-4.

Efforts would be made to deliver immediately lethal shots to target animals, and shooters would be required to complete NPS range qualifications. The National Park Service would use recommendations of the American Veterinary Medical Association (AVMA) for euthanasia of restrained elk (AVMA 2001). Under every alternative, the degree of human contact during all procedures that require handling of wild animals would be minimized, and in all alternatives, the National Park Service would "reduce pain and distress to the greatest extent possible during the taking of an animal's life" (AVMA 2001).

Distribution of Carcasses

Carcasses of all adult elk subject to lethal removal would be removed from the field to the extent possible, individually marked, sampled for chronic wasting disease, and as necessary stored in refrigerated trucks in the park until test results are available (typically 4 to 14 days). Due to the logistical constraints of removing a high number of carcasses or removing carcasses from remote locations, some carcasses may be left in the field and their heads removed to allow testing for chronic wasting disease.

A predetermined, small number of carcasses in which chronic wasting disease has not been detected and which were not subject to lethal injection may be returned to the field with a wide spatial distribution to approximate natural conditions expected with intact populations of native predators. If calves are lethally removed from the population, their carcasses could be left in the field, as chronic wasting disease has not been detected in free-ranging elk less than 18 months old. Overall, the number of carcasses left in the environment would reflect a natural state to the greatest extent possible.

Removal of carcasses from the field would be accomplished using techniques that would cause the least amount of impact on natural resources, wilderness, and visitor experience, such as removal on foot; using a litter or sled over frozen ground; on a horse, all-terrain vehicle, or truck; winching or dragging behind a horse, all-terrain vehicle, or truck; to facilitate removal from remote areas of the park. In general, helicopters would not be used to remove carcasses except from remote locations if determined necessary due to disease management concerns. Due to concerns in wilderness, preference would be given to non-motorized removal techniques to the extent possible. The final determination of what method would be used to remove carcasses from the field would be determined when the National Park Service completes the minimum tool analysis prior to any site-specific action as part of this plan/EIS. Refer to the "Wilderness Minimum Requirement / Minimum Tool Analysis" section below for further detail on this process. All carcasses and carcass parts would be transported according to all state and federal laws and regulations regarding transport of elk carcasses and parts from areas with known chronic wasting disease.

To the extent possible the National Park Service would donate carcasses and/or meat from elk in which chronic wasting disease is not detected and that were not killed using sedative agents or euthanasia drugs through an organized program to eligible recipients, including members of tribes, based on informed consent and pursuant to applicable public health guidelines. Donation of meat would be based on the most current guidance provided by the NPS Public Health

Program (NPS 2006a). In this case, special attention would be given to proper, immediate field dressing and if necessary refrigeration. The National Park Service would also ensure that the required withdrawal period (the number of days that must elapse between drug administration and slaughter so that meat from a treated animal is fit for human consumption) had passed prior to donation of meat from elk that had been subject to fertility control.

Although all carcasses would be tested for chronic wasting disease before donation, chronic wasting disease tests are not sensitive enough to be thought of as a "food safety test." A "not detected" result does not guarantee that the animal does not have chronic wasting disease. Therefore, meat donation to individuals would only occur after gaining the individual's informed consent (NPS 2006a). According to the most current NPS Public Health Program guidance, gaining informed consent would involve at a minimum the following elements:

Inform individuals about the disease, its distribution, and its prevalence.

Inform the individuals about the chronic wasting disease testing that has occurred and the determination that the disease has not been detected in the carcasses.

Inform individuals about any potential human health risks as it is understood by science at that time.

In accordance with the current NPS public health program guidance (NPS 2006a) and the need to gain informed consent from individuals who may consume the meat, donations could not be made to food pantries, soup kitchens, or any entity that intends to redistribute the product. The required guidelines for meat donation may change in the future, and the National Park Service would adjust the disposition of carcasses accordingly.

The National Park Service would identify interested organizations, agencies, and /or tribes with whom to partner in a meat donation program in order to defer the high cost of processing and packaging the meat.

Any remaining carcasses in which chronic wasting disease has not been detected and that can not be donated would be landfilled. This is expected to be a limited number of carcasses. Those that have tested positive for chronic wasting disease would be incinerated or chemically digested at facilities outside the park.

Field dressing procedures and carcass handling to minimize exposure to chronic wasting disease infectious material would be followed at all times in accordance with state wildlife management guidelines.

Opportunistic Research Activities

Because the elk population would be subjected to management under all action alternatives, the National Park Service would take the opportunity to conduct a research study that could benefit management of elk in the future. In the first few years of elk management, the National Park Service would evaluate a rectal biopsy procedure that would serve as a preclinical diagnostic test for chronic wasting disease in live elk. In addition, the National Park Service would, contingent on availability, evaluate the effectiveness of a fertility control agent that would last for multiple years and would require a single treatment without the need for a booster shot in a wild and free-ranging elk population. During the first year of implementation of the elk management plan, up to 120 elk would be anesthetized using ground darting methods, and a biopsy of the rectal mucosa tissue would be taken and samples sent to a veterinary diagnostic laboratory for testing for chronic wasting disease. While the elk were under anesthesia, a fertility control agent, GonaCon™, would be administered to at least half of the female elk via hand injection to evaluate the effectiveness of a multi-year, single contraceptive agent. Detailed information about GonaCon™ can be found in the description of Alternative 4 in this chapter. If GonaCon™ is not commercially available at study initiation, the National Park Service would collaborate with the National Wildlife Research Center to apply the agent under research authority. Blood samples would be taken from all animals to address any needs for subsequent information or diagnostic testing. All animals would be fitted with a radio-transmitter collar with a unique visual identifier.

Any animals that test positive as a result of the biopsy test would be located via radio telemetry and removed from the population via methods associated with the action alternatives. These animals removed would contribute to the annual population reduction target associated with the elk management actions.

In the second year of the study, annual removal activities to reduce the size of the population would ideally include about one-third of the radio-collared female elk that were subject to the fertility control agent and chronic wasting disease live test to assess the pregnancy and chronic wasting disease status of the elk. In the third year of study, another one-third of the remaining collared female elk would be removed as part of the population reduction activities, and these elk would be processed to assess pregnancy and chronic wasting disease status. In the fourth year of the study, the final third of the collared female elk would be removed and their pregnancy and chronic wasting disease status would be assessed.

Test animals would be lethally removed from the population over the four-year study. Elk would be examined for the presence of chronic wasting disease in the tissue and for any long-term effects of the original biopsy. The rectal tissue results would be correlated with the results of brain tissue samples to evaluate the efficacy of the rectal mucosa tissue biopsy test.

The rectal mucosa biopsy test, although applied in the field, does not provide immediate test results for the presence of chronic wasting disease. The application of the biopsy test in the management of the elk in the future is unknown. However, if in the future it is logistically and economically feasible to apply this or other diagnostic test within the framework of an action alternative, the National Park Service would selectively remove elk that test positive for the disease in an effort to reach annual population reduction targets. Knowledge and information gained from this study could contribute to the advancement of testing for chronic wasting disease with the goal of eventually leading to a test that provides immediate field results.

Education

The methods by which the park educates the public would be as described under Alternative 1. However, under all action alternatives, public education efforts would be enhanced to provide additional information about elk and their role in the Rocky Mountain ecosystem. In addition, educational materials would be developed to inform and increase public understanding of the management actions taking place in the park and the effects these actions have on vegetation, other wildlife, and visitors. Enhancements to the education program within the park could include any or all of the following:

Improved interpretive contacts and programs would detail the resource issues, management plan selected, monitoring program, and results and status of the resource.

Literature and brochures would also be developed and provided to the public at visitor centers, entrance stations, and community events.

A website dedicated to the management plan would be developed describing the information above, and, as information is collected, the website would be updated with results of field surveys.

Outreach programs to schools, groups, and community organizations would be tailored to discuss elk and vegetation management within the park.

Estimated Costs

The estimated one time infrastructure and annual costs of each action alternative are provided in the "Summary of Alternative Elements" table at the end of this chapter. A detailed description of the cost for each action alternative is provided in Appendix B.

The cost of each alternative was derived from multiple sources. Direct professional estimates were provided by staff from the National Park Service and the U.S. Department of Agriculture Animal and Plant Health Inspection Service, Wildlife Services Division for costs associated with lethal reduction, wolf release, chronic wasting disease testing, monitoring, education/interpretation, and aversion methods. Comparable costs were derived from literature sources and subject matter experts for fences, fertility control, and carcass disposal.

Cost estimates for the components of the alternatives include capital costs that occur once during the project as well as annual or recurring costs that are incurred throughout the life of the project.

The alternatives involve the use of contractors to conduct actions associated with intensive lethal reduction activities in the first four years of Alternative 2, fertility control activities in Alternative 4, and the lethal reduction of elk and release of wolves in Alternative 5. These have been estimated in the costs of each respective alternative. In addition to other federal contracting requirements, for implementing this plan, a contractor is recognized as a fully insured business entity, nonprofit group, or other government agency engaged in wildlife management activities that include trapping, immobilization, chemical euthanasia, or other lethal removal. The contractor must possess all necessary permits. Cost, efficiency, and effectiveness would be the factors that determine when supplemental personnel are needed.

ALTERNATIVE 2

Under Alternative 2, the elk population would be reduced to a low population target (1,200 to 1,700 elk: 200 to 400 park subpopulation; 1,000 to 1,300 town subpopulation) using lethal means (culling) implemented by NPS personnel and their authorized agents. See Appendix H for further discussion of culling and authorized agents. Inside the park, between 200 and 700 elk would be lethally removed annually within the first four years of the plan to bring the population to the target size as quickly as logistically possible. To maintain the target population range, 25 to 150 elk would be removed annually over the remaining 16 years of the plan. To the extent possible elk carcasses and/or meat resulting from these actions would be donated through an organized program to eligible recipients including members of tribes based on informed consent and pursuant to applicable public health guidelines. Under this alternative it is expected that 160 acres of aspen habitat could be fenced. Use of distribution techniques would also be required to meet vegetation objectives.

Elk Population Reduction

Under this alternative, between 200 and 700 elk would be lethally removed annually in the first four years and between 25 to 150 elk would be removed annually over the remaining 16 years to maintain the population size. The number of elk to be removed each year would be determined based on population estimates and harvest by hunters outside the park. Lethal reduction inside the park would be conducted by NPS personnel and their authorized agents who would be certified in firearms training, specially trained in wildlife culling, and be required to pass a proficiency test in order to qualify to participate in culling activities. Lethal reduction actions would be conducted in a manner that would minimize impacts on visitor use and experience. Mitigations would include varying the type of weapon or the times of day when actions occur.

A temporary capture facility, such as a corral trap, could be used inside the park if needed to reach population reduction targets, particularly during the intensive lethal reduction of the first four years. Areas not frequented by the public, such as Little Horseshoe Park, would provide the preferred locations for a temporary capture facility. Elk could be attracted to the facility using bait. Bait could attract other species of wildlife. Concentrating bighorn sheep could increase the potential for disease spread among the population. To mitigate this concern, the baiting locations would not be placed in areas known to be frequented by bighorn sheep, and lethal elk reduction actions would be implemented as quickly as possible to minimize the number of days that bait would be present in the environment. Alternatively, trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices could direct elk to the facility. Helicopters could be used adaptively for herding elk to a capture facility if monitoring indicates other methods are not effective. Following capture, American Veterinary Medicine Association-approved lethal removal methods such as shooting, penetrating captive bolt, or lethal injection would be used onsite. Every effort would be made to "reduce pain and distress to the greatest extent possible during the taking of an animal's life" (AVMA 2001).

Adult female elk would be the preferred target for lethal reduction because reducing the number of adult females in the population more effectively reduces the potential for population growth. However, some males and calves would also be removed to maintain at least 15% of the population as adult females and to prevent the bull to cow ratio from exceeding 80 bulls per 100 cows. In addition, individual elk could be targeted to simulate wolf predation (i.e., to take elk in poor physical condition in preference to healthy elk, calves in preference to cows, cows in preference to bulls). During capture operations, individuals not meeting age or gender criteria could be released. To reduce the potential for chronic wasting disease transmission while in the capture facility, the National Park Service would work quickly to release those animals that would not be subject to lethal control.

Lethal reduction activities could occur at any time of year. However, most lethal reductions would likely occur between November and February to allow the greatest opportunity to reduce the park subpopulation. Lethal reductions would be performed to minimize the likelihood of ophan calves and to minimize visitor impacts. Lethal reduction could be done anywhere in the park where logistically feasible. Particular emphasis would be given to areas of aspen on the primary elk range and areas of suitable willow habitat such as on the core winter range, where willow communities have the greatest need for protection from browsing pressure and where beavers influenced riparian habitat in the past.

Elk Distribution

Elk would still be expected to use the primary winter and summer ranges, although in greatly reduced numbers and lower densities. Population reduction activities using noise-suppressed weapons would not be expected to disperse elk long distances (i.e., out of the park), and only local elk movement may result as carcasses are being removed. Lethal reduction with unsuppressed weapons could disperse elk from areas of vegetation that are highly degraded, reducing browsing pressure. These activities would result in temporary dispersal of elk across short distances within the park while operations were ongoing and could deter elk foraging at other times. Small-scale reduction actions with unsuppressed weapons could also be used between late August and late November in the Kawuneeche Valley over a widespread area to facilitate the movement of elk to areas outside the park where they could be hunted. The long-term effects of suppressed and unsuppressed lethal reduction of elk redistribution are uncertain, and elk may avoid areas in the park for longer periods of time. They may also seek refuge in unhunted areas such as Estes Park and Grand Lake.

Aversive conditioning and herding would prevent or reverse habituation of elk and would disperse elk from sensitive areas on the elk range to relieve browsing pressure on aspen and willow, especially when lethal reduction activities are not taking place. Use of aversive conditioning and herding may increase during the maintenance phase of the plan due to the decreased degree of lethal reduction activity. Aversive conditioning could be used to encourage localized movements and to cause elk to avoid areas or to move elk from the Kawuneeche Valley to areas outside the park where they could be hunted. Herding – the act of bringing individual animals together into a group, maintaining the group, and moving the group from place to place – could encourage the movement of elk from primary winter range areas to traditional use areas on the primary summer range. Aversive conditioning and herding in the park would include the use of rubber bullets, cracker shot, non-lethal projectile rounds, visual devises such as sticks with streamers, trained herding dogs, people on foot, or riders on horseback. If necessary, helicopters could be used adaptively during herding efforts if monitoring indicates other methods are not effective. Based on monitoring of vegetation condition, the frequency and intensity of redistribution methods could be increased as needed to disperse elk or move them to the primary summer range.

A study conducted in Banff National Park in Canada used predator-resembling aversive conditioning to imitate predation events so that elk redistribution reflected a more natural state. The study temporarily modified the behavior of human-habituated elk by increasing the distance that elk move and their wariness of humans (Kloppers et al. 2005). In this alternative, the change in the distribution of elk in response to lethal reduction actions with unsuppressed weapons, herding, or aversive conditioning (as well as fencing to protect aspen, which is discussed below) would be monitored to determine the efficacy of the methods in achieving management objectives.

To the extent possible, redistribution actions would avoid and minimize potential adverse effects on sensitive species and other wildlife by restricting elk redistribution actions during known sensitive portions of species' life cycles or in sensitive locations (e.g., breeding or nesting seasons, migration corridors, nesting habitat).

If monitoring shows that management objectives are not being met, the National Park Service would consider release of wolves into the park to redistribute elk according to the process described in Alternative 5. Release would take place if opportunities were present to cooperate with adjacent land managers and the State of Colorado, and if supported by state and federal policy. The National Park Service would enter into discussion with the state to ensure consistency with state plans for managing wolves. The Colorado Division of Wildlife formed a multi-disciplinary working group that developed a wolf management plan, which was adopted by the Colorado Wildlife Commission in June 2005 to address management of wolves if they migrate into the state. In November 2005 the wolf working group was tasked to continue discussions through 2006, focusing on who should make the decision about potential reintroduction of wolves to Colorado and how to structure a compensation program. The National Park Service would continue to communicate with the wolf working group as their discussions progress and would cooperate with the state to ensure consistency with existing and any future wolf management plans.

As long as the gray wolf is a federally protected species, the National Park Service would need approval and applicable permits from the U.S. Fish and Wildlife Service to acquire, release, and manage wolves in the park. Permits would also be needed from individual states to allow transport across state lines and from the agency providing the source wolves. To implement the adaptive use of wolves under this alternative, the National Park Service would be required by the U.S. Fish and Wildlife Service to develop a detailed plan describing the process to transport, release, and manage wolves in the park. This more detailed plan would be subject to further NEPA compliance and further consultation with the U.S. Fish and Wildlife Service; this consultation would be deferred until determining that wolves would be needed. The National Park Service would continue to monitor the regional status of wolves as described in the "Elements Common to All Alternatives" section of this chapter and would continue to cooperate with other agencies on wolf-related issues.

Vegetation Management

Under this alternative, up to 160 acres of aspen habitat on the elk range could be fenced. Because this alternative reduces elk numbers to the lower end of the natural range of variation within the first four years of the plan and uses distribution techniques to reduce high concentrations of elk, temporary fences would be installed adaptively, based on vegetation response to elk management actions as indicated through the monitoring program. It is unlikely under this alternative that all aspen on the elk range would be fenced. The amount of fences that would be installed in the first 10 years of the plan would be limited to the extent possible to allow ample time to determine vegetation response to elk management actions and for further research to determine whether the presence of aspen in the elk range is part of the natural condition. However, the installation of fences could begin in the first year of the plan to allow monitoring vegetation response to management actions (e.g., control plots) as well as to provide protection from elk browsing.

The high level of elk population reduction in the early phase of the plan, followed by maintenance of the elk population size within the lower end of a natural range of variation in subsequent years and the use of distribution methods to increase elk movements and decrease densities, would facilitate recovery of suitable willow habitat on the elk range to meet management objectives without the use of fences.

When vegetation receives adequate protection (aspen are tall enough to withstand browsing pressures and still reproduce) or when elk density, numbers, and frequency of browsing (offtake) are low enough, as indicated in the "Monitoring and Data Collection" section, the fences would be removed. Fences, however, may be in place for the remainder of the planning period or longer, depending on vegetation response.

Once an area was adequately protected from elk herbivory, willow cuttings or plantings, mechanical thinning or removal, prescribed fire, or the recolonization of beaver could be used to facilitate regeneration of vegetation on the elk range as described in "Elements Common to All Action Alternatives" section. The ability to use these restorative techniques, particularly in unfenced areas, would likely occur later in the planning process.

Distribution of Carcasses

The distribution of carcasses would be as described in the section "Elements Common to All Action Alternatives." To the extent possible elk carcasses and/or meat would be donated through an organized program to eligible recipients including members of tribes based on informed consent and pursuant to applicable public health guidelines. Based on logistical constraints of carcass removal, some carcasses may be left in the environment. The number of carcasses that may be left in the environment would reflect a natural state to the greatest extent possible.

Chronic Wasting Disease Prevalence Testing

All adult elk subject to lethal removal would either be removed from the field or the heads would be taken and tested for chronic wasting disease as described in "Elements Common to All Action Alternatives."

If a field test that provides immediate results becomes available to allow live testing for chronic wasting disease, elk corralled during population reduction activities would be immediately tested, and those testing positive for the disease could be preferentially removed to reach the target elk population number. Those elk in which chronic wasting disease has not been detected could be released if the annual number of elk to be removed from the population to meet management objectives has been reached.

Minimum Requirement / Minimum Tool Analysis

A programmatic analysis of elements of the alternative has been included in the minimum requirement analysis that is provided in Appendix G. Under this alternative, the elements listed below would require analysis through a minimum tool analysis which would be conducted prior to site-specific implementation of actions. For a detailed discussion of the minimum requirement process, refer to the "Wilderness Minimum Requirement / Minimum Tool Analysis" section in "Elements Common to All Alternatives."

The following actions of Alternative 2 have been evaluated in a minimum requirement analysis (see Appendix G) and would also be subject to a minimum tool analysis prior to their use in wilderness areas.

The use of helicopters for monitoring elk and transporting fence materials. Helicopters could also be used adaptively if necessary for herding elk and for removing carcasses from remote locations due to disease management concerns.

The use of a temporary capture facility to conduct lethal reduction actions, identification of appropriate locations for the facility, and transportation and erection of the facility.

The use of trained herding dogs to herd elk.

The use of all-terrain vehicles or trucks to remove carcasses.

The use of aversion techniques to disperse elk.

The use of fences to protect aspen and the use of equipment to transport and erect the fences. The use of prescribed burning, identification of appropriate locations for burns, and use of equipment necessary to conduct those burns.

The use of mechanical vegetation thinning or removal activities, identification of appropriate locations, and use of equipment necessary to conduct the actions.

ALTERNATIVE 3

Alternative 3, the preferred alternative, relies on gradual lethal reduction (culling) of elk by NPS personnel and their authorized agents to achieve a high target elk population ranging between 1,600 to 2,100 total elk (600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation) by the end of the plan. See Appendix H for further discussion of culling and authorized agents. Inside the park, up to 200 elk would be removed annually over 20 years. Elk carcasses and/or meat resulting from these actions would be donated through an organized program to eligible recipients based on informed consent and pursuant to applicable public health guidelines. The higher elk population target under this alternative would require additional measures, including fences and distribution techniques, to meet vegetation objectives. Please see the "the Preferred Alternative" section at the end of this chapter for the rationale as to why this alternative was chosen as the preferred in this final plan/EIS.

Elk Population Reduction

Lethal reduction inside the park would be carried out under controlled conditions as described above for Alternative 2. The number of elk to be removed each year would be determined based on population estimates and harvest by hunters outside the park. Because of the lower number of animals removed each year, this alternative may not need a temporary capture facility. However, based on monitoring of the effectiveness of removal actions, a temporary capture facility may be used as an adaptive management tool in the future as described in Alternative 2.

Lethal reduction activities could occur at any time of year. However, most lethal reductions would be performed between November and February to allow the greatest opportunity to reduce the in park subpopulation. Lethal reductions would be performed to minimize the likelihood of ophan calves and to minimize visitor impacts.

The location of lethal reduction activities would be similar to those described in Alternative 2. Lethal reduction could be done anywhere on the elk range where logistically feasible. Particular emphasis, however, would be given to areas on the primary elk range of aspen and suitable willow habitat where willow communities have the greatest need for protection from browsing pressure and where beavers influenced riparian habitat in the past.

As logistical capabilities for using fertility control improve and longer-acting, multi-year drugs are developed, fertility control could be used as an adaptive management tool under this alternative to maintain and/or reduce the elk population size. The multi-year control agent would need to meet the requirements for use as described in Alternative 4. Implementation of fertility control activities to reduce and/or maintain the elk population would be as described in Alternative 4. To implement the adaptive use of fertility control agents in the future, the National Park Service would further consult with U.S. Fish and Wildlife Service, Colorado Division of Wildlife, and the public regarding details of that action and effects on federally threatened and endangered species.

Elk Distribution

Elk would still be expected to continue to use the primary winter and summer ranges but at moderately reduced numbers and densities. The dispersal effect on elk from the use of weapons during lethal reduction actions would be as described in Alternative 2. However, because of the lower number of animals removed in the first four years under Alternative 3, the frequency of lethal removal actions would be less, resulting in less dispersal from reduction actions during this time period compared to Alternative 2. The potential for a higher number of animals to be removed in the last 16 years under this alternative could result in a greater frequency of reduction than under Alternative 2, resulting in increased dispersal as a result of lethal removal actions during these years. Lethal reduction activities would disperse elk while operations were occurring and may also deter elk foraging at other times of the year.

Methods to redistribute and herd elk would be the same as described in Alternative 2. Because of the higher target population level under this alternative, use of aversive conditioning and herding would be more frequent over the 20-year implementation period to reduce browsing pressure on the vegetation than under Alternative 2. The distribution response of elk as a result of redistribution techniques would be monitored to determine the efficacy of the methods used.

The National Park Service would consider release of wolves into the park as an adaptive management approach to redistribute elk according to the process described in Alternative 5, if monitoring indicates that management objectives are not being met. Release would take place if opportunities were present to cooperate with adjacent land managers and the State of Colorado, and if supported by state and federal policy. The process for use of wolves as an adaptive management tool would be the same as described in Alternative 2.

Vegetation Management

Under this alternative, fences would protect aspen and montane riparian willow on the primary elk range. The National Park Service would determine the need for fences based on monitoring the response of vegetation to reduced elk numbers, lethal reduction activities, and redistribution methods. Monitoring of vegetation communities would provide the information necessary to determine how many acres of willow or aspen on the primary elk range need to be protected. Similarly, monitoring data would provide the information necessary to determine when fences can be removed once communities are restored.

Under this alternative it is expected that 160 acres of aspen habitat on the elk range would be fenced. Because of the gradual reduction in the elk population size over time, it is expected that installation of fences would begin within the first five years of the plan. Once vegetation receives adequate protection (the aspen are tall enough to withstand browsing pressures and still reproduce) or when elk density, numbers, and frequency of browsing (offtake) are low enough as indicated in the "Monitoring and Data Collection" section, the fences would be removed.

Because of the higher elk population target compared to Alternative 2, fences would be needed to protect riparian willow communities. Due to the highly degraded condition of willow on the primary winter range, it is expected that 260 acres of suitable willow habitat on the primary winter range would be fenced. Compared to other action alternatives, this alternative involves the lowest level of elk management, and although redistribution methods would be used to protect willow on the elk range, at this time the success that could be achieved with elk redistribution techniques is uncertain. Therefore, to ensure that management objectives for willow are also met on the primary summer range, it is expected that 180 acres of suitable willow habitat on the primary summer range would be fenced under this alternative.

Fences would be installed at levels commensurate with elk numbers and distribution that result from lethal reduction and distribution activities. This would ensure that there is ample food available in areas outside the fences for the number of elk remaining in the population which would prevent mass emigration of elk from the park and prevent further degradation of vegetation outside fenced areas.

Once an area was adequately protected from elk herbivory, willow cutting plantings, mechanical thinning or removal, prescribed burning, or recolonization by beaver could facilitate regeneration of vegetation on the elk range as described in "Elements Common to All Action Alternatives." These restorative methods could be used earlier in the planning process in fenced areas due to the higher level of protection provided against elk herbivory.

Distribution of Carcasses

The distribution of carcasses would be as described in the "Elements Common to All Action Alternatives" section. To the extent possible elk carcasses and/or meat resulting from these actions would be donated through an organized program to eligible recipients including members of tribes based on informed consent and pursuant to applicable public health guidelines. Because of the low number of elk removed each year, the number of carcasses needing to be disposed of would be less than Alternative 2 in the first four years but slightly higher in the last 16 years. The number of carcasses that would potentially be left in the field would not exceed natural conditions.

Chronic Wasting Disease Prevalence Testing

All adult elk subject to lethal removal would either be removed entirely from the field or the heads would be taken and tested for chronic wasting disease. Over the life of the plan, the number of elk tested would be less than under Alternative 2, as the number of elk needing to be removed from the population would be less to reach and maintain a higher population target under this alternative.

If a field test that provides immediate results becomes available to allow live testing for chronic wasting disease, elk that are subject to anesthetization or that are corralled during population reduction activities would be immediately tested, and those testing positive for the disease would be preferentially removed to reach the target elk population number. Those elk in which chronic wasting disease has not been detected could be released if the annual number of elk to be removed from the population to meet management objectives has been reached.

Minimum Requirement / Minimum Tool Analysis

A programmatic analysis of elements of the alternative has been included in the minimum requirement analysis that is provided in Appendix G. Under this alternative, the elements listed below would require analysis through a minimum tool analysis which would be conducted prior to site-specific implementation of actions. For a detailed discussion of the minimum requirement process, refer to the "Wilderness Minimum Requirement / Minimum Tool Analysis" section in "Elements Common to All Alternatives."

The following actions of Alternative 3 have been evaluated in a minimum requirement analysis (see Appendix G) and would also be subject to a minimum tool analysis prior to their use in wilderness areas.

The use of firearms to lethally remove elk or dart guns to anesthetize elk.

The use of helicopters for monitoring elk and transporting fence materials. Although unlikely, helicopters could also be used adaptively if necessary for herding elk and for removing carcasses from remote locations due to disease management concerns.

The use of horses to herd elk or remove carcasses.

The use of trained herding dogs to herd elk.

The use of all-terrain vehicles or trucks to remove carcasses.

The use of aversion techniques to disperse elk.

The use of fences to protect aspen and suitable willow habitat and use of equipment to erect the fences.

The use of prescribed burning, identification of appropriate locations for burns, and use of equipment necessary to conduct those burns.

The use of mechanical thinning activities, identification of appropriate locations, and use of equipment necessary to conduct the actions.

ALTERNATIVE 4

Alternative 4 would emphasize treating cow elk with a fertility control agent to the greatest extent possible given technological and logistical capabilities. In addition, lethal reduction (culling) of elk by NPS personnel and their authorized agents would be needed each year to reach plan objectives. See Appendix H for further discussion of culling and authorized agents. The target elk population of 1,600 to 2,100 total elk (600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation), which is on the higher end of the natural range of variation, would be achieved by the end of the 20-year plan. If using an agent that is effective for one year, up to 400 elk would need to be treated annually during the first four years of the plan and 200 for each of the remaining 16 years. When using a single-year fertility control agent, 80 to 150 elk would need to be lethally removed each year to reach plan objectives. For longer-lasting fertility control agents, either the number of elk treated or the number of elk lethally removed would be reduced. Elk carcasses and/or meat resulting from these actions would be donated through an organized program to eligible recipients including members of tribes based on informed consent and pursuant to applicable public health guidelines. Because of the higher elk population target under this alternative, additional measures, including fences and distribution techniques, would be required to meet vegetation objectives.

Elk Population Reduction

Fertility Control

Using fertility control agents, this alternative would reduce the number of calves born into the population each year, which would slowly contribute to the decline in elk population size. The use of fertility control agents to manage a free-ranging wildlife population has never been conducted. The National Park Service acknowledges that it may be difficult to control a high number of elk with fertility control, especially with the agents currently available, which last for only one breeding season. Therefore, lethal control (culling) by NPS staff and their authorized agents would also be needed to meet population targets.

Reduction of the elk population within the project area could be achieved in part using a single-year, multi-year, or lifetime duration fertility control agent. Using a single- or multi-year agent**,** a female elk may be treated multiple times during plan implementation; however, the female elk would resume full reproductive capability after the duration of the agent has expired. Fertility control administration would take place within park boundaries by certified NPS staff or contractors according to Director's Order 77-4: Pharmaceuticals for Wildlife. Best management practices for applying fertility control agents as described in Director's Order 77-4 and staff training would reduce safety risks associated with treating large numbers of animals. In addition, every effort would be made by staff to retrieve darts that have missed their target.

A lifetime fertility control agent would permanently prevent reproduction. No lifetime control agents currently available meet the established criteria for use on elk in the park (see "Requirements for Fertility Control Agents," below). However, if during the life of this plan such an agent becomes available, it could be used to meet and/or maintain the target population size.

Leuprolide acetate (referred to throughout the text as leuprolide), a single-year agent, has been tested in elk and found to cause infertility for one breeding season (Baker et al. 2002); it is currently available for use. It is estimated that this agent could logistically be administered to up to 400 cow elk per year in the first four years of the plan. Treatment would occur between

August and early September to prevent births in the following year. Elk would probably become more wary of management actions after the first four years of the plan, making treatment of a high number of elk logistically more difficult. Therefore, during the last 16 years of the plan 200 elk per year would probably be treated.

A potential multi-year reversible agent, GonaCon™, which has not been field tested or reported for use in free-ranging elk, could also be used in a small-scale investigation as described in the "Opportunistic Research Activities" section earlier in this chapter, treating approximately 60 elk until obtaining regulatory-approval. Using a potential multi-year agent such as GonaCon™, and assuming a three-year duration of drug effectiveness, the number of female elk needing treatment each year would probably be less than that described for a single-year agent, assuming similar lethal removal numbers. See "Potential Agents" section below for more information on leuprolide and GonaCon™.

Only female elk would be treated. By stopping reproduction in female elk, the calves that they would produce in the current and future years would not be recruited to the population. In addition, the treatment of males would be ineffective because one male can breed with many females. Therefore, the treatment of all dominant bulls, even if feasible, would not ensure that subordinate bulls would not then breed. The treatment of bulls would also likely lead to decreased rutting and breeding behavior.

Treatment with leuprolide could be done either by hand injection or by darting the elk assuming no withdrawal time. The preferred method for treatment with leuprolide would be by remote delivery of the agent and a short-term mark such as by paint ball to prevent multiple treatments within the same year. Although not harmful to the elk, it would be less efficient to re-treat already treated elk. If hand injection methods are used, elk would need to be captured as described in Alternative 2 and handled for treatment and marking.

At this time, single-year agents are only available to treat female adults. If a multi-year or permanent agent with no withdrawal period and with regulatory-approval or approved by a prescribing veterinarian for extra-label use becomes available and proves safe and effective on calves, female calves would be preferentially treated over female adults to eliminate the need for long-term marking. A short-term mark, as with a paint ball, would prevent multiple treatments of young-of-year individuals.

Treated elk would need to receive a readily recognizable long-term mark that warns individuals not to consume the meat if the elk was killed before the required withdrawal period had passed for a regulatory approved fertility control agent or immobilization drug, or if the fertility control agent was not regulatory-approved or approved by a prescribing veterinarian for extra-label use. For Food and Drug Administration (FDA) licensed drugs used according to label directions, the withdrawal period of an agent is identified on the label. For extra-label drug use, the period is determined by the prescribing veterinarian based on the best available scientific information. The preferred method of administering an agent that requires a long-term mark on the elk would be immobilization by dart followed by treatment and marking.

To treat large numbers of elk efficiently, a temporary capture facility could be used as an adaptive management tool inside the park. The location and details of the capture facility are the same as described in Alternative 2 except that bait would not be used and animals subject to fertility control would be released after treatment.

Long-term marking methods currently available include ear tags, freeze branding, passive transponders, and subcutaneous radio frequency tags. To balance the needs of monitoring treated individuals with that of reducing visual impacts, different marking methods may be employed as they become available.

Treatment activities could occur in any area of the park. However, treatment activities with agents needing to be administered during summer would mostly be completed on the primary summer range, while those agents needing to be administered during winter would be completed on the primary winter range. Treatment activities could occur during any time of day and at any time of year. The time of year for conducting treatment activities would depend largely on when the agent would be effective without unacceptable adverse effects on the elk. For example, if the agent was found to cause loss of fetuses when pregnant elk are treated, the timing would be adjusted based on best professional judgment to prevent treating pregnant elk.

Requirements for Treatment Agent

Several fertility control agents that might be effective for implementing this alternative are in development, and new agents may become available in the future. This section identifies the characteristics that any treatment agent must have before it is deemed acceptable for implementation in this alternative. As part of the adaptive management approach, an agent could be used experimentally under strict oversight, with use discontinued if it is found to be unacceptable for implementation.

Effective with a single treatment: The agent would effectively control fertility for the specific duration with a single dose. Elk in and around Rocky Mountain National Park are wild, free-ranging animals, and it would be impractical to capture the same individual more than once in a season for treatment. As shown with tule elk (*Cervus elaphus nannodes*) at Point Reyes National Seashore, porcine zona pellucida (PZP), a highly effective contraceptive, requires an initial treatment followed by a booster dose three weeks later; it is therefore considered unsatisfactory for fertility control in the free-ranging elk population in Rocky Mountain National Park.

At least 85% effective: Ideally, a fertility control agent would be effective in every treated animal. However, variability in the biological response to an agent may enable some individuals to remain fertile even after treatment. The lowest acceptable level of effectiveness that would enable the program to reach the target elk numbers would be 85%. An agent with lower effectiveness would require the treatment of a high number of females that would be logistically difficult to accomplish.

Appropriate approvals and certifications: Ideally, the agent would have regulatory approval for use in elk and would require no withdrawal period. Less optimally, it would be approved for use in an alternate species as an extra-label drug or approved for investigational purposes and would require no withdrawal period. If the agent was used for investigational purposes, the National Park Service or researcher would be required to obtain an investigational new animal drug exemption from the appropriate regulatory agency. This exemption requires specialized authorizations under a drug research project. All agents would need to be certified as safe for use in elk by the prescribing veterinarian. If the drug used has a required drug withdrawal period, all animals treated would be permanently marked to notify individuals who might harvest the animals not to consume the meat unless the established withdrawal period passed before slaughter.

Safe for treated animals: The agent would have no long-term effects on treated elk other than effective fertility control. This would include the absence of toxic, short-term reactions or debilitating, long-term effects that would increase mortality in the population. It also would not result in any genetic mutations that would interfere with the treated animal’s life cycle or be passed on to subsequent generations if the fertility control was not successful. An agent would also not be used if it caused a loss of fetuses 60 days or older or if it were to cause any debilitating health problems to a developing fetus carried to term. A conservative estimate of when fetuses would be 60 days or older would be after November 1 until June 15. To eliminate the chance of population loss, permanent sterility must not occur in more than 10% of treated elk when using a single- or multi-year reversible agent.

No recognizable behavioral effects: The fertility control agent would not result in recognizable behavioral effects. Some of the problems that would be avoided include the following:

> **Reduced courtship, rutting, and breeding behavior**. Watching and listening to bull elk during the fall breeding season is an important component of the visitor experience at Rocky Mountain National Park. Noticeable reduction in bulls' bugling, palpating, herding of cows, or challenges would adversely affect visitor experience. Reduced visitation would have a severe adverse effect on the local economy.
>
> In elk, pheromones, which are externally secreted chemicals that influence the physiology or behavior of other individuals of the same species, may trigger or enhance breeding-related behaviors, such as a bull collecting cows into a harem and defending that harem through such behaviors as bugling. If it altered release of pheromones, a fertility control agent could affect rutting and breeding behavior. Reduced pheromone release in some cow elk would be inconsequential if bulls continued natural current rutting and breeding behaviors without preference to treatment status.
>
> **Increased courtship, rutting, and breeding behavior**. PZP vaccine, although an effective contraceptive because it prevents pregnancy, caused prolonged rutting and breeding behavior in tule elk at Point Reyes National Seashore in California. If used in Rocky Mountain National Park, it would result in such behavior from September 15 to March 15. This behavior would be physically draining for the bulls, could increase elk-human conflicts such as collisions with vehicles, and would clearly be a recognizable behavioral change from natural current conditions.

Safe for non-target animals: The carcasses of dead elk serve as a food source for many other animals in the park. Some elk are killed and eaten by predators such as mountain lions and coyotes. Wild birds and mammals that feed on the elk carcasses include black bear, magpies, hawks, eagles, coyotes, and foxes. In areas close to human habitation, domestic cats and dogs may also feed on dead elk. Ideally, a fertility control agent must not have any known adverse effects on non-target animals that consume elk. These would include no toxicity, no change in fertility, and no genetic mutations that would interfere with life cycles or be passed on to subsequent generations. The long-term effects of agents on non-target animals are unknown. Based on an adaptive management approach, if additional information becomes available indicating that an agent has adverse effects on non-target animals, the use of the agent would stop or be modified to eliminate risks. Both leuprolide and GonaCon™ are proteins that are broken down during digestion, posing no risk of passing into the food chain (APHIS 2005, Becker and Katz 1993).

Potential Agents

While other agents may become available in the future, currently leuprolide and GonaCon™ could potentially be used to control elk populations. A description of these two agents and their potential for use in the park follows:

Leuprolide is an agent involving a gonadotropin-releasing hormone (GnRH) agonist (counteracts GnRH). Produced by the hypothalamus, a major portion of the brain, GnRH is part of a pathway that signals the body to produce sex hormones; without it, very little estrogen is produced. Leuprolide acts to suppress the secretion of this reproductive hormone. This drug is approved for therapeutic use in humans, and the four-month formulation has been shown to suppress ovulation and estrus in cow elk for one breeding season (Baker et al. 2002). Extra-label use of leuprolide, in accordance with the Animal Medicinal Drug Use Clarification Act of 1994, would require a prescription by a veterinarian. The veterinarian would also be responsible for establishing the withdrawal period for the drug or determining that there is no withdrawal time. The treated animals would require marking to prevent human consumption of the meat until the established period has past.

Treatment with leuprolide would occur between mid-July and mid-September. As described in "Requirements for Treatment Agents" section, leuprolide would be unlikely to cause loss of fetuses when pregnant elk are treated (D. Baker 2004). However if loss of fetuses is found to occur in elk, treatment times for use in the field would be adjusted to prevent treatment of pregnant elk.

GonaCon™ is a GnRH immunocontraceptive vaccine. Immunocontraception involves the production of antibodies that attack specific proteins, resulting in infertility. The aim of a GnRH vaccine is to bind to or "tie up" the GnRH produced within an animal's body so that it does not trigger reproduction. The vaccine induces the body to make antibodies against its own GnRH. As a result, following injection, the hormone's function is neutralized, resulting in infertility in females (NWRC 2004).

GonaCon™ has been shown to be effective in various wildlife species with one dose when administered with the AdjuVac adjuvant, a compound that increases the levels of antibodies (NWRC 2004). The vaccine has not yet received adequate evaluation in elk. However, it could be immediately tested on cow elk in the park on a strictly regulated, investigational basis with an investigational, new animal drug exemption and prescribing-veterinarian approval. The study would be terminated if monitoring found that the agent did not meet all criteria. Because GonaCon™ is not a regulatory-approved agent in any species, all treated elk would require a long-term mark to prevent human consumption of meat from treated elk.

The safety and effectiveness of GonaCon™ on calves is unknown.

Treatment with this agent would occur from November through mid-September to allow the agent to be effective in the upcoming breeding season. If loss of fetuses is found to occur in elk when tested in a controlled setting, treatment times for use in the field would be adjusted to prevent treatment of pregnant elk as described in "Requirements for Treatment Agents" section.

Lethal Reduction

Because of the remoteness of the park, the wide dispersion of elk in the summer months, and the short period within which to treat the elk, treatment of 400 elk with a fertility control agent each year may be difficult. If this number of elk could not be treated within the period, then additional lethal removal actions by NPS personnel and their authorized agents may be needed to further supplement the fertility control actions to meet population level objectives. See Appendix H for further discussion of culling and authorized agents. The number of elk that would need to be lethally removed each year would be 80 to 150. Lethal reduction inside the park would be carried out under controlled conditions as described above for Alternative 2. Because of the lower number of animals to be removed each year, a temporary capture facility could be used as an adaptive tool if other methods are shown to be less effective.

Unless a multi-year agent became available, lethal reduction would be needed more during the later years of the plan as the logistical constraints of applying fertility control increases due to increased elk wariness. As logistical capabilities for using fertility control improve or longer-acting drugs are developed, fertility control could become the sole means of controlling the elk population size.

Elk Distribution

Elk would still be expected to continue to use the primary winter and summer ranges but at moderately reduced numbers and densities. The dispersal effects on elk from the use of unsuppressed (noisy) weapons during any lethal reduction actions would be the same as those described in Alternative 3. Fertility control activities using remote darting would have minimal dispersal effects.

The use of herding, aversive conditioning, and unsuppressed weapons to redistribute elk would be as described above for Alternative 2, however they would occur more frequently. Because of the low use of lethal reduction and minimal dispersion that would result from fertility control actions, the park would frequently conduct aversive conditioning and herding to reduce browsing pressure on aspen and willow at a similar level as described in Alternative 3. The distribution response of elk as a result of fertility control and lethal removal activities, herding, aversive conditioning, and fences (discussed below) would be monitored to determine the efficacy of the methods.

Vegetation Management

Vegetation management methods and timing would be similar to those described above in Alternative 3. Under this alternative it is expected that 160 acres of aspen habitat on the primary elk range would be fenced. It is expected that 260 acres of suitable willow habitat on the primary winter range would be fenced. Fences would not be used on the primary summer range as in Alternative 3 but would rely on elk redistribution techniques to protect riparian willow habitat on this portion of the primary elk range. Monitoring of vegetation communities would provide the information necessary to determine how many acres of willow or aspen on the primary elk range need to be protected. Similarly, monitoring data would provide the information necessary to determine when fences can be removed once communities are restored.

Once an area was adequately protected from elk herbivory, willow cutting plantings, mechanical thinning or removal, prescribed burning, or recolonization by beaver could be used to facilitate regeneration of vegetation on the elk range as described in Alternative 2. These restorative methods could probably be used earlier in the planning process in fenced areas due to the higher level of protection against elk herbivory.

Distribution of Carcasses

The distribution of carcasses would be as described in the section "Elements Common to All Action Alternatives." To the extent possible elk carcasses and meat resulting from these actions would be donated through an organized program to eligible recipients including members of tribes based on informed consent and pursuant to applicable public health guidelines. Through time, the number of carcasses needing to be disposed under this alternative could decline as elk population management would rely more on fertility control with less reliance on lethal reductions.

Chronic Wasting Disease Prevalence Testing

All adult elk subject to lethal removal would either be removed entirely from the field or the heads would be taken and tested for chronic wasting disease.

With the current fertility control technology, under this alternative, the number of elk tested would be similar to Alternative 3 if a field test does not become available that allows testing of live elk. The number tested would decline if the technology of the fertility control agents improved such that management of the population could be predominantly a result of fertility control activities rather than lethal reduction.

If a field test that provides immediate results becomes available, allowing live testing for chronic wasting disease in elk, elk that are captured during fertility control activities would be immediately tested, and those testing positive for the disease would be preferentially lethally controlled to reach the target elk population number. Those elk in which chronic wasting disease has not been detected could be treated and released. If a field test becomes available, the number of elk tested under this alternative would be greater than under any other action alternative.

Minimum Requirement / Minimum Tool Analysis

A programmatic analysis of elements of the alternative has been included in the minimum requirement analysis that is provided in Appendix G. Under this alternative, the elements listed below would require analysis through a minimum tool analysis which would be conducted prior to implementation of site-specific actions. For a detailed discussion of the minimum requirement process, refer to the "Wilderness Minimum Requirement Analysis" section in "Elements Common to All Alternatives."

The following actions of Alternative 4 have been evaluated in a minimum requirement analysis (see Appendix G) and would also be subject to a minimum tool analysis prior to their use in wilderness areas.

The use of firearms to lethally remove elk or dart guns to anesthetize elk or to remotely treat elk with fertility control agents.

The use of helicopters for monitoring elk and transporting fence materials. Although unlikely, helicopters could also be used adaptively if necessary for herding elk and for removing carcasses from remote locations due to disease management concerns.

The use of horses to herd elk or remove carcasses.

The use of trained herding dogs to herd elk.

The use of all-terrain vehicles or trucks to remove carcasses.

The use of a temporary capture facility to administer fertility control agents, identification of appropriate locations for the facility, and use of equipment to transport and erect the facility.

The use of aversion techniques to disperse elk.

The use of fences to protect aspen and suitable willow habitat and the equipment used to transport and erect the fences.

The use of prescribed burning, identification of appropriate locations for burns, and use of equipment necessary to conduct those burns.

The use of mechanical thinning activities, identification of appropriate locations, and use of equipment necessary to conduct the actions.

ALTERNATIVE 5

This alternative would involve lethal reduction (culling) of elk in combination with the release and intensive management of a limited number of gray wolves within Rocky Mountain National Park in a phased approach to achieve an elk population that would fluctuate within the natural range of variation between 1,200 to 2,100 elk. National Park Service staff and their authorized agents would lethally remove 50 to 500 elk annually in the first four years to bring the population to 1,600 to 2,100 animals, which is on the high end of the natural range of variation. Up to 100 elk would be lethally removed annually over the next 16 years to meet the target population range. See Appendix H for further discussion of culling and authorized agents. At the same time, a small number of wolves would be released and then allowed to gradually increase to a maximum of 14 over the life of the plan. The number of wolves would be increased after determining through monitoring that the National Park Service could effectively manage the wolf population and that wolves would contribute to accomplishing the plan's management objectives of reducing elk densities and thus restoring vegetation conditions.

All discussion of wolves in this section is specific to those that are released and intensively managed and not related to naturally recolonizing wolves.

Because of the limited number of wolves under this alternative, lethal reduction would be the primary elk population reduction tool and wolves would be the primary redistribution tool. To the extent possible elk carcasses and/or meat resulting from these actions would be donated through a an organized program to eligible recipients based on informed consent and pursuant to applicable public health guidelines.

Elk Population Reduction

Lethal Reduction

During the initial phases of the plan, the small number of wolves would not be expected to contribute to the reduction of the elk population size. Therefore, lethal reduction (culling) of elk by NPS personnel and their authorized agents would be needed to reduce the elk population to within the natural range of variation and to facilitate meeting vegetation restoration objectives. Within the first four years of the plan, the elk population would be reduced by lethal reduction action to the high end of the natural range, 1,600 to 2,100 total elk (600 to 800 park subpopulation and 1,000 to 1,300 town subpopulation). This would be accomplished by the annual lethal removal of 50 to 500 elk. To maintain the elk population at the high end of the range, up to 100 elk could be lethally removed annually over the remaining 16 years of the plan. As the number of wolves in the park increases throughout the plan, the need for supplemental lethal reduction may decline. During later years of the plan, the elk population would be maintained between 1,200 and 2,100 (200 to 800 park subpopulation; 1,000 to 1,300 town subpopulation), depending on the effectiveness of elk redistribution by wolves and resulting vegetation conditions. The methods for lethal reduction would be the same as those defined above under Alternative 2.

Elk Distribution

The presence of wolves would be expected to disperse elk and inhibit them from over-concentrating on the elk range to varying degrees, based on the number of wolves present. Large concentrations of elk would be expected to disperse; however, due to the uncertainty of how elk would respond, a full analysis would be conducted throughout the life of the plan to track changes in elk distribution at varying wolf population levels. The distribution response of elk as a result of wolf release would be monitored as described in the "Monitoring and Data Collection" section of this chapter. No additional aversive conditioning or herding would be anticipated under this alternative.

Wolves

A limited number of gray wolves would be released in the park in a phased approach. Their breeding capacity and movements would be intensively managed over the life of the plan. This strategy of using wolves as a tool to manage wildlife has never been conducted and not all experts agree that an intensively managed wolf population is feasible biologically or logistically; therefore, this alternative is considered to be experimental. It is uncertain whether wolves would establish within the park, whether they would remain within the park boundaries, whether they would redistribute elk on the primary winter range enough to allow vegetation to recover, and how they would react to frequent recapture and release, if needed. Logistical problems in implementing the program could include obtaining permits for wolves as long as they are federally protected, finding a source of wolves, managing to keep wolves within park boundaries, and retrieving wolves that may cross park boundaries. This alternative, however, is being considered because wolves have been shown to be effective in controlling elk populations and have indirectly improved vegetation such as willow and aspen in other areas (Fortin et al. 2005, Coughenour 2002), so they are considered a potential tool for elk management within Rocky Mountain National Park.

It is expected that a small number of wolves would be able to meet the plan objectives by redistributing elk. Elk may use more open areas, move more frequently, and congregate less due to the threat of predation (Fortin et al. 2005), or they may retreat in smaller groups to areas of wooded vegetation to avoid detection by wolves (Creel and Winnie 2005). At higher wolf numbers, it is expected that wolves may also reduce elk population size to some degree through predation. With very small wolf numbers early in the planning period, lethal reduction actions by NPS personnel and their authorized agents would be needed to reduce elk numbers and densities to meet management objectives.

As long as the gray wolf is a federally protected species, the National Park Service would need approval and applicable permits from the U.S. Fish and Wildlife Service to acquire, release, and manage wolves in the park. The proposed use of wolves may not be compatible with the provisions of the Endangered Species Act, as it does not promote recovery of the listed species and it is uncertain whether approval would be granted. Permits would also be needed from individual states to allow transport between states and from the agency providing the source wolves. To implement this alternative, the National Park Service would be required by the U.S. Fish and Wildlife Service to develop a detailed plan describing the process to transport, release, and manage wolves in the park. This more detailed plan would be subject to further NEPA compliance and further consultation with the U.S. Fish and Wildlife Service.

Wolves would be released and managed in the park according to a rigid set of guidelines using two adaptive phases. In each phase, the number of wolves would be strictly controlled using fertility control methods or by removing individuals from the population. Throughout plan implementation, it may be necessary to bring in individual wolves to replace established wolves that may be lost due to mortality. The number of wolves that could be brought into the park would depend on constraints such as funding, appropriate approvals, and source availability. Under this alternative, all wolves would be fitted with global positioning system tracking collars, and their movements and activities would be strictly monitored.

The National Park Service has established required management criteria to meet during implementation of this alternative:

1. Wolves would be restricted to within park boundaries and be adequately managed to mitigate safety and property concerns. NPS staff or contractors would be hired and dedicated to managing and monitoring the wolves on a daily basis. Wolf movements would be strictly controlled to prevent any from crossing the park boundary unless there is cooperation with Colorado Division of Wildlife for management of wolves outside the park. Wolves that approached the boundary would be immediately moved back into the park by capture and transport back to a soft release pen. Although success of aversive conditioning methods is uncertain, such techniques would be attempted on wolves approaching the boundary. If these actions were not successful in keeping a wolf within the park, it would be relocated to an unoccupied territory outside the park (area with no wolves present that would be in need of wolves) or to a wolf sanctuary, or it would be lethally removed. If a wolf attacked domestic livestock (cattle, sheep, or horses) or other domestic animals such as pets, it would be lethally removed. The number of occurrences and the type of actions taken would be determined on a case-by-case basis for each individual wolf. Although there are no state or federal compensation programs for wolf-caused losses of domestic livestock, programs established by private groups, such as Defenders of Wildlife, may be applicable.
2. Wolves must find and kill elk as a primary food source. If not using elk as a primary food source, wolves would be removed from the park by capturing and relocating to an unoccupied territory outside the park or to a wolf sanctuary, or they would be lethally removed. Wolves may prey on other wildlife species such as deer or moose, and they may have a more diverse diet in the summer; however, their primary prey species should be elk.
3. Wolves must effectively redistribute elk. Wolves would be monitored to determine their effectiveness in meeting dispersal management objectives.

As stated earlier, use of wolves as a management tool to control elk populations involves numerous uncertainties:

Whether the park could gain appropriate regulatory approvals to obtain wolves for release in the park;

Whether wolves would establish in the park;

Whether park managers could effectively control wolf behavior and movements and keep wolves in the park; and

Whether a limited number wolves could redistribute elk to allow vegetation recovery.

Based on monitoring, the park would stop the use of wolves as an elk management tool at any time during the plan if any of the above criteria were not met or if wolves were not contributing to meeting the management plan objectives. The wolves would then be captured and relocated or lethally removed as described above, and the management plan would rely on lethal reduction of elk by NPS personnel and their authorized agents, as defined in Alternative 2.

During Phase 1, the National Park Service would evaluate how effectively the wolves could be managed, whether management objectives were being met, and the level of impact on other resources. The goal of Phase 1 would be to have at least one pair of wolves establish within a territory centered on the east side of the park, where the greatest extent of elk degradation on vegetation has occurred. To increase the potential to meet this goal and to evaluate the ability of the park to manage wolves, the park would release two pairs of wolves (two females and two males) using a soft release method on the east side of the park. Releasing two pairs would increase the potential of at least one pack establishing residence. A soft release involves allowing the wolves to acclimate in the general area of release in a confinement facility, providing them carcasses for food for six to eight weeks, and then releasing them to range freely in the park.

Male wolves would be given vasectomies to prevent reproduction. Females would retain their reproductive abilities. The reason males would be treated is because the surgery is less invasive in males than females and therefore less risk of complications and also because the vasectomy would be reversible. Vasectomies could be achieved through surgical means. The wolves would be expected to exhibit normal social behavior and establish territories, as suggested by research conducted on surgically sterilized wolves (Spence et al. 1999, Haight and Mech 1997, Mech et al. 1996a, and Mech et al. 1996b). This research indicates that wolves with vasectomies stayed in their territories and maintained pair bonds and performed breeding behavior such as digging dens.

If a wolf would die during Phase 1, its partner would be brought back to the soft release pen, a new mate would be introduced to the pen, and the pair would be released once a pair bond was established. After two to three years of monitoring and evaluating data, the National Park Service would determine whether to advance to Phase 2.

In Phase 2, the wolf population would be allowed to increase within the park, under tight control, to the optimum number of wolves to meet the management plan objectives while continuing to maintain management control. Wolves would need to demonstrate effective distribution of elk. As in Phase 1, the ability of the managers to control the wolves and the level of effects on resources would continue to be evaluated as the number of wolves increased.

The male wolves from Phase 1 would undergo vasectomy reversal to allow reproduction. Vasectomy reversal has been conducted successfully in canids and is considered a relatively simple procedure (Wittenauer 2005). The reversal would be performed by a veterinarian using aseptic methods to reduce surgery related risks. In this phase, wolf movements, activities such as denning, and population growth would be monitored. Managers would control the size of the wolf pack by such means as embryo reduction and/or removal of pups. Removed pups would be taken to captive wolf facilities or lethally removed, if necessary. Ecosystem simulation modeling (Coughenour 2002) has predicted that wolves released into Rocky Mountain National Park would stabilize in the park at a population of 14. Therefore, under Phase 2, the wolf numbers in the park would not be allowed to exceed 14 animals.

The intensive management of wolves under this alternative would result in stress to those individuals. The National Park Service recognizes this result and would, within the constraints of an action, reduce to the greatest extent possible any pain or distress that the actions may cause.

Vegetation Management

Under this alternative, it is expected that 160 acres of aspen habitat on the elk range would be fenced. Due to the presence of wolves and the redistribution of elk that would be expected under this alternative, fences would be installed adaptively based on vegetation response, as indicated through the monitoring program. Because wolves are expected to effectively disperse elk, the amount of fence that would be installed is expected to be less than under other alternatives. The installation of fences could begin in the first year of the plan to allow monitoring vegetation response to management actions (e.g., control plots) as well as to provide protection from elk browsing. The amount of fences that would be installed in the first 10 year of the plan would be limited to the extent possible to allow ample time to determine vegetation response to elk management actions and for further research to determine whether the presence of aspen in the elk range is part of the natural condition.

Monitoring of vegetation communities would provide the information necessary to determine how many acres of willow or aspen on the primary elk range need to be protected. Similarly, monitoring data would provide the information necessary to determine when fences can be removed once communities are restored.

With reduction in the elk population and increased dispersal and movement of elk by wolves and lethal reduction activities, it is expected that vegetation would recover naturally. Fences therefore would not be used to protect montane riparian willow on the primary winter range. Once an area was adequately protected from elk herbivory, willow cutting plantings, mechanical thinning or removal, prescribed burning, or recolonization by beaver could be used to facilitate regeneration of vegetation on the elk range as described in Alternative 2. The ability to use restorative techniques, particularly in unfenced areas, would likely occur later in the planning process.

Distribution of Carcasses

The distribution of carcasses would be as described in the section "Elements Common to All Action Alternatives." To the extent possible elk carcasses and/or meat resulting from these actions would be donated through an organized program to eligible recipients based on informed consent and pursuant to applicable public health guidelines. The number of carcasses left in the environment would reflect a natural state to the greatest extent possible; however, the logistical challenges of removing large numbers of carcasses during the first four years of the plan may require leaving some carcasses in the field after carefully considering impacts on natural resources, wilderness, and visitors. The number of carcasses needing to be disposed under this alternative would decline over time as elk population management would rely more on wolves with less reliance on lethal reductions.

Chronic Wasting Disease Prevalence Testing

During the initial phases of the plan when wolf numbers are low, chronic wasting disease prevalence testing would be the same as described above under Alternative 2. Eventually, the elk population size reduction may be predominantly by wolves rather than lethal reduction. NPS staff would be aware of the location of wolf kill sites through intense monitoring of wolves and their activities. Awareness of wolf predation locations would facilitate the collection of samples of wolf-killed elk for chronic wasting disease testing. The hypothesis that wolves may selectively prey on elk infected by chronic wasting disease could be evaluated by testing as many wolf-killed elk carcasses for the disease as possible.

Minimum Requirement / Minimum Tool Analysis

This alternative would require the development of a detailed plan to obtain, transport, release, and manage wolves in the park, with further NEPA compliance required at that time. A programmatic analysis of elements of the alternative has been included in the minimum requirement analysis that is provided in Appendix G. This alternative would also require evaluating implementation of the specific actions in wilderness areas of the primary elk range with a minimum tool analysis which would be conducted prior to implementation of actions. For a detailed discussion of the minimum requirement process, refer to the "Wilderness Minimum Requirement Analysis" section in "Elements Common to All Alternatives."

The following actions of Alternative 5 have been evaluated in a minimum requirement analysis (see Appendix G) and would also be subject to a minimum tool analysis prior to their use in wilderness areas.

The use of firearms to lethally remove elk or dart guns to anesthetize elk.

The use of helicopters for monitoring elk and wolves and transporting fence materials. Helicopters could also be used adaptively if necessary for removing carcasses from remote locations due to disease management concerns.

The use of a temporary capture facility to conduct lethal reduction actions, identification of appropriate locations for the facility, and use of equipment to transport and erect the facility.

The use of holding pens for wolves, identification of appropriate locations for holding pens, and use of equipment to erect the pens.

The use of horses to herd elk or remove carcasses.

The use of trained herding dogs to herd elk.

The use of all-terrain vehicles or trucks to remove carcasses.

The use of fences to protect aspen and use of equipment to transport and erect the fences.

The use of prescribed burning, identification of appropriate locations for burns, and use of equipment necessary to conduct those burns.

The use of mechanical thinning activities, identification of appropriate locations, and use of equipment necessary to conduct the actions.

Education

In addition to the education program described in the "Elements Common to All Action Alternatives" section of this chapter, the National Park Service would develop additional educational elements for the public regarding wolves and their role in the ecosystem and in managing elk populations. In addition, the program would include educating the public regarding the safety risks associated with wolves. This material would include information such as how to stay safe around wolves; how to protect pets, livestock, and property from wolves; and viewing etiquette.

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

Several actions suggested by the public were not incorporated into this plan/EIS. In Section 4.5(E)(6) of the NPS NEPA Guidelines (NPS 2001c), reasons to eliminate an alternative as infeasible include technical infeasibility, inability to meet project objectives or resolve need, conflicts with plans, policies or laws "such that a major change" would be needed to implement, and duplication with other, less environmentally damaging, less expensive or more feasible options, or has too great an environmental impact.

This section describes those alternatives or management tools that were eliminated from further consideration and the basis for excluding them from analysis in this plan/EIS.

Public Hunting within the Park: During public review of the draft plan/EIS, many comments advocated the use of hunting in the park to manage the elk population. During the planning process, an alternative was considered that would allow the public to be involved in management actions inside the park to directly reduce the elk population. This type of hunt would have involved opening areas of the park on the winter range to hunting using a lottery system reflective of a traditional hunt.

It is important for the reader to understand the differences between public hunting and culling activities. Although public hunting and culling are both used as conservation tools in ungulate management, there are differences between hunting and culling that must be clarified. Hunting is a recreational activity administered by state wildlife agencies through licenses and it involves fair chase and the taking of meat by the individual hunter. Culling, on the other hand, is a tool used to reduce populations that have exceeded their carrying capacity. It is a very controlled and structured activity, not a recreational activity like hunting, to minimize and/or prevent impacts on other members of the public and other resources. Because of the controlled nature of the activity, the proven skill of those authorized to take action, and the ability to be flexible in timing, location, and choice of management tools, culling actions are more efficient and potentially safer than hunting. Another important distinction is that carcasses and/or meat resulting from culling actions can be donated through an organized program to eligible recipients. More details and explanation of the differences between hunting and culling activities are provided in the text that follows as well as in Appendix H.

The National Park Service recognizes that public hunting is an important recreational activity and wildlife management tool in Colorado. Currently, hunting wildlife is permitted on approximately 98% of the federal lands in Colorado, including lands owned and managed by the U.S. Forest Service, Bureau of Land Management, and numerous national wildlife refuges throughout the state.

Traditionally, and as mandated through law, hunting has not been allowed in national parks. Congress has authorized hunting in at least 69 of the 390 National Park Service units and ungulate hunting occurs in at least 50 of the units that allow hunting. The units in which hunting is authorized are designated primarily as national rivers, lakeshores, seashores, recreation areas, preserves, and monuments. Outside of national parks in Alaska, Grand Teton National Park is the only national park in which hunting is allowed. Congress passed specific legislation in 1950 authorizing hunting (by licensed hunters deputized as park rangers) in portions of Grand Teton National Park, in part because elk were being fed on adjacent U.S. Fish and Wildlife Service lands.

National parks are recognized as nationally significant areas that preserve outstanding resources for the enjoyment of millions of visitors. In managing the National Park System, the National

Park Service must consider the impact of uses on park resources, including cultural and natural resources, when determining appropriate uses in fulfilling its obligation to provide for the enjoyment of the parks by the public. An appropriate use has been defined as a use that is suitable, proper, or fitting for a particular park or portion of a park. Providing enjoyment to the public is a critical component of the Organic Act. This enjoyment is for all citizens, whether they visit the parks or appreciate them from afar. The types of enjoyment that National Park Service units provide are "uniquely suited and appropriate to the superlative natural and cultural resources found in the parks." NPS policy also directs "high quality opportunities for visitors to enjoy the parks, and maintain within the parks an atmosphere that is open, inviting, and accessible to every segment of American society." Each of these mandates or policies may be impacted by hunting. Therefore, Congress has allowed hunting only in those units in which it is an appropriate use.

Using public hunting within Rocky Mountain National Park as a management tool for controlling the elk population would significantly displace the existing recreational use of the park by visitors. There are 90 years of expectations that recreational activities can take place in Rocky Mountain National Park without interference from hunting. Over three million visitors come to Rocky Mountain National Park each year to enjoy a variety of outstanding recreational activities, some of which are not available in areas outside the park. Given its proximity to Denver and other front range communities, it is in many ways an "urban" park and receives visitation year round. Hiking, horseback riding, snowshoeing and skiing in the backcountry are very popular activities along with sightseeing and wildlife viewing along the park's roadways.

The National Park Service recognizes and supports the Colorado Division of Wildlife's management of wildlife in areas outside and adjacent to the park through hunting. However, considering the current situation with the elk population using both the park and Estes Park as a refuge, hunting on national forest lands adjacent to the park does not resolve the needs established in the "Purpose and Need" chapter of this plan. As stated earlier in this plan/EIS, the agencies participating in this planning effort have recognized this concern and accept that because elk use areas beyond the park boundaries, management of the elk population requires continuing management by all agencies, both inside and outside the park. The effectiveness of the National Park Service actions inside the park to reduce the elk population and resolve the need for the plan would be greatly augmented if other agencies would take additional action outside the park. The National Park Service would continue to work collaboratively with the agencies outside the park in consideration of additional future actions that could be taken to manage the elk that use Estes Park as a refuge from hunting. The National Park Service would work throughout implementation of this plan to monitor changes in the elk population size in collaboration with the Colorado Division of Wildlife so that management actions can be adapted as needed inside the park to maintain a population size within the natural range of variation.

Using public hunting within the park as a tool to manage the elk population poses several concerns, based primarily on conflicts with traditional visitor uses of the park and effectiveness in meeting management objectives. All of the concerns discussed below were considered by the National Park Service in the evaluation of public hunting as an alternative for elk and vegetation management within the park.

A traditional hunt in the park would require the temporary closure of large areas on the primary elk range to allow enough area for hunters to safely hunt and enough time to find, kill, and remove the animals. To effectively meet management objectives, heavily used and popular areas of the elk primary winter range would need to be closed in the fall. Using trained NPS staff and authorized agents to cull elk (see Appendix H for a discussion of culling and authorized agents) would provide greater flexibility in the timing of reductions and the methods used to remove elk and the carcasses. Using a limited number of expertly trained NPS staff and authorized agents with highly specialized equipment and flexibility in methods to remove elk, trained personnel could selectively reduce the population with a minimum of disturbance to the other animals and to visitors from noise and actions associated with removal of carcasses. A traditional hunt without such flexibility and with less ability to mitigate impacts on visitors would conflict with the traditional uses of the park, significantly impact visitors' ability to enjoy outstanding park resources, and potentially increase the risk to public safety which is discussed in more detail below.

An alternative that involved public hunting to manage elk inside the park would be inconsistent with existing regulatory authority regarding public hunts in national parks and with longstanding basic policy objectives for NPS units, and because the likelihood that the park service would change its longstanding service-wide policies and regulation regarding hunting in parks is remote and speculative. (See Natural Resources Defense Council, Inc. v. Morton, 458 F.2d 827 [D.C.C. 1972]; National Rifle Association v. Potter, 628 F.Supp. 903 [1986]; NPS Director's Order 12 Handbook page 50; Headwaters, Inc. v. Bureau of Land Management, 914 F.2d 1174, 1181 [9th Cir. 1990]; Seattle Audubon Society v. Moseley, 80 F.3d 1401, 1404 [9th Cir. 1996]; Kootenai Tribe of Idaho v. Veneman, 313 F.3d 1094 [9th Cir. 2002]).

Throughout the years, the National Park Service has taken differing approaches to wildlife management, but has for the most part, from the beginning, maintained a strict policy of not allowing hunting in national parks. In 1929, Congress prohibited hunting within the limits of Rocky Mountain National Park. In the 1970s, Congress passed the General Authorities Act and the Redwood Amendment, which clarified and reiterated that the single purpose of the Organic Act is conservation. While the Organic Act gave the Secretary of the Interior the authority to destroy plants or animals to prevent detriment to park resources, it did not give the Secretary authority to permit the destruction of animals for recreational purposes. In 1984, after careful consideration of Congressional intent with respect to hunting in national parks, the National Park Service promulgated a rule (36 CFR 2.2) that allows public hunting in national park areas only where "specifically mandated by federal statutory law." The National Park Service has reaffirmed this approach in its management policies (NPS 2006).

Congress has not authorized hunting in any legislation for Rocky Mountain National Park. Therefore, to legally allow hunting at the park, Congress would need to specifically authorize hunting in Rocky Mountain National Park and the park service would need to promulgate a new regulation to implement the congressional action. The National Park Service has a legislative mandate to protect the natural and cultural resources within national parks to allow for their enjoyment by future generations. The National Park Service does not have a mandate to allow public hunting in parks. At this time, the National Park Service intends to exhaust all other possible alternatives before attempting to change its governing laws, regulations, or policies, due to concerns that such actions may have negative impacts on the resources of other parks in the national park system.

In addition to legal and policy-related concerns, hunting in the park was also preliminarily evaluated based on efficiency. Public hunts have been shown to be less efficient in meeting ungulate reduction project goals when compared to lethal reduction by trained agency staff. Doerr et al. (2001) noted that the highest kill rate (0.55 deer/hr) was achieved when lethal reduction actions occurred over bait. This was compared to hunting, which resulted in a rate of 0.03 deer/hr or 31 hunter-hours per deer killed. In addition to harvest rates, lethal reduction actions by agency staff also provided a higher selectivity than hunting. As the reduction in females was the primary goal, hunting took 59% females, whereas the take resulting from lethal reduction actions was 63% females (Doerr et al. 2001).

In addition to efficiency, safety is also an issue to consider when using lethal reduction methods. Lethal reduction actions by NPS staff and authorized agents offers safety features that a traditional hunt does not. Lethal reduction actions may need to take place during periods of high visitation or in high visitor use areas of the elk range. Hunting near developed areas or in areas that are frequently used by visitors increases the potential risk to public safety. Lethal reduction by NPS staff and authorized agents however provides an ability to more effectively mitigate the risks to the public and to adapt management actions based on monitoring the effectiveness of methods and the impacts. Mitigations to further reduce the risk to visitors that could be employed by NPS staff and authorized agents include but are not limited to shooting from an elevated stand in established shooting lanes with a backstop to control the distance traveled by the ammunition and using spotters to ensure that no visitors are in or near the area when actions are occurring as opposed to closing large areas of the park.

An additional concern with a traditional hunt is the increased potential to disperse elk to areas outside the park. As recognized as a concern in the "Purpose and Need for the Plan" section, elk already seek refuge in the Estes Park area from hunting that occurs on adjacent lands. Hunting in the park may only serve to exacerbate this problem by pushing even more elk into Estes Park, increasing potential risk to the public and property. Lethal reduction actions by NPS staff and authorized agents provide greater flexibility in mitigating this risk by the type of weapon used and selection of areas to implement the action.

A potential problem associated with relying on public hunting as a management tool in the park is whether an adequate number of hunters would participate annually. A lack of or decline in participation over the life of the plan could seriously impact the effectiveness of public hunting as a management tool, especially over the long term. Numerous people during public scoping and review of the draft plan/EIS expressed interest in helping the park reduce the elk population, but there is no assurance that this public interest in participating in population control would continue over the 20-year life of the plan. A number of studies that have analyzed managed public hunts have shown that retaining adequate hunter numbers is difficult, especially as ungulate densities drop and management enters the maintenance phase. Hansen and Beringer noted that "managed firearm hunts…lasting more than two consecutive days are not cost effective because participation and harvest decline sharply after day 2" (1997). In fact, they experienced difficulty recruiting adequate hunters for areas that already had experienced hunts. Kilpatrick and Walter experienced a 66% decline in hunter applicants in Connecticut from the first to the second years of a controlled hunt (1999), a 26% decrease in hunter participation after one year. Without consistent annual hunter effort, long-term management through public hunting would likely be unsuccessful and would need to be supplemented with or converted to lethal control by NPS staff and their authorized agents.

Although costs were not a primary consideration in the range of alternatives to be evaluated, it should be noted that a public hunt could not be done without costs to the National Park Service. A public hunting alternative would include cost for visitor management and for increased personnel to establish and manage closures while hunting was occurring; public relations including working with and/or managing the media would need to be funded to inform visitors of hunting activities in the park, associated closures, and additional safety precautions when using the park during the hunting period; additional public relations and enforcement staff and funding would be needed to address any public protests that might occur because of opposition to hunting in national parks; dedicated staff time would be necessary to direct, manage, and oversee the hunts; and additional staff time would be necessary for coordination of hunting activities with other park actions and activities. As with all of the action alternatives considered in this plan/EIS, an alternative that includes public hunting would also incur the costs of distribution activities that would need to occur when reduction actions are not being taken to ensure recovery of the vegetation on the primary elk range. Fences would need to be installed and maintained to protect aspen and willow. A monitoring program would be implemented to assess results of management actions to determine whether management objectives were being met or whether management actions would need to be altered.

In conclusion, the National Park Service considered and rejected a special public hunt as a reasonable alternative for this plan for the following reasons: 1) implementing a public hunt in Rocky Mountain National Park would significantly conflict with the long-standing traditional uses of the park and have significant impact on the visitor use and experience; 2) allowing a public hunt would require changes to basic NPS policy and, a change in federal law; 3) case law supports dismissing an alternative that would require a major change in long-standing basic policy; 4) other alternatives, such as lethal reduction by NPS staff and authorized agents, could be implemented without changing current laws and policies; 5) other alternatives, such as using trained NPS staff and their authorized agents, raise fewer safety concerns, would impact other visitors to a lesser degree, and would have substantially the same environmental effects; 6) other alternatives, such as using lethal reduction by NPS staff and their authorized agents, would have a higher degree of efficiency, and 7) other alternatives, such as using lethal reduction by NPS staff and their authorized agents would better meet the purpose, needs, and objectives of the plan, in accordance with Council on Environmental Quality(CEQ) regulations, than would a special public hunt.

Maximum Habitat Manipulation: This alternative focused on fencing all aspen and riparian willow habitat on both the primary winter and summer ranges in the park. The goal was to prevent access by elk to large portions of the preferred elk foraging habitat, encouraging elk to seek suitable forage in other areas of the park, Estes Park, or surrounding National Forest Service lands. Elk displaced from habitat they currently use in the park could intensify problems in areas that would remain unfenced. Significant questions were raised about whether this alternative would successfully meet the objectives of the plan, as well as concerns that the problems and impacts associated with elk would be shifted to other areas (e.g., upland habitats in the park and other locations outside the park, including Carter Lake and Loveland). Specifically, questions about the ability to fence the amount of area necessary to achieve vegetation objectives in the park, the impacts on visitor experience, and a lack of control over where elk would move limited this alternative's capability to achieve the plan's objectives. This alternative was not considered for further evaluation because it would likely shift the problem rather than solve it and would not adequately achieve the plan's objectives.

Translocation: This alternative would have involved capturing elk within the park and transporting them to areas outside the park with suitable habitat. This option to reduce the elk population would conflict with current NPS and state policies that prohibit exportation of elk from areas in which animals are known to be infected with chronic wasting disease to areas in which animals are not known to be infected. Although translocation has been used in the past by the park and other NPS units to address elk overpopulation, this incidence of chronic wasting disease in the elk population makes trapping and transporting a potential hazard to wildlife and to public health and safety. Therefore, this alternative was dismissed from further consideration.

Shipment to Euthanizing Facility: One management tool considered early in the planning phase was to capture elk by corralling and then shipping them to a facility to be euthanized. Based on further evaluation and discussions with the NPS veterinarian as well as public input from the U.S. Humane Society, it was determined that shipment to slaughter would cause greater stress on the animals as they are corralled, handled, and guided into trucks for transport to the facility, resulting in an increased potential for self-induced injury to the animals. It had been determined that lethal removal in the field through the use of trained agency staff; anesthetizing and euthanizing; or capturing, anesthetizing, and euthanizing would achieve the population objectives of the plan while lessening to the extent possible the pain and distress caused to the individual elk. Shipping to a facility outside the core area of chronic wasting disease infection would conflict with NPS and state policies for transport of elk from areas where chronic wasting disease is known to exist. Therefore, capturing and shipping animals to a euthanizing facility was not further analyzed in the plan/EIS.

Maximum Fertility Control throughout the Planning Period without Lethal Reduction: This alternative would have relied on fertility control as the only means of reducing and maintaining the elk population throughout the 20-year planning period. Early in the planning process, the agencies evaluated an alternative using available fertility control technologies to manage the elk population without the need to lethally remove elk. Only short-term fertility control agents would be available for immediate implementation. Based on population modeling projections, approximately 900 female elk would need to be treated annually to reach a population at the high end of the natural range of variability (1,600 to 2,100 animals) by the end of the 20-year plan. This alternative was dismissed from further consideration as unreasonable to implement for a number of reasons. It would be logistically and economically infeasible for NPS staff and their authorized agents to capture and treat annually such a high number of free-ranging female elk. Treating 400 deer per year even with the most effective, remotely delivered contraceptive is beyond the logistical capabilities of most commercial ranching facilities or zoos (NPS 2004c). The capture, treatment, and marking of 900 female elk in Rocky Mountain National Park, considering the terrain and the free-ranging nature of the elk, would be significantly more difficult than this, and well beyond the financial, logistical, and operational abilities of the park, especially given the many concurrent demands on park resources and funding. In addition, the ability to capture and treat 900 female elk each year would decline over time as elk would become more wary of management actions, reducing the ability for this alternative to meet the long-term management objectives of the plan. To prevent births in the following year, treatment would occur between August and September when visitation to the park is high. The impacts on visitors from a high number of elk that would bear a marking and the high frequency of management actions in the summer months would result in a significant level of adverse impacts on visitors that could be reduced via alternate management actions.

As fertility control agents improve and technologies advance in the ability to administer agents in the wild, the ability of the National Park Service to achieve population objectives solely with fertility control agents increases. Alternative 4 relies on fertility control to the maximum extent feasible; however, until a longer-lasting agent becomes available for use in wild, free-ranging populations, the use of short-term fertility control agents would be supplemented with lethal reduction actions. If during the life of the plan a multi-year fertility control agent becomes available, the National Park Service would manage the elk population size using only fertility control under Alternative 4 and could use it as a means of elk population control in an adaptive manner under Alternative 3.

Self-sustaining Wolf Population: This alternative would have reestablished wolves in the park and would have allowed their population to self-regulate. There would have been no limits imposed on wolf population growth or distribution. Without active management of the population, wolves would have been expected to disperse from the park as their numbers increased over time. Without support of agencies within the region to protect wolves from depredation outside the park, there would be no assurance that a wolf population would survive. This alternative has been dismissed from further consideration because of a lack of support from other agencies within the region; concerns by neighbors related to perceived and real threats to property and safety; the degree of expected human property-wolf conflicts; and the intensive management that would be required to respond to external issues, such as social impacts, would likely interfere with the ability to meet the objectives of the plan.

As stated earlier in this chapter, the National Park Service would consider the use of a highly managed wolf population under the preferred alternative, Alternative 3, as an adaptive tool if opportunities were present to cooperate with adjacent land managers and the State of Colorado, and if supported by state and federal policy. The park would also work with other federal, state, and local agencies on regional wolf issues such as natural wolf recolonization or a regional restoration effort as described in the "Elements Common to All Alternatives: Natural Wolf Recolonization" section.

SELECTION OF THE PREFERRED ALTERNATIVE

Since publication of the draft plan/EIS and receipt and analysis of public comments, the National Park Service has re-evaluated the alternatives in determination of a preferred alternative. Alternative 3 has been defined as the National Park Service preferred alternative in the final plan/EIS based on the rationale provided below.

Selection of the preferred alternative is based on the overall ability of the alternative to meet park objectives, support the purpose of the park, and minimize adverse effects on the resources of the park while providing for public use and enjoyment. Although other action alternatives would also meet these criteria, a number of additional factors were considered in the selection of the preferred alternative.

The National Park Service has given consideration to the expected availability of funds to implement the plan and has determined that to meet the objectives of the plan/EIS within forecasted available funds, population reduction activities would need to be conducted gradually. In comparison to Alternative 2, which would involve a high level of reduction of elk early in the planning period, Alternative 3 would reduce the elk population at a more gradual rate over 20 years. This more gradual approach to population reduction could be conducted within existing operations and capabilities and through existing funding sources. This would considerably reduce the cost of the plan compared to Alternative 2, which would require contractors due to the intensive reduction activities in the first four years of the plan.

The elk population reduction methods associated with Alternative 3 would have a high degree of certainty of being successful, and implementation would be less complex compared to Alternatives 4 and 5. Alternative 3 would have a greater level of effectiveness with less time and resources dedicated to implementation than Alternative 4, which emphasizes the use of fertility control agents and Alternative 5, which would use a highly managed wolf population. Alternative 4 would have substantial logistical challenges associated with treating large numbers of female elk with the short-term fertility control agent that is currently available for use. Alternative 5 would also present logistical challenges and require significantly higher levels of park resources to continuously monitor and manage a wolf population that would be maintained within the park boundaries. Due to the experimental nature of Alternative 5 in using a highly managed wolf population, there is a greater level of uncertainty in successfully controlling the elk population and meeting vegetation objectives under this alternative.

In addition, a gradual reduction in the elk population over time would result in less impact on visitor use and experience and result in no long-term economic loss. Although Alternative 3 may require temporary closures resulting from reduction activities of small areas on the elk range, the smaller-scale reduction actions would be less frequent and for shorter periods of time, and less noise would be produced when compared to the reduction activities associated with Alternative 2 and potentially with Alternative 5.

HOW ALTERNATIVES MEET THE OBJECTIVES

As stated in the "Purpose of and Need for Action" chapter, all action alternatives selected for analysis must meet all objectives to a large degree. The action alternatives must also address the stated purpose of taking action and resolve the need for action; therefore, the alternatives and the effects they would have on park resources in the project area were individually assessed in light of how well they would meet the objectives for this plan/EIS. Alternatives that did not meet the plan/EIS objectives were rejected as inappropriate (see the "Alternatives Eliminated from Further Consideration" section in this chapter).

Table 2.2 summarizes the elements of the alternatives being considered. Table 2.3: Analysis of How the Alternatives Meet the Objectives compares how each of the alternatives described in this chapter would meet the objectives for this plan/EIS. The "Environmental Consequences" chapter describes the effects on each impact topic under each of the alternatives, including the impact on recreational values and visitor experience. These impacts are summarized in Table 2.4: Summary of Environmental Consequences. (Tables 2.2, 2.3, and 2.4 are at the end of this chapter.)

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is the alternative that will best promote national environmental policy expressed in the National Environmental Policy Act (NEPA). Section 101(b) of NEPA identifies six criteria to help determine the environmentally preferred alternative. The act directs that federal plans should:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
4. Preserve important historical, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;
5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The environmentally preferred alternative would cause the least damage to the biological and physical environment, and would best protect, preserve, and enhance historical, cultural, and natural resources. Alternative 5 is considered the Environmentally Preferred Alternative in its ability to best meet the six national environmental goals.

1. All of the action alternatives would meet goal 1 as they would restore the elk and vegetation on the elk range to what would be expected under natural conditions. This would provide for continued enjoyment of these resources in the park for future generations. All of the action alternatives would restore vegetation within the park so that it functions as natural communities providing habitat for a large diversity of wildlife species. Alternative 1, continuing current management, would result in impairment of aspen and willow communities in the park as it would not reverse the expected long-term continued degradation of montane riparian willow and aspen. In the long-term, there would be an inability for enjoyment of these resources by future generations.
2. All of the action alternatives would meet goal 2 to varying degrees with Alternative 5 meeting it to the largest extent. All of the alternatives would improve the vegetation condition of the elk range and ensure that aspen would be present for the enjoyment of visitors. However, Alternatives 3 and 4 would use fences on the primary elk range to protect montane riparian willow that would obstruct to a minor level the viewshed, which some visitors would find aesthetically displeasing. In addition, the recovery of vegetation on the landscape would represent an unnatural state as areas in fences would recover to a level higher than expected with natural levels of herbivory. Alternative 2 and 5 would fulfill this goal to a large degree, as they would not use willow fences to protect vegetation on the primary winter range and vegetation would be restored across the landscape reflective of natural conditions. Alternative 5 would do this to a greater degree as the distribution of elk by wolves is what would be expected under natural conditions. The least amount of aspen fencing is expected to be needed under Alternative 5. In addition, the presence of wolves in

the park under Alternative 5 would increase visitor appreciation of the park. Alternative 1 would not meet this goal as the vegetation condition on the elk range would continue to degrade and aspen would be lost on the landscape which would adversely affect visitor appreciation of the park.

3. All of the action alternatives would improve public health and safety inside the park by reducing elk abundance, densities, and habituation to humans. This would result in decreased potential for human-elk conflict such as vehicle accidents and property damage. However Alternatives 2 and 5 would achieve this goal to a larger degree. Alternative 2 would reduce the elk population to a lower level and through use of lethal controls, aversive conditioning, and herding, would decrease densities of elk and as a result increase elk wariness of humans, reducing the potential of human-elk conflict. Alternative 5 meets this goal to the greatest degree, as wolves would be more effective in reducing elk densities and would also increase elk wariness reducing their habituation to humans and developed areas. Alternative 1 would not meet this goal as elk densities and abundance would remain high and elk would continue to become habituated to developed areas thereby increasing the potential for human-elk conflicts.

4. All of the action alternatives meet goal 3 by restoring the vegetation on the elk range to reflect natural conditions and preventing the loss of important habitat that supports a large variety of wildlife species. The action alternatives therefore maintain the wide variety of resources within the park for the enjoyment of visitors. Alternative 5 would meet this goal to an even greater degree as wolves would be present within the park, increasing even further the diversity of resources and activities within the park for visitor enjoyment. Alternative 1 would not meet this goal, as vegetation on the elk range which supports a diversity of species would be degraded and aspen would be lost, thereby reducing the diversity of resources and activities enjoyed by visitors.

5. The action alternatives would meet this goal to varying degrees. All of the action alternatives would restore elk and vegetation on the elk range to reflect natural conditions that would continue to be enjoyed by visitors. The reduction in elk abundance and densities under the action alternatives would also reduce elk habituation to developed areas providing enhanced protection of public safety and property. These results increase the balance between the public's use and appreciation of the park and the surrounding area and the resources. Alternative 5 would meet this goal to a lesser degree however due to the potential for wolf depredation on livestock or domestic animals, which would not represent a balance between population and resource use in the area. Alternative 1 would not meet this objective as vegetation within the elk range would continue to be degraded and aspen would be lost. Continued high levels of elk abundance and densities would increase conflict between visitors to the park and residents in surrounding areas that would not represent a balance between the population and resource use.

6. Enhancing the quality of renewable resources recycling of depletable resources is not applicable to the management of elk and vegetation within the park.

TABLE 2.2: SUMMARY OF ALTERNATIVE ELEMENTS

Alternative Actions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Target elk population range	Population would fluctuate between 2,200 and 3,100 animals; however, it could rise above or drop below this range due to variables such as weather, emigration, or immigration.	The target population range would be at the low end of the range of natural variation. Population would fluctuate between 1,200 and 1,700 animals (200 to 400 park subpopulation; 1,000 to 1,300 town subpopulation).	The target population range would be at the high end of the range of natural variation. Population would fluctuate between 1,600 and 2,100 animals (600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation).	The target population range would be at the high end of the range of natural variation. Population would fluctuate between 1,600 and 2,100 animals (600 to 800 park subpopulation; 1,000 to 1,300 town subpopulation).	The target population range would be broad and fluctuate within the natural range of variation. Population would fluctuate between 1,200 and 2,100 elk (200 to 800 park subpopulation; 1,000 to 1,300 town subpopulation).
Elk population reduction	No management of elk would occur inside the park. Elk population would fluctuate according to forage availability and weather conditions supplemented by hunting that occurs outside the park.	The elk population would be reduced by lethal reduction (culling) by NPS personnel and their authorized agents. In the first four years, approximately 200 to 700 elk would be removed each year. In the last 16 years, approximately 25 to 150 elk per year would be removed to maintain the population. The number of elk removed annually would be determined based on monitoring.	The elk population would be reduced by lethal reduction (culling) by NPS personnel and their authorized agents. Up to 200 elk would be lethally removed each year. The number of elk removed annually if any would be determined based on monitoring.	The elk population would be reduced through a combination of fertility control and lethal reduction actions (culling) by NPS personnel and their authorized agents. Using a single-year agent, 400 elk per year would be treated in the first four years of the plan and 200 per year in the remaining 16 years. In addition, approximately 80 to 150 elk would be lethally removed each year. The number of elk that would be treated with multi-year or life-time duration agents is unknown. The number of elk treated and/or removed annually would be determined based on monitoring.	The elk population would be reduced through a combination of wolves and lethal reduction actions (culling) by NPS personnel and their authorized agents. In Phase 1, two pairs of wolves would be released. In Phase 2, if necessary, wolves would gradually increase up to 14. Lethal reduction would remove 50 to 500 elk per year in the first four years and in the remaining 16 years, up to 100 elk would be lethally removed each year to maintain the population, if needed. The number of elk removed annually if any would be determined based on monitoring. Wolf movement and activity would be continuously monitored and their activities restricted to within the boundaries of the park.

TABLE 2.2: SUMMARY OF ALTERNATIVE ELEMENTS (CONTINUED)

Alternative Actions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Euthanasia or capture facility	No active management of the elk population would occur inside the park; therefore, there would be no use of a euthanasia or capture facility.	A temporary capture facility could be used during the reduction phase to efficiently remove a high number of elk to meet population targets.	Because of the lower number of elk that would need to be lethally removed each year, a capture facility may not be needed but could be used adaptively.	A temporary capture facility could be used adaptively to treat and mark elk treated with a fertility control agent and for lethal reduction actions.	A temporary capture facility could be used during the reduction phase to efficiently remove a high number of elk to meet population targets.
Herding (directed movement of elk)	No active management of the elk population would occur inside the park; therefore, no herding would occur.	Herding using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices, and if necessary, helicopters could be used adaptively to encourage elk migration from the primary winter range to the primary summer range, to move elk from the Kawuneeche Valley to areas outside the park where they could be hunted, and to direct elk to a capture facility during the reduction phase to efficiently remove a high number of elk.	Herding using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices, and if necessary, helicopters could be used adaptively to encourage elk migration from the primary winter range to the primary summer range and to move elk from the Kawuneeche Valley to areas outside the park where they could be hunted. These methods may also be used to move elk into a capture facility, although the need for an elk capture facility is less likely under this alternative.	Herding using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices, and if necessary, helicopters could be used adaptively to encourage elk migration from the primary winter range to the primary summer range and to move elk from the Kawuneeche Valley to areas outside the park where they could be hunted. If a capture facility is needed to administer and mark elk with fertility control agents and for lethal reduction actions, herding may be used to direct elk to the capture facility.	Same as Alternative 2 for the movement of elk into a capture facility, although the need for an elk capture facility is unlikely.
Aversive conditioning (used to disperse concentrations of elk)	Agency staff could use aversive conditioning to move elk that are exhibiting aggressive behavior.	Same as Alternative 1. In addition, aversive conditioning as with rubber bullets, cracker shot, visual devises, trained herding dogs, people on foot, riders on horseback, or noisy weapons could be used as needed to prevent excessive concentrations of elk in unfenced areas.	Same as Alternative 2. However, aversive conditioning would be used more frequently to prevent excessive concentrations in unfenced areas.	Same as Alternative 3.	No aversive conditioning of elk would be needed as wolves would effectively redistribute the elk.

TABLE 2.2: SUMMARY OF ALTERNATIVE ELEMENTS (CONTINUED)

Alternative Actions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Fences	Approximately 12 acres of montane riparian willow, aspen, and herbaceous and upland shrub vegetation are fenced for research purposes. Fences are also used to a limited extent to protect plants in landscaped areas.	Same as Alternative 1. In addition, 160 acres of aspen habitat could be fenced on the elk range to protect aspen stands from elk herbivory as needed, based on monitoring of vegetation response to management actions.	Aspen habitat would be fenced the same as Alternative 2. 260 acres of suitable montane riparian willow could be fenced on the elk primary winter range and 180 acres on the primary summer range. Fences would be installed commensurate with elk reductions and in a phased approach based on monitoring of vegetation response to management actions.	Aspen habitat would be fenced the same as Alternative 2. 260 acres of suitable montane riparian willow habitat could be fenced on the elk primary winter range. Fences would be installed commensurate with elk reductions and in a phased approach based on monitoring of vegetation response to management actions.	Same as Alternative 2, but with less fencing expected to be necessary.
Chronic wasting disease prevalence testing	Animals suspected of having chronic wasting disease are lethally removed and tested. When possible, elk carcasses found are removed and tested for chronic wasting disease to indicate trends.	Same as Alternative 1. In addition, all adult elk that are lethally removed would be tested for chronic wasting disease. If a field test became available that allowed immediate live testing for chronic wasting disease, captured elk would be tested and those testing positive for the disease would be removed.	Same as Alternative 2, although the number tested would be less due to the lower number of elk removed over time.	Same as Alternative 2, although the number tested would be less due to the lower number of elk removed over time and may decline over time if an effective, multi-year, fertility control agent is developed and management of the population would be predominantly through fertility control activities rather than lethal reduction. If a field test became available that allowed immediate live testing for chronic wasting disease and fertility control involves capture, elk would be tested and those testing positive for the disease would be removed.	Same as Alternative 2, although the number tested would be less due to the lower number of elk removed over time and could decline over time as management of the population may be predominantly through wolf activities and predation rather than lethal reduction, although wolf killed elk would be tested.

TABLE 2.2: SUMMARY OF ALTERNATIVE ELEMENTS (CONTINUED)

Alternative Actions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Distribution of carcasses	Targeted chronic wasting disease-suspect carcasses are disposed of appropriately through incineration or chemical digestion.	Same as Alternative 1. In addition, most elk carcasses resulting from lethal reduction actions would be removed from the field. Some carcasses may be left in the environment and the number would reflect a natural state to the greatest extent possible. The National Park Service would identify interested organizations, agencies, and/or tribes to partner with in a meat donation program to defer program costs. Carcasses and/or meat would be donated to the extent possible or carcasses would be disposed of appropriately (incineration, chemical digestion, or landfill).	Same as Alternative 2, although the number of elk carcasses would be less in years 1 through 4.	Same as Alternative 2, although the number of elk carcasses would decline if management could rely more on fertility control.	Same as Alternative 2, although the number of elk carcasses would decline if wolves increase management of the elk population.
Vegetation restoration methods to stimulate aspen and/or willow regeneration	No additional vegetation restoration methods would be employed.	Vegetation restoration methods (prescribed burning, mechanical vegetation removal, active planting of willow cuttings) would be employed once aspen and montane riparian willow are adequately protected from excessive browsing. In fenced aspen areas, these methods would be employed sooner than in areas that are unfenced.	Same as Alternative 2, although methods could be employed sooner in fenced areas.	Same as Alternative 3 in aspen habitat on the primary elk range and in suitable montane riparian willow habitat on the primary winter range.	Same as Alternative 2.
Beaver reintroduction	Beaver would not be actively reintroduced within areas of the elk range.	If beavers do not naturally recolonize, they would be reintroduced into suitable habitats once montane riparian willow recovery is adequate to support a colony indefinitely.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.

TABLE 2.2: SUMMARY OF ALTERNATIVE ELEMENTS (CONTINUED)

Alternative Actions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Monitoring	Elk numbers and distribution are monitored on a yearly basis using aerial and ground surveys. The status of potential natural wolf recolonization is monitored. The status of beaver populations is monitored.	In addition to the monitoring conducted under Alternative 1, monitoring would be conducted for the following parameters: More frequent elk population size, composition, and distribution. Condition of aspen, montane riparian willow, and herbaceous vegetation in terms of structure, regeneration, and cover. Informal and/or formal surveys to determine visitor response to elk and vegetation management activities.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2. In addition, activities and movements of released wolves would be monitored continuously. Wolf kills would also be monitored for chronic wasting disease. Informal and/or formal visitor surveys could also be conducted to determine how the potential to hear and see wolves may have changed visitor experience.
Opportunistic research activities	No management of elk would occur inside the park and therefore no opportunistic research activities would occur.	Within the first few years of management, research activities would be conducted involving up to 120 elk to evaluate a live chronic wasting disease test and the effectiveness of a multi-year fertility control agent.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.
Education	No enhancements to current education or interpretive programs.	Additional public information would be developed and provided to the visitor on the role of elk in the environment and the potential safety risks and changes in the visitor experience associated with elk management actions.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2. In addition, public information would be developed to educate the public on the role of elk and wolves in the environment and potential safety risks associated with wolves.
Estimated costs					
One-Time Costs		$972,000	$2,174,100	$1,569,100	$763,250
Annual costs (Years 1 – 4)		$1,099,061	$212,055	$655,370	$1,232,754
(Years 5 – 20)		$211,755	$212,055	$423,370	$599,421

TABLE 2.3: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Objectives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Restore and/or maintain the elk population to what would be expected under natural conditions, to the extent possible. Maintain a free-roaming elk population. Decrease the level of habituation. Restore the elk population size in order that it fluctuates within the natural range of variation, between 1,100 and 2,100 elk. Redistribute elk to reflect a more natural state.	Does not meet objective. The elk population would continue to be less migratory, more sedentary, and less vigilant as elk would be able to forage for longer periods and in high concentrations in locations that do not pose threats or stress. Elk densities would continue to be high on the core winter range. The elk population size would continue to be outside the natural range of variation ranging between 2,200 and 3,100 elk.	Fully meets objectives. Elk would be forced off the primary winter range to ensure that most elk migrate to summer range. This would represent a return to behavior more typically associated with seasonal elk movements. Elk would be more migratory and less sedentary. Redistribution actions and lethal control activities would cause elk to be more wary of people and reduce over-concentration of elk in certain areas of the park which would reflect a more natural condition. The elk population would fluctuate between 1,200 to 1,700 elk, which would be on the lower end of the natural range.	Meets objectives to a large degree but would take longer to achieve than Alternative 2. The effects of Alternative 3 on behavior in the elk population would be similar to those described for Alternative 2. However, elk would be excluded from fenced areas of their range, which would be an unnatural condition. The elk population would fluctuate between 1,600 to 2,100 elk, which would be on the higher end of the natural range.	Meets objectives to a large degree the same as described for Alternative 3.	Fully meets objectives. The presence of wolves on the primary winter range in summer would encourage elk migration to traditional summer elk range at higher elevations. The presence of wolves, combined with the effects of lethal reduction activities, would make elk in the park more wary and would reduce the densities of elk, particularly in the core winter range. This would result in more natural elk distributions. The elk population would fluctuate within the natural range of variation between 1,200 to 2,100 elk.

TABLE 2.3: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES (CONTINUED)

Objectives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Restore and/or maintain the natural range of variation in vegetation conditions on the elk range, to the extent possible. Prevent loss of aspen clones within high elk use areas. Restore and maintain sustainable willow. Increase willow cover within suitable willow habitat on the primary winter range. Maintain or improve the condition of willow on the primary summer range. Reduce the level of elk grazing of herbaceous vegetation.	Does not meet objective. Vegetation on the elk range would continue to be adversely affected to a large degree because the elk population size would remain large and over - concentrated, and less migratory. With continued high levels of elk herbivory, aspen would not be able to regenerate in high elk use areas of the elk range. The older trees that are present would continue to be lost due to mortality leading to further reductions in overall stand sizes on the primary winter range. Continuing current high levels of elk herbivory and absence of beaver would result in an inability of willow to regenerate particularly in areas of the core winter range resulting in further reductions in willow distribution and localized loss of willows.	Fully meets objectives. The rapid reduction in elk numbers and increased distribution and migration of the population and the protection of aspen stands of the elk range with fences would result in large reductions in elk herbivory on the elk range in a short period of time. This would facilitate community level changes toward a more natural condition. The loss of aspen stands on the elk range would be prevented and recovery would occur as aspen regeneration, stand size and complexity, and cover would be increased to a large degree. With a large reduction in elk population, increased dispersal of the population, and increased water table as a result of beaver recovery or reintroduction, willow reproduction, seedling establishment, height,	Meets objectives to a large degree. Within fenced areas of aspen and willow, the objectives for vegetation restoration and recovery would be fully met as described in Alternative 2. The recovery of vegetation outside of fenced areas on the elk range would be less and would take longer to achieve as the elk population target is at a higher level and reduction is slower compared to Alternative 2. In addition, the recovery of vegetation across the landscape would be less reflective of natural conditions as fenced areas would recover more fully and rapidly compared to unfenced areas and there would not be a patchy distribution of vegetation reflective of the condition that would occur naturally with the presence of predators.	Meets objectives to a large degree as described in Alternative 3. Without fences to protect willow on the primary summer range, the recovery of vegetation in this area would be more reflective of natural conditions in terms of patchiness across the primary summer range landscape; however the level of recovery would likely be less in comparison to alternatives that involve the use of fences, wolves, and/or a lower elk population size.	Fully meets objectives. The reduction in elk numbers and increased distribution and migration of the elk population as a result of the activities of wolves, as well as lethal reduction and the protection of aspen stands on the elk range, would result in vegetation recovery as described in Alternative 2. The recovery of vegetation across the landscape would be most representative of the natural condition.

TABLE 2.3: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES (CONTINUED)

Objectives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
(continued)	Elk would continue to remain on the primary winter range year round further impacting vegetation during the growing season.	volume, and cover on the elk range would increase. As a result, the abundance and distribution of willow on the elk range would increase. Large reductions in elk herbivory would result in reduced levels of grazing of herbaceous vegetation. Recovery of vegetation across the landscape would be reflective of natural conditions.			
Opportunistically collect information to understand chronic wasting disease prevalence in the park within the framework of the plan.	Fully meets objective. Monitoring for chronic wasting disease-infected animals within the park would continue to occur year-round, but would be limited to intermittently available carcasses that result from natural mortality, chronic wasting disease death, road kills, or lethal removal of infected elk.	Fully meets objective. In the early years, lethal reduction operations would produce elk carcasses in sufficient numbers to collect information to understand chronic wasting disease prevalence within the Rocky Mountain National Park / Estes Valley population.	Fully meets objective. Opportunities to collect information would be similar to Alternative 2, but somewhat fewer elk would be lethally removed.	Fully meets objective. Opportunities to collect information would be the same as Alternative 3.	Fully meets objective. Opportunities to collect information would be similar to Alternative 2 in the early years, but may decrease as wolves become more responsible for elk population regulation, although monitoring wolf killed elk would also occur.

TABLE 2.3: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES (CONTINUED)

Objectives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Ensure that strategies and objectives of this plan/EIS are not in conflict with those of chronic wasting disease management.	Meets objective to some degree. The continued high densities of elk would contribute to a higher likelihood of transmission of chronic wasting disease in the elk population. The sedentary nature of ungulates on their primary winter range and tendency to congregate in large herds may increase the probability of contact with sources of infection that reside in the environment. This would continue to occur under this alternative which is inconsistent with chronic wasting disease objectives. Monitoring for chronic wasting disease-infected animals and removing carcasses that may increase environmental contamination within the park would continue to occur year-round. This would continue to be consistent with chronic wasting disease management objectives.	Fully meets the objective. Lowering the size and density of elk population could potentially lower the prevalence of chronic wasting disease. Additionally, a less sedentary elk population and localized dispersal of highly concentrated elk would help lower the risk of disease transmission. Monitoring for chronic wasting disease would greatly increase because there would be a large number of carcasses available.	Fully meets the objective. The effects of Alternative 3 on the prevalence of chronic wasting disease in the elk population and monitoring activities would be similar to those for Alternative 2. Because of the gradual reduction of the elk population to the higher end of the natural range, the time to fully achieve the objective would be longer.	Fully meets the objective as described in Alternative 3.	Fully meets the objective. Wolves may prey on weaker, diseased elk than stronger, healthy elk. If this were to happen, selective predation on elk with chronic wasting disease would remove a higher proportion of diseased animals from the population. Monitoring would be the same as under Alternative 2.

TABLE 2.3: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES (CONTINUED)

Objectives	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Continue to provide for elk viewing opportunities.	Fully meets objective. Because elk in and around the park would remain plentiful and habituated, visitors would continue to have abundant opportunities to view elk, often from the convenience of their cars.	Meets objective to a large degree. Fewer elk that are more wary of humans would somewhat reduce viewing opportunities in the park, including at the large meadows bisected by the main roads. Despite this reduction, visitors would continue to have many opportunities to view elk, including during the fall rutting season.	Meets objective to a large degree. Effects on visitors due to management of the elk population would be similar to those of Alternative 2. However, target elk population numbers would be achieved more gradually, and the overall reduction would be less than Alternative 2. Visitors would therefore be less likely to notice elk management activities or effects.	Meets objective to a large degree. Visitor opportunities to view elk would be the same as described in Alternative 3.	Meets objective to a large degree. Visitor opportunities to view elk would be the same as under Alternative 3 except elk would be more dispersed. There would be continued elk viewing opportunities in large meadows. Visitors would have the opportunity to see elk and other wildlife in a more natural setting similar to Alternative 2.
Recognize the natural, social, cultural, and economic significance of the elk population.	Meets objective to a large degree. The existence of the elk population would continue to recognize the social and cultural significance of the elk by providing view opportunities for those individuals and tribes that value elk. Associated economic gains would continue in the area. The elk population size and distribution and associated habitat conditions would continue to be outside the range of natural variation; reducing the park's ability to meet it's mission to maintain or restore the natural ecosystem.	Fully meets objective. The ability to view elk would continue to provide social benefits to the visitor and associated economic gains would continue. The maintenance of the elk population would provide cultural benefits to tribes who value the elk as part of their history. Managing elk and associated habitat conditions within the natural range of variation improves the park's ability to meet its mission and fully recognize the natural significance of elk in the ecosystem.	Fully meets objective as described in Alternative 2.	Meets objective to a large degree similar to that described in Alternative 2. However, the use of fertility control agents reduces the natural significance of the elk population and the use of visible markings to indicate elk that have been treated with a fertility control agent would adversely affect elk viewing opportunities.	Fully meets objective as described in Alternative 2. However this alternative would best reflect natural conditions of elk distribution and habitat condition on the elk range with the release of wolves. This would improve to the greatest extent the park's ability to meet it's mission and fully recognize the natural significance of elk in the ecosystem.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Elk Population	The size and density of the elk population would represent long-term, local and range-wide, moderate, adverse effects. The less migratory, more sedentary, and less vigilant elk population represents a long-term, local to range-wide, moderate, adverse effect. Habituation to humans and the potential for human-elk conflict would continue to pose long-term, regional, and negligible-to-moderate effects. High densities would continue to have adverse effects on body condition and energy expenditures, resulting in long-term, local, adverse, and moderate effects. Annual aerial monitoring would result in annual, short-term, winter-range-wide, minor, adverse effects. The increased potential for transmission of chronic wasting disease	Maintenance of aspen, restoration of riparian willow communities, and the return of beaver with a subsequent increase in surface water would represent a long-term, local-to-range-wide, moderate, beneficial effect. Fencing of aspen would represent a long-term, local, minor adverse effect. The reduced elk population size and densities would represent a long-term, range-wide, moderate benefit. Reversal of the trend toward a less migratory population would represent a long-term, range-wide, moderate benefit. Redistribution actions, lethal reduction actions, and research activities would reduce the level of habituation to humans, resulting in a moderate beneficial effect, as would the effects associated with lethal reduction actions or the use of a capture facility. Alternative 2 would increase the bull:cow ratio, a theoretical minor	Decreased foraging pressure from fencing in riparian willow would result in a long-term, local, minor-to-moderate benefit. The reduced elk population size and densities would have effects similar to but incrementally less than the long-term, range-wide, moderate benefit described for Alternative 2. Disturbance associated with installation of fences in aspen and riparian willow would have a short-term, local, negligible-to-minor, adverse effect. Restricted availability of habitat would have a long-term, minor, adverse effect. Effects on elk behavior and the population's age and sex structure would be similar to those described for Alternative 2. Effects on body condition and energetics would be the same as Alternative 2 but incrementally greater because of the increased use of redistribution activities and fences.	The effects on elk habitat would be the same as those described for Alternative 3: long-term, local, minor-to-moderate benefit. The long-term, range-wide, moderate, beneficial effects on population size and density would be the same as described for Alternative 3. Lethal reductions, redistribution, research activities, and remote administration of the fertility control agent (i.e., darting) would positively affect elk behavior and migration tendencies and reduce habituation producing long-term, range-wide, moderate benefits. Affects on age and sex composition would be long-term, range-wide, minor benefits. Increased energy expenditures by bull elk in a two-week longer rut if Leuprolide were used would have negative effects on individual elk. Stress and energy expenditure	The benefits to elk habitat would be long term, local to range-wide, and moderate to major as a result of redistribution of elk by wolves and the range-wide effects on habitat conditions. The effects on elk population size and density would be long-term, range-wide, moderate benefits. Wolves' effect on elk density would be long term, local, moderate, and beneficial. Decreased habituation to humans, increased wariness and wildness, and decreased sedentary behavior would be long term, local, minor-to-moderate, and beneficial. Increased elk movements would represent a long-term, range-wide, moderate benefit. Increased fitness of the elk population would be a long-term, range-wide, minor-to-moderate benefit.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Elk Population (continued)	would be a long-term, regional, moderate, adverse effect on the population. Alternative 1 would generally contribute long-term, adverse effects on the elk population ranging up to major. These effects contribute to the overall adverse cumulative effects of other past, present, and future actions, but do not result in an adverse cumulative effect greater than moderate. Alternative 1 would not result in impairment.	benefit. Management actions associated with lethal reduction activities, herding, overflights, research activities, and other potentially disturbing actions would increase stress and energy expenditures in individual elk. In the long-term, the management action would reduce competition and energy expenditures for forage in the population representing an overall net moderate benefit. Reducing the potential for transmission and prevalence rate for chronic wasting disease would be a minor benefit. Overall, Alternative 2 would have a long-term, local-to-range-wide, moderate, beneficial effect on the elk population. The overall cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would include short-term, minor adverse impacts and long-term, local-to-range-wide, minor-to-moderate	In the long-term, reduced competition and energy expenditures for forage and habitat would result in an overall minor net benefit. The effects with respect to the prevalence of chronic wasting disease would be a long-term, range-wide, minor benefit. The overall beneficial effect of the management actions associated with Alternative 3 on the elk population would be long-term, local, and moderate. The overall cumulative effects of Alternative 3 would be similar to the short-term, minor adverse impacts and long-term, range-wide, moderate benefits of Alternative 2, with a small decrease in the benefits to the elk population because	associated with capture would have negative effects on individual elk. In the long-term, reduced competition and energy expenditures for forage and habitat would result in an overall minor net benefit. The effect on the prevalence of chronic wasting disease would be a long-term, range-wide, minor benefit. Balancing the various positive and negative effects of the management actions and research activities, the effects of Alternative 4 would be long term, local to range-wide, minor to moderate, and beneficial. Cumulative effects of Alternative 4 would be the same as described for Alternative 3. Alternative 4 would not result in impairment.	Effects on the age and sex composition of the elk population would be similar to those described for Alternative 2. Short-term effects associated with lethal reduction and research activities would be local, minor-to-moderate, and adverse. In the long term, a smaller and less dense elk population combined with increased fitness resulting from wolves would represent a range-wide, moderate benefit. Wolves would preferentially prey on young, old, weak, and diseased elk, potentially reducing the prevalence of chronic wasting disease, a long-term, range-wide, minor-to-moderate benefit. Alternative 5's contribution to the

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Elk Population (continued)		benefits. Alternative 2 would not result in impairment.	Alternative 3 would not realize benefits as quickly as Alternative 2. Alternative 3 would not result in impairment.		overall cumulative impacts on the elk population would be similar to those described for Alternative 2, although the release of the gray wolf would have additional short-term and long-term adverse effects for elk, as well as long-term, range-wide, cumulative benefits that would be incrementally greater than the benefits associated with Alternative 2. Alternative 5 would not result in impairment.
Vegetation	Expected continuing high levels of elk herbivory and potential loss of aspen would have a long-term, major, adverse impact. An inability to use prescribed fire would be a major, long-term, adverse effect. The continued reduction and survivorship of montane riparian willow would result in long-term, major, adverse impacts.	This alternative would facilitate community-level changes toward a more natural condition. The protection provided to aspen from elk herbivory would be a long-term, major, beneficial effect. The ability to use fire and other restorative actions within aspen stands would be a major, long-term benefit.	This alternative would facilitate gradual, community-level changes toward a more natural condition. Protecting aspen with fences and reduced elk herbivory would result in long-term, major benefits. The ability to use fire and other restorative actions within aspen stands would be a major, long-term benefit.	This alternative would facilitate gradual, community-level changes toward a more natural condition. The protection of aspen stands would result in major, long-term benefits as described in Alternative 3.	This alternative would facilitate community-level changes toward a more natural condition. Reduced elk population size, increased elk movements, and changed elk grazing patterns would result in long-term, major benefits for aspen.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Vegetation (continued)	The continued inability to use fire to stimulate regeneration would have long-term, major, adverse effects. The adverse effects on upland and riparian herbaceous vegetation would be long-term and moderate in areas where elk concentrate. The long-term effects on bitterbrush and sagebrush upland shrubs would be moderately adverse. Changes in individual species abundance would result in long-term minor, adverse impacts. Continued adverse effects on subalpine and alpine willow would range up to major. The adverse effects on subalpine and alpine herbaceous vegetation would be minor and long-term. The long-term, adverse effects of exotic plant species as a result of elk herbivory would be negligible to minor.	The recovery of montane riparian willow across the landscape would be patchily distributed, reflective of natural conditions. The increase in abundance, competitive ability, survivorship, and conversion to taller montane riparian willow would result in long-term, major, beneficial impacts. Vegetation recovery methods would have long-term, major, beneficial effects. The long-term beneficial effects on upland and riparian herbaceous vegetation would be minor to moderate. The conversion of herbaceous habitat to montane riparian willow would represent a minor-to-moderate, adverse effect. The long-term, beneficial effects on shrub species would be moderate. Increases in individual species abundances would result in long-term, minor, beneficial effects. Increased mule deer population and	In fenced areas, montane riparian willow would transform from shorter willow to taller willow, increase in cover, and survivorship, a major, long-term benefit. Outside fenced areas the plan would result in long term, moderate benefits to montane riparian willow. With adaptive management, the overall long-term benefit would be major. The recovery of montane riparian willow across the landscape would not be representative of natural conditions, as recovery would be more complete in fenced areas. The long-term, adverse effects on herbaceous vegetation in fenced areas would be minor to moderate due to conversion from grassland to shrub habitat, although this would reflect natural conditions. Outside fenced areas, the long- term, beneficial effects would be negligible to minor.	Benefits to montane riparian willow in fenced areas would be long-term and major as described in Alternative 3. Outside fenced areas, benefits to montane riparian willow would be long-term and moderate With adaptive management, the overall long-term benefit would be major. The recovery of montane riparian willow across the landscape would not be representative of natural conditions same as Alternative 3. The long-term, adverse effects on montane riparian herbaceous vegetation in fenced areas would be minor to moderate as described in Alternative 3. Outside fenced areas, the long-term, beneficial effects would be negligible to minor.	The ability to use fire and mechanical vegetation removal actions within aspen stands would be a major, long-term benefit. The recovery of vegetation across the elk range would result in a patchy distribution, most reflective of natural conditions. The increased abundance, competitive ability, and survivorship of montane riparian willow would result in long-term, major, beneficial impacts. The ability to use vegetative restoration tools to improve montane riparian willow regeneration would have long-term, major, beneficial effects. The long-term beneficial effects on upland and riparian herbaceous vegetation would be minor to moderate. The conversion of herbaceous vegetation to willow would represent a minor-to-moderate, adverse effect on herbaceous vegetation; this would reflect natural conditions.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Vegetation (continued)	The cumulative, adverse effects on vegetation would be long-term and moderate to major. Management plans to restore vegetation in the park would result in minor-to-moderate, beneficial cumulative effects. Alternative 1 would result in impairment.	thus herbivory would result in long-term, moderate-to-major, adverse effects. The reduction in disturbance from elk grazing would result in long-term, major, beneficial effects on subalpine and alpine willow and minor benefits on native plant species cover and abundance. The long-term benefit of reducing the potential for exotic plant species infestation would be negligible to minor. In the reduction phase of the plan, agency lethal reduction operations, herding, carcass disposal, installation of fences, and use of temporary capture facilities would result in short- and long-term, minor effects. Effects would be reduced to negligible to minor during the maintenance phase of the plan. Cumulative benefits on aspen, willow, herbaceous, and alpine	The long-term beneficial effects on bitterbrush and sagebrush upland shrub species would be minor. Increased mule deer population and thus herbivory would result in long-term, moderate, adverse effects. Reduced elk herbivory in subalpine and alpine willow habitats would result in long-term, moderate-to-major, beneficial effects, and localized, long-term, minor, beneficial effects on native plant species cover and abundance. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor. Effects of localized trampling and loss of individual plants during management activities would be both short-term and long-term and negligible to minor.	The long-term, beneficial effects on bitterbrush and sagebrush upland shrub species would be minor. Increased mule deer population and herbivory would result in long-term, moderate, adverse effects. Reduced elk herbivory in subalpine and alpine willow habitats would result in long-term, moderate-to-major, benefits, and localized, long-term, minor, beneficial effects on native plant species cover and abundance. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor. Effects of localized trampling and loss of individual plants during management activities would be both short-term and long-term and negligible to minor.	The long-term, beneficial effects on bitterbrush and sagebrush upland shrub species on the primary winter range would be moderate. Increases in individual species abundances would result in long-term, minor, beneficial effects. Reduced elk herbivory in subalpine and alpine riparian and upland willow and herbaceous habitats would result in long-term, major, beneficial effect on riparian and upland willow and minor benefits to herbaceous vegetation. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor. Effects of localized trampling and loss of individual plants during management activities would be both short-term and long-term and negligible to minor.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Vegetation (continued)		vegetation would be moderate-to-major, long-term. Cumulative impacts on upland shrub vegetation would be long-term, major, and adverse. Management plans to restore vegetation in the park would result in overall minor-to-moderate, beneficial, cumulative effects. Alternative 2 would not result in impairment.	The cumulative effects would be moderate-to-major, long-term benefits on aspen, riparian willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat would be moderate. Management plans to restore vegetation in the park would result in minor-to-moderate, beneficial, cumulative effects. Alternative 3 would not result in impairment.	The cumulative effects would be moderate-to-major, long-term benefits on aspen, riparian willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat would be moderate. Management plans to restore vegetation in the park would result in minor-to-moderate, beneficial, cumulative effects. Alternative 4 would not result in impairment.	Effects would be reduced to negligible during the maintenance phase of the plan. The cumulative effects would be moderate-to-major, long-term benefits on aspen, riparian willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat would be long-term, moderate, and beneficial. In other areas of the park, the release of wolves would have minor-to-moderate, beneficial, cumulative effects. Alternative 5 would not result in impairment.
Special Status Species	Changes in habitat would lead to negligible, adverse effects on the greenback cutthroat trout, greater sandhill crane, river otter, and bald eagle; negligible-to-minor, adverse effects on the Colorado River cutthroat trout and Canada lynx; and minor, adverse effects on the wood frog. The boreal toad could experience moderate, adverse effects. The cumulative effects would be short term and	The adverse effects on special status species of elk reduction and redistribution activities and research activities would be short-term and negligible. The benefits that would accrue would be negligible for greenback cutthroat trout, greater sandhill crane, long-billed curlew, bald eagle, and wolverine (decreasing to no effect in the fifth through 20th years for bald eagle and wolverine); minor for river otter, Canada lynx, and wood	Reduction and redistribution activities and research activities would have a temporary, negligible, adverse effect on special status species. Beneficial effects of Alternative 3 would be negligible for the bald eagle or wolverine; negligible for long-billed curlew and greater sandhill crane; negligible to minor forgreenback cutthroat trout, and wood frogs; minor for Colorado River cutthroat trout and Canada lynx; minor	The effects of Alternative 4 on special status species would be beneficial and similar to those described for Alternative 3 except for disturbance effects associated with lethal elk reduction activities, redistribution actions, fence installation activities, and research activities, which would have temporary, negligible, adverse effects. Alternative 4 would have negligible effects on the	The effects of Alternative 5 on special status species would be similar to those described under Alternative 2. Short-term negligible adverse effects would occur from disturbance associated with lethal reduction and research activities; beneficial effects associated with montane riparian willow and aspen habitat recovery would be long-term, park-wide, and negligible.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Special Status Species (continued)	long term, minor, and adverse. Alternative 1 would not result in impairment.	frog; minor-to-moderate for special status species that rely on montane riparian, wetland, and aquatic habitats; and moderate for boreal toad and Colorado River cutthroat trout. The cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse. Alternative 2 would not result in impairment.	to moderate for special status species that rely on montane riparian, wetland, and aquatic habitats; and moderate for boreal toad. The cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse. Alternative 3 would not result in impairment.	greater sandhill crane, bald eagle, and wolverine; negligible to minor benefits for greenback cutthroat trout; minor benefits for long-billed curlew, and river otter, Colorado River cutthroat trout, wood frog, and Canada lynx; minor to moderate benefits for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for the boreal toad. The cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse. Alternative 4 would not result in impairment.	The cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse. Alternative 5 would not result in impairment.
Other Wildlife Species	The range of adverse effects associated with habitat changes would be negligible for bighorn sheep, moose, and bobcat; minor for most small mammals, and fish; minor to moderate for mule deer, butterflies, upland shrub birds, waterfowl and shorebirds; moderate for	Helicopter overflights that would transport fence material into the park and if necessary, to herd elk and remove carcasses would result in a short-term, localized, negative effect on individuals of wildlife species in the area of activity.	The effects on wildlife would be similar to, but in most cases incrementally less than, those described for Alternative 2. Benefits for species strongly associated with montane fenced riparian willow habitat would be long term, local, and minor to moderate.	The effects of implementing Alternative 4 on wildlife would be similar to those described for Alternative 3 on the primary winter range. Benefits for species on the primary winter range strongly associated with montane fenced riparian willow habitat would be	In general, the effects of Alternative 5 are similar to those described for Alternative 2, with some important differences. The benefits would range from negligible to moderate for small mammals; minor for ungulates; negligible to minor for predators, minor

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	amphibians and reptiles; and moderate to major for beaver and for songbirds and cavity nesters. Adverse effects associated with forage competition between elk and white-tailed ptarmigan may occur at a minor-to-moderate intensity. Beneficial effects on wildlife that result from continuing current management would range from negligible to minor for mountain lions and for raptors that forage in grasslands to minor for scavenger species that rely on carrion, including bald and golden eagles.	Negative effects associated with lethal elk reduction actions and carcass removal would result in short-term impacts on wildlife in the form of potential disturbance and temporary displacement. Additional long-term, local, negligible-to-minor adverse effects would be associated with fences around aspen stands for moose and possibly bighorn sheep. Minor-to-moderate, adverse effects on mule deer and upland shrub birds would be associated with increases in the deer population. Use of a capture facility would have up- to- minor adverse effects on wildlife habitat. Research activities associated with procedures to test for chronic wasting disease in live elk and effectiveness of a fertility control agent done in concert with elk management actions would negatively affect individuals of wildlife species while activities were taking place but would not have population-level effects. There would be no effect on other wildlife from fertility	Disturbance from helicopter overflights would have localized negative effects on individuals of wildlife species. Research activities done in concert with elk management activities would have effects the same as Alternative 2. Cumulative effects of other plans, projects, and actions combined with the effects of Alternative 3 would be long-term, moderate, and adverse. Alternative 3 would not result in impairment.	long term, local, and minor to moderate. The use of a capture facility to treat a high number of elk would have short-term, adverse effects on wildlife habitat up to minor in intensity. The administering of fertility control agents for population management and research purposes via darting methods would have negative effects on individuals of other wildlife populations in the vicinity of the activity. Cumulative effects of other plans, projects, and actions combined with the effects of Alternative 4 would be long-term, moderate, and adverse. Alternative 4 would not result in impairment.	to moderate for scavenger species, numerous avian species, fish, amphibians, and reptiles; moderate for beaver; and moderate to major for songbirds, cavity nesting birds, and wildlife habitat in general. The effects of wolf predation would be adverse and minor for individual ungulates, but ultimately, ungulate populations would benefit. Coyote would experience a minor-to-moderate, adverse effect. Minor adverse impacts on upland shrub birds would occur. Research activities done in concert with elk management activities would have effects the same as Alternative 2. Cumulative effects would be short-term, minor-to-moderate, and adverse. Alternative 5 would not result in impairment.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Other Wildlife Species (continued)	Cumulative effects on wildlife would be short- and long-term, minor, and adverse. Alternative 1 would not result in impairment.	control agents administered by hand to test subjects. Restored habitats would benefit wildlife species, with the magnitude of the benefits being negligible for bighorn sheep, mountain lion, and bobcat; negligible to minor for black bear; minor for moose, red fox, scavengers, small mammals, raptors, upland shrub birds, and fish; minor to moderate for ptarmigan, waterfowl and shorebirds, and amphibians and reptiles; moderate for beaver and butterflies; and moderate to major for songbirds and cavity nesters. There would be no net effect on coyotes and impacts on red foxes would be adverse and negligible. Cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would be long-term, moderate, and adverse. Alternative 2 would not result in impairment.			
Water Resources	Hydrological changes as a result of a reduced beaver population in the park would continue to represent	Recolonization or reintroduction of beaver would cause long term, local, moderate, beneficial effects	Recolonization or reintroduction of beavers would result in long term, local, moderate, beneficial	Recolonization or reintroduction of beavers would result in overall effects on hydrology similar	Recolonization or reintroduction of beavers would result in overall effects on hydrology similar

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Water Resources (continued)	a long-term, local, major, adverse effect on hydrology and stream structure in the winter elk range. Effects would be moderate, but progress to major later in the plan in the summer elk range. Sediment entering streams from erosion of bare ground would be long term, local, minor, and adverse in the winter elk range and Kawuneeche Valley, but negligible in other areas of the primary summer range. Bank destabilization would cause a slight increase in turbidity, resulting in long-term, local, negligible-to-minor, adverse effects on water quality in the core winter range and Kawuneeche Valley and negligible adverse effects on water quality in the remainder of the winter and summer elk range. Slight increases in water temperature during the summer months would represent a long-term, local, negligible, adverse effect on water quality. Effects on water quality from elk introducing bacteria,	on hydrology in the elk core winter range and possibly Kawuneeche Valley and minor benefits in other portions of the primary winter range and the primary summer range. Increased willow cover with decreased erosion and turbidity would result in a long-term, local, negligible, beneficial impact on water quality. Short-term adverse impacts from lethal control and vegetation management activities would be local and negligible to minor with mitigation measures. Increased stream shading would produce a long-term, local, negligible, beneficial effect on water temperature. Slightly less contamination from the introduction of bacteria, ammonia, nitrates, and fecal matter by elk would result in a local, negligible, beneficial effect. Prescribed burns could potentially alter stream chemistry in the short term, a local, minor, adverse effect. Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and	effects on hydrology, although changes in hydrology would vary between fenced and unfenced areas. Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial. Cumulative effects on water quality would be negligible and adverse. Alternative 3 would not result in impairment.	to those described for Alternative 3. No effect on water quality would occur from the use of fertility control agents. Cumulative effects on hydrology and stream structure would be long term, minor to moderate,and beneficial. Cumulative effects on water quality would be negligible and adverse. Alternative 4 would not result in impairment.	to Alternative 2. The release of wolves would have no effect on water quality. Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial. Cumulative effects on water quality would result in no effect. Alternative 5 would not result in impairment.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Water Resources (continued)	ammonia, nitrates, and fecal matter to surface waters would be long term, negligible, and adverse. Cumulative effects on hydrology would be long term, major, and adverse. Cumulative effects on water quality would be long term, moderate, and adverse. Alternative 1 would not result in impairment.	beneficial. There would be no cumulative effects on water quality. Alternative 2 would not result in impairment.			
Soils and Nutrient Cycling	The adverse effects on soils from compaction and bare ground would be long term, local, and minor in the core winter range but negligible elsewhere in the elk range. Effects from erosion on soils would be long term, local, negligible to minor, and adverse. Increased bank instability from reduced willow cover would result in a long-term, local, negligible, adverse effect. In upland shrub areas, a 30% decrease in calcium, magnesium, and other cations would continue to result in a long-term, local, minor-to-moderate, adverse impact on soils in the primary winter range but	Reduced bare ground and compaction and, therefore, erosion would result in a long-term, local, minor, beneficial effect on soils. Improved bank stabilization would be a long term, local, negligible, beneficial effect. Short-term effects of management activities would be local, minor, and adverse to soils, except for mechanical thinning and prescribed burning, which would have local, minor-to-moderate, adverse effects. Effects on nutrient cycling aspects of soils in willow and aspen areas would be long term, local, minor, and beneficial. Increases in nitrogen inputs would be a	Reduced bare ground, compaction, and erosion would result in a long-term, local, minor benefit on fenced soils and a local, negligible, beneficial effect on unfenced soils. Short-term effects from management activities would result in minor, local, adverse impacts, except for mechanical thinning and burning, which would be minor to moderate. Improved bank stabilization would be a long-term, local, negligible benefit. Impacts on nutrient cycling would be similar to those described under Alternative 2, although effects would be incrementally greater in	Reduced bare ground, compaction, and erosion would result in a long-term, local, minor benefit to fenced soils in the winter elk range and a local, negligible, beneficial effect on unfenced soils in the primary winter and summer elk range. Short-term effects from the plan's activities would result in minor, local, adverse impacts on the winter and summer elk ranges, except for mechanical thinning and burning, which would be minor to moderate. Improved bank stabilization would be a long term, local, negligible benefit. Impacts on nutrient cycling	Effects from elk population reduction on bare ground, compaction, and erosion would be similar to those described for Alternative 2. Impacts on nutrient cycling for aspen and willow would be similar to those described under Alternative 2. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2. Effects from mechanical thinning and burning on nutrient cycling would be the same as described for Alternative 2. Effects on mycorrhizae would be the same as described for Alternative 2. The release

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Soils and Nutrient Cycling (continued)	minor in the primary summer range. Reduction in available soil nitrogen and carbon over time in aspen and willow communities would be a long-term, local, minor, adverse effect. A reduction in overall pools and fluxes of nitrogen and carbon in short willow and aspen areas would be a long-term, local, moderate, adverse effect. Increases in nitrogen inputs to mixed conifer habitats would have long-term, local, minor, adverse effects on the elk core winter range but negligible-to-minor effects in other portions of the elk range. Continued reduction in mycorrhizal levels and changed species composition would result in a long-term, minor, adverse effect on soils in the core winter range and a negligible adverse effect on the remainder of the elk range. The continued lack of flooding from a reduced beaver population represents a long-term, local, minor, adverse effect on soils.	long-term, local, moderate benefit in the elk core winter range, and minor benefits would occur locally on the remainder of the primary winter range and the primary summer range. Increases in cation availability would result in a minor, beneficial effect on upland shrub area soils. Mechanical thinning of willow and aspen sites would increase nitrogen mineralization and nitrification, a local, long-term, minor, beneficial effect. Prescribed burns would result in long-term, minor benefits and short-term, local, minor, adverse effects. Willow replantings would slightly increase nitrogen and carbon pools, a local, negligible beneficial effect. Upland shrub area soils would experience local, minor benefits. Increased mycorrhizal levels in the soil would produce a long-term, local, minor, beneficial effect. Increases in the water table associated with increases in beaver would	fenced areas. Increases in cations and phosphorus on upland shrub areas would be the same as described for Alternative 2. Effects on soils from changes in nutrient cycling from mechanical thinning activities would be the same as described for Alternative 2. Effects from prescribed burns would be the same as described for Alternative 2. Effects from willow replantings would be the same as described for Alternative 2. Effects on mycorrhizae would be the same as described for Alternative 2. Overall benefits from increased flooding of soils would be long term, local, and minor. Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor to moderate, and beneficial. Cumulative effects on nutrient cycling would be long term, minor, and adverse.	would be similar to those described under Alternative 2, although effects would be incrementally greater in fenced areas. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2. Effects on soils from changes in nutrient cycling from mechanical thinning activities would be the same as described for Alternative 2. Effects from prescribed burns would be the same as described for Alternative 2. Effects from willow replantings would be the same as described for Alternative 2. Effects on mycorrhizae would be the same as described for Alternative 2. Overall benefits from increased flooding of soils would be long term, local, and minor. Cumulative effects on bare ground, compaction, erosion, and flooding on soils would be long term, minor to moderate, and beneficial. Cumulative effects on cycling on soils	of wolves would likely directly contribute negligible, beneficial effects on nutrient cycling and soil productivity. Effects from increased microbial activity from flooding of soils would be similar to those described for Alternative 2. Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor to moderate, and beneficial. Cumulative effects on nutrient cycling would be long term, minor, and adverse. Alternative 5 would not result in impairment.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Soils and Nutrient Cycling (continued)	Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor, and beneficial. Cumulative effects on nutrient cycling would be long term, moderate, and adverse. Alternative 1 would not result in impairment.	represent a long-term, local, moderate, beneficial effect. Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor, and beneficial. Cumulative effects on nutrient cycling would be long term, minor, and adverse. Alternative 2 would not result in impairment.	Alternative 3 would not result in impairment.	would be long term, minor, and adverse. Alternative 4 would not result in impairment.	
Natural Soundscape	Maintenance of research plot fencing would have a negligible, adverse effect on soundscapes. Effects of redistribution techniques on soundscapes would continue to be short-term, local, negligible, and adverse. Short-term effects that would continue to periodically occur for management actions would continue to be local, negligible, and adverse. Monitoring would continue to result in short-term, negligible-to-major, adverse effects. Cumulative effects of other plans and projects and the actions of Alternative 1 would continue to be short-	Lethal removal of elk using noise-suppressed weapons would result in short-term, local, minor, adverse effects. Unsuppressed weapons would have short-term, local, negligible-to-major adverse effects on undeveloped areas and short-term, local, minor adverse effects on developed areas. Effects of darting associated with lethal reduction or research activities would be short-term, local, and negligible to minor for developed and negligible to moderate for undeveloped areas. Removal of carcasses would result in short-term, negligible, adverse effects in developed areas and	Effects from lethal removal using subsonic noise-suppressed weapons would have the same effect as described for Alternative 2. Unsuppressed weapons would have short-term, local, negligible to major effects in undeveloped, and short-term, local, minor, adverse effects in developed areas. Darting associated with lethal reduction or research activities would have the same effect as under Alternative 2. Removal of carcasses would have the same effects as described for Alternative 2. Fencing under Alternative 3 would be more extensive than under Alternative 2 but	Effects from lethal removal using both noise-suppressed and unsuppressed weapons would be the same as described for Alternative 3. Effects of darting associated with lethal reduction or research activities would be the same as described for Alternative 2. Removal of carcasses would have the same effects as described for Alternative 2. With fertility control, dart gun use, human activity, and annual treatments would result in short-term, local, and negligible to moderate effects.	The initial release process would have a short-term, local, negligible, adverse effect on soundscapes. Were wolves to be adversely conditioned or lethally removed, effects on soundscape would be short-term, local, negligible to moderate, and adverse. Effects of wolves' howling on the park's soundscape could vary from minor to moderate and would be short-term, parkwide, and beneficial; and would occur at least for the length of the plan. Wolf monitoring and recapture efforts would result in a short-term, major, adverse effect on soundscapes if helicopters

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Natural Soundscape (continued)	term, local and regional, minor-to-major, and adverse. Alternative 1 would not result in impairment.	negligible to minor, adverse in undeveloped areas. If helicopters were used to remove carcasses from remote areas, effects on soundscapes would be short-term, negligible-to-major, and adverse. Erecting a capture facility would have short-term, local, minor adverse effects on soundscapes. Vehicles accessing the capture facility would have short-term, local, minor, adverse effects on soundscapes in developed and undeveloped areas. Effects from fencing installation would be short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas. If helicopters were used, effects would increase to short-term, negligible-to-major, and adverse. Effects on the soundscape from prescribed burns would be minor to major, short-term, local, and adverse. Mechanical thinning activities would result in short-term, local, moderate,	overall effects would be the same. Effects on soundscapes from prescribed fire would be the same as described for Alternative 2. Redistribution techniques under Alternative 3 would have the same intensity as under Alternative 2. Effects of herding on soundscapes would be the same as described in Alternative 2. Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2. Effects of monitoring would be the same as described for Alternatives 1 and 2. Cumulative effects would be similar to those described for Alternative 2. Alternative 3 would not result in impairment.	Erecting and using a temporary capture facility would have the same effects as described for Alternative 2 Redistribution techniques would have the same intensity level as Alternative 3. Effects of herding on soundscapes would be the same as in Alternative 2. Effects from fencing would be the same as described for Alternative 3. Effects from prescribed fire and mechanical thinning would be the same as described for Alternative 2. Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2. Effects of monitoring would be the same as described for Alternative 2. Cumulative effects would be similar to those described for Alternative 2. Alternative 4 would not result in impairment.	were used. Effects of lethal removal using both noise-suppressed and unsuppressed weapons would be the same as described for Alternative 2. Effects of darting activities would be the same as described for Alternative 3. Removal of carcasses would have the same effects as described for Alternative 2. Erecting and using a temporary capture facility would have the same effects as described for herding on soundscapes would be the same as in Alternative 2.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Natural Soundscape (continued)		adverse effects. Effects from redistribution techniques would be short-term, local, moderate, and adverse in undeveloped areas and short-term, local, minor, and adverse in developed areas. Herding would have short-term and long-term, local, negligible to major, adverse impacts. Effects on soundscapes from actions to manage aggressive or injured animals would be the same as described for Alternative 1. Effects from monitoring would be the same as for Alternative 1. Cumulative effects would be similar to those described for Alternative 1. Alternative 2 would not result in impairment.			Effects on soundscapes from fencing would be the same as described for Alternative 3. Effects on soundscape from prescribed fire and mechanical thinning would be the same as described for Alternative 2. Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2. Effects of monitoring would be the same as described for Alternative 2. Cumulative effects would be similar to those described for Alternative 1. Alternative 5 would not result in impairment.
Wilderness	Noticeable levels of vegetation degradation in willow and aspen communities would continue to have a long-term, local, moderate, adverse effect on wilderness. Limited fencing activities	Recovery of vegetation in localized area would result in a long-term, moderate, benefit to wilderness, representing more natural conditions. Lethally removing elk using noise-suppressed and unsuppressed weapons result	Effects from the reduction of elk, addition of fencing, prescribed fires, and mechanical thinning on natural conditions would be the same as described for Alternative 2. Lethally removing elk using noise-suppressed and	More natural conditions for vegetation and ecosystems would be a long-term, range-wide, moderate, benefit to wilderness. Fencing, prescribed fires, and mechanical thinning would have long-term, range-wide, moderate,	Recovery of willow and aspen vegetation in localized areas would result in a long-term, moderate, benefit. Effects of releasing wolves in wilderness would be long term, park wide, and major beneficial. The process of releasing wolves

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wilderness (continued)	would result in local, negligible, adverse effects. Minimal redistribution technique use in wilderness would result in short-term, local, minor, adverse effects. Removing animals suspected of having chronic wasting disease would have a short-term, local, minor, adverse effect. Monitoring of elk and vegetation would have a short-term, regional, negligible-to-major, adverse effect. Cumulative effects on wilderness would be long-term, minor to moderate, and adverse as well as short-term, minor to moderate, and adverse. Alternative 1 would not result in impairment.	in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Darting associated with lethal reduction or research would result in local, minor, adverse effects. Carcass removal would result in short term, local, minor, adverse effects. Erecting a temporary capture facility associated with lethal reduction would be a short-term, local, moderate, adverse effect. Effects of accessing wilderness would be short-term, local, minor to moderate, and adverse. Effects on wilderness from installing fencing and the presence of fences around aspen would be long term, local, moderate, and adverse. Prescribed fires would have short-term, local, moderate, adverse effects; mechanical thinning would have short-term, local, moderate, adverse effects. Fire would restore a natural process into wilderness areas that would result in a long-term, moderate, local beneficial	would be short term, local, unsuppressed weapons would have the same effects as in Alternative 2. Effects from darting associated with lethal reduction or research would be the same as in Alternative 2. Carcass removal would have the same effects as described for Alternative 2. Effects of accessing the wilderness would be short-term, local, minor to moderate, and adverse. Effects on wilderness from installing fencing and the presence of fences around aspen and willow would be long term, local, major, and adverse. Prescribed fires would have the same effects as described for Alternative 2, as would restoring natural processes into wilderness areas and mechanical thinning. Use of helicopters would have effects as described for Alternative 2. Monitoring would have short term, regional, moderate, and adverse effects. Effects of	beneficial effects on wilderness. Lethally removing elk using noise-suppressed and unsuppressed weapons would result in short-term, local, negligible-to-major, adverse effects. Effects on wilderness from darting associated with lethal reduction or research would be the same as in Alternative 2. Carcass removal would have the same effects on wilderness as described for Alternative 2. Erecting a temporary capture facility would have the same effects on wilderness as described for Alternative 2. Effects from installing fencing and the presence of fences around aspen and willow would be long term, local, major, and adverse. Use of helicopters would have the same effects as described for Alternative 2. Prescribed fires would have the same effects as described for Alternative 2, as would restoring natural	would have short term, local, minor, adverse effects on wilderness. Lethally removing elk using noise-suppressed and unsuppressed weapons would have the same effects as in Alternative 2. Effects from darting associated with lethal reduction or research would be the same as in Alternative 2. Carcass removal would have the same effects as described for Alternative 2. Effects of accessing the wilderness would be short-term, local, minor to moderate, and adverse. Erecting a temporary capture facility associated with lethal reduction would have the same effects as described for Alternative 2. Effects on wilderness from installing fences and the presence of fences around aspen would be the same as described for Alternative 2. Use of helicopters would have the same effects as described for Alternative 2. Prescribed fires would have the same effects as for

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wilderness (continued)		effect in areas treated. Tagging or marking study elk and fertility control agents' disruption of natural biological processes for treated elk would result in short-term, range-wide, minor, adverse effects. Use of helicopters would have short-term, range-wide to regional, negligible-to-major, adverse effects. Effects of redistribution techniques would be short term, local, minor, and adverse. Herding would result in short-term, local, adverse effects that would vary from minor to moderate. Removing animals suspected of having chronic wasting disease would have the same effects as for Alternative 1. Monitoring would have short term, regional, moderate, and adverse effects. Recovery of willow and aspen within wilderness would be a long-term, moderate benefit. Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term,	redistribution techniques minor, and adverse. Herding would have the same effects as described for Alternative 2. Tagging or marking study elk and fertility control agents' disruption of natural biological processes for treated elk would result in short-term, range-wide, minor, adverse effects. Removing animals suspected of having chronic wasting disease would have the same effects as for Alternative 1. Monitoring would have the same effects as for Alternative 1. Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate to major, and adverse. Alternative 3 would not result in impairment.	processes into wilderness areas and mechanical thinning. Effects of redistribution techniques would be similar to Alternative 2. Herding would have the same effects as described for Alternative 2. Removing animals suspected of having chronic wasting disease would have the same effect as for Alternative 1. Monitoring would have the same effects as for Alternative 1: short term, regional, moderate, and adverse. Effects of accessing the wilderness would be short-term, local, minor to moderate, and adverse. Fertility control and research activities would have short-term, local, minor, adverse effects. The tagging of treated elk and disruption of natural biological processes would have long-term, range wide, minor, and adverse effects. Cumulative effects on wilderness would be long term, minor to moderate,	Alternative 2, as would restoring natural processes into wilderness areas and mechanical thinning. . Tagging or marking study elk and fertility control agents' disruption of natural biological processes for treated elk would result in short-term, range-wide, minor, adverse effects. Effects of redistribution techniques would be similar to Alternative 2. Herding would have the same effects as described for Alternative 2. Effects of removing animals suspected of having chronic wasting disease would be short term, local, negligible-to-minor, and adverse. Monitoring would have the same effects as for Alternative 1. Effects from the reduction of elk, addition of fencing, prescribed fires, and mechanical thinning on natural conditions would be the same as described for Alternative 2. Cumulative effects on wilderness would be long

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wilderness (continued)		moderate, and adverse. Alternative 2 would not result in impairment.		and adverse as well as short term, moderate to major, and adverse. Alternative 4 would not result in impairment.	term, minor to moderate, and adverse as well as short-term, moderate, and adverse. Alternative 5 would not result in impairment.
Socioeconomics	No change in visitation attributable to the elk would be expected, resulting in continued moderate-to-major, long-term, beneficial impact in the region. Alternative 1 would continue to contribute a long-term, moderate, beneficial impact from its contribution to hunting. Revenues related to elk would continue to be a moderate, long-term benefit to Rocky Mountain National Park, and elk-related costs would be long-term, minor, and adverse. The Town of Estes Park would continue to receive long-term, moderate benefits from elk-related revenues and negligible, adverse effects from costs. The Estes Valley Recreation and Park District would receive negligible benefits from elk-related revenues, but would continue to experience long-	Alternative 2 would be expected to create a net short-term, minor-to-moderate, adverse effect on tourism and recreation draw, but a negligible, long-term effect on visitation. There would be a net negligible-to-minor, adverse, long-term impact on hunting. There would be no effect on visitation to the park or region or on hunting as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease live testing. Rocky Mountain National Park, Estes Park, and the Estes Valley Recreation and Park District would experience short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities. In the short and long term, there would be a minor-to-	Alternative 3 would be expected to create a net short-term, minor to moderate adverse effect on tourism and recreation draw, but a negligible long-term effect on visitation. In the short-term, visitation would decrease, but long-term visitation would not be affected. The National Park Service, Estes Park and the Estes Valley Recreation and Park District would experience a short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities. There would be no effect on visitation or hunting as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease live testing. In the short and long-term, there would be a minor to moderate benefit to	A drop in visitation due to large-scale fertility control for population management, lethal reduction, and fencing, with losses of $3 million in sales, $1 million in personal income, and 75 jobs would have a moderate, adverse impact in the long term. There would be no effect on visitation to the park or region as a result of short-term research activities on chronic wasting disease live testing. A drop in hunter activity and direct economic contribution from hunters near the east and west sides of the park would result in a minor-to-moderate, adverse, short- and long-term, impact would result due to use of fertility control agents on a large-scale for population control. The effects to hunting as a result of research activities involving	Potential for a 10% gain in visitors, an additional $3 million in sales, $1 million in personal income, and 75 new jobs within the park and the surrounding area would be a net moderate beneficial impact on park visitation and tourism in the Estes Valley. Short term, there would be a net negligible to minor impact on hunting activity as a result of this alternative. There would be a net negligible-to-minor, adverse, long-term impact. There would be no effect on visitation or hunting as a result of short-term research activities on multi-year fertility control agent and chronic wasting disease live testing. The park would probably see a moderate-to-major, long-term increase in annual entrance fee revenue and a moderate, short- and long-

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socioeconomics (continued)	term, moderate, adverse effects from costs. The overall impacts on the Colorado Division of Wildlife would continue to be negligible to minor and adverse. There would be a continued long-term, minor-to-moderate, adverse impact on landscaping and private property. There would continue to be a moderate, long-term, adverse impact on the ranching and agricultural community. Elk would continue to make a minor-to-moderate, seasonal contribution to congestion and traffic accidents in the park and Estes Park. This alternative would have a minor to moderate beneficial, long-term effect on body shops. Elk would continue to contribute a net minor-to-moderate benefit to the quality of life of Estes Valley residents. Property values would experience a negligible, long-term impact.	moderate benefit to homeowners and loss to landscaping companies. Agriculture would experience minor-to-moderate, short- and long-term benefits. Traffic congestion would decrease in the short-term, but there would be minor, long-term, beneficial impacts. Elk-related traffic accidents would decrease in the short and long term, and beneficial impacts would be negligible to minor. There would be a minor, short- and long-term adverse impact on Estes Park body shops. There would be minor, short- and long-term benefits to property values. The moderate to major cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 2. The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 3.	homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor-to-moderate, short- and long-term benefits. Traffic congestion would decrease in the short-term, but there would be minor, long-term beneficial impacts. Elk-related traffic accidents would decrease in the short and long-term, and beneficial impacts would be negligible to minor. There would be a minor short and long-term adverse impact on Estes Park body shops. Impacts on hunting activity and experience would be the same as under Alternative 2. The impacts on property values would be the same as under Alternative 2. The moderate to major cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 3. The minor to moderate adverse cumulative effects within the Estes	immobilization drugs and fertility control agents would not be distinguishable from the effects of the large-scale treatment of the population. Net impacts on the public sector would be minor to moderate and adverse in the long term due to the decrease in visitors. Traffic congestion would decrease in the short-term, but there would be minor, long-term beneficial impacts. Elk-related traffic accidents would decrease in the short and long-term, and beneficial impacts would be negligible to minor. There would be a minor short and long-term adverse impact on Estes Park body shops. This alternative would result in a net negligible, long-term, adverse impact on property values. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.	term increase in costs. The Town of Estes Park would experience a moderate-to-major, long-term increase in revenue. The Estes Valley Recreation and Park District would experience a negligible to minor net effect due to decreased elk near the east side of the park and increased visitors. Wolves would have a moderate-to-major negative impact on CDOW costs. Local homeowners would likely see a minor, short- and long-term decrease in landscaping costs. The net short- and long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible. There would be short- and long-term, minor, adverse impact as a result of potential wolf depredation on pets. There would be a net minor-to-moderate, short- and long-term benefit to agriculture. There would be a minor short- and long-term, adverse impact on Estes Park body shops and a

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socioeconomics (continued)	Cumulative benefits within the socioeconomic environment would continue to be long-term and moderate to major. Cumulative adverse effects would continue to be long term and minor to moderate.		Valley socioeconomic environment would continue under Alternative 3.		minor short- and long-term, beneficial impact from reduced accidents. There would be a net, minor, long-term, beneficial impact on property values. The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 5.
Public Health and Safety	Impacts on safety over the long term resulting from visitors' efforts to view or photograph elk are negligible and adverse. This could increase the intensity of long-term, adverse risks from negligible to minor with increased visitation. The impact of elk control activities on staff and volunteer safety is long term, negligible to minor, and adverse. The possibility of chronic wasting disease transmission to humans from handling elk under Alternative 1 would remain long term, negligible, and adverse. The use of firearms and dart rifles for	Lethal control activities would result in long-term, adverse impacts on employee health and safety at a negligible-to-minor intensity. Reduced elk numbers, concentrations, and habituation in combination with redistribution activities would result in a long-term, negligible-to-minor, beneficial impact on health and safety. Use of darts and handling of drugged animals for lethal reduction or research activities would have short- and long-term, adverse impacts on health and safety that would be mitigated by adherence to NPS policy and protocol *to* a negligible to minor level.	Reduced elk numbers, concentrations, and habituation to humans in combination with aversive conditioning activities would result in a long-term, negligible-to-minor, beneficial impact. Use of darts and handling of drugged animals for lethal reduction or research activities would have short- and long-term, adverse impacts on health and safety that would be mitigated by adherence to NPS policy, guidance, and protocol to a negligible to minor level. Adverse impacts from handling elk carcasses and live elk to be tested for chronic wasting disease would be negligible.	The risk posed by the elk population and management and reduction activities would be similar to Alternative 3. Risks associated with the use of darts and handling drugged animals for population management or research activities would have long-term, adverse impacts on health and safety, mitigated to a negligible to minor level. With observing standard precautions, risks of consuming meat from treated elk would be reduced, the long-term, adverse impacts on health and safety to a negligible level.	Lethal control and research activities would result in long-term, adverse impacts on employee health and safety at a negligible to minor intensity. Reduced elk numbers, concentrations, and habituation in combination with aversive conditioning activities would result in a long-term, negligible to minor, beneficial impact on health and safety. Adverse impacts of using a capture facilities for lethal reduction would be short term and negligible to minor. Herding or bait lines to get elk to the facility would result in long-term, negligible-to-minor, adverse impacts.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Public Health and Safety (continued)	lethal control of elk infected with chronic wasting disease results in long-term, negligible-to-minor, adverse impacts for staff or contractors. The long-term, adverse impacts on public health and safety of vegetation management, including fencing, under Alternative 1 are negligible. Cumulative impacts would continue to be minor to moderate and beneficial.	Adverse impacts of capture facilities for lethal reduction on health and safety would be short- term and negligible to minor. Herding or bait lines to get elk to the facility would result in long-term, negligible-to-minor, adverse impacts. Carcass handling would result in long-term, negligible, adverse impacts. Effects on public health and safety from activities associated with fencing would be short-term, negligible, and adverse. Effects on public health and safety from thinning or prescribed burns would be short-term or long-term, minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible. Cumulative impacts would continue to be minor to moderate and beneficial.	Staff training and limited area closures during more frequent redistribution actions would keep associated short-term, adverse impacts to a negligible-to-minor level. Impacts of human-elk interactions outside the park on public health and safety would be long term, negligible, and beneficial. The effects on public health and safety from activities associated with fencing would still be short-term, negligible, and adverse. The effects of prescribed burning and mechanical thinning would be the same asunder Alternative 2. Cumulative impacts would continue to be minor to moderate and beneficial.	The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3. Adverse impacts on public health and safety due to smoke would be short term and negligible. Cumulative impacts would continue to be minor to moderate and beneficial.	Adverse impacts associated with wolf release activities and monitoring and tracking wolves after release would be minor. With wolf management and public education, long-term, adverse impacts on health and safety would be negligible. Long- and short-term adverse impacts from elk seeking refuge would be negligible-to-minor in campgrounds, visitor centers, and other areas with high concentrations of people. The impact of human-elk interactions outside of the park would be negligible. The effects from fencing and prescribed burning would be the same as under Alternative 3. Adverse impacts on public health and safety due to smoke would be short term and negligible. Cumulative impacts would continue to be minor to moderate and beneficial.

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Visitor Use and Experience	Opportunities to view elk would continue to provide a moderate-to-major benefit over the long term. High concentrations of visitors viewing elk would cause moderate-to-major, adverse impacts over the long term for visitor preferring less crowding; minor-to-moderate for others. Visitors who prefer to view the park's wildlife under more natural conditions would experience negligible-to-moderate, long-term, adverse impacts. Impacts on aspen and willows from elk over-browsing would continue to cause minor-to-major, long-term, adverse effects on visitors who are aware of the conditions; for the overall visitor population, the effect would be minor and adverse. Experimental fencing to protect selected aspen communities would result in a negligible, long-term, adverse impact on visitors' experiences. The use of helicopters would result in negligible-to-major, short-term, adverse impacts.	The adverse impacts on visitors who visit the park with an interest in viewing elk would be negligible to minor over the long term. Impacts on visitor experience from crowding would be negligible, long term, and beneficial. The net effect for those who prefer to view elk and other wildlife in a relatively natural setting would be minor, long term, and beneficial; for most visitors, the beneficial impact would be negligible to minor. The return of plant communities would result in a minor, long-term benefit. Adverse impacts lethal control activities would be short term and moderate in the first four years reduced to minor in the remaining 16 years of the plan.	Adverse impacts of small-scale, lethal control using firearms would be short term and minor to moderate. Use of firearms with noise suppression and subsonic ammunition at night would reduce adverse impacts on visitor use and experience to minor. Effects on visitors due to management of the elk population would be similar to those of Alternative 2, including impacts on visitor experience from crowding, viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting, and the return of plant communities. The effects of lethal reduction activities on visitors' experience would be similar to those under the last 16 years of Alternative 2, short-term, adverse and minor. The effects of firearms use to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for	Visitor opportunities to view elk and the impact on visitors' experience, including crowding, would be the same as under Alternative 3: negligible to minor over the long-term. Viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting would be similar to opportunities under Alternative 2: negligible to minor, long term, and beneficial. The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2: negligible-to-minor, long-term, and beneficial. Elk treated with a fertility control agent for population management and research activities would receive a short-term mark, such as from a paintball, to prevent multiple treatments, and possible markings to warn hunters against consumption. Hunters could experience minor, adverse impacts over the long term from such warnings. Human-made	Visitor opportunities to view elk would be the same as under Alternative 3 in the early years of the plan and for crowding, such as at somewhat greater in the later years. Dispersal of elk by wolves would be greater and viewing opportunities in large meadows would increase, resulting in a minor, long-term benefit. There would be an overall negligible-to-minor, long-term, beneficial impact due to improved natural settings from wolves' overall impacts on other wildlife, but a negligible to minor, adverse impact on the ability of visitors to view certain species affected by wolves. For the visitors who value wolves or a more complete ecosystem, the opportunity to see or hear wolves would provide a long-term, minor-to-moderate benefit. For visitors who fear wolves and would choose not to hike or backpack as a result of wolf presence would experience a long-term, minor to moderate adverse impact. Increased visitation and

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Visitor Use and Experience (continued)	Cumulative benefits would be long-term and moderate.	The effects of firearms use to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk for research purposes would have short-term, minor, adverse effects. Seeing a capture facility could have minor adverse effect on some visitors. The adverse impacts on visitors as a result of closures during lethal elk reduction activities would be negligible to minor and short term. Aerial activity associated with monitoring, management of elk, or fence installation would produce negligible-to-major, short-term, adverse impacts on visitors' experience. Fencing would cause a long-term, local, minor-to-major, adverse impact. The use of prescribed burns to stimulate growth of aspen and willows -would cause negligible-to minor, adverse impacts over the long term. Cumulative impacts would continue to be moderate, long-term, and beneficial.	research purposes would have short-term, minor, adverse effects. The effects of area closures would be similar to the last 16 years of Alternative 2. Aerial activity associated with monitoring or management of elk would be similar to Alternative 2. Fence to protect aspen and montane riparian willow would result in major adverse impacts. The effects of prescribed fire would be the same as under Alternative 2. The cumulative impact would continue to be moderate, long-term, and beneficial.	marks or collars would diminish the viewing experience, and visitors would experience short-term, minor, adverse effects over the long term. Adverse impacts associated with fences would be the same as under Alternative 3: long-term, major, and adverse. The effects of prescribed fire would be the same as under Alternative 2: long-term, negligible to minor, and adverse. The effects of firearms use to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects. Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.	increased opportunities wolf sightings, would result in long-term, minor, adverse impacts on visitor experience. The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2. If emphasis must be placed on lethal reduction over the actions of wolves, the effects on visitor experience would be as similar to those under Alternative 2. If wolves are effective in reducing elk numbers and distributing elk, there would be minor to moderate, long-term, positive impacts on those who perceive wolves to be an ethical and natural method for reducing elk populations and controlling their movements. The impacts associated with an elk capture facility plus holding pens that would be used for the release of wolves would produce

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Visitor Use and Experience (continued)					impacts similar to Alternative 2. If area closures would be more intense in the first four years, impacts would be similar to Alternative 2. Aerial activity associated with monitoring or management of elk would be similar to Alternative 2. The effects of aspen fencing would be similar to those under Alternative 2. The effects of prescribed fire would be the same as under Alternative 2. The effects of firearms use to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk for research purposes would have short-term, minor, adverse effects. The cumulative impacts would continue to be moderate, long-term, and beneficial.
Park Operations	The ongoing monitoring and management activities throughout the park would create long-term, negligible, adverse effects. Park staff would continue to update media regularly with the	The logistical and operational changes involved in the lethal reduction would result in short-term, minor-to-moderate, adverse impacts for the first four years, declining to short-term and	The operational changes involved in the lethal reduction would result in short-term, minor-to-moderate, adverse effects for the life of the plan. The beneficial effects of reduced	Lethal reduction and fertility control activities and the removal of carcasses would result in long-term, minor-to-moderate, adverse effects on park operations. The labor involved in the	The release and monitoring of wolves would result in short-term, negligible-to-minor, adverse effects on park operations. Lethal reduction activities would result in minor-to-moderate,

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Park Operations (continued)	condition of the elk population and its habitat, and no measurable change would occur in the management of volunteers, resulting in long-term, negligible, adverse effects on park operations. Cumulative effects would be long-term, minor-to-moderate, and adverse.	minor for the remainder of the plan. Tasks related to the capture facility would result in short-term, negligible-to-minor, adverse impacts on park operations. The decreased need for managing elk/human conflicts would result in short- and long-term, minor, beneficial effects. During lethal reduction activities, increased visitor control would result in short-term, negligible-to-minor, adverse effects. Fence installation would result in short- and long-term, negligible, adverse effects on park operations. The tasks and allocation of resources related to continued monitoring activities would create long-term, minor-to-moderate, adverse effects. Redistribution techniques would have a long-term, minor-to-moderate, adverse effect. Increased prescribed burning would have short-term, minor, adverse effects. The initial development of new interpretive and educational media would result in a short-term, minor-to- moderate, adverse effect	elk-human conflicts would be short- and long-term and of minor intensity. During lethal reduction activities, the increased need for visitor control would result in short-term, negligible to minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, minor-to-moderate, adverse effects. Monitoring activities would create long-term, minor-to-moderate, adverse effects. Elk redistribution would result in long-term, moderate, adverse effects on park operations. The increased prescribed burn activities would create short-term, minor, adverse effects. Developing new interpretive and educational media would result in a short-term, minor-to-moderate, adverse effect on park operations in the early period of plan implementation. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures and fertility control drug	construction and teardown of a temporary capture facility would result in a short-term, minor, adverse effect. The decreased need for traffic and crowd control would result in long-term, minor, beneficial effects. During lethal reduction activities, the increased need for visitor control would result in short-term, negligible-to-minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, minor-to-moderate, adverse effects. Monitoring activities would create long-term, moderate, adverse effects. Redistribution techniques would result in long-term, moderate, adverse effects. The increased prescribed burn activities that would be conducted would create short-term, minor, adverse effects. Developing new interpretive and educational media would result in a short-term, minor to moderate, adverse effect on park operations in the first years of the plan.	adverse effects in the short term, but decline to short-term and minor for the remainder of the plan if wolves were successful. The tasks related to the capture facility would result in short-term, negligible-to-minor, adverse effects on park operations. Elk-human conflicts would decrease in the park, but the need for traffic and crowd control would slightly increase over time, resulting in short-term, minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, negligible, adverse effects on park operations. Herding to a capture facility would have a long-term, minor, adverse effect. Prescribed burning would have short-term, negligible to minor, adverse effects. Information, education, and outreach activities associated with the wolf release program would result in a moderate to major, adverse effect, which would be reduced to minor

TABLE 2.4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES (CONTINUED)

Impact Topic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Park Operations (continued)		on park operations in the early period of plan implementation. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures in a free-ranging population in concert with elk management activities would result in a negligible adverse effect. Cumulative effects would be long-term, minor to moderate, and adverse.	effectiveness in a free-ranging population in concert with elk management activities would result in a negligible adverse effect. The cumulative effects would be long term, minor to moderate, and adverse.	Implementation of a three-year research study to evaluate chronic wasting disease testing procedures and fertility control drug effectiveness in a free-ranging population in concert with elk management activities would result in a negligible adverse effect. The cumulative effects would be long term, minor to moderate, and adverse.	in the long term. Initial integration of wolves and lethal reduction into interpretive materials would result in a short-term, moderate to major, adverse effect that would reduce to minor in the long-term. Increased monitoring under this alternative to include wolf activity and visitor response to wolves would result in long-term, moderate adverse effects. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures in a free-ranging population in concert with elk management activities would result in a negligible adverse effect. The cumulative effects would be long-term, minor to moderate, and adverse.

This page intentionally left blank

Affected Environment

This page intentionally left blank

AFFECTED ENVIRONMENT

ELK POPULATION

Population Size and Growth

Since 1969, the Rocky Mountain National Park / Estes Valley elk population has more than tripled. Population estimates peaked between 1997 and 2001, with annual estimates ranging from about 2,800 to 3,500. Since 2002, winter estimates in the park and Estes Valley outside the park have declined, ranging from about 1,700 to 2,200.

The population includes three subpopulations that exhibit different population dynamics and migration patterns (Larkins 1997, Lubow et al. 2002): 1) Moraine Park / Beaver Meadows (referred to as Moraine Park), 2) Horseshoe Park, and 3) the Town of Estes Park. Elk tend to stay within these areas, although 15% regularly move among subpopulations. The population dynamics of the Moraine Park and Horseshoe Park subpopulations do not differ and will be collectively referred to here as the park subpopulation. Elk population dynamics are different between the park and town subpopulations.

After lethal reduction activities within Rocky Mountain National Park ended in 1968, the park subpopulation initially increased at an annual rate of 6.5% and then gradually slowed to reach an estimated carrying capacity of approximately 1,069 animals in 1991 (Lubow et al. 2002). Since that time, the size has remained stable, fluctuating around approximately 1,000 animals. The population-based carrying capacity estimate of 1,069 is consistent with three other estimates based on either ecosystem simulation modeling or forage biomass and energy considerations (Hobbs et al. 1982, Coughenour 2002, Singer et al. 2002). The elk population size on the park winter range areas is primarily limited by the amount of available forage on the winter range (Hobbs et al. 1982, Coughenour 2002, Lubow et al. 2002, Singer et al. 2002), which is strongly related to weather conditions. Assuming existing habitat and continuation of weather patterns that occurred in the second half of the 20th century, the park subpopulation is expected to continue to fluctuate between 800 and 1,100 animals (Coughenour 2002).

Elk did not winter in the Town of Estes Park in noticeable numbers until about 1975 to 1980 (Hobbs et al. 1982). The town subpopulation increased at an estimated maximum average rate of 11% from 1979 to 1983 and was still increasing 5.2% per year from 1991 to 2001. Although the origin of the town population was likely emigration from the park, the subsequent growth of the town subpopulation appeared to be independent of the park subpopulation (Lubow et al. 2002). Population estimates reached a high between 1997 and 2000, with annual estimates ranging from about 2,000 to 2,500 elk. Estimates from 2001 to 2005 have ranged between about 1,000 and 1,400 elk in the Estes Valley area. These lower estimates coincided with increased numbers in the park (2001) and/or increased observations of elk from the Rocky Mountain National Park area east of the Estes Valley (2002-2003), as well as increased hunter harvest outside the park (see “Distribution and Movements” section).

The potential for further population growth in the town subpopulation is uncertain. Multiple and conflicting carrying capacity estimates have been made for the Estes Valley outside the park with corresponding population size estimates ranging from Coughenour's 1,400 to 2,000 using an ecosystem modeling based approach (2002) to Lubow et al.'s 2,454 to 3,284 using a population modeling based approached (2002). Recent observations suggest that the elk subpopulation in town may be stabilizing, but this has also coincided with dry weather conditions and alterations in migration patterns. Thus, the stability in elk numbers or changes in habitat use may not be a long-term trend (Monello et al. 2005).

Carrying capacity in the town area in 1996 was estimated to be only 5% less than if the area was still in a pristine, natural condition (Coughenour 2002, Singer et al. 2002). Development and the creation of Lake Estes reduced the land area available for elk foraging, but fertilization and irrigation enhanced the productivity of other areas (e.g. golf courses). Future carrying capacity will be driven by weather conditions as well as the balance between further development and artificial enhancement of the landscape.

Sex and Age Composition

As the population size increased, the ratio of calves:100 cows and spikes:100 cows decreased in the park and in town (Bear 1989, Lubow et al 2002). Estimates based on population modeling indicate a decline from about 36 to 28 calves:100 cows in the park between 1986 and 2001, and from about 50 to 30 calves:100 cows in town between 1978 and 2001 (Lubow et al. 2002). Spike ratios also declined steadily over the same time periods, from about 12 to 7 spikes:100 cows in the park and 11 to 5:100 cows in town (Lubow et al. 2002). Unpublished data collected by the park and the Colorado Division of Wildlife show that from 2002 to 2005, the ratios of calf:100 cows have ranged between 21 to 31 in park and 29 to 46 in town and ratios of spikes:100 cows have ranged between 4 to 6 in the park and 8 to 24 in town.

Bull ratio changes initially declined and then rose steadily in the park but remained steady in town (Lubow 2002). Modeled ratios in 2001 indicated about 22 bulls:100 cows in the park, and 6 bulls:100 cows in town. The lower proportion of bulls in town than the park likely reflects the differential effect of hunter harvest outside the park on the town subpopulation (Lubow et al. 2002). Unpublished data collected by the park and the Colorado Division of Wildlife show that from 2002 to 2005, bull:100 cow ratios have ranged between 5 to 21 in the park and 12 to 27 in town.

Elk Densities

Elk group sizes during winter can range from a single individual to over 600 animals in Moraine Park and the golf course areas in Estes Park (Larkins 1997). Elk densities are variable in the park, with high (76 to 170 elk/mile^2) to very high (171 to 286 elk/mile^2) concentrations on about 7% of the winter range, centered in Moraine Park / Beaver Meadows (Singer et al. 2002). The remainder of the winter range generally has moderate (26 to 75 elk/mile^2 on 11% of the winter range) to low (<26 elk/mile^2 on 82% of the winter range) densities (Singer et al. 2002). Although elk use lower-density areas of the winter range to rest or as they move between areas, time spent foraging is highly concentrated on a small percentage of the winter range (Singer et al. 2002). Elk densities on core winter range areas that are greater than 260 elk/mile^2 are the highest concentrations ever reported for a free-ranging population in the Rocky Mountains (Monello et al. 2005). Evidence from various research conducted in the park indicates that the high densities of elk in specific areas are as significant as the total population size in terms of impacts on vegetation. Elk are generally less concentrated on summer range areas.

The average density in Estes Park is 74 elk/mile^2. Site-specific density information is not available for Estes Park, but a similar pattern exists with very high concentrations in areas with excellent foraging conditions (e.g. golf courses) and lower concentrations in other areas (e.g. roads and parking lots). Elk use essentially all parts of the Estes Valley, with concentrations occurring in the area between Dry Gulch and Devil's Gulch Road, along U.S. highway 34, the Crocker Ranch area, on both golf courses, and between Fish Creek and Colorado Highway 7 (Larkins 1997).

Distribution and Movements

The Rocky Mountain National Park / Estes Valley elk population spends approximately seven months per year on winter range and three months on summer range. The remaining two months are spent on or in transition between these two ranges (see Appendix C). Within their seasonal ranges, elk move in response to various factors, including weather and hunting (Larkins 1997). Elk respond to hunting by moving from areas that are open to hunting to areas where hunting is prohibited.

The elk population exhibits large, seasonal migrations between primary winter and summer ranges (Figure 3.1). The timing of migration depends on weather, in particular snow depth, which determines when forage on the summer range will become available. Generally between 75% and 90% of the population migrate to higher elevations or the Kawuneeche Valley for the summer (Larkins 1997). Elk from the three major winter range areas exhibit distinct migration routes to and from their summer ranges (Larkins 1997). Elk that winter in Moraine Park / Beaver Meadows migrate over the Ute Trail and to the Kawuneeche Valley, where they calve, and most remain for the summer, although some migrate back to alpine areas for the summer. Elk from Horseshoe Park and Estes Park migrate up the Fall River drainage and spend summer in alpine areas of the park. However, the timing of the migrations of the two subpopulations is different, with Horseshoe Park elk migrating to higher elevations in the Cache la Poudre and Fall River areas to calve, while elk from town calve in Horseshoe Park before proceeding to higher elevations for summer.

The primary winter range falls within park boundaries (Figure 1.1), extending from Cow Creek on the north to Hollowell Park on the south and west to Hidden Valley. Elk that winter in the park concentrate in two areas: Moraine Park / Beaver Meadows (8,140 feet) and Horseshoe Park (8,589 feet). A small group of elk (100 to 200 animals) winters on the alpine tundra. In general, about one-third of the Rocky Mountain National Park / Estes Valley population winters in the park (Lubow et al. 2002); however, park subpopulations make temporary cross-boundary movements out of the park to lower elevations, especially during snowfall events.

Most of the winter range is outside the park in the Estes Valley and on adjacent private and U.S. Forest Service Lands (Figure 1.1). The Town of Estes Park (7,522 feet) provides continuous elk winter range with Moraine Park and Horseshoe Park. Elk are attracted to the town area for several reasons, including extensive grasslands, some of which are nutritionally enhanced by fertilization (e.g., golf courses); limited predation in comparison to the park; and lack of hunting.

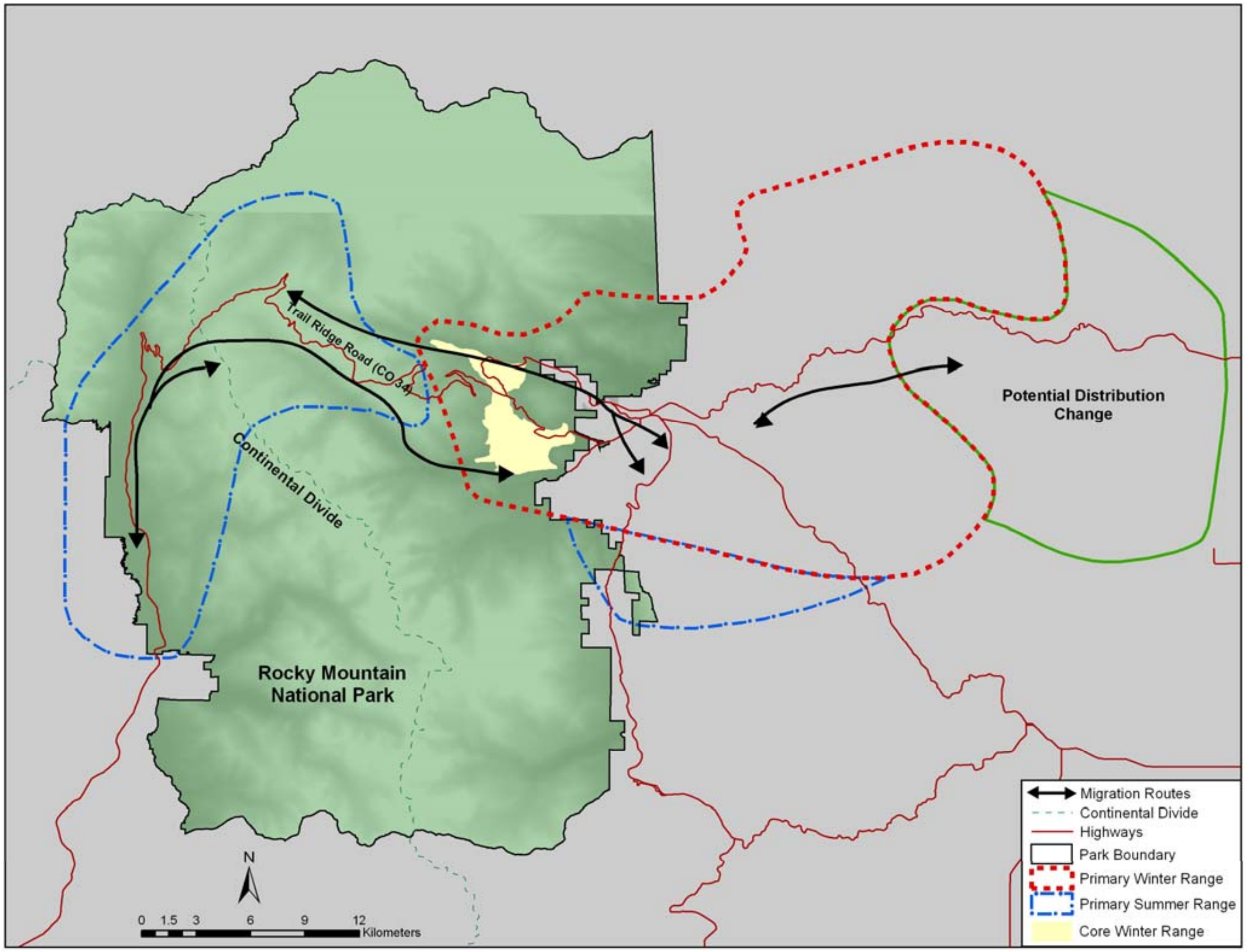


FIGURE 3.1: ELK MIGRATION ROUTES

In addition, the town lies at a lower elevation than winter range in the park, and consequently has lower snow depths and more favorable winter temperatures for elk (Singer et al. 2002). During winter, elk also range east of the Estes valley, with elk numbers and time periods varying depending on habitat conditions, snowfall, and hunting (Spowart 2003). Elk range north to Crosier Mountain and Glen Haven and east to Drake and Bobcat Gulch and the vicinity of the Meadowdale Ranch (Bear 1989, Larkins 1997, Spowart 2003). Elk also use Storm Mountain, Jug Gulch, Bear Gulch, and the Pole Hill-Nixon Park areas (Spowart 2003). Other elk populations also use areas east of the Estes Valley (Bear 1989); the extent to which Rocky Mountain National Park / Estes Valley elk mix with these populations is not known, but it is estimated that at least 1,000 elk from the RMNP/EV population spend several months per winter in these areas (Spowart 2003).

Primary summer range areas in the park are at higher elevations in alpine and subalpine habitat, and in the Kawuneeche Valley on the west side of the park (Figure 1.1). Outside the park, elk summer in the Twin Sisters, Lion Gulch, Pierson Park, Lake Pasture, Big Elk Park, and Big Elk Meadows areas (Larkins 1997, George 2003). At least 10% to 15% of the Rocky Mountain National Park / Estes Valley population has been documented to summer on the winter range. Recent park surveys indicate that during summer, at least 100 to 200 animals stay on the park winter range areas, and as many as 550 animals stay on town winter range areas. The only large group of elk **(**> 300 animals**)** that summer on the winter range generally uses the Meadowdale Ranch and 18-hole golf course on the east end of Estes Park. This group has stayed in this area since at least the 1970s (Stevens 1980a), although their numbers have increased over the last 30 years.

In the fall of 2002, three elk that were radio-collared in the park were observed further east, just west of the town of Loveland, along with a much larger group of elk than the resident population in that area. This coincided with much smaller population estimates in the Estes Valley than previous years, suggesting that 200 to 300 elk that normally wintered in the Estes Valley moved eastward. Following the 2002-2003 winter, two of the radio-collared elk returned to summer in the park, while the third remained with the population near Loveland. Since that time, the size of the Loveland population has remained higher than it was prior to 2001, while the size of the Rocky Mountain National Park / Estes Valley population estimates have been lower, particularly for the town subpopulation. The cause of any potential shift eastward is unknown, although suggestions have included effects of drought, several significant snowfall events, and limited forage due to high elk densities in the Estes Valley. It is unknown whether some or all of these elk still summer in the park and whether recent shifts are temporary or long term.

Reproduction

The elk breeding season generally begins in late August and extends through November, with a peak in breeding behavior from mid-September to mid-October. Cow elk may become sexually mature as yearlings, although the proportion that successfully breeds is highly variable. Nutritional and environmental factors influence yearling cow pregnancy rates; winter severity and population density can be important factors (Houston 1982). Cow elk between ages 3.5 years and 7.5 years are generally the major contributors to the productivity of elk populations (summarized in Raedeke et al. 2002). In cows more than three years of age, body condition and environmental stresses influence reproductive success (Raedeke et al. 2002).

While yearling bulls are physiologically capable of breeding, behavioral interactions generally preclude this behavior. Bulls up to three years of age are unable to compete successfully against mature bulls. Older bulls tending harems usually prevent access to cows in estrus through intimidation and by physically driving yearling bulls away (Squibb 1985). Because of social structure, bulls do not generally manage to acquire harems until their third or fourth year (Armstrong 1987). The largest bulls in prime condition (usually six to eight years old) are the most successful at gathering harems and fending off challengers. The most aggressive bulls will assemble harems that are typically 5 to 15 cows, but harems can be larger. One bull will breed many females.

During the rut, mature bulls fend off rivals with chases and sparring matches, and herd cows to keep them in a guardable harem. Bulls bugle both to warn other males and to attract females. They also engage in other activities such as urine spraying, wallowing, and thrashing vegetation with antlers to gain attention.

Calves are typically born in late May and early June. Calving is known to occur in the Estes Valley, both in the park and in Estes Park, along migration routes to the alpine summering areas, and in the Kawuneeche Valley. When calving, cows seek solitude in forest or shrub cover. While calves are mobile within hours of birth, mothers often leave their newborns hidden in cover while they forage. Calves develop quickly and are usually weaned by late summer (Armstrong 1987).

Survival and Mortality

The largest source of mortality for adult elk in the population is hunting; however, elk that spend winter in the park or Estes Park are not affected by hunting unless they leave to use adjacent U.S. Forest Service or private lands where landowners allow hunting. This can occur, particularly in response to heavy snowstorms.

Lubow et al. estimated survival rates from 1965 to 2001 in the park and 1978 to 2001 in town (2002). During these periods, bull survival increased from 52% to 79% in the park, but remained constant at 42 % in town. Low but increasing male survival in the park indicate that these individuals are also subject to harvest at some times, but vulnerability has declined over time. Lubow found that adult female survival was about 91% for both park and town and concluded that harvest did not appear to have a differential effect on cow survival in the park versus town subpopulations. However, in the past several years, cow harvest has increased, so this may no longer be the case.

A calf mortality study conducted in Rocky Mountain National Park and the Estes Valley between 1979 and 1982 found that malnutrition was the most significant source of mortality (~35%), followed by hunting (~23%), predation by coyotes (~17%), and disease (~12%) (Bear 1989). Most death from malnutrition occurred in the first few weeks after birth, and was attributed to cows being in poor condition due to weather or resource limitations. As population sizes and densities increased from 1965 to 2001, calf survival to eight months of age declined in both park and town (Lubow et al 2002). Calf survival to 20 months also declined strongly in the park as elk density increased, and was present but less apparent in town. In 2001, calf survival to eight months was 35% and 88% in the park and town, respectively. Survival to 20 months was 24% in the park and 73% in the town.

Habitat

Winter Range

Elk use Moraine Park / Beaver Meadows and Horseshoe Park as winter range, where they forage in the meadows and bed down in nearby forested areas. The area consists of low-lying valleys created by glacial moraines that have formed large, open meadow areas east of the Continental Divide. These valleys lie on an east-west traverse to form continuous elk habitat with the town of Estes Park. Herbaceous wetlands within these areas of the park have a high component of sedges (*Carex spp*.), juncus, and Canadian reed-grass (*Calamagrostis canadensis*). These understory species in the riparian shrub community are heavily grazed by elk. They make up a significant portion, though not a majority, of these areas. The terrain of Moraine Park (8,140 feet) consists of a large, open meadow/grassland area that is bordered by lodgepole pine (*Pinus contorta*) and Douglas-fir (*Pseudotsuga menziesii*) on north facing slopes and ponderosa pine (*Pinus ponderosa*) on south facing slopes. The Big Thompson River runs west to east through the middle of Moraine Park, with numerous old/abandoned and active channels in the flat, eastern grassland areas. The river is bordered by mountain willow (*Salix monticola*), flat-leaved willow (*Salix planifolia*), Geyer's willow (*Salix geyeriana*), mountain birch (*Betula occidentalis*), and alder (*Alnus spp.).*

To the north of Moraine Park lies Beaver Meadows, which consists of grasslands and upland shrubs that are interspersed with patches of ponderosa pine. It is transected by Beaver Brook, a small tributary to the Big Thompson River, which supports wetland species similar to those found in Moraine Park. The grassland areas of Moraine Park / Beaver Meadows consist primarily of Parry's oatgrass (*Danthonia parryi*) and long-haired needlegrass (*Stipa comata*). Moraine Park and Beaver Meadows also support intermittent stands of trembling aspen. Some of these occur in open grassland areas, while others are found on forested slopes, where they are gradually being overtaken by conifers.

Horseshoe Park (8,589 feet) lies approximately 2.5 miles north of Moraine Park / Beaver Meadows. It is similar to Moraine Park, with most of the area consisting of grassland areas dominated by Parry's oatgrass and long-haired needlegrass. The Fall River runs west to east through Horseshoe Park, with mountain willow and flat-leaved willow dominating areas adjacent to the river. However, Horseshoe Park is narrower than Moraine Park, and the Fall River does not tend to braid into different channels as occurs in Moraine Park. Horseshoe Park also has numerous stands of trembling aspen.

Summer Range

Elk, especially those that winter in Moraine Park, use the Colorado River valley, on the west side of the park, particularly the Kawuneeche Valley, during summer and fall. The valley is characterized by extensive wet meadow areas surrounded by lodgepole pine. Riparian shrubs include mountain willow, flat-leaved willow, and mountain birch. Numerous aspen stands also occur.

Treeline occurs between 11,000 and 11,600 feet and consists of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmanii*) interspersed with grassy openings. Summer range in alpine areas above treeline consists of numerous vegetation communities. For example, sites that are exposed to high winds and have coarse soils are characterized by moss campion (*Silene acaulis*), plant sandwort (*Arenaria obtusiloba*), Rocky Mountain nailwort (*Paronychia sessiliflora*), and dwarf clover (*Trifolium nanum*); whereas sites that have high moisture levels are dominated by Rocky Mountain sedge (*Carex scopulorum*), marsh marigold (*Caltha leptosepala*), and Parry primrose (*Primula parryii*) (Stevens 1979b). Alpine willow occurs in drainages and other wet areas.

Food Habits

Elk are adaptable animals that can switch from one forage species to another, allowing them to occupy a wide variety of habitats. Forage preferences change by season and also depend on forage availability, which varies between years based on weather conditions. Elk generally use areas that allow them to use both the food resources of open grasslands and shelter of the forest. Their digestive systems allow them to take large amounts of food into the rumen, then regurgitate and digest it while in the security of forested areas.

Elk diet in the park can encompass a wide variety of species in a wide variety of habitats. Grasses usually make up most of the diet, but woody shrub species are also important. Studies in the park indicate that winter diet generally includes 58% to 76% grasses, 8% to 16% willow, 0% to 13% upland shrub, 0% to 12% pine species, and a trace to 7% each of forbs and aspen (Monello et al. 2005). On the park winter range, Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), bluejoint reedgrass (*Calamagrostis canadensis*), and mountain muhly (*Muhlenbergia montana*) are the most frequently consumed grasses. As the winter progresses, elk in the park increase their intake of browse species, which retain a higher nutritional value than grasses and forbs into late winter. The most common browse species consumed are willow leaves and stems, antelope bitterbrush (*Purshia tridentata*) stems, and shrubby cinquefoil (*Potentilla fruticosa*) stems (Hobbs et al. 1981).

While elk forage primarily in open areas, they also rely on forested areas for cover. Cows and bulls remain separate for much of the year, with cows favoring the security of groups while bulls focus less on security and more on food intake to maximize body size and antler growth (Geist 1982, 2002).

Elk Behavior

Because there are no major predators of elk in the Rocky Mountain National Park area (Singer et al. 2002), elk behavior and distribution is likely different than if their major predators were present because they can optimize their foraging strategies by decreasing their vigilance for predators (Laundré et al. 2001). Studies conducted in other locations showed that elk will decrease their use of areas where predators are present (Altmann 1956, Ripple et al. 2001). In the absence of an intact predator base, elk in the park and town are more sedentary than they would be under natural conditions, with large groups remaining in high-use areas for long periods. Due to their close proximity to people in the park and town, these elk have lost their natural wariness and are highly habituated, allowing people to approach very closely. These behaviors reduce the wildness of the Rocky Mountain National Park / Estes Valley population.

Elk may be found as individuals, in small groups, or in larger groups at any time of the year (Murie 1951); however typical group sizes tend to change seasonally. Elk are gregarious, and winter groups are generally the largest. In the spring, cows are often in small groups or alone when calves are born. During the summer, cows, calves, and young bulls generally occur in groups of variable size. Older bulls are often alone or in small groups. The fall mating season changes elk social structure. Older bulls join the cows, and younger animals and cow/calf groups are often smaller as each harem may be tended by one mature bull. Younger bulls sometimes band together, but some remain near the cow/calf groups and join these groups later in the season.

Body Condition and Energetics

Elk body condition varies seasonally, being highest during summer and lowest in winter (Coughenour 2002). The body condition of adult elk in the park subpopulations is lower than would be expected in a population that is not at carrying capacity (Bender and Cook 2002). Activities associated with the rut are energetically demanding, particularly for bulls. Mature bulls eat less than usual during this period, so they enter winter with their surplus body fat depleted. Unlike bulls, cows continue to eat normally during the rut and maintain good body condition (Murie 1951, Geist 1982).

Chronic Wasting Disease

Prevalence of chronic wasting disease in elk in the region is estimated to be 0.3% to 2.1%, based on CDOW hunter harvest surveys. Prevalence in the Rocky Mountain National Park / Estes Valley population has not been determined specifically, so the regional estimate is used. There is currently no validated live test for chronic wasting disease in elk, so cases are determined only by sampling tissue from carcasses. Outside the park, prevalence of the disease is estimated based on samples collected from hunter harvest.

VEGETATION

Focal Vegetation

The impact analysis in this plan/EIS focuses on the following vegetative types (Figure 3.2):

Aspen that are located in the grasslands of the elk range. These aspen are affected by elk herbivory and are not subject to succession by conifers. They are referred to simply as aspen throughout this plan/EIS;

Willow, which is the predominant component of the riparian shrub and the subalpine and alpine shrub vegetative categories;

Bitterbrush and sagebrush upland shrubs;

Riparian and upland herbaceous; and

Subalpine and alpine herbaceous.

These vegetation types that occur on the elk range are most impacted by elk herbivory, have been most studied, and are expected to be most affected by the proposed management alternatives. Table 3.1 provides the area covered on the primary elk range by each type. Although forests make up a large portion of the primary elk range, conifer forests provide little forage for elk (Hobbs et al. 1981, Singer et al. 2002), have little effect on elk populations, are not expected to be impacted by this plan, and therefore will not be retained for further discussion.

TABLE 3.1: ACRES OF FOCAL VEGETATION DISTRIBUTED ON THE PRIMARY ELK RANGE

	Total Range Acres	Winter Range Acres	Summer Range Acres
Non-conifer-associated aspen	545	400	145
Riparian shrub (including willow)	1,854	655	1199
Subalpine and alpine shrub (including willow)	2,238	2	2,236
Riparian herbaceous	2,614	514	2,100
Upland herbaceous	1,619	1,434	185
Bitterbrush and sagebrush upland shrub	368	349	19
Subalpine and alpine herbaceous	9,581	11	9,570

While this plan references various research results based on exclosure of elk from areas of the elk range, it is important to note that because elk and mule deer are native to Rocky Mountain National Park, some level of herbivory effects is expected. This research is presented to show the potential for vegetation response in the absence of herbivory.

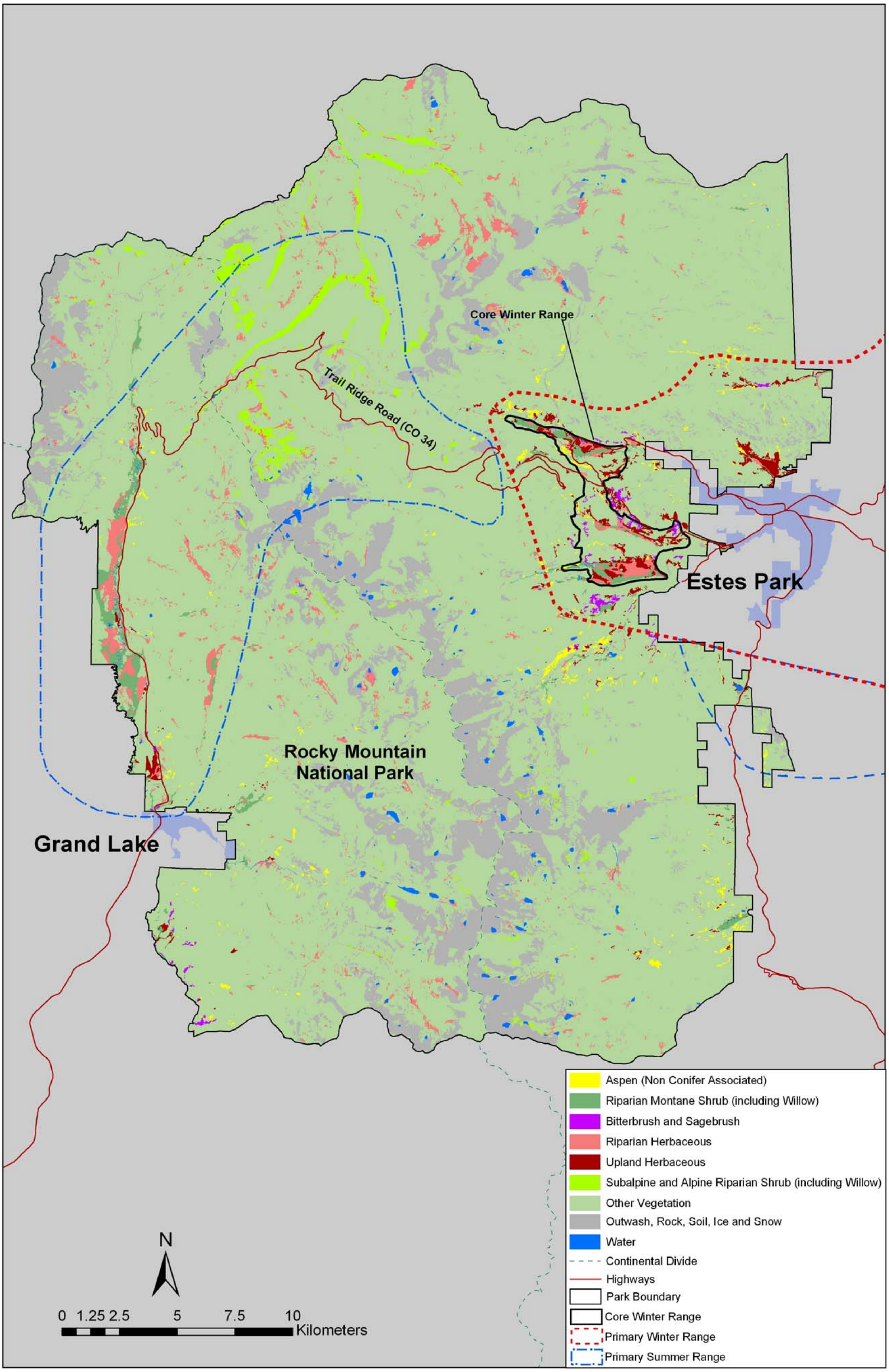


FIGURE 3.2: FOCAL VEGETATION TYPES IN ROCKY MOUNTAIN NATIONAL PARK

Aspen

Reproduction

Aspen trees that are connected by their roots are referred to as a clone, and almost all aspen stands that have been studied in the western U.S. are made up of a single clone or mosaic of clones (Shepperd and Engelby 1983, Schier 1985, Kay 1997a). Few aspen trees live more than 200 years (Jones and Schier 1985), but aspen clones are often hundreds if not thousands of years old (see also Kay 1997b). When aspen clones are lost in localized areas, the loss may indicate that the system is outside its range of natural variability.

Aspen almost always reproduce asexually (Shepperd and Engelby 1983, Schier 1985). Asexual, or vegetative, reproduction is when the interconnected roots give rise to suckers that eventually become aspen trees. Periodic disturbances such as fire, avalanche, beaver activity, and elk browsing are necessary for aspen to regenerate vegetatively. The disturbance promotes the growth of new suckers, and the existing trees resume growth (Schier 1985). Deteriorating, overmature aspen clones often fail to regenerate because they have no new suckering and tree growth that would increase vitality of the clone, but rather they maintain existing trees over a shrinking root system (Schier 1975).

Aspen establishment can also occur through sexual reproduction by means of seeds. This type of reproduction is thought to be rare in the western United States because seedlings can survive only a narrow range of conditions, which have not been commonly present in this area for thousands of years (Shepperd and Engelby 1983, McDonough 1985).

Aspen addressed in the elk plan do not require fire to regenerate (W. Baker et al. 1997); light surface burns can stimulate sucker production by allowing more solar radiation to warm the mineral soil (Romme et al. 1995). Prescribed fire is currently not being used as a tool to stimulate aspen growth because no aspen suckers less than 6 feet can escape elk herbivory on the elk winter range, and elk herbivory in the winter range has almost eliminated the ability of those aspen to regenerate into trees (Olmsted 1979 and 1997, W. Baker et al. 1997, Suzuki et al. 1999).

Distribution and Historical Establishment

Approximately 5% of aspen in the park are located on the elk winter range or in Kawuneeche Valley and have been negatively affected by elk browsing (Suzuki et al. 1999); approximately 370 acres are found on the winter range and 130 acres on the summer range. The aspen discussed in this plan are those that are considered to be non-conifer associated and will be referred to as aspen in this document.

The distribution and abundance of aspen have declined during the 20th century (W. Baker et al. 1997, Peinetti et al. 2001). This decline is significant because aspen communities provide habitat for a disproportionately large number of plant and animal species in the park (Mueggler 1985, Connor 1993, Turchi et al. 1994, Simonson et al. 2001). Loss of aspen plants or suppression of their growth often leads to a localized loss of plant and animal species (Nietvelt 2001, Dobkin et al. 2002).

The decline in aspen has been documented in other areas across the western United States over the last 100 to 200 years (Bartos 2001). Although most of the declines are attributed to a lack of fire, which allows conifers to shade out and eliminate aspen stands, elk have also been identified as a primary factor inhibiting aspen regeneration and growth in those areas (White et al. 1998, Bartos 2001, Rolf 2001, Romme et al. 2001).

It is not yet known when the aspen in the park were established or how the distribution of aspen fluctuated prior to the last 250 years in the park. In addition, when known, the 19th century distribution of aspen cannot be assumed to be representative of a long-term, static state. There is no sound evidence that aspen were present on the elk winter range prior to elk extirpation by 1880 (Monello et al. 2005). Research was conducted to age various aspen trees on the elk winter range, but none of the resulting estimated dates were prior to elk extirpation (W. Baker et al. 1997, Olmsted 1979). However, the results could also be a function of aspen longevity, which typically does not extend beyond 100 to 150 years of age (Jones and Schier 1985).

The best available information indicates that aspen have been present in most of their current locations for hundreds of years (Monello et al. 2005). Aspen are generally a clonal species that have not reproduced by seed in the western U.S. for hundreds of years (Romme et al. 2001), and some studies at Yellowstone National Park find at least a small percentage of aspen establishment prior to 1880 (Romme et al. 1995, Ripple and Larsen 2000). Additionally, studies have documented aspen establishment during periods when large elk populations of over five hundred animals were present (Olmsted 1979, W. Baker et al. 1997), such as before 1880. Modeling found that aspen can regenerate, depending on the elk density and amount of time elk spent feeding in the aspen stands (Weisberg and Coughenour 2003).

However, there may have been no aspen clones in the park on the elk winter range prior to elk extirpation. The lack of elk herbivory, along with fires that were common during the 1880s, could have provided favorable conditions for establishment of aspen in the elk range by seed (Rowdabaugh 1978, Veblen and Lorenz 1991, Mast et al. 1998, Veblen et al. 2000). Aspen can reproduce by seed and establish new aspen stands, especially following fires (Kay 1993, Quinn and Wu 2001). This type of reproduction has been documented in the western United States in association with large fire events (Romme et al. 1995, Romme et al. 2001). In addition, modeling found that almost any population size of elk in the park can prevent aspen cohort establishment, and that current stands are primarily a result of aspen expansion while elk were extirpated from the area (Coughenour 2002).

Debate about aspen establishment is not isolated to Rocky Mountain National Park (Monello et al. 2005). However, until further research can refute the hypothesis that the presence of aspen is not a result of elk extirpation, the park plans to manage aspen on the elk winter range as a natural component in those areas.

Herbivory

In Rocky Mountain National Park, the annual offtake (consumption of biomass) of aspen in the core winter range is 18% (Zeigenfuss n.d.). This level of herbivory has prevented aspen suckers from maturing into trees capable of escaping elk herbivory ($\geq$ 8 feet in height) on the elk range since at least 1970, as shown in Figure 3.3 (W Baker et al. 1997, Olmsted 1997, Suzuki et al. 1999, Kaye et al. 2005).

As a consequence, existing aspen trees are declining rapidly as they die of old age (Olmsted 1997, Kaye et al. 2005), resulting in overmature, deteriorating aspen stands with no small or mid-size trees to continue the vitality of the stands. Furthermore, a 42% reduction of large trees (Olmsted 1997) and a 30% reduction of growth in the aspen stands throughout the park elk range (Kaye et al. 2005) occurred between 1975-76 and 1995-96.

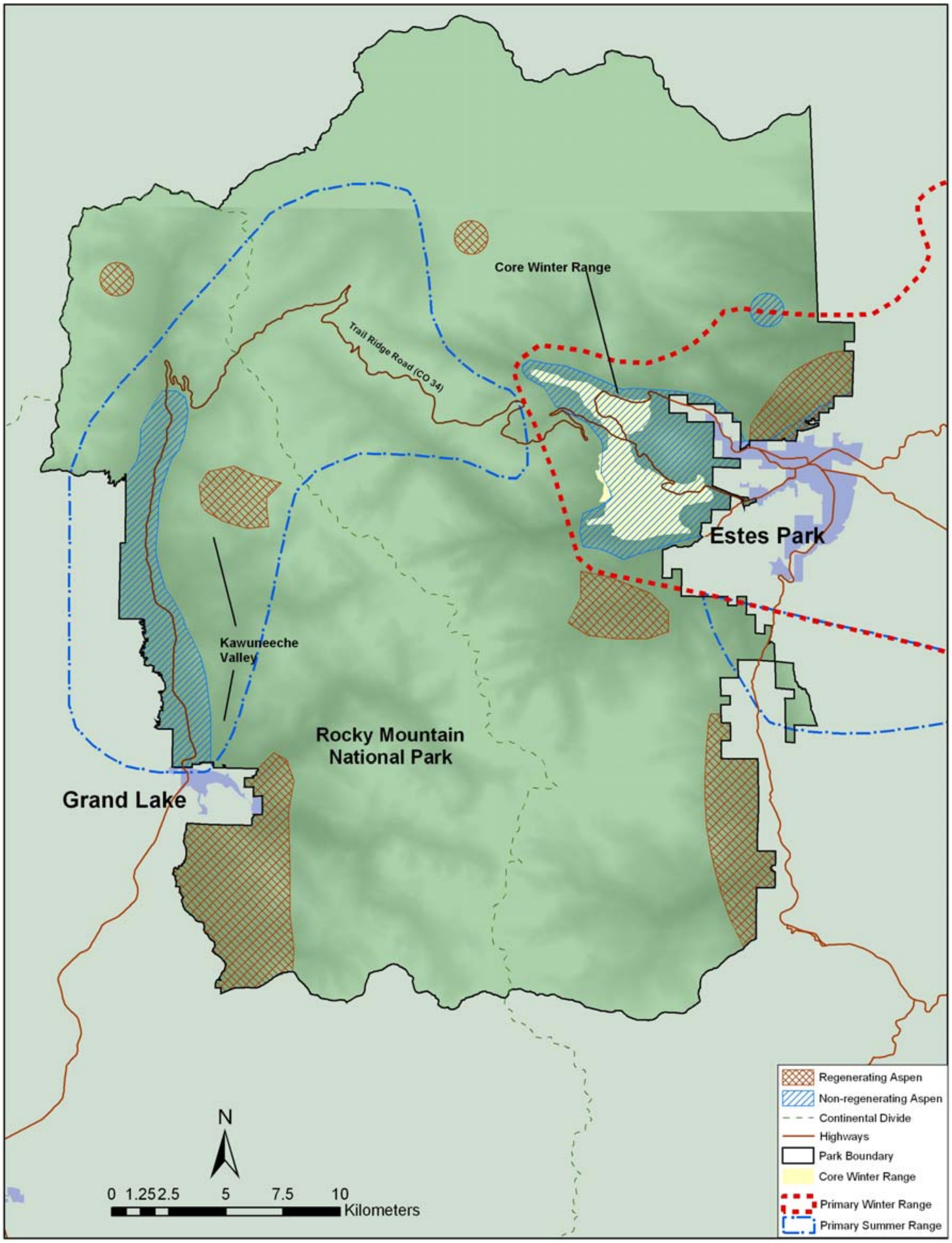


FIGURE 3.3: ASPEN REGENERATION

Research supports the hypothesis that elk numbers and distribution both directly affect aspen regeneration in the park, although it may be impossible to know which is a more important predictor of aspen utilization rates (W Baker et al. 1997). For example, aspen stands only produced a new cohort (trees of the same age) of trees in the park when the elk population was less than 600 animals (W Baker et al. 1997). Also, only those aspen stands with less than a 50% utilization rate by elk can escape herbivory and successfully establish a new cohort (Olmsted 1979). In addition, elk densities may need to be 26 elk per square mile or lower to allow aspen on the winter range in the park to regenerate (Weisberg and Coughenour 2003).

An analysis of two 35-year aspen exclosures on the elk winter range showed that aspen can successfully regenerate and contain multiple age classes of aspen. The ratio of live to dead trees was twice as high for stands inside the exclosures. Stocking rates inside and outside the exclosures averaged 637,000 and 122,980 suckers per square mile, respectively, and there are also more live branches and fewer dead branches inside versus outside the exclosures (W Baker et al. 1997).

For most people, perhaps the most obvious impact of elk herbivory is the stripping of bark off live trees. The nutritional value of bark is unknown. However, aspen barking by elk is not believed to be related to food shortages; aspen were barked when only 350 elk were estimated to be on the winter range. Bark stripping does not usually kill aspen, but it can create inoculation sites for pathogens that lead to aspen mortality (Hinds 1985). Therefore, bark stripping is not nearly as important as the tree death and lack of regeneration caused by elk at current numbers and densities.

Montane Willow

The montane zone extends below an elevation of approximately 9,500 feet. The following discussion pertains to willow within this zone.

Reproduction

Willows in Rocky Mountain National Park establish themselves on three principal landforms that provide the necessary conditions of bare, moist mineral soil: point bars along stream channels; abandoned, draining beaver ponds; and abandoned channels that function as oxbows (Cooper et al. 2003). The latter two landforms are both associated with the presence of beaver in an area, suggesting that beaver are important in both asexual and sexual reproduction used by willow for establishment.

Sexual reproduction is accomplished through production and successful germination and establishment of seeds. Willow seeds are only viable for a few days and can only take root in wet areas with unvegetated or disturbed soils with good light availability (Cottrell 1993, Cottrell 1995). Willow seeds have limited aerial or water dispersal ability and low entrapment rates, which compromises their establishment success. In addition, seedling growth is slow, and their roots may take 3 or 4 growing seasons to reach groundwater level, making them susceptible to drought, desiccation, and disturbance (Cooper et al. 2003).

Even though reproduction by seed is currently the most common method of willow establishment in Rocky Mountain National Park, current browsing levels by elk on the winter range have greatly decreased this ability by inhibiting seed production, dispersal, and survival. The condition of willow stems is so poor due to heavy elk browsing that many areas in Moraine Park lack seed-producing willows and receive very low seed rain densities. In some areas with less elk use, the presence of surviving, old, tall willow plants provides better seed production, as in the western portions of Moraine Park compared to the eastern portions, as shown in Figure 3.4 (Gage and Cooper 2003 in Cooper et al. 2003). Figure 3.4 shows seed rain in Horseshoe Park (Gage and Cooper 2003 in Cooper et al. 2003).

Asexual, or vegetative, reproduction occurs when existing willow roots or a willow stem cut by beaver gives rise to new shoots that become new plants. Shoots from the roots of a willow are important because they allow existing willow plants and root systems to maintain themselves for periods of 100 years or longer. Beaver cuttings also allow willows to colonize areas that are suitable for willow growth but not seedling establishment; this effect may be important on a landscape scale. In addition, beaver ponds drown some plants but allow opportunities for new colonization for other plants like willow (Cooper et al. 2000, B. Baker et al. 2005). Beaver can also enhance willow establishment, survival, and dominance in the landscape because of the competitive advantage willow have in riparian areas (B. Baker et al. 1992, B. Baker et al. 2005). Drying wetlands may be invaded by non-wetland species, causing changes in plant community composition in riparian areas (ter Brack and Wiertz 1994, Vasander et al. 1997, Minkkinen et al. 1999). Little to no establishment of willows in the park occurs asexually due to little beaver activity in the area (Cooper et al. 2003).

As discussed in the "Water Resources" section, the loss of beaver dams and subsequent degradation of hydrologic conditions needed for willow establishment and survival may prevent willows protected from elk browsing from responding well until favorable hydrologic conditions are restored (B. Baker et al. 2005). In addition, once willow areas are converted to herbaceous plants, willow seeds or cuttings cannot compete and reestablish in those areas until beavers change the hydrology and create bare soil areas favorable to willow establishment (Cooper 2001).

Another factor impacting willow establishment in the Kawuneeche Valley on the elk summer range is the Grand Ditch water diversion (see "Water Resources" section). The Grand Ditch reduces the peak flows of water into the Colorado River and Kawuneeche Valley, lowers the groundwater, and reduces the soil water content on gravel bars, thereby lowering the required bare, moist soil needed for willow establishment (Cooper et al. 2000).

The fire management plan calls for the postponement of burns in willow until they can be adequately protected from elk herbivory as outlined in this plan. Park managers believe that fires in montane riparian willow of the park historically occurred every 35 to 200+ years due to the wet conditions often present, but when they did occur they were stand replacing. Currently, with the altered hydrologic and herbivory conditions and the associated increase in dying willows and accumulations of dry woody material, conditions are more conducive to fire. Although not necessary for willow regeneration, it has been suggested that the use of fire or mechanical removals could speed the process (B. Baker 2005).

Distribution

Willow is the dominant woody shrub in almost all riparian areas in Rocky Mountain National Park. There are primarily three species of willow on the elk winter range: Geyer's willow, mountain willow, and flat-leaved willow (Zeigenfuss et al. 2002). Park-wide, mountain willow and flat-leaved willow tend to be co-dominant below 2,900 m (9,500 feet), while flat-leaved willow dominates above this elevation (Cottrell 1995).

The distribution and abundance of willow within the current boundaries of Rocky Mountain National Park has been reduced several times since settlement both by human disturbance and elk herbivory. Modeling suggests that willow cover did not exhibit an increase when elk were extirpated by the 1880s (Weisberg and Coughenour 2003).

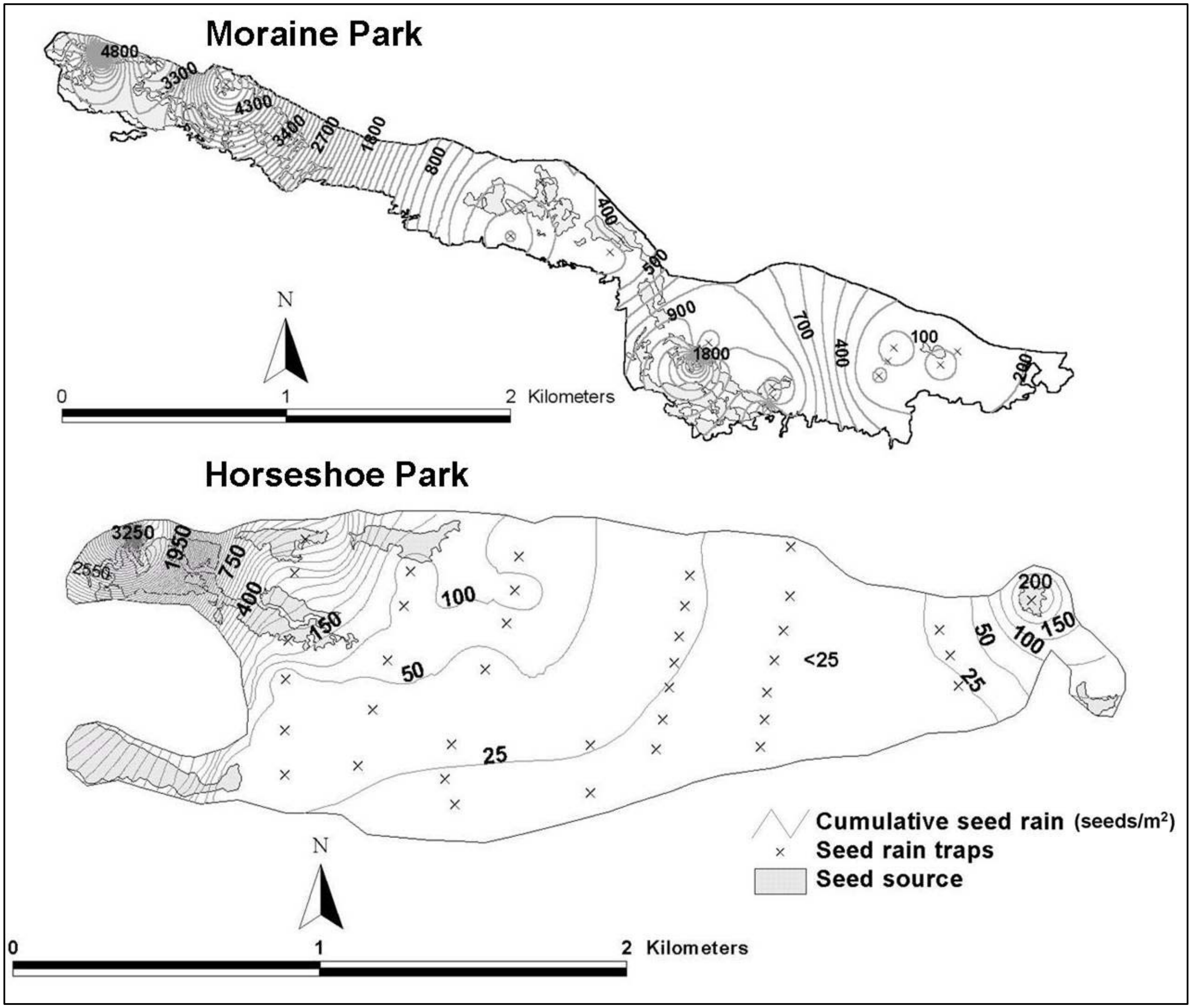


FIGURE 3.4: MORAINE PARK AND HORSESHOE PARK SEED RAIN

Reports from the late 19th century suggest that Moraine Park had more extensive willow and riparian shrub cover at that time than it did in the 1930s and 1940s, probably because many areas were drained and cut down for haying purposes as the area was settled (Gysel 1960). In addition, although the previously mentioned development in elk winter and summer range areas was not studied for its specific effects on willow, it is believed that there was some reduction in willow due to development.

Over the past 50 to 60 years, riparian shrub cover, assumed to primarily be willow, has declined by approximately 20% in Moraine Park and Horseshoe Park and is being replaced by herbaceous communities. Willow declines in Moraine Park are visibly correlated to a 69% reduction in surface water (see “Water Resources” section), caused by a greater-than-90% decline of the area’s beaver population since 1940 (Packard 1947, Peinetti et al. 2001, Zeigenfuss et al. 2002, and see “Other Wildlife” section). Although not as strongly linked, willow declines in Horseshoe Park can also likely be attributed to a 47% decrease in surface water and 90% decline in the beaver population (Packard 1947, Peinetti et al. 2001, Zeigenfuss et al. 2002).

Willow declines in Horseshoe Park are largely due to the Lawn Lake Flood (see “Water Resources” section; Peinetti et al. 2001), which created a new lake directly upstream from the confluence of Roaring Brook and Fall River. Existing willow in these areas were either destroyed by the alluvial fan created by the deposited debris or flooded out by the new lake, and some willows in downstream areas were directly removed by flood waters (Peinetti et al. 2001).

Park staff and researchers have anecdotally noticed a decline in willow in a trend similar to that on the primary winter range, especially over the past 10 years. Although no studies have been conducted to separate out elk from moose herbivory impacts, elk occur in larger numbers, are more sedentary in more vulnerable willow patches, and browse in spring, which is a more critical time for willow as they put on growth for the year (Cooper and Westbrook 2005).

Herbivory

Willows have developed two primary defenses against the effects of browsing: first, they exhibit rapid vertical growth rates that extend growth beyond the height of browsing (Bryant et al. 1983); and second, willow can produce defense compounds that make them less palatable to large ungulates (Singer et al. 1994). However, neither defense is likely to be effective if ungulate consumption levels are too great, especially if intense herbivory is combined with beaver activity or poor site conditions (Monello et al. 2005).

Willow growth and height in the intermountain west is often determined by large ungulate and beaver browsing (Singer et al. 1994), as well as site conditions such as soil type, length of growing season, nutrient concentrations, and water table height (Cottrell 1995, Peinetti 2000). Elk can directly decrease willow growth and size (Singer et al. 2002), and indirectly reduce willow by out-competing and reducing beaver (see “Other Wildlife” section), which maintain surface and groundwater levels as well as establishment sites favorable to willow (Cooper et al. 2003, and see “Water Resources” section).

These direct and indirect elk affects have resulted in a transition of tall willow to short willow and in suppression of short willow plants from becoming tall willow over the last 60 years in Moraine Park and Horseshoe Park (Peinetti et al. 2001, B. Baker et al. 2005), as shown in Figure 3.5. Willow may be short because they are newly established, elk may rub their antlers tearing down tall willow, or beaver may have cut down tall willow for food. The interaction of beaver and current elk herbivory levels strongly suppress willow growth (B. Baker et al. 2003), because once beaver cut down willow, the new regrowth is more suitable as elk forage since all stems are in reach (B. Baker et al. 2005).

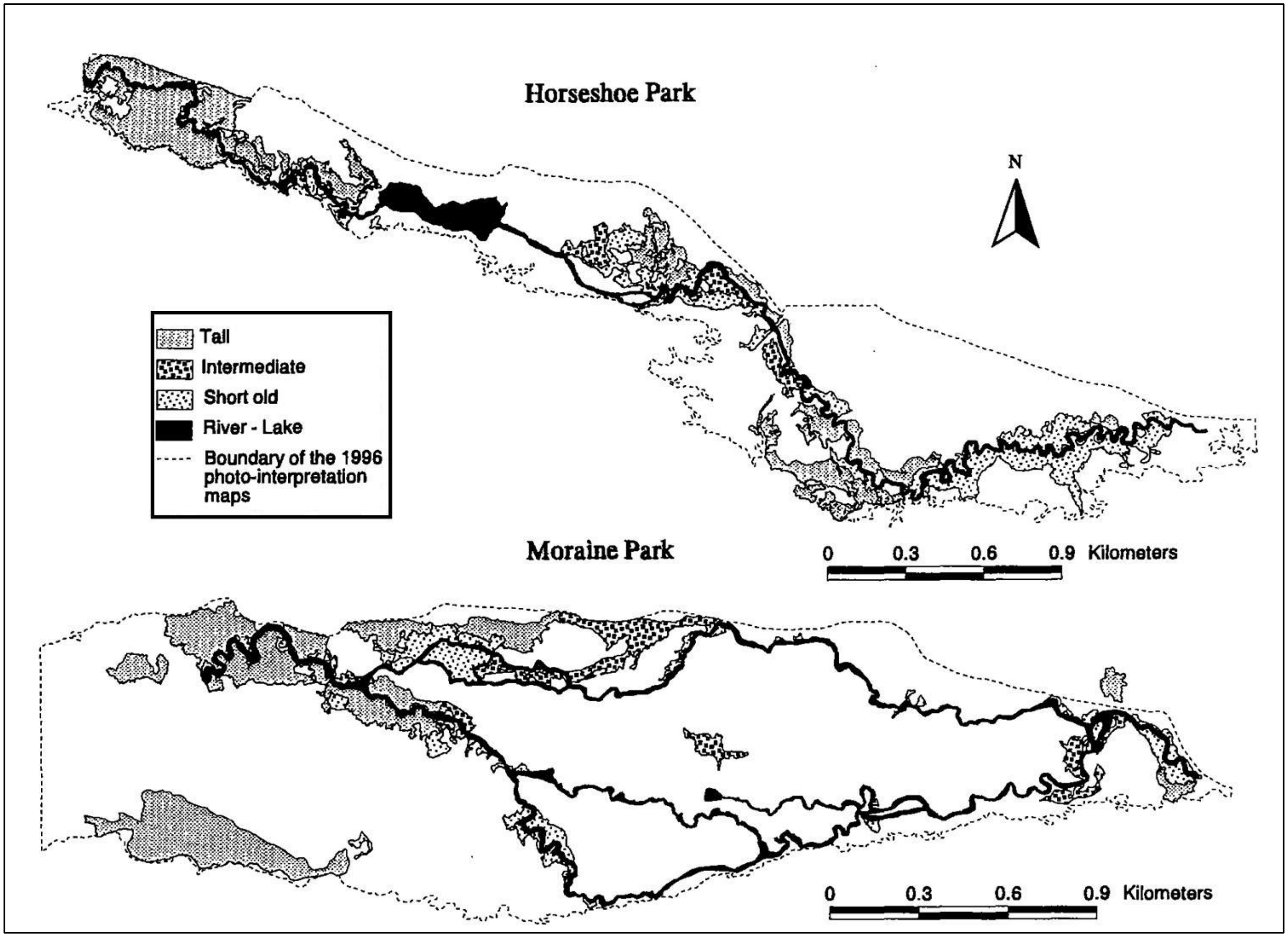


FIGURE 3.5: MORAINE PARK AND HORSESHOE PARK TALL-TO-SHORT WILLOW CONVERSION

In addition, short willow can be old or young plants (Cooper et al. 2003) that are simply shorter than their tall willow counterparts of the same species. These shorter willows are suppressed by current elk browsing levels; currently few to no willow plants grow beyond 3 feet tall (Peinetti et al. 2001, Zeigenfuss et al. 2002, Cooper et al. 2003).

Patches of tall willow still exhibit significant reproduction in Endovalley, Moraine Park, and Kawuneeche Valley; however, no young willows grow into tall willow. This is an unstable condition because even if the tall willow can withstand elk herbivory pressures, they will be less able to survive other natural stresses such as fire, disease, river bank erosion, and beaver herbivory (Cooper 2001).

The following information presents the average consumption rates and production of willow on the winter range. In Rocky Mountain National Park, elk were observed in riparian willow 7% of the time, which suffered an average annual 33% offtake (consumption of shrub production) (Schoenecker et al. 2004). Research has focused on elk winter range willow rather than summer range willow. Based on researcher and park staff observations, primary summer range willow cover is declining.

Willow have declined approximately 20% on the primary winter range (Singer et al. 2002, Zeigenfuss et al. 2002, Peinetti et al. 2001). One exclosure site in Beaver Meadows illustrates elk herbivory impacts. After 35 years, willow volume and height were 98% greater inside the exclosure than outside (Schoenecker et al. 2002). On average, willow sites had 66% lower willow production in grazed versus exclosed plots after four years (Schoenecker et al. 2004). Herbivory reduced height, canopy size, and litter biomass of willows, leading to 64% less nitrogen yield in grazed plots (Schoenecker et al. 2004).

Willow growth and size were optimized at an approximate elk consumption rate of 21% and negatively affected at 37%. Optimal willow growth refers to the maximum observed willow production in the presence of elk herbivory, which was greater than ungrazed willows. Negative willow growth represents a 40% decline in most components of willow growth from maximum growth levels. Elk densities greater than or equal to 83 elk per square mile generally resulted in a 40% decline in willow size and growth parameters (Singer et al. 2002). However, as discussed in the "Elk" section, willow consumption rates, elk densities, and willow production vary greatly across the winter range (Peinetti et al. 2001, Singer et al. 2002, Zeigenfuss et al. 2002).

The effects of elk herbivory on willow production, which is the new biomass grown by the plant each year, have not been conclusively shown. One study found elk significantly reduced willow production after four years of excluding grazing (Zeigenfuss et al. 2002), but another found that while browsed plants were smaller, there was similar overall biomass production because the willow produced longer, thicker shoots in the lower levels of the plant canopy (Peinetti et al. 2001, B. Baker et al. 2005).

Non-streamside willows showed a decrease in the ability of roots to reach groundwater sources because the plants allocate more of their carbon to stems and leaves than to roots in response to high levels of herbivory (Menezes et al. 2002, Peinetti et al. 2001). Despite herbivory, in areas where water is flowing in streams, the roots of established willow plants three years of age or older can easily reach the groundwater, which generally does not fall below 3 feet during the growing season (Zeigenfuss et al. 2002, Cooper et al. 2003, Menezes et al. 2002). However, many researchers believe that the effect of shallower water tables are minimal when compared to elk browsing effects (Singer et al. 2002, Zeigenfuss et al. 2002) because many stream-side plants with excellent water availability are in poor condition due to the effects of elk browsing (Peinetti et al. 2001, Zeigenfuss et al. 2002, Cooper et al. 2003).

Elk have reduced beaver populations by out-competing beaver for food resources (particularly willow), which in turn reduces surface and groundwater levels and establishment sites, which decreases willow. Large expanses of willow have died where streams have become totally dry and water tables have apparently experienced dramatic decreases, suggesting that willow growth and survival in the park primarily depend on ground water from streams and snowmelt instead of rainfall (Alstad et al. 1999). Many stream channels in Moraine Park that were filled with water and bordered by live willow in 1937 are now dry with large, dead willow on the old stream banks.

Bitterbrush and Sagebrush Upland Shrubs

Reproduction

No research has been conducted specifically on the factors affecting upland shrub reproduction or recruitment in Rocky Mountain National Park. However, it is known that natural disturbances such as fire and browsing can greatly affect the growth and reproduction of both bitterbrush and sagebrush. Seeds are the primary method of reproduction of bitterbrush (Daubenmire and Daubenmire 1968; West 1968) and sagebrush (Ratzlaff and Anderson 1995) following fire.

Bitterbrush has a greater tolerance to fire because it can resprout from previously existing plants if the fire is not too intense (Blaisdell and Mueggler 1956). Conversely, sagebrush plants are easily killed by fire and can have trouble reestablishing because they only reproduce by seed (Kershaw et al. 1998, Wambolt 1998, Wambolt et al. 2001). Recovery rates for both species following fire can range from just a few years resulting in a rejuvenated shrub community to over 30 years and a greatly deteriorated community (Bunting et al. 1985, Wambolt et al. 2001).

The park's fire management plan calls for the postponement of burns in upland shrubs until they can be adequately protected from elk herbivory as outlined in this plan. The future use of fire in these areas will not be used for the promotion of upland shrub regeneration, but rather for the attainment of other community protection and ecological restoration objectives as detailed in the fire management plan.

Distribution

Bitterbrush and sagebrush are found on arid plains and slopes throughout the Rocky Mountains. The natural or historic (pre-1860) coverage of bitterbrush and sagebrush on the winter range in Rocky Mountain National Park is unknown. By the time shrub communities in the park were studied in the 1930s, they had been significantly altered. Market hunting during the 1860s and 1870s significantly reduced elk and deer numbers, likely allowing upland shrubs to expand, but fires in ponderosa pine forests during the 19th century (Veblen et al. 2000, Ehle 2001) and expanding deer population in the early 1900s (Stevens 1980a) may have also greatly decreased shrub abundance.

By the 1930s, managers in the park concluded that the expanding deer population was having a large, negative effect on upland shrubs (summarized in Grater 1945). Despite the decline in deer starting in the 1940s, which was further facilitated by National Park Service reduction programs, sagebrush apparently continued to decline (Gysel 1960), but no quantitative data related to distribution were ever collected on upland shrub population trends.

Herbivory

As discussed in the "Other Wildlife" section, upland shrubs are an important diet component for deer in the park, and to a lesser extent elk, because they maintain higher protein levels than grasses (Kufeld et al. 1973, Stevens 1980a, Hobbs et al. 1981). Between 1968 and 1992, elk use increased while deer use decreased in upland shrub communities (Zeigenfuss et al. 1999, Stevens 1980a). Small mammals have also been found to feed extensively on bitterbrush seeds (Martin et al. 1951) and can have a large, detrimental effect on bitterbrush recruitment (Clements and Young 1996).

One study observed elk in upland shrub communities 10% of the time and found a 12% annual consumption of upland shrub biomass (Schoenecker et al. 2004). From 2001 to 2002, there was 21% total shrub consumption and 49% leader use in bitterbrush (Nescavil 2003). Also, based on two exclosures, nitrogen yields in upland sagebrush were 70% less than in ungrazed sites (Singer and Schoenecker 2003). This level of herbivory has negatively affected total estimated annual shrub production in 2002 (Nescavil 2003).

Excluding elk and deer for four years had no affect on bitterbrush production or size (Zeigenfuss et al. 2002); however, after 25 years, bitterbrush increased 12% to 15% where it was not initially present and 31% to 37% where it was initially present (Gysel 1960). After 35 years, upland shrub (sagebrush) current annual growth was 67% higher inside exclosures versus outside (Schoenecker et al. 2002). Bitterbrush is more resistant to browsing than sagebrush due to plasticity in growth rates and resource allocation traits (Bilbrough and Richards 1993).

If large ungulate herbivory follows fire events, it can often result in long-term or permanent shrub loss (Wambolt et al. 2001). Herbivory causes small, long-term costs to the shrubs, which reduce their capacity for growth. Conversely, fire is a one-time event that may decrease the net energy available to the shrub.

In Rocky Mountain National Park, total shrub canopy area and volume can recover after a burn in the absence of browsing or if the levels of browsing are less than the current high levels (Nescavil 2003). Resprouting of bitterbrush was observed in all sites after prescribed fire was applied in the park, but bitterbrush size declined after the first and second year and production declined after the second year. This suggests that additional plant mortality took place during the first year after the fires (Zeigenfuss et al. 2002). Nesvacil and Olmsted (2002) found that decreases in bitterbrush canopy area, volume, and estimated annual production continued six and seven years post-burn, while total shrub canopy area, volume, and annual production only differed due to grazing. This suggests that bitterbrush can resprout adequately after burning, but the current levels of herbivory in Rocky Mountain National Park are impeding regeneration (Nesvacil and Olmsted 2002) and altering post-fire successional patterns (Nesvacil 2003).

Therefore, on May 13, 2003, a memorandum was included in the management files that states:

> Until management actions have been taken to change the population and distribution of elk in the park, the use of prescribed fire in areas with antelope bitterbrush, rabbit brush, sage brush, and wax currant will result in unusually high levels of herbivory post-fire, leading to a net loss of upland shrub habitat. …[P]lans to utilize prescribed fire as a tool to reduce fuel and reintroduce fire to the ecosystem will be postponed to a later date, presumably until actions have been taken to manage the elk population and distribution. When and if elk densities are lowered, the park will continue to pursue scientific research regarding the effects of elk herbivory following any prescribed fire treatments.

Riparian and Upland Herbaceous Plants

Reproduction

By definition, herbaceous plants have no woody components; therefore, they do not persist through winter. The diversity of the herbaceous plants comprising the elk range and their reproduction methods is beyond the scope of this plan to detail. However, under normal conditions, a stand-replacing fire in upland herbaceous communities is expected every 0 to 35 years (NPS 2004a) and expected by park managers in riparian herbaceous communities every 35 to 200+ years.

Distribution

Fire suppression may allow ponderosa pine trees to expand into and overtake some of the upland meadows that make up the core of the elk winter range and their primary forage base. This could potentially lead to a significant decrease in elk forage, but no formal research has been conducted on this subject, and historic and current photographs indicate this is not occurring to any appreciable extent (Veblen and Lorenz 1991). Historic and current photographs do show that stands of ponderosa pine are much denser, and it appears that they may now occupy former meadows; however, this does not appear to be the case in the elk range.

Herbivory

Annual herbaceous offtake rates are reported to be 55% in riparian willow and 60% in upland shrub communities, with most offtake occurring in summer and winter, respectively (Singer et al. 2002). Mountain bunchgrass steppe and mixed prairie communities, the most comparative systems to the park, can withstand offtake rates of 40% but not 60%. Therefore, the consumption rates in the park are extremely high and, based on evidence from other areas, may alter herbaceous communities (Singer et al. 2002). Herbaceous plants in willow communities may be particularly vulnerable because the majority of grazing is occurring during the growing season (Augustine and McNaughton 1998). However, Singer et al. (2002) has shown herbaceous consumption to be about 28% in both winter and summer.

The effects of these offtake levels resulted in an 18% to 29% reduction of herbaceous production in willow communities in 1998. The production was higher in grazed versus ungrazed sites in 1994, 1995, and 1996 when precipitation was above average, suggesting that elk may have greater effects when precipitation is average or below-average (Zeigenfuss et al. 2002).

As a result of offtake levels, after 35 years, elk herbivory reduced the annual aboveground production of herbaceous vegetation by 32% (Schoenecker et al. 2004). Also, in grazed sites, nitrogen yield of upland herbaceous plants was reduced by 35% and of riparian herbaceous plants by 20% (Singer and Schoenecker 2003). Furthermore, the herbaceous root biomass was either not affected or was significantly greater in grazed versus ungrazed areas (Schoenecker et al. 2002) and may be an underground response to the decline in shrubs (Singer et al. 2002). Coughenour (2002) predicted that under current grazing pressures, root biomass would decline but eventually stabilize.

No large-scale shifts or trends in plant species abundance, biodiversity, or composition have been attributed to elk herbivory (Singer 1995, Schell and Stohlgren 1997, Stohlgren et al. 1999, Zeigenfuss et al. 1999, Zeigenfuss et al. 2002, Singer et al. 2002). In upland bitterbrush sites, ungrazed sites had a higher percent cover of prairie sage (*Artemisia ludoviciana*) and sulphur buckwheat (*Eriogonum umbellatum*) after four years (Zeigenfuss et al. 2002). In grasslands there was an increase in the percent cover of forbs (broadleaf herbs other than grasses) and *Carex* spp. between 1968 and 1992 (Zeigenfuss et al. 1999). In willow riparian areas, grazed sites had more goldenrod species (*Solidago* spp.) and ungrazed sites had more bluebell (*Mertensia ciliata*) after four years (Zeigenfuss et al. 2002). There was an increase in grass cover on grazed versus ungrazed riparian sites after four years (Zeigenfuss et al. 1999) and a 40% decrease in grass biomass in grazed sites after 35 years (Schoenecker et al. 2002).

Subalpine and Alpine Vegetation

Distribution

The alpine tundra consists of areas above timberline at approximately 11,000 feet. The park contains over 50 square miles of alpine tundra, and elk use about 39% of it from June until October. Tundra vegetation was first described by Kiener (1939), Griggs (1956), and Willard (1963), which Stevens (1980b) summarizes into the following types: fellfields covered by cushion plants, such as mosses; alpine turf and alpine marsh, both primarily composed of sedges and wildflowers; snowbed, characterized by rushes, grasses, and wildflowers; and riparian willow areas. The distribution of these plant associations is primarily determined by physiography, snow accumulation, moisture availability, exposure, temperature, and substrate (Kiener 1939, Griggs 1956, Willard 1963, Stevens 1980b).

Herbivory

Very little work has been done in the alpine areas regarding elk herbivory and willows. Recent analysis of 12 transects in subalpine and alpine plant communities collected over varying intervals between 1971 to 1996 found that flat-leaved willow showed a 48% cover and 37% height decline, and that short-fruit willow (*Salix brachycarpa*) showed a 70% cover and 40% height decline over the 25 year period (Zeigenfuss 2005). These trends do not definitively correlate with elk herbivory; however, they do support general observations by park staff and researchers.

In addition, recent analysis of the 1971 to 1996 transects show an increase in cover and frequency of grasses and an initial decrease followed by an increase in frequency of forb species (Zeigenfuss 2005).

Two graminoid species (*Deschampsia caespitosa* and *Carex elynoides*) that Hobbs et al. (1982) identified as major elk diet components increased in cover. Although the increase in bare ground frequency is not a concern at this time, continuation of such increases could indicate problems from overgrazing and hoof action (Zeigenfuss 2005).

Exotic Species

There is currently no evidence that elk herbivory is increasing exotic plant species abundance or coverage in the park (Singer et al. 2002, Zeigenfuss et al. 1999). Landscape analyses have also failed to find evidence that grazing increases the spread of exotic plant species in the park or other Rocky Mountain grasslands, and suggests that even when at very high density, elk may actually reduce non-native plant species coverage (Stohlgren et al. 1999). However, a 54% increase in the exotic grass timothy (*Phleum pratense*) was observed in park meadows from 1968 to 1992 (Zeigenfuss et al. 2002).

Rutledge and McLendon (1996) found no evidence that Canada thistle will dominate a specific site for long periods in the absence of continued disturbance, which presumably would include high levels of elk. In response to many park staff and visitor reports, in 2003 the park reexamined a small sample of Rutledge and McLendon's study sites from 1987. After 16 years with no treatment, the ten sites increased from 12.8 acres to 69.8 acres. Although no formal studies have been conducted to quantify the cause of the increase, and by nature exotic plants increase and invade even healthy vegetation communities, the reduction of well-developed willow communities increases thistle invasion in riparian communities, and continued disturbance makes areas more vulnerable to Canada thistle invasion in the park (Rutledge and McLendon 1996).

SPECIAL STATUS SPECIES

Background

The Endangered Species Act of 1973 requires an evaluation of the effects of proposed actions on all federally listed endangered and threatened species with potential to be affected by the action. Species proposed for listing and candidate species also are evaluated. The U.S. Fish and Wildlife Service determines if a species needs protection under the Endangered Species Act and whether to classify a species as an endangered, threatened, proposed for listing, or candidate species. Endangered species are considered to be in danger of extinction throughout all or a significant portion of their range; threatened species are those likely to become endangered in the foreseeable future; species proposed for listing are in the process of being listed; and candidate species are determined to warrant protection and are being considered for listing as an endangered or threatened species. Candidate species do not have legal protection.

NPS policy also requires examination of impacts on federally listed, proposed, and candidate species as well as state-listed threatened, endangered, candidate, rare, declining, and sensitive species (NPS Management Policies Section 4.4.2.3.). The Colorado Division of Wildlife determines if a species needs legal protection within Colorado. Species listed as endangered or threatened by the state are defined in the same way as federal endangered and threatened species. The state also designates species of special concern, which have no legal protection.

Appendix D presents species with federal endangered, threatened, proposed for listing, or candidate for listing status. The U.S. Fish and Wildlife Service reviewed the list and has concurred (October 18, 2005). Species considered endangered, threatened, or of special concern by the Colorado Division of Wildlife are included in Appendix D. The sources used by the park to identify listed species also are included in Appendix D. Table 3.2 includes species that are known to occur in the park or could potentially occur in the park, and species that occur outside the park. These species could be affected by the proposed NPS actions associated with this plan and have been retained for a full evaluation of effects.

Species Retained for Further Analysis

Boreal Toad

At the time of analysis for this document, the Southern Rocky Mountain population of the boreal toad was a federal candidate for listing. As of September 29, 2005, the U.S. Fish and Wildlife Service published a notice in the Federal Register notifying the public that they were no longer considering it for listing "because it does not constitute a distinct population segment as defined by the ESA" (USFWS 2005). It remains a candidate species on the federally listed species occurring in Rocky Mountain National Park, attached as Appendix D, because the U.S. Fish and Wildlife Service has not updated the park's list. The state of Colorado does list the toad as endangered because of large population declines from 1975 to 1990; therefore, the species is retained for further analysis. The Colorado Division of Wildlife developed a recovery plan in 1994, which was updated in 1997 and 1998 (Loeffler 1998). Rocky Mountain National Park is a signatory of the *Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad (Bufo boreas boreas)* (Loeffler 1998).

TABLE 3.2: SPECIAL STATUS SPECIES WITH POTENTIAL TO BE AFFECTED BY THE PLAN

Common Name	Scientific Name	Status
Boreal toad	*Bufo boreas boreas*	SE
Wood frog	*Rana sylvatica*	SSC
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	FT, ST
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	SSC
Greater sandhill crane	*Grus canadensis tabida*	SSC
Long-billed curlew	*Numenius americanus*	SSC
Bald eagle	*Haliaeetus leucocephalus*	ST
River otter	*Lutra canadensis*	ST
Wolverine	*Gulo gulo*	SE
Canada lynx	*Lynx canadensis*	FT, SE

Key to Status: FE = federally endangered; FT = federally threatened; FC = federal candidate for listing; SE = state endangered; ST = state threatened; SSC = state species of special concern

Boreal toads are the only high-elevation species of toad in Colorado, occurring from 2,135 to 3,660 m (7,000 to 12,000 feet). Breeding habitat includes lakes, marshes, ponds, and bogs with sunny exposures and quiet, shallow water. Boreal toad breeding does not begin until the winter snowpack starts to thaw, which ranges from May to July in toad sites in Rocky Mountain National Park (Hammerson 1999). Severe population declines are attributed to a skin disease known as chytrid fungus (*Batrachochytrium dendrobatidis*).

Twenty-one sites in the park are known to have or have historically had boreal toads. Timber Creek and Green Mountain Trail on the west side and Sheep Lakes and Horseshoe Park on the east side all historically had toads and all overlap with the elk range. Currently, only four known sites within the park have boreal toads. Only the Big Meadows site on the west side of park overlaps with primary elk summer range.

The Colorado Division of Wildlife and the park are working cooperatively to captive breed toads from the park to attempt to maintain a genetic bank from park toads and to provide toad stock for park reintroductions potentially to occur as soon as 2007.

Wood Frog

The wood frog is a state species of special concern, downlisted from threatened in 1998 by the Colorado Wildlife Commission. It is of concern to the state because its distribution is small and disjunct (Hammerson 1999) and its habitat has suffered destruction and degradation.

Wood frogs are found in riparian areas, including beaver ponds and willow thickets. They feed on worms, spiders, and insects; their predators include trout, although they generally avoid areas inhabited by trout (Hammerson 1999). In Rocky Mountain National Park, wood frogs have only been found in the Kawuneeche Valley (Corn et al. 1997), which overlaps with the elk summer range. Therefore, any management activity that would interrupt breeding or would alter riparian habitat or water quality in the Kawuneeche Valley has the potential to impact the wood frog.

Signaled by the males begin calling, the breeding season of wood frogs starts even before the last snowfall and while ice still forms on water at night. Depending on the year, this could be in May (Hammerson 1999), with eggs being laid in May to June (Bagdonis 1971).

Greenback Cutthroat Trout

The greenback cutthroat trout is federally and state listed as a threatened species. Greenbacks are one of four trout species native to Colorado, all of which declined substantially with the settlement of Colorado in the 1800s, primarily because of land and water exploitation along with the introduction of non-native salmonid fish species such as brook trout. Salmonid fish can out-compete and hybridize with greenbacks in colder habitats because of their greater young-of-the-year size and ability to reach sexual maturation one year earlier than greenbacks (USFWS 1998). Greenback cutthroat trout spawn begins when the water temperatures reach 5°C to 8°C (USFWS 1998), which in the park can be between late May and mid July, depending on the water body. In one area of the park, emerging fry were observed in late August (Bulkley 1959).

Since the decline of greenbacks took place primarily in the 1880s, it is difficult to determine their exact historic distribution. It is believed the park was not widely inhabited by greenbacks; however, due of alterations to their native habitat, Rocky Mountain National Park is one of the few areas where the species can be adequately reintroduced, and the park has played a large role in the recovery of greenbacks.

Within the park, greenbacks are primarily found in the North Fork of the Big Thompson River, Roaring River, Fern Creek, Hidden Valley Creek, and the Wild Basin area. They seek shelter under streamside willows and other riparian vegetation. Any alteration of riparian areas or water quality has the potential to impact the greenback cutthroat trout. The U.S. Fish and Wildlife Service monitors all populations in the park, and continued reintroduction efforts are pending. The National Park Service is currently preparing the greenback cutthroat trout management plan and environmental assessment to determine the future of greenback trout restoration efforts in the park.

Colorado River Cutthroat Trout

The Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) is a state species of special concern. Their decline is due to the same factors that affect greenback cutthroat trout, namely competition and hybridization with non-native fish, pollution, and habitat destruction.

Colorado River cutthroat trout spawn after water flows have peaked in spring or early summer. In Rocky Mountain National Park, Colorado River cutthroat trout occur primarily in the Colorado River, Timber Creek, Onahu Creek, North Inlet, Ptarmigan Creek, and Paradise Creek. Due to extensive restoration efforts by the Colorado Division of Wildlife and U.S. Fish and Wildlife Service, this species has been removed from the state list of threatened species. Any alteration of riparian areas or water quality has the potential to impact the Colorado River cutthroat trout.

Greater Sandhill Crane

The greater sandhill crane is a state species of special concern. The crane population was greatly reduced by the 1940s due to hunting, habitat change, and disturbance. Although generally thought to be very sensitive to human disturbance, some cranes have been found to nest in close proximity to areas such as highways (Barrett 1998).

Greater sandhill cranes arrive in Colorado by May to breed, have young in June, and migrate in August (Andrew and Righter 1992). There is only one known pair of cranes that nest in the park; they have returned to the Kawuneeche Valley since 1997 to nest in a riparian willow/herbaceous area along a beaver pond. Any alteration of riparian areas or water quality has the potential to impact the greater sandhill crane.

Long-billed Curlew

The long-billed curlew is a state species of special concern. The closest area to the park where it breeds and nests is in eastern Larimer County. It is a considered a rare migrant through the park and has been sighted in Moraine Park in the fall and spring on occasion.

The habitat of the long-billed curlew includes riparian areas and shorelines (Andrew and Righter 1992). Elk range overlaps with potential long-billed curlew migratory habitat in the park; therefore, any potential management activities associated with the alternatives may affect the curlew.

Bald Eagle

The bald eagle is a state-listed threatened species. Bald eagles have made a dramatic recovery since the pesticide DDT was banned, and they were removed from the federal list of threatened and endangered species in August 2007. They require undisturbed habitat with minimal human activity. Recreational activities, such as camping, have been shown to adversely affect the behavior of adult eagles and likely the survival of their young (Steidl and Anthony 2000).

Bald eagles breed in March and have young in April, which completely leave the nest by the end of August (Andrew and Righter 1992). Bald eagle populations in Colorado increase dramatically in the winter, when they move to the plains and western rivers and parks (Winternitz 1998). This same pattern occurs with bald eagles in Rocky Mountain National Park: in the summer one bald eagle pair forages in the park and in the winter up to six pairs do so. The eagles primarily use habitats on the west side of the park between Shadow Mountain Dam and Columbine Bay, which is not within the elk range, although their foraging territories could extend into the elk range. Bald eagles are not known to nest within the park. Bald eagles primarily feed on fish in reservoirs and rivers. However, they also feed on dead or crippled animals such as waterfowl or winter-killed deer and elk. Therefore, management activities that could affect carrion availability and quality could also affect the bald eagle population.

River Otter

The river otter is a state threatened species that was downlisted from endangered by the Colorado Division of Wildlife in 2003. Otter populations have diminished as a result of habitat alterations, human encroachment, trapping, water diversions, and degradation of water quality. The river otter was formerly extirpated from the park, but 43 otters were reintroduced to the park in the upper Colorado River between 1978 and 1984 (Armstrong 1987) Based on otter population surveys performed in 2001 (Herreman and Ben-David 2001), the otter population along the Colorado River in the park was estimated to be 18 animals.

Fish are usually the otter’s primary food item, but they will eat frogs, insects, and aquatic birds when available. The presence of shrubs and stream shading are important variables that contribute to otters’ habitat selection in the park (Herreman and Ben-David 2001). River otters in

Rocky Mountain National Park breed in spring, but implantation does not occur until the following spring. Young are born in March or April (Armstrong 1987).

Management activities that could affect riparian vegetation along the Colorado River or actions with potential to affect water quality could affect the river otter.

Wolverine

The wolverine is a state-listed endangered species. Currently, the wolverine is either extirpated from Colorado and the park or there are too few for a viable population (Seidel et al. 1998). Intensive survey efforts throughout Colorado, including 5,833 miles of snow tracking, 62 locations of hair snags, 110 locations of remote infrared cameras, and 686 trap nights of snares found only 10 sets of tracks that appeared to have a high probability of being a wolverine. None of these tracks were in or near the park (Seidel et al. 1998); however, since 1953, 84 probable sightings have been reported in Rocky Mountain National Park.

Although their existence in Rocky Mountain National Park has not been confirmed, wolverines elsewhere breed in summer, but implantation does not occur until January. In Alaska, young are born in March and leave the nursery den in April or May (Armstrong 1987).

The State of Colorado considers the species critically imperiled and has created the *Draft State of Colorado Conservation Strategy for Lynx and Wolverine* (Seidel et al. 1998). Rocky Mountain National Park is a signatory to the plan and may supplement additional wolverines if they are determined to be found in the park. However, this would need to be done in cooperation with Colorado Division of Wildlife (and consequently the Colorado state legislature) because the park is too small to support a wolverine population on its own. There are currently no foreseeable plans by the state or park to reintroduce the wolverine.

Wolverines are very susceptible to human activities and may abandon their den sites in response to such minor disturbances as cross-country skiers (Copeland 1996). Elk range overlaps with wolverine habitat in the park; therefore any potential management activities associated with the alternatives may affect wolverines.

Wolverines are opportunistic carnivores that primarily feed on carrion. They typically occur in very low densities at mid to high elevations (Ruggiero 1994). Currently within the park, wolverine and elk habitat use primarily overlaps in the summer, but since elk mortality is very low in the summer, it is unlikely that elk are a major source of food for wolverines. In winter, any mortality among the 100 to 200 elk that live in alpine areas of the park likely provides food for wolverines. Therefore, there is potential for management activities to impact wolverines by altering carrion availability and quality.

Canada Lynx

The Canada lynx, a federally listed threatened species and state listed endangered species, was reintroduced into southwestern Colorado by the state starting in 1999 with the purpose of establishing a viable population. During that first winter, the division had 19 records of four radio-collared lynx moving north from their release site and spending some time in or near the park between October 8, 1999 and April 28, 2000. Subsequent documented occurrences of lynx in the park include the latest noted on October 30, 2005.

The park contains approximately 145,815 acres (54% of the park) of potential lynx habitat. Mature conifer forests are necessary for denning, and riparian areas are frequented during the summer. Lynx are a specialized carnivore: snowshoe hares (*Lepus americanus*) provide up to

97% of their diet (Koehler and Aubry 1994). Although uncommon, carrion (including ungulates) can also make up a large portion of a lynx's diet when other prey sources are scarce (Brand et al. 1976). Therefore, there is a potential for management activities to impact lynx due to alteration of carrion availability and quality.

Human presence can have a major impact on lynx survival and behavior. For example, roads can be a primary source of mortality for lynx (Halfpenny et al. 1999), and human activities, particularly in the winter, can cause lynx to avoid prime habitats (Oliff et al. 1999). However, repeated and consistent human disturbance will not necessarily preclude lynx from using an area, as they may adapt behaviorally or physiologically (Bowles 1995). Elk range overlaps with potential lynx habitat in the park; therefore, any potential management activities associated with the alternatives may affect lynx.

Species Excluded from Further Analysis

All species presented in Appendix D were considered during the development of this document. The bonytail (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) do not occur in the park, but are federal downstream species in the Upper Colorado River basin. The least tern (*Sterna antillarum*), pallid sturgeon (*Scaphirhynchus albus*), piping plover (*Charadrius melodus*), and whooping crane (*Grus americana*) also do not occur in the park, but are federal downstream species in the South Platte River basin. None of these species are expected to be impacted by the alternatives addressed in this plan. Although the plan will likely result in the return of beavers and beaver ponds and therefore a potential Endangered Species Act water depletion concern because of evaporative losses, this will not be considered an Endangered Species Act issue because it will result in the return of natural conditions that likely existed before the elk population expansion; therefore, these species will not be retained for analysis.

The Preble's meadow jumping mouse (*Zapus hudsonius preblei*) does not occur in the park, but occurs at lower elevations in the state. None of the actions associated with the plan are expected to affect the jumping mouse or its habitat. The yellow-billed cuckoo (*Coccyzus americanus*) does not occur in the park except accidentally, but is found at lower elevations in Grand County. Although the Mexican spotted owl (*Strix occidentalis lucida*) does not currently occur in the park, there may be some potential suitable habitat in the park. However, neither the owl's prey base nor habitat overlap with current or possible activities related to this plan. These federally listed species are not expected to be impacted by the alternatives addressed in this plan and will not be retained for further analysis.

Colorado butterfly plant (*Gaura neomexicana* spp. *coloradensis*) is a federally listed threatened species. The biggest threats to the plant are non-selective herbicide spraying, agricultural activities, water development, competition from exotic plants, and loss of habitat to urban growth. The plant grows in riparian areas at elevations below 7000 feet, outside of the evaluated elk range, and management actions associated with this plan would not affect the Colorado butterfly plant; thus it is not retained for further analysis.

Ute ladies'-tresses (*Spiranthes diluvialis*) is a federally threatened species. The major threats to the species are related to loss of habitat from agriculture and development. The plant grows in riparian areas at elevations below 7000 feet, outside the elk range that is being evaluated, and management actions associated with this plan would not affect Ute ladies'-tresses. This species will not be retained for further analysis.

The Barrow's goldeneye (*Bucephala islandica*), ferruginous hawk (*Buteo regalis*), and American white pelican (*Pelecanus erythrorhynchos*), state-listed species of special concern, all migrate through the park. Because these species do not nest in the park and the habitat which they use while migrating is not expected to be impacted by the alternatives, these species will not be retained for further analysis.

The American peregrine falcon (*Falco peregrinus anatum*), a state-listed species of special concern, has nested in the park cliffs on Sheep Mountain, Lumpy Ridge, and Cow Creek area. Despite not occurring in the park at this time, neither its food source nor its habitat overlap with current or possible activities related to this plan, and will not be retained for analysis.

The Rocky Mountain capshell snail (*Acroloxus coloradensis*), a state-listed species of special concern, occurs only at Finch Lake in the park. This species will not be retained for further analysis because lakes are not expected to be impacted by any alternatives in this plan.

OTHER WILDLIFE SPECIES

Nearly 350 vertebrates are found in the Rocky Mountain National Park area, including 276 species of birds, 52 mammals, 11 fish, four amphibians, and one reptile. The distribution of species within the park varies by season, elevation, and varieties of habitats present. Species that are not threatened or endangered but may be affected by elk management activities are described in this section. Appendix E contains a list of wildlife species found in the park.

Amphibians and Reptiles

Amphibians that occur in the park include the boreal toad (*Bufo boreas*; see "Special Status Species" section), tiger salamander (*Ambystoma tigrinum*), western chorus frog (*Pseudacris triseriata*), and wood frog (*Rana sylvatica*). Amphibians generally prey on invertebrates, though some may eat small vertebrates.

The only known reptile in the park is the western terrestrial garter snake (*Thamnophis elegans*). The garter snake frequents riparian habitat.

Fish

As discussed in the "Special Status Species" section, native fish species that occur in the park are greenback cutthroat trout (*Oncorhynchus clarki stomias*) and Colorado River cutthroat trout (*O. clarki pleuriticusottus bairdi punctulatus*; west slope). Other native fish species include mountain sucker (*Catostomus platyrhynchus*; west slope), western longnose sucker (*C. catostomus griseus*), western white sucker (*C. commersoni suckii*; may be introduced in west slope waters), and mottled sculpin (*Cottus bairdi*).

Exotic fish that occur in the park are brown trout (*Salmo trutta*), eastern brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus gairdneri*), and Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*).

Small- to Medium-Sized Mammals

Small- to medium-sized mammals in the park include the deer mouse, montane vole, least chipmunk, Uinta chipmunk, chickaree, Wyoming ground squirrel, golden-mantled ground squirrel, Abert's squirrel, northern pocket gopher, Nuttall's cottontail, snowshoe hare, pika, and yellow-bellied marmot. Small mammals in the park are found in a variety of habitats.

Ungulates

In addition to elk, three other ungulates occur in Rocky Mountain National Park: mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), and moose (*Alces alces*). These ungulates are spatially segregated for part of the year: moose primarily occur on the west side of the park during the summer in the vicinity of the Kawuneeche Valley; mule deer occur throughout the park in the summer, but in winter are most often found on the east side of the park near or overlapping with elk winter range areas; and bighorn sheep are found in several mid- to high-elevation areas throughout the course of the year. Elk, which considerably outnumber the other ungulates in and near the park, overlap with all of these ungulates due to their large seasonal migrations.

Ungulates may compete for forage if the two species in question have overlapping diets, overlap in range use, and one or both have levels of forage consumption large enough to limit available forage (Hobbs et al. 1996a, Hobbs et al. 1996b). If competitive effects are strong enough and favor a particular ungulate at the expense of another, this can affect the production, distribution, and/or population size of another species (e.g., Hobbs et al. 1996a, Hobbs et al. 1996b, Forsyth and Hickling 1997).

Mule Deer

The number of mule deer that inhabited the Rocky Mountain National Park area before 1915 is unknown, but it is clear that mule deer were heavily hunted and suffered large declines throughout Colorado and the Rocky Mountain National Park area during the late 1800s and early 1900s (Stevens 1980a, CDOW 1999). After Rocky Mountain National Park was created, deer populations increased until 1938, apparently at least partially in response to management actions aimed at protecting them from poachers and predators (Monello et al. 2005). Since 1938, deer populations have declined, initially possibly due to an overpopulation of mule deer reducing their own forage base (Stevens 1980a), and from 1943 to 1958 in response to a deer reduction program that was instituted in conjunction with the elk reductions to improve range conditions on the east side of the park. Deer numbers appeared to continue to decline even after reductions were terminated in 1968. This is not unique to the Rocky Mountain National Park area, as the entire western U.S. has observed a decrease in mule deer numbers since at least the 1970s (CDOW 1999).

Mule deer summer throughout the east side of the park and on the west side in areas such as the Kawuneeche Valley, Specimen Mountain, and the North Inlet Drainage. They also summer in the northern portions of the park in the Poudre Drainage and the Long Draw Reservoir areas. During the winter, deer in the North Inlet Drainage move southwest out of the park or move to the east side. Deer in the upper Kawuneeche Valley and Poudre Drainage move south and east toward the Estes Valley. Deer near Long Draw move either northeast to the lower parts of the Poudre Canyon or southeast toward the Estes Valley. The primary mule deer winter range within the park is on the east side below 9500 feet in the montane life zone, overlapping with elk winter range. Connor et al. found that the mule deer population size decreased 11% between 2001 and 2003, from 833 to 561 (2004). They also reported that adult female survival for Estes Valley was about 10% lower than expected for female mule deer in the intermountain west, and concluded that the low survival rate may be at least partially responsible for the population decline. The mule deer population estimates for the past two winters indicate that there are 500 to 600 mule deer in the Estes Valley population (Watry 2005g).

Ecosystem modeling suggests that under natural conditions and with wolves present in Rocky Mountain National Park, deer populations on elk winter range areas would be limited to approximately 200 animals (Coughenour 2002). The same model also predicts that without wolves, deer would be limited to a similar population size through competition with elk.

Competition with Elk

Although mule deer are considered browsers and elk as grazers, elk can have a large impact on mule deer through physical exclusion and competition for food. Kufeld et al. summarized the diet of mule deer in the Rocky Mountains and found it largely composed of browse (shrubs and trees) and forbs throughout the year, with a low to moderate use (~20%) of grasses in the spring (1973). Deer exhibit their greatest need for browse during winter because they cannot subsist on dry, senescent grasses (CDOW 1999, Kufeld et al. 1973). Stevens found that in the park during winter, mule deer diets consisted largely of browse, including bitterbrush (25%), big sagebrush (15%), green rabbitbrush (13%), and wax current (7%), along with small amounts of various other species; forbs made up 16% and grasses made up 14% of the winter diet (1980). Elk can also greatly increase their intake of browse species when grasses are unavailable or the nutritional quality of grasses becomes less than browse, such as during winter (Hobbs et al. 1981).

Deer are smaller than elk and can be displaced from preferred feeding areas (CDOW 1999). Because elk are competitively dominant, are at carrying capacity on their winter range in Rocky Mountain National Park, which overlaps considerably with mule deer winter range areas, and are having an effect on upland shrub species, they may have negative impacts on mule deer production and population size (Hobbs et al. 1996a, Hobbs et al. 1996b, Forsyth and Hickling 1997, CDOW 1999). This is indirectly supported by the fact that deer numbers and habitat use continued to decline while elk numbers and habitat use increased in the best deer habitats (upland shrub) after the control program was terminated in the park (Zeigenfuss et al. 2002). In general, elk and deer population estimates over the last 50 to 75 years from Rocky Mountain National Park are inversely correlated. Continued mule deer declines throughout the 20th century in conjunction with an increasing elk population suggest that elk may be affecting mule deer. However, it should be noted that in 1949 and 1952, Guse identified declines in the winter and summer populations, respectively, well before the control program was terminated (1966).

Chronic Wasting Disease

Mule deer in Rocky Mountain National Park are infected with chronic wasting disease. Out of 261 mule deer sampled in the Estes Valley and Rocky Mountain National Park east side wintering population between 1997 and 2002, chronic wasting disease was prevalent among 5.4% (Connor et al. 2004). Simulation modeling predicts chronic wasting disease has the potential to cause drastic population reductions in deer (Miller et al. 2000, Gross and Miller 2001). However, this does not mean the population declines in mule deer over the last 50 to 70 years are due to chronic wasting disease; chronic wasting disease was not detected in free ranging cervids until the 1980s and was not documented in mule deer in the park until 2001. Mule deer have declined throughout Colorado and the western United States, including areas where chronic wasting disease have not been documented (CDOW 1999). Currently, Rocky Mountain National Park removes any deer that display clinical signs of chronic wasting disease and any deer that test positive through a live test. All carcasses that are found are removed if possible and also tested.

Bighorn Sheep

Bighorn sheep are particularly sensitive to human disturbances. Prior to 1880, bighorn sheep were reported to be much more abundant and occupy a much greater area in Rocky Mountain National Park than they currently do (Ratcliff 1941, Packard 1939). Ratcliff suggested that there may have been as many as 4000 sheep in the park during the early 1800s (1941). From the time the Estes Valley was settled up to the current time, bighorn numbers have varied in the park. Declines have occurred due to market hunting, competition with livestock, development, and disease (Packard 1939, Packard 1946, Goodson 1978, McClintock 2004), while at other times populations have been stable or increased, partially in response to intensified management (Contor 1958, Capp 1967, Goodson 1978). Most recently McClintock estimated the population size of west side population to be about 290 bighorn sheep, and the size of the mummy range population to be about 80 bighorn sheep (2004).

Competition with Elk

Bighorn sheep are primarily found at higher elevations in the park. Elk use these areas, especially during the summer and fall but also in small numbers during the winter. Capp (1967) and Harrington (1978) examined summer range use by elk and bighorn sheep in alpine areas of Rocky Mountain National Park and found bighorns and elk were spatially segregated: bighorns tended to use steep, rocky slopes while elk used open meadow areas. Capp (1967) and Singer et al. (2002) found elk in alpine areas to primarily consume forb and browse species (willow) in the summer, while bighorns primarily consume grasses (Capp 1968). Based on this evidence, there appears to be little competition for food or range use between elk and bighorn sheep in Rocky Mountain National Park. However, the population size and range use of elk has increased considerably since the study periods of Capp (1967) and Harrington (1978), and elk are capable of displacing sheep from preferred feeding areas (Goodson 1978). Overall, competition between elk and bighorns is likely of little consequence to sheep when compared to such factors as disease.

Disease

Pneumonia-induced die-offs (*Pasteurella* spp.) are the principal factor affecting bighorn sheep population dynamics in the western United States. Bighorn populations on the east side of the park, and possibly those on the west side, experienced a pneumonia-induced die-off in 1994. It appeared that few of the lambs born in the Mummy Range sheep population between 1994 and 2001 survived to become yearlings), with questionable lamb survival in west side populations as well. Many pathogens associated with pneumonia epidemics are present in bighorn ewes of both east and west side populations; of concern are small yearling ratios observed suggesting the population is not recruiting at levels needed for sustainable growth (McClintock 2004).

Moose

Historically, moose (*Alces alces*) were not common in Colorado or Rocky Mountain National Park. There is only one recorded historic occurrence of a moose in the park: Estes (1939) reported killing a moose in Moraine Park in 1860. In 1978-79, the Colorado Division of Wildlife introduced 24 moose to the North Park area, about 19 miles northwest of Rocky Mountain National Park, to establish a viable moose population for hunting. A moose was first observed in the Kawuneeche Valley in 1980, with the first winter observations in 1985. The current population in Rocky Mountain National Park is estimated to be about 100 moose (Dungan 2005). Moose are primarily found west of the Continental Divide in the Colorado River drainage, but occasionally are observed east of the Continental Divide. About one-fourth of the total population occurs in the Kawuneeche Valley.

Moose in Colorado are close to the southern limit of their distribution in the United States. Studies conducted in other areas suggest that bears and wolves may limit the size and density of moose populations and their localized effects on vegetation (Bergerud et al. 1983, Ballard et al. 1987, Boutin 1992, Peterson 1999). The absence of wolves in Rocky Mountain National Park could be resulting in higher densities of moose with greater effects on the plant community than would occur with an intact predator base (Monello et al. 2005).

Competition with Elk

Moose and elk use the Kawuneeche valley in spring, summer, and fall. Late fall and winter use of the valley by moose appears to be minimal, while some elk do use the Kawuneeche Valley during winter (Dungan 2005). The extent of site-specific overlap in moose and elk habitat use in the park is not known; however, studies in other locations found that moose were not tolerant of large groups of elk and maintain some separation in their distribution (Peek and Lovaas 1968, Jenkins and Wright 1987). Willow make up 93% of summer moose diets in the park (Dungan 2005). Moose and elk use the willow communities in the Kawuneeche Valley during late spring and summer. Although no studies have been conducted to separate elk from moose herbivory impacts, elk occur in larger numbers, are more sedentary in more vulnerable willow patches, and browse in spring, which is a more critical time for willow as they put on growth for the year (Cooper and Westbrook 2005).

Predators and Scavengers

Potential predators of elk in the park and surrounding areas include mountain lion (*Felis concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), black bear (*Ursus americanus*), and golden eagle (*Aquila chrysaetos*). Gray wolf (*Canis lupus*) and grizzly bear (*Ursus arctos*) are other native predators; however, these species no longer occur in the area. Gray wolves were likely gone before the park was established, and the grizzly bear disappeared soon after the park was established (Armstrong 1987). Predator populations in the park were controlled from 1917 to 1926 to encourage recovery of ungulate populations, with records of approximately 50 coyotes and 20 mountain lions eliminated (Stevens 1980a). However, the predator control program probably benefited deer populations more than elk; at the time of control programs, elk populations appeared to continue to increase (Stevens 1980a).

Mountain lion and coyote can kill healthy adult elk, but their primary prey typically consists of bighorn sheep, deer, or small mammals (Hornocker 1970, Gese and Grothe 1995, Smith and Anderson 1996, Crabtree and Sheldon 1999, Kunkel et al. 1999). No studies have suggested that mountain lions or coyotes have the ability to limit elk population size, and the finding that elk in the park have reached their carrying capacity (Coughenour 2002, Lubow et al. 2002, Singer et al. 2002) in the presence of unexploited mountain lion and coyote populations indicates neither predator has a significant effect on elk populations in the area.

It is not known how many mountain lions inhabit the park; however, they are observed fairly frequently. They are most abundant in broken country with good cover of brush or woodland. In the park and surrounding areas, mule deer are their primary prey; however, elk are taken occasionally (Armstrong 1987).

Coyotes are common in the park. They are highly adaptable animals and range through a wide variety of habitats. Coyotes have a broad diet that consists principally of small- to medium-sized mammals and some birds (Armstrong 1987). Larger prey, such as deer or elk, is taken on occasion, especially when snow or ice impedes travel for ungulates. Coyotes have been observed killing young calves and appear to spend more time hunting in prime calving areas when cows are giving birth than other times of the year. During winter, scavenging can be important.

Bobcat are considered common in the park. They occur in woodland, shrubland, and forest-edge habitat throughout the park. The primary prey of bobcats consists of rabbits, hares, and a variety of other small mammals and birds, but they may also take elk calves if circumstances permit (Armstrong 1987, Bear 1989).

Black bear are strongly tied to forested habitats (Rogers 1976, Powell et al. 1997). They are omnivorous, eating plant and animal matter, and primarily scavenge rather than kill elk, but can be effective predators of elk, especially calves (Knight et al. 1999, Smith and Anderson 1996). Research on black bears in the park conducted from 1985 to 1991 found that less than 8% of black bear diets consisted of mammals, and elk were not among the mammal species identified (Zeigenfuss 2001). In general, the park provides poor to marginal black bear habitat, and bear densities are relatively low, bears are small, and cub survival is low relative to other populations in Colorado (Zeigenfuss 2001, McCutchen 1993). The population size in the park is estimated to be 20 to 25 bears (Zeigenfuss 2001).

Golden eagles are known to breed in the park and are observed fairly frequently. They feed primarily on small mammals. Prey remains of bighorn sheep lambs have been found in nests, and while golden eagles could take elk, especially calves, predation on elk has not been documented in the park.

Scavengers in the park include black bear, coyote, mountain lion, bobcat, red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), common raven (*Corvus corax*), gray jay (*Perisoreus canadensis*), Steller's jay (*Cyanocitta stelleri*), black-billed magpie (*Pica hudsonia*), and turkey vultures. Bald and golden eagles have been observed feeding on elk carcasses.

Other Species Associated with Elk Grazing and Behavior

Birds

Over 300 bird species have been observed in the Rocky Mountain National Park area. Birds in the park include year-round residents, seasonal migrants and breeders, and occasional visitors. The large majority of these birds are seasonal residents; only 26 species are considered common, year-round inhabitants of the park. The Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004) identified bird species of continental importance that need to be managed to reverse long-term declines, and 13 of these (22%) are known to occur in Rocky Mountain National Park. Birds in the park that could be affected by elk include ptarmigan, songbirds/neo-tropical migrants, raptors (also see "Predator" section), waterfowl, and shorebirds.

Ptarmigan

White-tailed ptarmigan (*Lagopus leucurus*) are members of the grouse family that primarily inhabit elevations above treeline. During the winter, they are found only in areas where willow is a dominant or co-dominant plant species. Their diet is dominated by willow buds, leaves, and twigs from October to June, but is more diverse during the summer and includes herbaceous and browse species (May and Braun 1972).

Between 1975 and 1991, the size of the ptarmigan populations that occur on elk summer range along Trail Ridge Road in the park fluctuated, with substantial variation observed between years in average brood sizes and adult survival (Braun et al. 1991, Wang et al. 2002a). Braun et al. found that the decline was concurrent with a decline in willow cover and an increase in elk population size and suggested that heavy use of willow by elk in early winter and early spring constrained ptarmigan breeding densities by reducing the amount of food available to ptarmigan in late winter during the early breeding period when ptarmigan establish breeding territories. They further suggested that expansion of elk population and range in the park might affect ptarmigan population dynamics (1991). However, Wang et al. analyzed 1975 to 1999 data on population growth rates of ptarmigan and elk population sizes and determined that elk population sizes were not related to population growth rates (2002a). Wang et al. found that local weather exerted a stronger influence on the population dynamics of ptarmigan (2002b).

Songbirds

At least 150 songbirds have been observed in the park. About one-third of these are neo-tropical migrants, defined as birds that spend winter south of the United States or Tropic of Cancer (Connor 1993). Many neo-tropical migrants and songbirds breed in the park (Johnsgard 1986). The diversity of songbirds and neo-tropical migrants in the park is greatest in aspen, riparian willow, and ponderosa pine habitat (Connor 1993, Turchi et al. 1994), which combined make up only 9% of the park area. The primary elk winter range in the park is important for songbirds because it contains 55% of these habitat types. The Kawuneeche Valley contains 9% of the park's aspen and willow riparian habitat. These areas are the only large, continuous areas of such habitat.

Turchi et al. found bird species richness to be significantly higher in aspen than conifer habitat, and percent shrub cover (0.5-2 m or 1.5 to 7 feet in height) within aspen stands to be the single most important predictor variable for bird species richness in the park (1994). About 13 avian species breed almost exclusively in aspen, including Williamson's and red-naped sapsuckers, which are species of continental importance (Rich et al. 2004). Cavity-nesting species such as woodpeckers, swallows, bluebirds, chickadees, and nuthatches use live and dead standing trees, including aspen, as roosting and nesting sites. Zaninelli and Leukering (1998) and Duberstein (2001) suggest that live aspen trees are more important to cavity-nesting birds than dead trees, and that different bird species used different sizes and densities of aspen. Lloyd (1997) surveyed bird species present in aspen stands on and off the winter range, and found the mountain chickadee to be more abundant in stands located off the winter range. He attributed this to the fact that mountain chickadees tend to inhabit coniferous forests, which are much more abundant around aspen stands off the winter range versus on.

Riparian habitats support the highest bird diversity of any western habitat type, while being one of the rarest (< 4% of the park). Black swift, dusky flycatcher, red-naped sapsucker, rufous hummingbird, Lewis's woodpecker, and calliope hummingbird occupy various riparian habitats. Bird species specifically associated with willow include Wilson's warbler, Lincoln's sparrow, fox sparrow, song sparrow, yellow warbler, and white-crowned sparrow. Long-term bird monitoring in willow habitat indicates that the fox sparrow disappears from willow habitat when heavy willow grazing impacts the lower half of the shrub and understory vegetation. Leukering and Carter found that different bird species in the park used different sizes and densities of willow, indicating that short and tall willow are both important (1999).

Montane shrub (upland shrub) habitats, composed of antelope bitterbrush, sagebrush, *Ribes* spp., *Potentilla* spp., and common juniper, provide many avian species with valuable food and cover. Montane shrubs may be critical to western hummingbirds during migration. Brewer's sparrow, sage thrasher, dusky flycatcher, Virginia's warbler, calliope hummingbird, green-tailed towhee, rufous hummingbird, and mountain bluebird are species of continental importance (Rich et al. 2004) that use upland shrub habitat in the park. Jelhe et al. found the three most frequently observed species in upland shrub habitats were green-tailed towhee, house wren, and western wood-pewee (in review). Other species commonly observed included American robin, broad-tailed hummingbird, chipping sparrow, mountain bluebird, pine siskin, red crossbill, Steller's jay, violet-green swallow, and yellow-rumped warbler. Green-tailed towhees and sage thrashers nest exclusively in montane shrub habitat type. Partners in Flight (Rich et al. 2004) gives Colorado a high responsibility for conservation of the green-tailed towhee because Colorado contains 20% to 40% of the entire breeding population of this species (Kingery 1998). Jelhe et al. found that three shrub species accounted for more than 90% of green-tailed towhee nest locations: 47% were in common juniper, 38% were in sagebrush, and 9% were in antelope bitterbrush (in review).

Alpine tundra is a specialized, fragile habitat type. Black- and brown-capped rosy finches are two alpine tundra specialists that are species of continental importance (Rich et al. 2004). The brown-capped rosy finch, which breeds only on alpine peaks of the Intermountain West, has one of the smallest populations and ranges of any North American land-bird.

Raptors

Three species of *accipiters* — northern goshawk (*Accipiter gentilis*), Cooper's hawk (*A. cooperii*) and sharp-shinned hawk (*A. striatus*) — breed in the park. Their long tails and short, broad wings enable them to hunt in densely wooded habitat. Nests have been found in lodgepole pine and aspen, in or near small groves of aspen, and in riparian areas intermixed with dense lodgepole pine and Douglas fir within 550 yards of open meadows. A high proportion of accipiter nests in the park have been found in the elk winter range in the montane zone. Their nests tend to be on north-to-northwest-facing slopes but have also been found on east facing slopes. The northern goshawk often hunts in open meadows where their principle prey, the Wyoming ground squirrel (*Spermophilus elegans*), is abundant. Other prey used by the three species of accipiters includes birds, chipmunks, chickaree, snakes, and small mammals.

Prairie falcons (*Falco mexicanus*), peregrine falcons (*F. peregrinus*), American kestrels (*F. sparverius*), red-tailed hawks (*Buteo jamaicensis*), and turkey vultures (*Cathartes aura*), can also be found breeding within the park. Prairie and peregrine falcons nest on south facing cliffs below 10,000 feet in the Lumpy Ridge area of the park, and American kestrels nest in tree cavities in ponderosa pine snags. Two prairie falcon pairs breed on south-facing cliffs in the alpine tundra, with one site at 12,000 feet. Their principal prey tends to be birds and to a lesser degree small mammals. American kestrels will also catch large insects such as grasshoppers and butterflies. Red-tailed hawks are the most common raptor in the park and usually nests in old-growth, live ponderosa pines, with some breeding pairs nesting on south-facing cliffs. All known red-tailed hawk nests are within the montane zone in association with ponderosa pine, aspen, and Douglas fir. Turkey vultures, next in size to the two eagles, are scavengers and have been observed feeding on the carcasses of elk, deer, and bighorn sheep. They roost and nest on cliffs, but nests could also be found in hollow logs. They do not build nests, but use scrapes in gravel, or needles and leaves in a log. One colonial roost is known in the Lumpy Ridge area.

The “Special Status Species” section (above) discusses bald eagles and the “Predators and Scavengers” section (above) discusses golden eagles.

Waterfowl

Four species of waterfowl — the mallard, green-winged teal, ring-necked duck and Canada goose — frequently nest in the park, Primary nesting habitat includes the shoreline of beaver ponds, small ponds, and lakes. They occasionally nest along the banks of rivers and streams. Nests are located in dense sedges that grow 1.5 to 3 feet in height along shorelines or may also be found in understory vegetation beneath willow. Young-of-the-year ducklings and goslings rely on dense aquatic vegetation along the edges of ponds and lakes that provide feeding habitat and protective cover from predators. Other species of waterfowl are migrants moving through the park during the spring and fall. The common merganser, Canada goose, common goldeneye, mallard, and rarely the hooded merganser, red merganser, and Barrow's goldeneye can be found during the winter months feeding and roosting in open water along flowing streams.

Only two species of shorebirds, spotted sandpiper and killdeer, are known to nest in the park. Spotted sandpipers nest in a depression in dense grass, sedges, or gravel near the shoreline of beaver ponds, lakes, and streams. Killdeers nest in open, sparsely vegetated, upland habitat in meadows. Other species of shorebirds that frequent the park are migrants passing through the park in the spring and fall and can be found in association with riparian habitat, wetland meadows, and exposed mudflats in beaver ponds or other small ponds. Long-billed curlews, a rare migrant to the park, have been observed feeding in muddy, water-filled elk wallows in open meadows such as Moraine Park and Horseshoe Park in the fall.

Butterflies

Simonson et al. examined butterfly diversity in six different habitat types on the elk winter range in Rocky Mountain National Park (2001). They found that butterfly diversity, richness, and uniqueness were highest in aspen and wet meadow habitat types and that butterfly species richness exhibited a strong correlation to plant species richness. Plant species most commonly used include sulphurflower, various willow species, and a variety of grass species. A variety of butterfly species in the park have been documented to use these habitat types and species (Bray 2004).

Aspen habitat in the park supports western tiger swallowtail, Weidemeyer's admiral, and the dreamy duskywing, which are considered rare by the state of Colorado.

Sulphurflower, which had 50% less cover in grazed sites than ungrazed sites (Singer et al. 2002) is an important host plant for Sheridan's hairstreak, blue copper, Rocky Mountain blue, and bramble hairstreak (Bray 2004). Willow leaves provide food for caterpillars of Scudder's sulphur, arctic fritillary, frigga fritillary, and the mourning cloak. In addition, four butterflies that spend winter in the park — hoary coma, green coma, Milbert's tortoiseshell, and mourning cloak — depend on the sporadic spring bloom of willows for nectar. Twenty-seven butterfly species in the park use grass and sedge as host plants. Plant leaf litter is important to caterpillars because when they are disturbed while eating leaves, caterpillars often drop to the ground to seek safety. Zeigenfuss et al. found less leaf litter in grazed areas, so in those locations, caterpillars may find it harder to find refuge from predators (1999).

Beaver

Beaver are a keystone species that have profound effects on ecosystem structure and function (Naiman et al. 1988) and have been identified as a focal species for the NPS Inventory and Monitoring Vital Signs Program. Beaver modify their environment by cutting aspen and willow for food and construction material, by building dams that raise the water table, and by building ponds that trap sediment and increase nitrogen availability to willow (Naiman et al. 1988, Baker and Hill 2003). Beaver dams slow current velocity, increase deposition and retention of sediment and organic matter in their ponds, and reduce downstream turbidity on floodplains, increase the area of soil-water interface, elevate the water table, change the annual stream discharge rate by retaining precipitation runoff during high flows and slowly releasing it during low flows, alter stream gradients by creating a stair-step profile, and increase resistance to disturbance (Naiman et al. 1988). Beaver foraging can alter species composition, density, growth form, and distribution of woody vegetation.

Willows provide an important source of food and construction material for beaver. Willow leaves are high in protein content and are readily eaten during the summer. The bark of willow stems may be the only source of winter food for beaver that live in locations where surface water freezes during winter (Baker and Cade 1995). Beaver are central place foragers that cut and remove entire stems at or near the ground surface. They often cut all stems from preferred shrubs growing near their winter food caches, dams, and lodges, but become more selective as foraging distances increase (Baker and Hill 2003).

Beaver cut stems near the ground surface, which stimulates sprouting from the root crown. Increased stem turnover rate and beaver preferences for tall stems increases plant productivity. Factors other than beaver also affect willow growth, such as ungulate browsing, soil type, length of growing season, nutrient concentrations, and water table height (Singer et al. 1994, Cottrell 1995, Peinetti 2000). The interaction of beaver cutting and elk browsing strongly suppresses compensatory growth in willow, which alters the structure and function of the willow community and facilitates conversion from a tall to a short willow community (B. Baker et al. 2005). Beaver in the park prefer relatively tall, unbrowsed willow and select against short, hedged willow (Baker et al. 2004). Thus, willow communities in the park that have been hedged short by elk are largely unsuitable as beaver habitat.

Beaver populations in the park have declined dramatically since 1940. Trapping from 1941 to 1949 probably initiated declines, but intense elk browsing apparently has prevented their recovery (Baker et al. 2004). Elk use of willow leaders averaged 85% during 1968 to 1992 (Zeigenfuss et al. 1999). Beaver populations declined in Moraine Park from more than 300 in 1940 (Packard 1947) to 12 in 1994 to 1998 (Zeigenfuss et al. 2002). Beaver surveys and aerial photographs in 1999 revealed only one beaver colony in Moraine Park. The beaver population on the east slope of the park occurs mostly in areas with low elk use and was about 40 individuals in 1999 to 2001; beaver are largely absent from willow areas with heavy elk use (/Baker et al. 2004). Similarly, in the Kawuneeche Valley on the west side of the park, beaver numbers were estimated to be about 60 in 1949 and only 30 in 1999 (Mitchell et al. 1999).

The greater-than-90% decline in beaver numbers in Moraine Park correlates with a 69% reduction in surface water and concurrent willow declines over the last 50 to 60 years (Peinetti et al. 2000, Zeigenfuss et al. 2002). Similarly, a 90% decline in the beaver population in Horseshoe Park contributed to a 47% decrease in surface water and concurrent willow declines (Zeigenfuss et al. 2002). Beaver dams and ponds on the Colorado River in the Kawuneeche Valley greatly enhanced the depth, extent, and duration of inundation associated with floods (Westbrook et al. 2006). Beaver dams raised the water table during periods of high and low flows and spread water laterally and downstream to locations out of reach of spring floods or other hydrologic processes (Westbrook 2005, Westbrook et al. 2006). Each beaver dam studied eased the water table decline that occurs in drier summer months over nearly one quarter of the 58 hectare study area (Westbrook et al. 2006).

The lack of beaver accelerates willow declines in Moraine Park and Horseshoe Park by inhibiting the development of appropriate sites for willow seedling establishment and by limiting recharge of shallow aquifers. Abandoned beaver ponds and abandoned channels (ox-bows) associated with beaver are two of the three landform types in the park that provide suitable sites for willow establishment by seed (Cooper et al. 2003). Sediment deposited by beaver dams in the Kawuneeche Valley greatly increased habitat heterogeneity by creating a mosaic of highly variable vegetation establishment and survival patches (Westbrook 2005). Beaver cuttings allow willows to colonize areas that are suitable for willow growth but not for seedling establishment (Cottrell 1995); reproduction via stem fragments is lacking on elk winter ranges that lack beaver. Once established, willows can survive and remain productive for 100 years or longer. Thus, beaver and willows can persist indefinitely as mutualists in a landscape that lacks intense browsing pressure by additional herbivores such as elk.

WATER RESOURCES

Hydrology

Rocky Mountain National Park contains 1143 acres of lakes and ponds, with 167 lakes greater than an acre and 397 less than an acre. Streams in the park total 532 miles, with an additional 38 miles of intermittent streams. The Continental Divide bisects the park into two distinct watersheds; water flowing west drains into the Colorado River, and water flowing east empties into the Missouri and Mississippi Rivers. The headwaters of four major river basins originate in the park, including the Big Thompson, North Fork of the St. Vrain, North Fork of the Colorado, and the Cache la Poudre Rivers. Only the Big Thompson and the North Fork of the Colorado are in the project area. In addition, Fall River, Boulder Creek, and Mills Creek are included for discussion. See Figure 3.6 for a map of the park's streams, rivers, and lakes.

The Big Thompson River flows east through Moraine Park through a series of channels that converge at the far eastern side of Moraine Park. The Big Thompson River, like other rivers and streams in the park, has a flow regime dominated by snowmelt, with approximately 37% of the annual stream flow occurring during June. The low levels of beaver activity in the area has resulted in the stream stage being near stream level most of the summer, which in turn results in limited groundwater recharge and low groundwater levels (Gage and Cooper 2003).

The groundwater of Moraine Park also flows east, where it creates upwelling on the western and southwestern side of a large bedrock outcrop in the center of the park before it continues to flow around the outcrop to the south or dumps into the Big Thompson River on the north. Unlike the shallow and stable groundwater levels at the discharge areas, the groundwater level is much deeper east of the outcrop, creating a large dry area in Moraine Park (Cooper et al. 2003).

Mills Creek flows east through Hollowell Park along two major channels. It is dammed by beavers several times throughout its course. Beaver Brook flows east through Beaver Meadows along one main channel.

Fall River flows east through Horseshoe Park along a strongly meandering channel with pool-riffle morphology (Gage and Cooper 2003). The relationships between stream flow and stage, and groundwater recharge and level, as well as their relationship to beaver activity, are the same as for the Big Thompson River (Cooper et al. 2003).

The Colorado River flows south through the Kawuneeche Valley, and ranges between 25 and 50 feet wide. Between 1954 and 2001, the mean annual discharge was 1.8 m^3/second, and mean annual peak flow was 16.1 m^3/second. The flow regime is dominated by snowmelt with marked daily fluctuations in flow during the melt period.

The lowest peak discharge on record was during 2002 at 5.2 m^3/second (Westbrook 2005).

The Grand Ditch water diversion has greatly affected the Colorado River. This water diversion project located alongside the Never Summer Mountains predates the establishment of Rocky Mountain National Park. Construction was begun in 1890 and completed in 1936. The 17-mile system delivers an average of 20,000 acre-feet of water annually over the Continental Divide at La Poudre Pass to the eastern plains of Colorado by diverting water from the Colorado River to the Cache la Poudre River. Between mid-May and mid-September of each year, the ditch captures the flow of eleven headwater tributaries of the Colorado River, intercepting an average of 29% of the total annual runoff from the Upper Colorado River Watershed. This reduces instantaneous annual peak flows of all recurrence by as much as 55%, the frequency of overbank

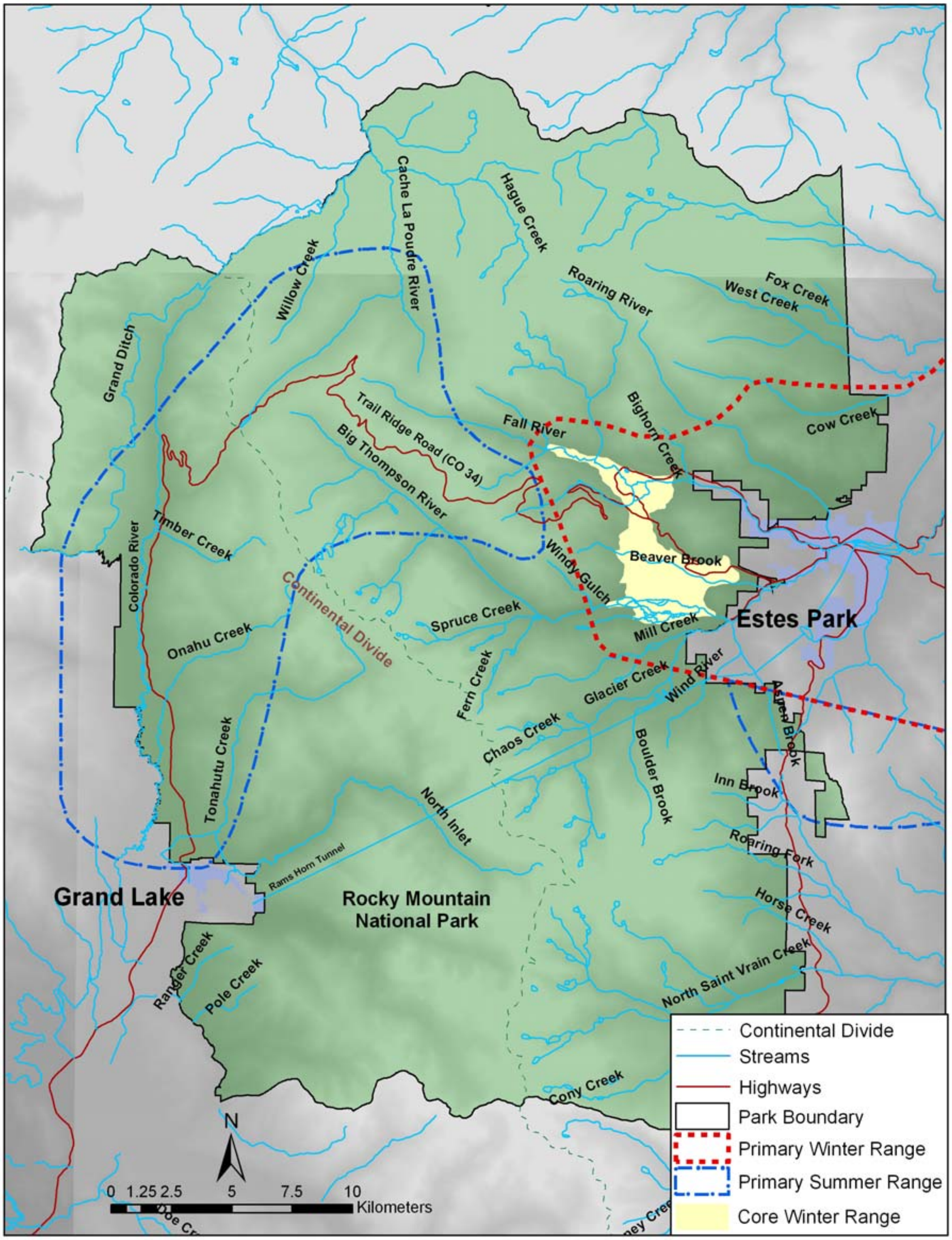


FIGURE 3.6: SURFACE WATERS OF THE PRIMARY ELK RANGE IN ROCKY MOUNTAIN NATIONAL PARK

flooding and channel maintenance flows by about 50%, the amount of surface water in the Colorado River watershed above Baker Gulch by about 50%, and the three-, seven- and 30-day low flows by about 40%. In addition, water levels in the toeslope wetlands of Lost Creek have been reduced by as much as 20 inches, and in Red Creek, more than 20 inches below the surface in a year with low summer rainfall. The impact of the Grand Ditch on river stage and groundwater levels in the Kawuneeche Valley is less noticeable, with approximately a 4- to 8-inch decrease due to the river's large width compared to its depth (Woods 2000).

Effects of Previous Lands Uses and Beaver on Current Hydrology

Previous land uses have played a role in the current hydrology of the park. Rocky Mountain National Park was established in 1915, but additional parcels in Moraine Park and Horseshoe Park were not acquired until 1962 and 1932, respectively. In Moraine Park, development that has affected hydrology includes the Moraine Park golf course, and drainage and irrigation ditches (Peinetti et al. 2001). Within the project area, the Lawn Lake backcountry dam at one time affected hydrology but has since been removed.

Beaver have historically had a significant effect on the hydrology in the project area. Their activities include creating dams and canals, which increase river complexity by slowing water current velocity, elevating the groundwater level, equalizing the water discharge rate by retaining runoff during high flows and slowly releasing it, altering waterway gradients by creating a stair-step profile, and increasing resistance to disturbance within the waterway (Gurnell 1998, Naiman et al. 1988, B. Baker et al. 2005). Beaver, prevalent during the late 1800s and early 1900s, have been declining in the park since 1940, which has altered park hydrology (B. Baker et al. 2005). For more detail on the history and biology of beaver, see the “Other Wildlife” section in this chapter.

Aerial photographs of Moraine Park between 1946 and 1996 show a 56% reduction in length from fewer river meanders and a 69% reduction in the amount of surface area of water from decreased impounding, mostly from beaver ponds of the Big Thompson River. These reductions were attributed to the reduction in beaver activity throughout that same time period (Peinetti 2000). Aerial photographs of Horseshoe Park between 1937 and 1996 show a 44% reduction in length and a 47% reduction in the amount of surface water of the Fall River, which, as with the Big Thompson River, is attributed to the reduction in beaver (Peinetti 2000).

A flood caused in 1982 by the collapse of an earthen dam at Lawn Lake deposited over 750,000 tons of rock at the confluence of Roaring River and Fall River (Jarrett and Costa 1993), creating an alluvial fan at the confluence. The alluvial fan created a new lake called Fan Lake directly upstream that existed from 1982 to 1995, flooding 12 acres of willow habitat.

Downstream, the flood was dispersed into meadow areas and was too small to significantly alter the hydrology of Fall River and the Horseshoe Park area (Jarrett and Costa 1993). However, the debris killed several families of beaver, and more beaver were forced to leave when Fan Lake flooded the willow.

Groundwater depths in the Kawuneeche Valley respond to changes in river stage (particularly in mid to late summer), hillslope runoff, summer rainfall, and recharge from beaver ponds. However, the beaver control over groundwater levels outweighs all other factors, since the beaver dams recharge groundwater in locations far from the river channel and beaver pond (Westbrook 2005, Westbrook et al. 2006).

With current hydrological conditions, during the growing season water tables near streams of the elk winter range generally remain above approximately three feet (Zeigenfuss et al. 2002, Cooper et al. 2003).

Water Quality

The Water Resources Division of the National Park Service has compiled a baseline water quality inventory for Rocky Mountain National Park (NPS 2001b). The inventory contains surface water quality data from six of the U.S. Environmental Protection Agency's databases for 684 monitoring stations (most were a one-time sampling effort) from 1901 to 1998. The project area includes one mile upstream and three miles downstream of any surface water in Rocky Mountain National Park to completely capture any effects on water quality that might be occurring in the park.

Fifteen groups of parameters exceeded screening criteria at least once within the project area, including dissolved oxygen, pH, chlorine, cadmium, copper, silver, zinc, fluoride, sulfate, nitrite, cadmium, lead, fecal indicator bacteria concentrations, turbidity, and alkalinity (NPS 2001b). Results are described below:

> Approximately 300 observations of dissolved oxygen concentrations below the 4 mg/L level for the protection of freshwater aquatic life occur during depth sampling in Lake Granby.
>
> Of almost 10,000 pH measurements, 2,588 observations were less than or equal to 6.5, while 47 were greater than or equal to 7.0. Data collected in the Loch Vale Watershed (near Bear Lake) accounted for most of these low pH levels, including measurements as low as 1.3 at Sky Pond in 1991. These measurements point to effects of acid deposition.
>
> Turbidity exceeded screening criterion only below Estes Park, outside the park.
>
> Fecal coliform concentrations exceeded the Water Resource Department criterion for 64 data points, some inside the park (near the NPS housing area sewage treatment plant outfall and the National Park Village sewage treatment plant outfall) and outside the park.
>
> Nitrite concentrations exceed drinking water criterion two times (out of 2,798 measurements) in Sky Pond (>1 mg/L) in the park. This is likely due to nitrogen deposition from air pollution.
>
> Sulfate concentrations exceed secondary drinking water criterion from 1941 to 1957 in the Colorado River downstream from Shadow Mountain Lake. No samples since have exceeded this criterion.
>
> Total alkalinity at 160 stations (95% of measurements occurred in the park) were below the NPS Air Resources Division's threshold, indicating sensitivity to acid deposition from 1981 to 1995. No samples since 1995 were included in the Environmental Protection Agency's database.

The data from this study indicated that surface waters within the project area were generally of good quality, with some impact from natural and human activities. Potential natural sources of contaminants include erosion from seasonal flooding and geologic weathering. Potential anthropogenic sources of contaminants include municipal and industrial wastewater discharges (downstream of park), atmospheric deposition, stormwater runoff, agricultural activities (downstream of park), and recreational use (NPS 2001b). Because Rocky Mountain National Park straddles the Continental Divide, it contains only headwaters, with no pollution potential from sources occurring upstream.

Elk and Beaver Effects on Water Quality

The overpopulation of elk is another potential source of water contamination, although no studies have quantified the levels. With more elk than anticipated under natural conditions, it is possible that more fecal coliform and nitrogen from feces and urine are entering surface waters.

In addition, although no quantified observations have been made, there likely has been an increase in turbidity of water due to the reduction in willow along banks, which leads to destabilized banks and increased erosion. A balance of erosion and deposition is expected under natural conditions; however, there may be more erosion than deposition, increasing turbidity of park waters flowing out of the elk range (Cooper 2003).

Although no research has been completed on the subject in the park, the decrease in beaver numbers and their activity since 1940 may contribute to increased turbidity. Beaver dams and canals slow water current velocity and increase deposition and retention of sediment and organic matter in the pond, which decreases turbidity downstream of the dam, increases the soil to water interface, and increases resistance to disturbance (Gurnell 1998, Naiman et al. 1988).

SOILS AND NUTRIENT CYCLING

Background

Soils are largely the result of the geology and geologic processes. Mountains in Rocky Mountain National Park were formed by a series of granitic batholiths intruded into Precambrian mica schists and pegmatites. Glacial activity, occurring as recently as 12,000 years ago, has created much of the geologic landforms evident in the park today by decomposing the mountains. Glacier-carved valleys and their associated features are present along the St. Vrain River, Big Thompson River, Colorado River, and associated tributaries. For example, Moraine Park is the remnant of a glacial lake formed by the Thompson Glacier, and the fine sediments deposited in the lake now support wetland and grassland meadows. Moraines result from the scouring action of glaciers and are composed of unconsolidated rock and debris such as boulders, cobbles, gravel, sand, and clay. Ultimately, the weathering of the glacial and alluvial granites, schist, and gneiss parent material developed soils in the park (Natural Resources Conservation Service [NRCS] 2000).

In 1998, an Order 2 soil survey was completed in the lower elevations of the park and an Order 3 soil survey was completed for other areas of the park. The following general soil properties of the park were reported (NRCS 2000):

> Soils of the low elevation valleys are generally very deep, loamy, and formed in alluvium from the nearby mountains. Particularly on the east side of the park, soils have dark-colored surface horizons. In the floodplains, they are poorly or very poorly drained with stratified textures. On stream terraces they are well drained.
>
> Soils of the glacial moraines are very deep, well or somewhat excessively drained, and loamy or sandy with a high content of rock fragments. They formed in till derived mainly from granite, gneiss, and schist.
>
> Soils of the subalpine mountain slopes are generally well or somewhat excessively drained, loamy with a high content of rock fragments, and have light-colored surface horizons. Depth to the underlying bedrock ranges from shallow to very deep. Typically, soil reaction becomes more acid with increasing elevation, as the climate becomes cooler and moister. These soils formed mainly in material weathered from granite, gneiss, and schist.
>
> Soils of the alpine mountains and ridges are generally well drained, loamy with a high content of rock fragments, strongly acid, and have dark-colored surface horizons. These soils formed mainly in material weathered from granite, gneiss, and schist. Poorly drained soils are common in landscape depressions and drainageways.

Compaction, Bare Ground, and Erosion

Elk hoof action is a main factor in soil compaction in the park. Compaction decreases the amount of oxygen in the soil, which eventually can lead to plant death and increased bare ground and soil erosion. In comparing elk exclosure sites and grazed sites after 35 years, research indicates an increase in bulk density in grazed sites (a measurement of soil compaction) for mesic meadow, aspen, and willow vegetation types (Binkley et al. 2003). However, there was no trend identified for the rocky upland sagebrush community. In the grazed sites, increases in bare ground have been observed but do not exceed 5% of the affected area. Increased soil heating, evaporative losses, nitrogen losses, and erosion may be occurring in these locations (Singer and Schoenecker 2003).

Singer et al. also found that elk grazing has increased the percent of bare ground by 4.6% and increased bulk density of soils by 1.7% on the primary winter range (riparian willow and upland shrub/grassland sites) for sites that had not been protected from elk grazing for four years in Rocky Mountain National Park, although the difference was not statistically significant (2002). Therefore, the transport of soil to waterways is not a concern on most of Rocky Mountain National Park's winter range since the area consists of mostly flat sites and very gentle slopes (Singer et al. 2002).

Zeigenfuss et al. measured a 4% increase in bare ground in transects that were established in 1968 (when elk numbers were released from artificial controls) and measured through 1992 (1999). The only transects with a statistically significant increase in bare ground were in grasslands. Other vegetative communities measured were meadow, willow, aspen, sagebrush, and bitterbrush.

Although not quantified, direct observations in Moraine Park in Rocky Mountain National Park show increased bank instability and erosion due to the reduced amount of willows and their root systems along streambanks.

Nutrient Cycling

Nutrient cycles are considered the cornerstone of ecosystem sustainability, which can be defined as the maintenance of plant communities and nutrient cycles of a particular ecosystem over at least a 50 to 200 year time frame. Ecosystem scientists measure nutrient cycles by determining the amount of nutrient for each stage of a nutrient cycle and by measuring the nutrient content of each material in which the nutrient is stored. This can include measuring nutrients in belowground and aboveground stocks (materials that store nutrients) such as soil, root mass, litter, and aboveground vegetative matter.

Understanding nutrient cycles can be important because depletion of nitrogen and soil organic matter can reduce long-term plant productivity (Vitousek 1982) and could result in change in plant community composition (Schoenecker et al. 2001).

Nitrogen

Nitrogen is one of the most important nutrients for plants; however, it must be fixed into a usable form before plants can use it. Inorganic nitrogen in the atmosphere can only be used by lower-level plants and fungi. The nitrogen cycle involves fixing nitrogen from the atmosphere via bacteria, fungi, and acinomyetes, or by lightning. Once nitrogen is available in an organic form, plants can use it to manufacture proteins. Plants can store organic nitrogen, returning it to the biogeochemical cycle when they die. This nitrogen is converted by decomposers to inorganic nitrogen in the form of ammonia, which is then converted to ammonium in a process called mineralization. Ammonium is then converted, via nitrification, into nitrites and, ultimately, nitrates, the very soluble, organic form that plants can use. Nitrogen can also be returned to the atmosphere in a chemical process referred to as denitrification (Pidwirny 2006).

Ungulates, such as elk, can accelerate, decelerate, or have no impact on nutrient cycling. Ungulates consume aboveground nitrogen through herbivory on plants and thereby reduce the amount of plant litter that falls to the soil surface every year. Root biomass and inputs from root turnover are usually thought to be reduced by ungulates. However, in Rocky Mountain National Park root biomass has been shown to increase as a result of elk grazing. Ungulates deposit feces and urine on the soil surface. Ungulates may also move nitrogen around the landscape on multiple temporal and spatial scales (such as from the winter to summer range). Ungulates and their grazing can alter any of the main components of the nitrogen cycle: nitrogen pools, nitrogen fluxes on an annual basis in and out of their primary winter and summer ranges (e.g., nitrogen loss via erosion, nitrate leaching, ammonia volatilization from ungulate urine), or nitrogen fluxes on a daily basis to habitats within a summer or winter range (Singer and Schoenecker 2003, Schoenecker et al. 2004).

Nutrient acceleration occurs when plant species compensate for herbivory by increasing their growth rates and nutrient uptake.

In Rocky Mountain National Park, research suggests that elk may either not be accelerating nutrient cycling (Coughenour 2002, Schoenecker et al. 2004) or that they may slightly accelerate or decelerate local soil and plant nitrogen concentrations (Binkley et al. 2003, Menezes et al. 2001, Zeigenfuss et al. 2002), depending in part on vegetation communities. Schoenecker et al. (2004) found that ungulate herbivory significantly affected nitrogen mineralization and nitrates in short willow and aspen vegetation communities, and further suggested that nitrogen in being depleted from the willow and possibly aspen vegetation communities. Binkley et al. (2003) measured total soil nitrogen and total soil carbon in the same areas and did not find differences in these nutrient measures. Binkley et al. (2003) and Schoenecker et al. (2004) found almost no net change in nitrogen in upland grass/shrub communities' soils. Because the ecosystems in Rocky Mountain National Park are nitrogen limited, understanding the role of elk in nitrogen cycling is important for future ecosystem sustainability (Menezes et al. 2001).

Some evidence shows that elk may be reducing total nitrogen pools in aspen and short willow communities by transferring nitrogen away from these aspen and willow communities (Schoenecker et al. 2004).

Elk transfer organic nitrogen by spending a large portion of their time feeding while in aspen and willow communities and then spending a large portion of their time resting, defecating, and urinating while in forest and upland shrub communities (Schoenecker et al. 2004). This transfer is important, since nitrogen deposited in urine and feces is 20% to 29% of total nitrogen mineralization (Lane and Montagne 1996). However, Schoenecker et al. detected no decrease in nitrogen mineralization rates in aspen communities (2004).

Schoenecker et al. also suggested that there may be a seasonal net movement of nitrogen from the elk summer to winter range, based on analyzing body mass lost on the winter range (2004).

Other Nutrients

In addition to nitrogen, comparing grazed to ungrazed sites after 35 years showed a substantial decrease in the amount of extractable calcium, magnesium, potassium, and phosphorus in upland shrub communities: 33% on average (Binkley et al. 2003). This was not found in other plant communities studied (aspen and mesic meadow).

Elk, Beaver, and Nutrient Cycling in Rocky Mountain National Park

Elk may also indirectly affect nutrient availability in Rocky Mountain National Park by playing a role in the reduction of beaver populations in the park. Elk herbivory on willows in the winter may affect regrowth of willows, the beaver's winter food. By limiting the beaver's food, elk may be limiting the extent of beavers in the park, thereby affecting nutrient cycling (B. Baker et al. 2005). By flooding areas, beaver cause increases in microbial action in soils (Songster-Alpin and Klotz 1995). In addition, flooding spreads nutrients across the riparian areas (Westbrook 2005).

Beaver increase organic matter in an area threefold, through the damming of sediments and organic materials (Naiman et al. 1988). However, when flooding caused by beaver is reduced and the soils become drier, the nutrients can become firmly bound in the roots of grasses (Ives 1942), making them unavailable to willows.

Microbial Activity

Mycorrhizal fungi have a symbiotic relationship with plants by forming mycrorrhizae between plant roots and fungi. These mycorrhizae allow movement of nutrients between plants and fungi, providing benefit to the plants. Carbon flows to the fungus, while inorganic nutrients move to the plant (Sylvia 2004). In nutrient-limited soils, nutrients taken up by the mycorrhizae can lead to improved plant growth and reproduction, so plants with mycorrhizae can more often tolerate environmental stresses than nonmycorrhizal plants.

Herbivores generally affect mycorrhizal fungi negatively, across plant and herbivore species, as their herbivory on plants reduce plants' carbon stock, and, therefore, the amount of carbon transferred to the mycorrhizae (Gehring and Whitham 2002). Herbivory can also affect species composition of mycorrhizal communities (Gehring and Whitham 2002). When moose herbivory on willow species was studied against exclosures, mycorrhizal infections of willow protected from herbivory were increased by up to 42% in the 10-to-15 cm soil depth (Rossow et al. 1997). Therefore, by protecting plants from herbivory, plants are both strengthened by increased mycorrhizae and by reduced aboveground herbivory. There is no data with regards to this in Rocky Mountain National Park.

NATURAL SOUNDSCAPE

The natural soundscape include natural and human components. It also includes the “natural quiet” that occurs in the absence of natural and human sound sources.

The natural soundscape can be defined as the natural ambient sound level of a park. "It is comprised of the natural sound conditions in a park which exist in the absence of any human-produced noises. These conditions are actually composed of many natural sounds, near and far, which often are heard as a composite, not individually” (NPS 2000). In other words, the natural ambient sound level is the total existing sound environment, less all human-caused sound. *Management Policies*, Section 4.9 states “Natural soundscapes exist in the absence of human-caused sound. The natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Natural sounds occur within and beyond the range of sounds that humans can perceive, and can be transmitted through air, water, or solid materials” (NPS 2006b).

Noise, an element that can degrade the natural soundscape is defined as “…unwanted or undesired sound, often unpleasant in quality, intensity or repetition. . . . In a national park setting, noise is a subset of human-made noises” (NPS 2000). Noise may vary in character from day to night and from season to season. Noise intrusions also have two dimensions: duration and the decibel level relative to the natural soundscape (Harris, Miller, Miller, and Hanson, Inc. 2001).

Noise is generally defined as unwanted or intrusive sound. Sound can be perceived as noise because of loudness, pitch, duration, occurrence at unwanted times or from an unwanted source, or because it interrupts or interferes with a desired activity. A sound that is considered neutral or desirable by one person may be considered unpleasant noise by another person because of a perception of inappropriateness or disturbance, or unwanted content or meaning. Noise can adversely affect park resources or values, including but not limited to natural soundscape, wildlife, and visitor experience. It can directly impact them by modifying or intruding upon the natural soundscape, masking the natural sounds that are an intrinsic part of the environment.

Some human-caused sound is considered acceptable when associated with purposes and uses for which the park was created. Director’s Order 47 (NPS 2000) and *Management Policies* Section 4.9 (NPS 2006b) require park units to determine the level of human-caused sound that is necessary for park purposes and to achieve that level by reducing noise and restoring the natural soundscape to the greatest possible extent.

Soundscape at Rocky Mountain National Park

No park-specific sound measurements were made to determine natural ambient sound levels in Rocky Mountain National Park for this plan. The natural soundscape there includes sounds produced by such sources as wind, thunder, insects, bird and animal calls, falling rocks, streams, and waterfalls. One unique element of the park’s natural soundscape is the bugling of bull elk that can be heard throughout the park during late summer and fall.

Between 30 and 70 commercial flights flying between 15,400 and 19,000 feet pass over the park daily (NPS 2004f). A Federal Aviation Administration Special Flight Rule (FAA SFAR No. 78) temporarily banned the use of low-flying, commercial air tours over Rocky Mountain National Park in 1997 (FAA 2005). Commercial air tour operations over Rocky Mountain National Park were permanently banned by the Federal Aviation Administration effective as of January 2003 (Federal Aviation Regulations, 14 CFR Section 136.5).

In 1998, data collection was started for the development of a study plan to characterize ambient sound in the park. The project was designed to evaluate noise characteristics in the park with respect to noise from aircraft tour overflights. However, Section 806 of the National Parks Air Tour Management Act of 2000 permanently banned commercial air tours over the park, and the study was suspended after Phase I was completed. The 1998 data were the first noise data collected in the park. One-hour sound level measurements were taken at eight sites by Harris, Miller, Miller, and Hanson (1998), on one to three occasions each, in forest, tundra, and meadow habitats. Background level measurements were determined, and then intrusions from jets, other aircraft, and other human-based noises were noted. Background sounds in forested areas ranged from 25 decibels (dBA) for wind to 46 dBA for elk; from 26 dBA (wind) to 38 dBA (other animals) in meadow areas; and 27 dBA (wind) in tundra areas.

One-hour sound level measurements of 15 sites in Rocky Mountain National Park, taken to examine how to measure noise intrusions in national parks, provide additional baseline data with which to estimate the natural and current soundscapes of the park (Harris, Miller, Miller, and Hanson, Inc. 2001). Some undeveloped sites where wind in the foliage was heard were as low as 20 to 30 dBA). At other developed sites, intrusions into the natural soundscape occurred, including low levels of traffic noise (25 to 35 dBA), helicopter overflights (50 to 73 dBA), propeller aircraft (55 dBA), and jet overflights (35 to 50 dBA).

Noise levels vary between day and night in Rocky Mountain National Park. Because human activity mostly occurs during the day, noise levels in the park are higher then than at night. Night provides greater opportunity to experience the natural sounds in the park with less human influence.

The primary human-made sounds present in the park are noises associated with vehicles and campground use. Engines are a major source of human-caused sound in the park. These include automobiles, motorcycles, and trucks, aircraft, and generators. Other common sources of human-caused sound in the park include electronic devices such as radios and automobile horns, human vocalizations, and vehicle tires on roads. Human-caused sound is typically higher between May and September, corresponding with higher park visitation during these months.

WILDERNESS

The 1964 Wilderness Act defines wilderness:

> "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

In Rocky Mountain National Park, 94% of the park is recommended wilderness, 1% is designated wilderness, and the remaining 5% is classified as administrative, historic, and roads (see Figure 3.7). NPS *Management Policies* (NPS 2006b) states that all wilderness categories, including suitable, study, proposed, recommended, and designated, shall be treated as wilderness; thus, all categories of wilderness were considered in this analysis. The total wilderness area in Rocky Mountain National Park is 251,381 acres (NPS 2001a). Six U.S. Forest Service administered wilderness areas lie adjacent to the park, including Indian Peaks, 73,291 acres; Rawah, 73,068 acres; Comanche Peak, 66,791 acres; Never Summers, 20,747 acres; Neota, 9,924 acres, and; Cache la Poudre, 9,238 acres. A wilderness management objective for Rocky Mountain National Park is to cooperate and coordinate the management of the park's wilderness with management of the adjacent U.S. Forest Service wilderness areas. Information, techniques, and ideas will be freely shared and discussed that will lead to better protection and management of wilderness areas administered by both agencies (NPS 2001a).

All backcountry/wilderness areas of Rocky Mountain National Park are designated in one of four management classes based on the following criteria: type and amount of use, accessibility and challenge, opportunity for solitude, acceptable resource conditions, and management use. Table 3.3 presents some of the primary characteristics associated with each backcountry/wilderness management class.

National Park Service policy dictates that all management decisions affecting wilderness must be consistent with the minimum requirement concept, by completing a minimum requirement analysis on potential actions in wilderness. The minimum requirement analysis enables managers to examine and document whether a proposed management action is appropriate in wilderness and, if it is, what is the least intrusive equipment, regulation, or practice (minimum tool) that will achieve wilderness management

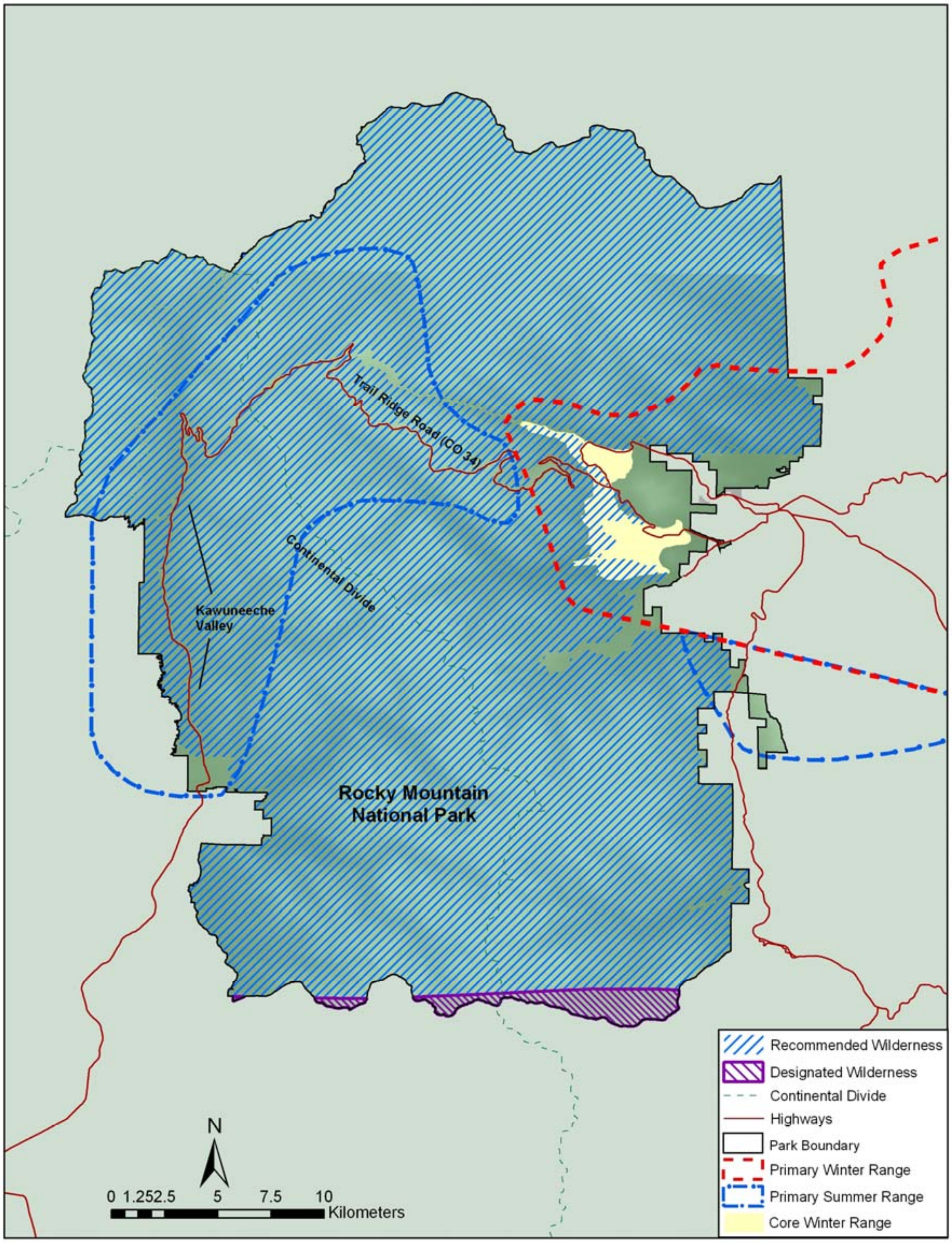


FIGURE 3.7: WILDERNESS TYPES IN ROCKY MOUNTAIN NATIONAL PARK

TABLE 3.3. ROCKY MOUNTAIN NATIONAL PARK WILDERNESS MANAGEMENT CLASSES

Class	RMNP Acreage	Public Use	Opportunity for Solitude	Management Use
1	170,236	Day use only; no stock use; no camping except for management activities and in winter (with restrictions)	Outstanding opportunity for solitude; natural sounds prevail	No designated or maintained trails; no signs or cairns; evidence of management is rare; mechanized equipment only during emergency operations or "absolutely critical" as determined by a minimum requirement analysis and approved by Superintendent
2	36,832	Low to moderate use; no stock use; area camping for seven or fewer persons allowed; no fires	High most of the year; moderate during summer; some noise interferes with natural sounds	No designated trails, but some designated routes; minimum cairns as necessary; no facilities; signs only as needed to protect resources and public safety; no motorized equipment except when approved with minimum requirement analysis
3	27,474	Moderate to high use; designated campsites; fires in campsites only; stock use on designated trails and camp sites only	Low to high depending on time of year, day of week, time of day, weather, and other factors	Facilities (e.g., privies, hitchrails, cabins, tent pads, signs) per minimum requirement concept; designated, formally constructed trails
4	23,313	High use; stock use on designated trails only; day use only (except eight designated camp areas)	Low to moderate depending on time of year, day of week, time of day, weather, and other factors	Facilities (e.g., privies, hitchrails, cabins, tent pads, signs) per minimum requirement concept; designated, formally constructed trails

objectives. The completion of this process assists managers in making informed and appropriate decisions concerning actions conducted in wilderness (NPS 2001a).

In wilderness, how a management action is carried out is as important, if not more important, than the end product. When determining minimum requirement, the potential disruption of wilderness resources and character will be considered before, and given significantly more weight than, economic efficiency and convenience. If a compromise of wilderness resources or character is unavoidable, only those actions that preserve wilderness character in the long term and/or have localized, short-term adverse impacts will be acceptable (NPS 2001a).

As stated in the park's backcountry/wilderness management plan (NPS 2001a), stricter standards are used with regard to the use of motorized equipment and mechanical transport in non-emergency actions. In Class 1 areas of the park, hand tools and traditional practices are typically used. Motorized equipment and mechanical transport are not allowed, except during emergency operations or when "absolutely critical" for the protection of natural or cultural resources as determined on a case-by-case basis using a minimum requirement analysis and approved by the superintendent. In Classes 2, 3, and 4, hand tools and traditional practices are used whenever possible. Motorized equipment and mechanical transport are not routinely used, unless their use is first reviewed using the minimum requirement analysis or approved in an existing management plan (e.g., backcountry/wilderness management plan, fire management plan).

The elk winter range includes primarily Class 4 areas of wilderness, with some Class 1 and Class 3 areas. The elk summer range, which is at higher elevations, includes predominantly Class 1 areas, with some Class 3 and a few Class 4 areas.

SOCIOECONOMICS

The socioeconomic affected environment includes the socioeconomic impact area and the baseline conditions within that impact area. The primary impact area is Rocky Mountain National Park and the Estes Valley, including the town of Estes Park, in Larimer County because this is:

The region in which the concentrations of elk are highest,

The area in which visitation is most influenced by the presence of elk, and

The area within which proposed actions will primarily take place.

The town of Grand Lake in Grand County on the west side of the park may also be affected; however, the magnitude of the effects from proposed actions would be very small. Therefore, the socioeconomic conditions of Grand Lake are not characterized in this chapter, but the effects on Grand Lake are analyzed qualitatively in Chapter 4, "Environmental Consequences."

The major components of socioeconomic conditions in the Estes Valley include economics (employment, income, sales, tourism), demographics (population, age, ethnicity, housing), fiscal circumstances (budgets and operations for government agencies), and the social environment (rural nature, agriculture, mountain setting). Elk and vegetation in this primary impact area affect these socioeconomic conditions in various ways.

Current Economic Conditions and Trends

The economic conditions of the geographic area of effect are described through income and employment trends, characteristics and demographics of the labor force, and descriptions of the area's major economic sectors, especially tourism and recreation.

Employment

The Estes Valley's largest employers include the local school district, the Estes Park Medical Center, the Town of Estes Park government, the Estes Valley Recreation and Park District, the National Park Service, and the Harmony Foundation. The Estes Valley also has a notable construction sector that reflects the rapid growth in the area over the past 15 years. Large tourism and recreation employers include the Holiday Inn and YMCA of the Rockies (Town of Estes Park 2005b).

As shown in Table 3.4, tourism-related employment sectors dominate the Estes Valley economy, which centers on the Town of Estes Park and Rocky Mountain National Park.

The largest Estes Valley employment sectors are retail trade and arts, entertainment, and accommodation and food services, which together make up 43% of Estes Valley employment. These industries employ many people but do not pay high wages. Between 1990 and 2000, Estes Valley employment grew by about 50%. The bulk of the growth occurred in tourist-related, service-employment sectors.

The Estes Valley labor force has both a relatively low unemployment rate and low participation rate, indicative of a strong economy and with a disproportionate number of retirees.

TABLE 3.4: EMPLOYMENT BY INDUSTRY, ESTES VALLEY, 1990 AND 2000

Industry	Number of Persons 1990	Percent of Total 1990	Number of Persons 2000	Percent of Total 2000
Agriculture, forestry, fishing and hunting	38	1	28	1
Mining	0	0	17	0
Construction	206	7	390	9
Manufacturing	105	3	261	6
Wholesale trade	58	2	55	1
Retail trade	658	22	736	16
Transportation, warehousing, and utilities	114	4	151	3
Information	NA	0	124	3
Finance, insurance, and real estate	234	8	280	6
Professional services	129	4	320	7
Educational, health, and social services	501	17	628	14
Arts, entertainment, food, and accommodation services	130	4	1,243	27
Other services	649	22	202	4
Public administration	195	6	120	3
Total Employment	**3,017**	**100**	**4,555**	**100**

Source: U.S. Census Bureau (2001)

Employment fluctuates by season in the Estes Valley. Monthly employment data are available only at the county level, so Larimer County, Colorado, serves as a proxy for the Estes Valley. Larimer County seasonally employed more individuals in all industries and in the accommodation and food services sector in the summer months of 2004, partially reflecting the Estes Valley's dominant tourism industry. Rocky Mountain National Park uses roughly 1,600 volunteers each year for various tasks, which would not be evident in the employment data (NPS 2005l). Most of those volunteers work in the more temperate summer and autumn months, many on programs related to elk, such as the Bugle Corps.

Tourism and Recreation

Tourism and recreation is the largest industry in the Estes Valley, evidenced by relative prominence of the retail, service, construction, and related economic sectors that benefit from visitors who vacation at Rocky Mountain National Park and in Estes Park. In the employment and income data presented earlier, direct tourism and recreation account for more than 40% of the Estes Valley economy.

Several amenities exist in the Estes Valley area, all of which draw visitors to come to and remain in the area. In addition to Rocky Mountain National Park, these recreational opportunities include Roosevelt National Forest; the shopping districts of the Town of Estes Park; the facilities of the Estes Valley Recreation and Park District facilities, including two golf courses; and the Big Thompson River. Additionally, the Town of Estes Park holds events year-round that draw visitors, such as ethnic festivals, gallery tours, the Estes Park Wool Market, the Rooftop Rodeo, and Elk Fest.

The Contribution of Rocky Mountain National Park to the Local Economy

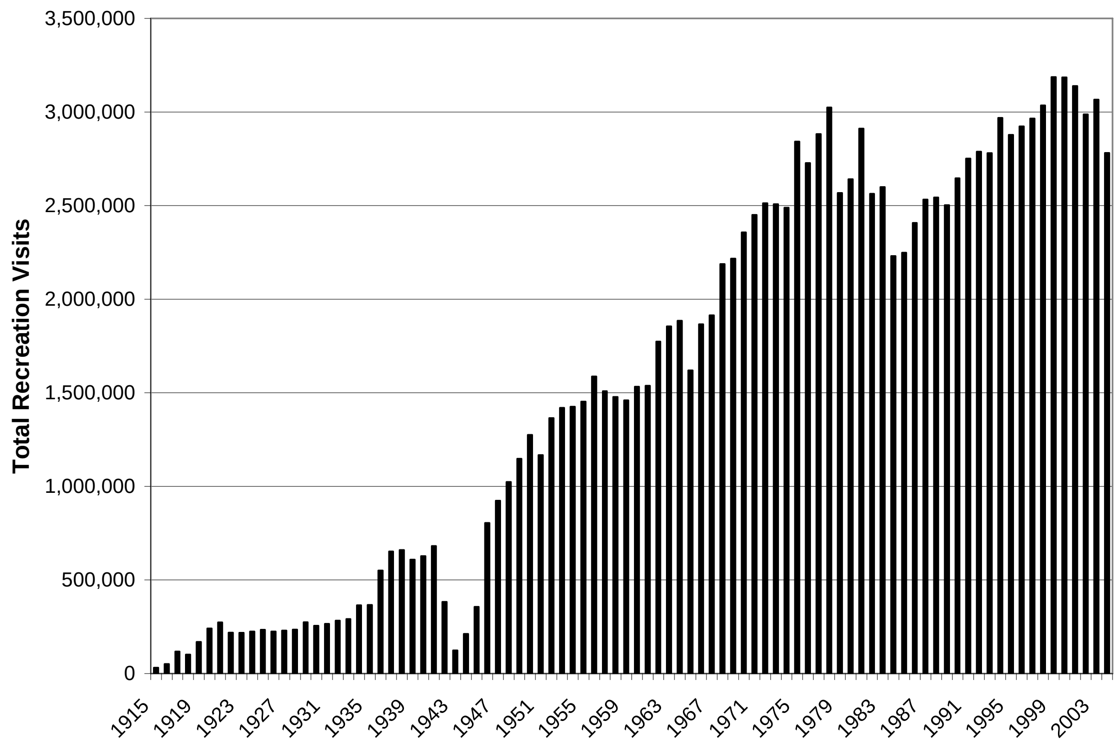
The National Park Service estimated that visitation to Rocky Mountain National Park approximated 2.8 million in 2004; Figure 3.8 shows the trend in overall recreation visits to Rocky Mountain National Park since 1915. Table 3.5, below, shows that most visitors enter Rocky Mountain National Park through Estes Park, rather than through Grand Lake. As illustrated by the table, in 2003, this gate was used by 71% of visitors.

Rocky Mountain National Park's busiest months each year are June through September. September has consistently accounted for between 14% and 16% of total annual visitation (NPS 2005k). Forty-five percent of visitors to the park are non-local day visitors, from areas outside the study area. Not included in this number are the non-local visitors who stay overnight in the park. Overnight visitors account for 6.5% (or 189,336) of total annual visitation, and though the information is not available to determine what portion are non-local, the proportion is likely similar to the proportion of non-local day visitors. Of these non-local visitors, most come from Denver, Boulder, Fort Collins, and Texas.

The National Park Service, in concert with Michigan State University, created the Money Generation Model (MGM) to assess the economic impacts of the Service's park units, including Rocky Mountain National Park, on their local areas. In 2003, the MGM estimated that Rocky Mountain National Park's 3.1 million recreation visits were split into the following categories: 10% local visitor day trips; 45% non-local visitor day trips; 35% hotel stay visits; and 10% camping stay visits (NPS 2005e). Local is defined as Larimer County.

The MGM calculated Rocky Mountain National Park's total annual economic impact on the local area as $204 million in sales, $69 million in personal income, and nearly 5,000 jobs (NPS 2005e). This included direct economic effects of $154 million in direct sales of goods and services, $52 million in personal income, and 4,200 jobs for the local area. Those sales, income, and jobs reverberated through the economy, generating $50 million in secondary sales, $17 million in secondary personal income, and another 740 secondary jobs. Secondary sales, income, and jobs are those that result from rounds of spending that occur subsequent to the initial spending by visitors (e.g., personal consumption, expenditures of local employees).

Part of Rocky Mountain National Park's economic contribution stems from its 19 concessioner contracts with companies that operate in Rocky Mountain National Park. They provide horseback riding on livery trails, wood sales, guided rock climbing trips, and retail sales at the Trail Ridge Store. These concessioners employed roughly 150 persons and generated $4.8 million in gross sales in 2004 (Hannon 2005).



Source: National Park Service, Visitation Statistics, Public Use Statistics Office, http://www2.nature.nps.gov/stats/, July 2005.

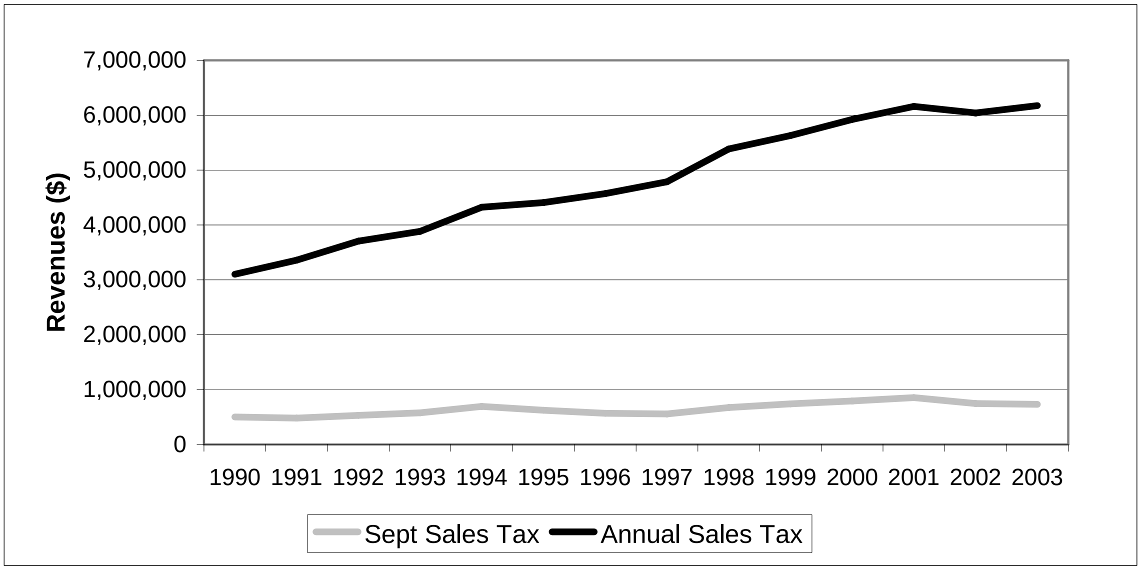
FIGURE 3.8: TOTAL RECREATION VISITS TO ROCKY MOUNTAIN NATIONAL PARK, 1915 THROUGH 2004

TABLE 3.5: RECREATION VISITS THROUGH ROCKY MOUNTAIN NATIONAL PARK'S ENTRANCES IN THOUSANDS, 1996 THROUGH 2003

	Estes Park	Grand Lake	Other Entrances	Total Visits	Annual Change
1996	2,186	478	194	2,857	NA
1997	2,185	479	221	2,885	1.0%
1998	2,239	498	190	2,927	1.5%
1999	2,285	499	304	3,089	5.5%
2000	2,324	449	316	3,088	0.0%
2001	2,255	433	350	3,038	-1.6%
2002	2,102	435	355	2,891	-4.8%
2003	2,138	460	395	2,993	3.5%

Source: National Park Service, Visitation Statistics, Public Use Statistics Office, http://www2.nature.nps.gov/stats/, July 2005.

The Town of Estes Park collects a 4% sales tax on retail sales and on accommodation and food services, among other services. Figure 3.9 highlights the town's annual and September tax collections from 1990 through 2003.



Source: Town of Estes Park, Finance Department, sales tax collection data obtained in 2004.

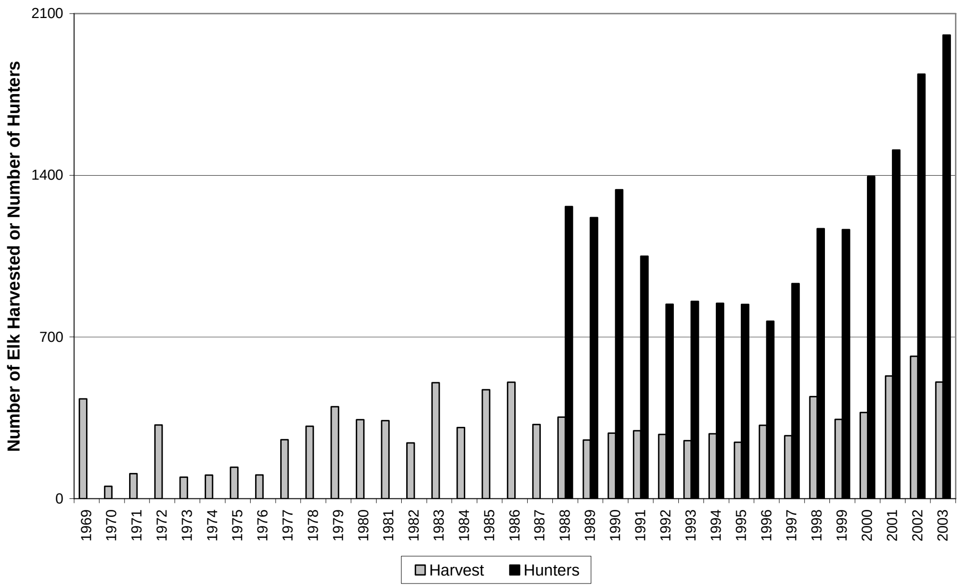
FIGURE 3.9: TOWN OF ESTES PARK ANNUAL AND SEPTEMBER SALES TAX COLLECTIONS, 1990 THROUGH 2003

The town's annual sales tax collections rose steadily from 1990 through 2003. Sales in September (the peak season for elk viewing) remained rather steady over this period, causing its share of annual sales tax collections to decline from 16% to 12% between 1990 and 2003. Though the proportion of annual visitation to Rocky Mountain National Park captured in September has remained steady over the years, sales to those visitors as a proportion of annual sales have apparently declined. These data suggest that an increasing proportion of the September visitors do not spend the night. Thus, the positive economic impacts of the elk are probably not increasing at the same rate as overall economic impacts of the park.

Lodging and accommodations, retail and gifts, and restaurants make up the largest portion of sales tax collections in Estes Park. The town has a wide range of lodging options. These include almost 30 hotels and motels, 10 bed and breakfast accommodations, more than 40 cabins and cottages, more than 10 inns and lodges, about 20 rental condominiums and companies offering rentals, and seven campgrounds and recreational vehicle parks (Town of Estes Park 2005a). The town's occupancy rate in September likewise dropped from 80% to 64% during 1999 to 2003.

Impacts of Hunting on the Local Economy

Hunting is an important recreational activity in the Estes Valley and Larimer County. Figure 3.10 presents data on the number of elk harvested and the number of hunters around Rocky Mountain National Park in the vicinity of the Estes Valley. The data spanning 1969 through 2004 are provided for Colorado Division of Wildlife Game Management Unit 20 around Estes Park and Game Management Unit 18 around Grand Lake. Figure 3.11 shows the game management units near the park.



Source: Colorado Division of Wildlife. 2005. Big game hunting season recap summaries and harvest survey statistics, http://wildlife.state.co.us/huntrecap/, July 2005.

FIGURE 3.10: ELK HARVESTED AND HUNTERS IN THE FIELD IN GAME MANAGEMENT UNIT 20, ESTES PARK, 1969 THROUGH 2004

In Game Management Unit 20, the number of elk harvested has been 300 to 600 animals since 1969. The economic impact of hunting is much greater on the west side of Rocky Mountain National Park; the number of hunters around Grand Lake is more than twice that of Estes Park. Hunter numbers appear steady around Grand Lake, but hunter numbers around Estes Park rose substantially from the late 1990s through 2004. The Colorado Division of Wildlife estimated that hunters spent roughly 16,500 days hunting around Estes Park, with no specification for residents and non-residents (CDOW 2005b). Using the Colorado Division of Wildlife's 2004 hunting economic impact model, it is estimated that hunters around Estes Park spend about $50 per day, and hunters around Grand Lake spend about $70 per day, totaling $825,000 and $1.7 million in direct economic effects from hunting in the two areas, respectively (BBC 2004).

Fiscal Conditions of Government Entities

Several government agencies other than the National Park Service would be financially affected by any elk and vegetation management actions. These agencies include the Town of Estes Park, the Estes Valley Recreation and Park District, and the Colorado Division of Wildlife. It is anticipated that any financial impacts on the Town of Grand Lake would be minimal, and its fiscal conditions are not analyzed. Also, it is unlikely that any impacts from the alternatives would affect the U.S. Forest Service or the Bureau of Land Management, since their visitation is probably not driven by the management actions in the alternatives. The National Park Service's budget for revenues, expenditures, and capital investments in Rocky Mountain National Park is highlighted in the "Park Operations" section. The National Park Service estimates that it currently spends less than 1% of its budget directly on the management of elk and vegetation in the park, out of a 2004 budget of $20.4 million (Johnson 2005).

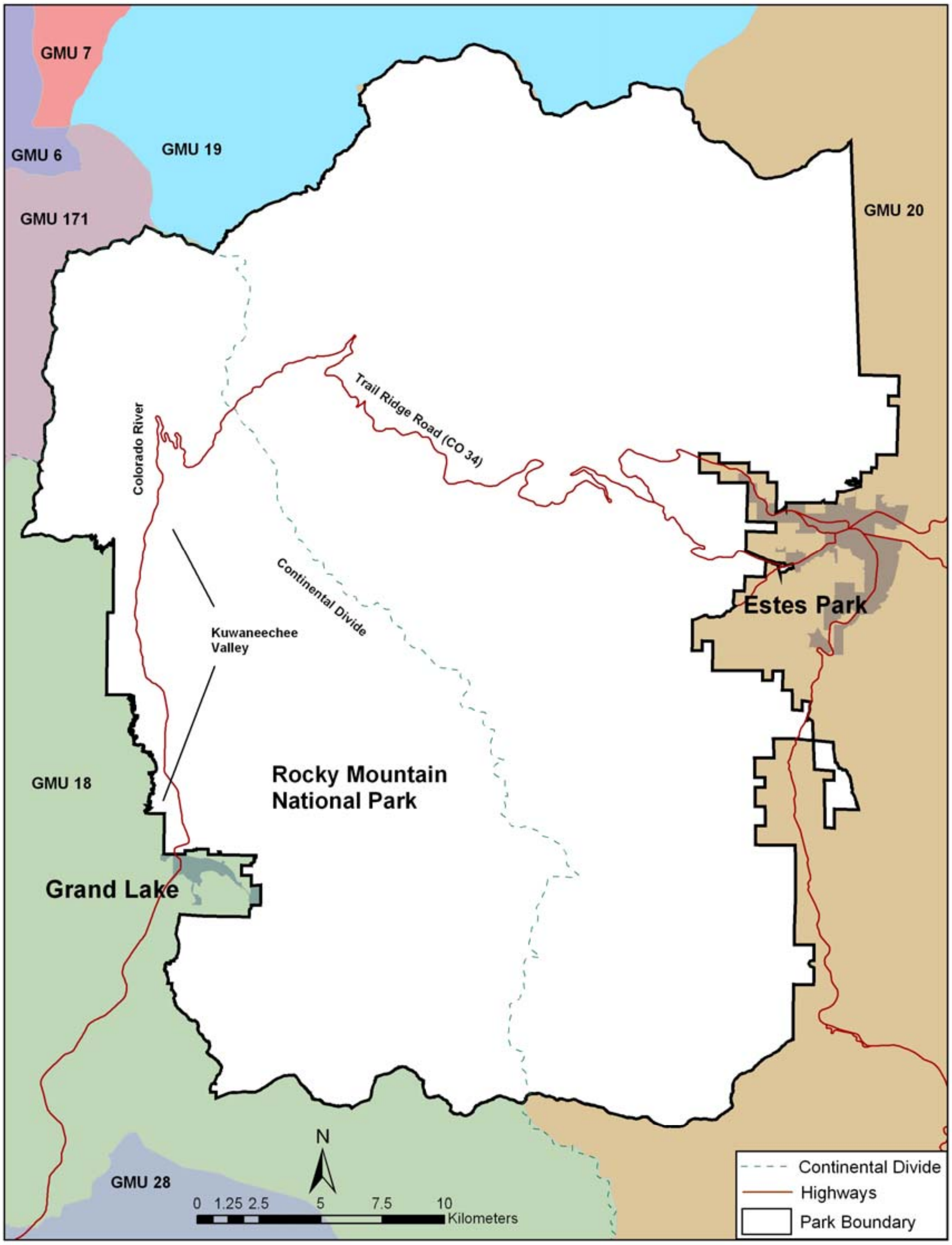


FIGURE 3.11: GAME MANAGEMENT UNITS IN THE VICINITY OF ROCKY MOUNTAIN NATIONAL PARK

Town of Estes Park

The 2002 budget for the Town of Estes Park is summarized in Table 3.6. The town collects most of its revenues through sales and use taxes within town limits, and it devotes a large portion of its expenditures to culture and recreation, reflecting the tourism and recreation focus of the area. The town employs roughly 100 full-time individuals and 50 seasonal persons. Officials were unable to estimate costs for managing elk and repairing any damage they may cause to town property, but implied that expenditures were minimal (Feagans 2005).

Estes Valley Recreation and Park District

The Estes Valley Recreation and Park District's 2005 budget is presented in Table 3.7. This agency derives almost all its revenues from user fees at its recreational facilities and devotes nearly all its budget to maintenance and operations. They employ 16 individuals full-time year-round and an additional 60 to 80 seasonal employees each summer. An estimated $12,000 to $14,000 (approximately 0.5% of the district's budget) were spent on managing elk and repairing any damage they cause to district property in 1999 (Gengler 2005).

Colorado Division of Wildlife

The Colorado Division of Wildlife's fiscal year 2002-2003 budget is presented in Table 3.8. The division generates most of its revenues through licensing fees with some assistance from federal and state funds, and it devotes more than half its expenditures to wildlife and habitat management. The Colorado Division of Wildlife employs roughly 650 individuals throughout Colorado. Much of the division's expenditures within the Estes Valley involve elk and other wildlife management.

Contribution of Elk to the Current Economic Conditions

The elk in and around Rocky Mountain National Park contribute to the economy of the Estes Valley in several important ways. Most notably, elk contribute to the draw that brings visitors to Rocky Mountain National Park and the surrounding areas. Elk also affect the economy through landscaping damage and repair on private and public property, including agricultural lands; traffic congestion and accidents; property values; and quality of life for local residents. These economic effects are both positive and negative.

Interviews with 29 representative local residents and industry representatives (stakeholder interviews) and surveys of visitors to the area were the primary tools used to characterize and quantify, where possible, these economic impacts in the Estes Valley.

Visitation to the Area

Stakeholder interviews suggested that elk are an important element of the overall scenery and nature of Rocky Mountain National Park that attracts millions of visitors each year (Harvey Economics 2005). Elk's contribution to that visitor draw increases in September, during the elk rutting and bugling season. In one study, between 20% and 30% of Rocky Mountain National Park visitors indicated that they would visit the park less often if they were less likely to see or hear elk (Fix et al. 2004). In another study, when asked to note the primary motivations to visit Rocky Mountain National Park, approximately 70% of visitors to Rocky Mountain National Park stated that they came to view elk, among other reasons (Cordova 2000b).

TABLE 3.6: 2002 BUDGET FOR THE TOWN OF ESTES PARK

Budget Item	2002 Dollars ($)
Revenues	
Sales and use tax	$6,261,334
Other taxes	$403,477
Licenses, permits, fees and charges	$1,630,479
Intergovernmental revenue	$1,489,967
Transfers from enterprises	$1,158,216
Total Revenues	$10,943,473
Operating Expenditures	
Public safety	$2,520,407
Culture and recreation	$1,820,334
General government and other	$3,230,165
Total Operating Expenditures	$7,570,906
Transfers to other governments or enterprises	$2,542,834
Capital Outlay	$2,999,386
Principal Payments	$175,167
Interest Payments	$236,573
Debt Outstanding	$3,248,741

Source: Colorado Department of Local Affairs, Municipal Budgets 2002, http://www.dola.state.co.us/LGS/TA/compendium.htm, July 2005.

TABLE 3.7: 2005 BUDGET FOR THE ESTES VALLEY RECREATION AND PARK DISTRICT

Budget Item	2005 Dollars ($)
Revenues	
General fund	$392,642
Recreation, parks and trails	$301,498
Aquatics	$91,350
Golf courses	$1,537,777
Marina	$204,735
Transfer from Conservation Trust Fund	$48,500
Total Revenues	$2,576,502
Operating Expenditures	
Maintenance and operations	$2,317,132
Contingency	$21,032
Total Operating Expenditures	$2,338,164
Transfer to Conservation Trust Fund	$105,000
Capital Expenses	$179,000

Source: EVRPD 2005.

TABLE 3.8: BUDGET FOR COLORADO DIVISION OF WILDLIFE, FISCAL YEAR 2002-2003

Budget Item	2003 Dollars ($)
Revenues	
License revenue	$60,654,392
Federal and state aid and grants	$21,735,437
Interest	$2,949,021
Goods and services	$876,305
Other	$763,525
Total Revenues	$86,978,680
Expenditures	
Wildlife habitat and species mgmt	$20,649,693
Wildlife recreation	$33,087,488
Wildlife education and information	$9,567,018
Responsive management	$27,285,450
Total Expenditures	$90,589,649

Source: Colorado Division of Wildlife, 2003 Annual Report, http://wildlife.state.co.us/AnnualReport/2003/report.pdf, July 2005

Based on these inputs, elk contribute significantly to the draw for visitors in September and to a lesser degree throughout the rest of the year. Typically, about 15% of visitors to Rocky Mountain National Park visit in September (NPS 2005k). Since 70% of the draw for visitors in September is due directly to the elk, then approximately 11% of overall visitation is attributable to elk, not including their added influence for visitors to come to Rocky Mountain National Park throughout the rest of the year. That rate of influence indicates that elk generate up to $30 million in sales, $10 million in personal income, and 750 jobs in the Estes Valley each year. The elk are also then responsible for 15% of the town's sales tax revenue, or about $900,000 each year.

Landscaping Damage

The effects of elk on the Estes Valley economy extend beyond the attraction of visitors. The elk, especially in their currently high and concentrated numbers within the Estes Valley, browse landscaping plants and grass, consequently damaging those landscaped areas on both public and private lands. The Estes Valley Recreation and Park District estimates that elk cost the District $12,000 to $14,000 in management and landscaping maintenance each year (Gengler 2005). The Town of Estes Park spends very little each year to repair landscaping damage on town property (Feagans 2005).

While landscaping damage is a negative impact for the local economy, it is also a benefit for local landscaping companies that generate more work and income by relandscaping properties. One landscaping company estimated that it generates about $70,000 annually in gross sales from installing elk-proof landscaping fence and selling shrubs and plants due to elk damage (Dudzinski 2003). If such revenues were consistent across the five landscaping companies in Estes Park, elk landscaping damage costs local residents as much as $350,000 each year, benefiting those local landscaping companies.

There is one operating cattle ranch within the primary impact area, and the owner indicated that the ranch accommodates the presence of browsing elk by reducing its herd to the carrying capacity of the land for grazing. The owner estimated that the ranch could run 50 to 100 additional cattle each year if the elk did not graze his land. This rancher's opportunity cost amounts to roughly $90,000 to $180,000 in lost revenues each year due to the elk (Adams 2003).

Switzer-Land Alpacas is an 8-acre farm located on the Mary's Lake Road in Estes Park. The farm has a herd of about 50 alpacas of various breeds and employs one full-time and two part time staff members. The main activities of the farm include selling and breeding alpacas. The farm manager reported that there are no impacts from elk to the alpacas themselves or to the business. The elk and the alpacas graze on the grass on the farm, but the amount that the elk eat does not affect the amount available for the alpacas (Beck 2006).

Private landowners in the vicinity sell permits to hunt on their property. This generates revenue for those landowners, and it is not expected that there would be a decrease in landowners' ability to sell permits as a result in the reductions in the elk population that are considered in this plan.

Traffic Congestion and Accidents

Elk also cause traffic congestion and have been involved in elk-automobile accidents in Rocky Mountain National Park and the Estes Valley. Colorado Department of Transportation (CDOT) traffic counters at the intersection of U.S. Highways 34 and 36 counted more than six million vehicles in 2004 (CDOT 2005). In the confines of Estes Park and the valleys leading into Rocky Mountain National Park, such traffic levels would likely cause congestion with or without elk; therefore, quantifying the impact of elk on traffic volumes alone is not attempted here.

The Colorado Department of Transportation tracks traffic accidents in the Estes Valley. The statistics for 1993 through 2002 show that accidents involving wild animals have generally increased concurrently with the area's rise in residency and tourism in the area, as have the total number of automobile accidents. No explicit information is available about accidents involving elk.

A stakeholder interview with an auto body shop owner in Estes Park lent insight into the costs of elk-automobile collisions in the Estes Valley. He indicated that his shop works on an average of one automobile involved in an elk collision each month, or about 12 automobiles per year (Thoms 2004). He estimated that each collision costs the automobile owner about $2,000 in bodywork, which equates to roughly $24,000 each year in revenue to the body shop from elk-related traffic accidents. There are three auto body shops in Estes Park, and if each performs about the same amount of work on elk-related automobile collisions, the total cost to automobile owners from elk-related accidents, and revenues for these auto body shops, could be a much as $75,000 per year.

Elk Influence on the Local Quality of Life

Elk also influence the Estes Valley through a contribution to quality of life for local residents and, through that quality of life, by sustaining or improving residential and commercial property values. The median price of owner-occupied homes in the Estes Valley rose by 125% between 1990 and 2000. Housing prices are affected by many factors, including economic growth, demand for and supply of housing, new housing developments, and quality of life. The distinct effect of elk on property values is not estimated here. However, in the stakeholder interviews conducted for this study, about 70% of residents interviewed indicated that elk are an important part of the quality of life of the Estes Valley. These respondents also often noted, though, that elk are not a primary reason for which new residents come to live and work in the Estes Valley.

PUBLIC HEALTH AND SAFETY

Rocky Mountain National Park is responsible for maintaining safe conditions that protect the health and safety of employees and the public in the park. Statutory and regulatory provisions applicable to units of the National Park Service require the park to not only provide safe facilities, utilities, and grounds within the park but also promote safety in park program and project operations. While the park is not responsible for safety in nearby towns such as Estes Park or Grand Lake, it recognizes that in-park elk management actions may impact safety in town.

Health and Safety Concerns Related to Elk and Elk Management

Interactions between Elk and Visitors

Like all wild animals, elk behavior can be unpredictable. Humans who approach too closely may trigger defensive behavior. Reports compiled from the park's Elk Bugle Corps volunteers indicate an average of three to five incidents per year involving charging bulls (commonly during the autumn rut) and approximately one per year of cows protecting newborn calves in the June calving season (Langdon 2004a). These incidents represent only what has been reported during times that volunteers are present. Actual numbers may be higher. So far, these incidents have resulted in no human injuries (Pettibone 2005). However, three volunteers have been injured while on elk-viewing duty since 1990: one was bitten by a dog and two sustained injuries from tripping (Langdon 2005d).

The most common locations for incidents are in or near Horseshoe Park, Beaver Meadows, and Moraine Park, the large meadows bisected by roads in the eastern part of the park, so staff and volunteers take extra precautions to reduce such incidents in these areas. Despite warning signs, volunteers and rangers intervene nearly every evening to return visitors to a safe distance from elk, and visitors have been known to physically fight over maintaining a safe distance from elk (Langdon 2005d). Visitors can also be aggressive toward other visitors who they perceive are interfering with their elk viewing opportunities. Ideally, three rangers assisted by Elk Bugle Patrol volunteers would patrol these three meadows every evening during the autumn rutting season, from the end of August to the end of October. Budget restrictions currently limit the park to assigning two rangers to this duty each evening, the minimum to maintain acceptable visitor safety (Langdon 2004a). Budget projections for the next few years suggest that the staffing situation, and therefore visitor safety in and around the meadows, will remain unchanged.

Protecting visitors places staff and volunteers at risk. Traffic congestion at the meadows increases the risk of vehicle collisions and associated personal injuries; Elk Bugle Corps volunteers who direct traffic are particularly vulnerable. Volunteers performing crowd control are at risk from nearby elk (Langdon 2004a). When the elk are easily visible along the roadway in meadows and visitor levels along the roadway and traffic become unsafe, rangers sometimes herd the elk away by horseback for visitor and traffic safety. Risks to rangers include falls from horses and elk charges.

The Rocky Mountain National Park communications center reports three collisions between elk and motor vehicles in 2004 (out of 89 vehicle accidents), occurring on 19 July, 19 August, and 17 November. In all three cases, the vehicle occupants were uninjured, and injuries to elk were minimal (Holien 2005a, 2005c). This compares to four collisions between deer and motor vehicles in 2004 (Holien 2005b).

Chronic Wasting Disease

Although existing evidence suggests that chronic wasting disease is not transmissible to humans (Belay et al. 2004), the Colorado Division of Wildlife recommends that hunters take precautions, including not handling or consuming elk or deer that appear sick, and not consuming brain, spinal cord, eyes, spleen, tonsils, pancreas, or lymph nodes of harvested animals (CDOW 2003a). The park's interim operating plan for handling deer and elk provides safety precautions for personnel monitoring, treating, or handling elk from infected areas (NPS 2001g).

Within the park, those most likely to face exposure to chronic wasting disease are employees and volunteers working with carcasses of potentially infected deer and elk, as when taking tissue samples for testing or when disposing of carcasses. Because hunting is illegal within the park, park visitors are unlikely to directly encounter diseased elk. However, because elk freely cross park boundaries, hunters (who often consume meat from the elk they take) in Game Management Unit 20 (surrounding the park's eastern boundary) and Game Management Unit 18 (surrounding the park's western boundary) could be affected by the park's elk management policies. On average over the past six years, Game Management Unit 20 has averaged 1759 elk hunters annually, and Game Management Unit 18 has averaged 4974 elk hunters annually. See Tables 3.9 and 3.10 for the numbers of elk and deer hunters each year from 1999 through 2004.

TABLE 3.9: GAME MANAGEMENT UNIT 20 HUNTERS

Year	Elk	Deer
2004	2,652	2,197
2003	2,007	1,902
2002	1,838	1,443
2001	1,498	1,226
2000	1,393	1,002
1999	1,165	910

Source: Colorado Division of Wildlife website http://wildlife.state.co.us

TABLE 3.10: GAME MANAGEMENT UNIT 18 HUNTERS

Year	Elk	Deer
2004	5,218	2,535
2003	5,195	1,720
2002	4,457	1,401
2001	4,356	1,167
2000	5,167	2,069
1999	5,449	1,608

Source: Colorado Division of Wildlife website http://wildlife.state.co.us

No chronic wasting disease statistics are available for the park, so chronic wasting disease prevalence is estimated from harvest estimates in adjacent Game Management Units. Prior to 2002, chronic wasting disease prevalence in elk was less than 1% in all Game Management Units where it was known to occur. Estimates in more recent years have had higher prevalence estimates. Elk Data Analysis Unit E-9 (Game Management Unit 20) which is adjacent to most of the east side of the park had the second highest chronic wasting disease prevalence estimate during the 2005-2006 hunting season: 2.6%, with a 95% confidence level ranging from 0.3% to 4.8% (Miller 2006). This was higher than the three-year average from 2003-2005 of 1.7%, with a 95% confidence interval of 0.9% to 2.5% (Miller 2006). Elk Data Analysis Unit E-8 (Game Management Unit 18, 181) which is adjacent to most of the west side of the park had the third highest chronic wasting disease prevalence estimate during the 2005-2006 hunting season: 0.5%, with a 95% confidence level ranging from 0.0% to 1.5% (Miller 2006). This was lower than the three-year average from 2003-2005 of 1.2%, with a 95% confidence interval of 0.4% to 2.1%

(Miller 2006). Currently, park staff lethally take only those elk showing symptoms consistent with chronic wasting disease. Staff took one elk in 1981, 1998, and 2002, six in 2003, three in 2004, eight in 2005 and none in 2006. In addition, staff tests elk carcasses for chronic wasting disease. The carcasses tested were three in 2001, 15 in 2002, 26 in 2003, 16 in 2004, 12 in 2005 and nine in 2006 (Watry 2007). Primary concerns include accidental human exposure to wildlife drugs when performing the lethal removal, and handling of elk that may have chronic wasting disease. To reduce risks, these operations take place during hours when visitor activities are low, after extensive training in the use of wildlife pharmaceuticals and wildlife handling, and staff follow safety procedures when handling elk in areas where chronic wasting disease is present (NPS 2001g). To date, no staff members have been injured in such operations.

Health and Safety Concerns Related to Vegetation and Vegetation Management

Since 1935, 26 plots totaling 12 acres of willow stands, aspen clones, and other vegetative communities have been fenced in research projects to determine the effectiveness of such protective measures against over-browsing. Safety concerns include lacerations, bruises, and crush injuries during installation and maintenance, as well as potential injuries from unintended contact with fences by unwary visitors or staff. Injuries could also occur when releasing animals that manage to enter the enclosures and are unable to get out. No recorded injuries have occurred related to fence installation and maintenance or to freeing trapped animals.

VISITOR USE AND EXPERIENCE

Rocky Mountain National Park covers 265,461 acres in the Front Range of northern Colorado. The park's 2,988,475 visitors in 2002 ranked sixth among national parks. Visitors numbered 3,067,256 in 2003 and 2,781,899 in 2004, with 2,768,717 forecast for 2005 (NPS 2004g, NPS 2005f). As shown in Figure 3.12, the number of visits typically peaks in July and August (678,086 and 626,473, respectively, in 2003 and 633,725 and 561,193 in 2004) then drops over the next three months (465,941; 262,699; and 69,681 in 2003, 407,864; 200,180; and 52,173 in 2004) (NPS 2005f). The busiest weekend of the year often corresponds with the Estes Park Elk Festival in early autumn.

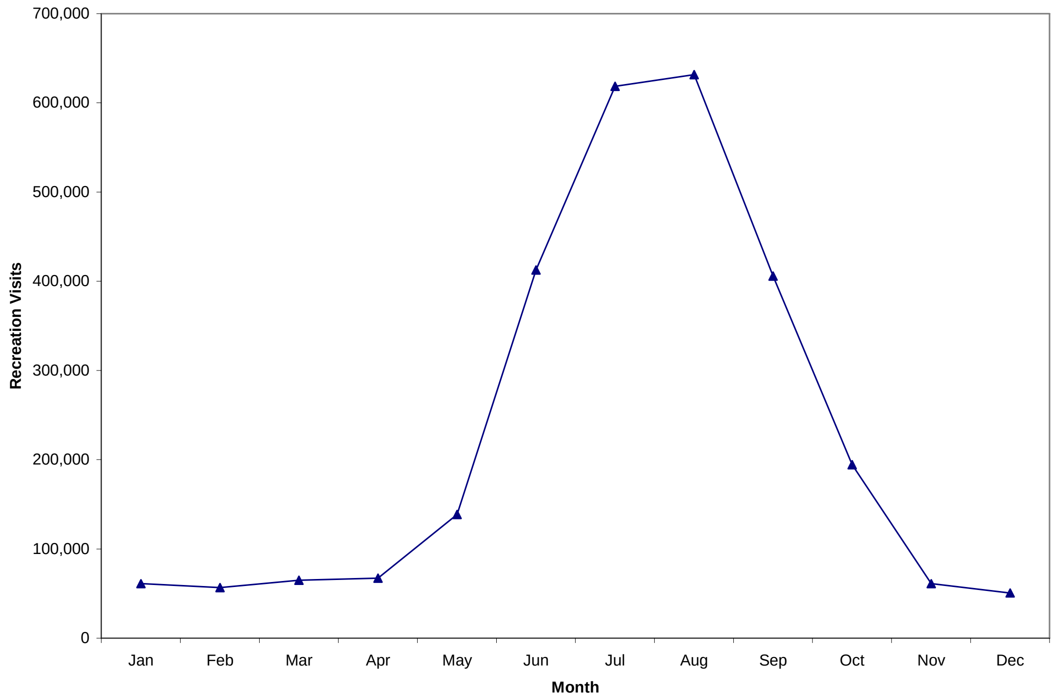


FIGURE 3.12: AVERAGE ROCKY MOUNTAIN NATIONAL PARK RECREATION VISITS BY MONTH, 1979 - 2003

Approximately 70% of visitors access the park through the east entrance, near the town of Estes Park (NPS 2005i). The town offers a wide range of tourist attractions, including hotels, restaurants, shops, golf, wildlife viewing, and special events, including the Estes Park Elk Festival in late September or early October. The nearby Arapahoe and Roosevelt National Forests allow multiple outdoor activities such as camping, hiking, rock climbing, mountain biking, off-road vehicle riding, wildlife viewing, hunting, skiing, and snowmobiling. Another 15% enter at the west entrance near Grand Lake, and the remaining entrances admit another 15% of visitors (NPS 2005i). Near the park's west entrance, visitors can enjoy five major reservoirs at the Arapahoe National Recreation Area or visit Grand Lake, the largest glacial lake in Colorado. Approximately 500,000 Rocky Mountain National Park visitors make the trip from Estes Park to the Grand Lake area each year when Trail Ridge Parkway is open, generally late May to early October (Town of Grand Lake 2005).

The National Park Service does not track where visitors go once within the park; however, the park's primary attractions are its scenery and wildlife. A survey during 1994 and 1995 found that

91.7% of visitors rated natural scenery as an extremely important park feature, and 83.1% rated wildlife as extremely important (NPS 1995). In a visitor survey in September and October 1999, the two most common reasons for visiting the park were to view wildlife (74.3%) and to view mountain scenery (73.1%). Fall is the favorite season for elk viewing (Johnson and Monello 2001); 66% of those visiting the park then did so primarily to view elk (Cordova 2000b). Many visitors tell park staff that they enjoy seeing the “tame” elk (Langdon 2005d), but perhaps as often, visitors comment that elk do not seem as wild as they should be (Muenchrath 2006).

The most popular elk viewing areas include Horseshoe Park, Moraine Park, and Upper Beaver Meadows on the park's east side. Aspen and willow communities in all three are severely impacted by elk browsing, and even the least impacted areas in the eastern winter range show visible signs of damage (Ronca 2005d). Areas in the Kawuneeche Valley such as Harbison Meadow and the Holzwarth Ranch Meadow are favorite viewing areas on the west side; damage to vegetation in Kawuneeche Valley is becoming increasingly visible (Ronca 2005d). Cub Lake Trail is popular with visitors willing to hike for elk viewing (Apt 2001).

Popular summer activities include not only viewing wildlife and scenery but also hiking, camping, climbing, fishing, mountaineering, and horseback riding on nearly 360 miles of trails. Campers have nearly 600 sites accessible by car, while backcountry visitors have another 208 sites available; in 2004, car-accessible campgrounds hosted 153, 855 visitors, and backcountry campgrounds hosted 26,522 (NPS 2005f). Wintertime activities are primarily cross-country skiing and snowshoeing in the west and snowshoeing in the east. Sledding areas at Hidden Valley and Bear Lake receive heavy use on weekends (NPS 2005h).

Many people visit the park in autumn to enjoy the colorful foliage, particularly aspen, an activity so popular that news media along the Front Range report where leaves are likely to be near peak color during upcoming weekends. In some areas, the effects of elk are pronounced enough that visitors have noticed and commented on the over-browsing of aspen and willow. Many popular facilities in the park, including the Moraine Park Museum, the Moraine Park Campground, and the Sheep Lakes Information Station, are near experimental exclosures to assess effectiveness of fencing at protecting vegetation (Langdon 2005d). Park-wide, the visitor centers receive six to 12 questions per day about the damage to aspen trees in the lower meadows (Langdon 2005c). Similar numbers of visitors ask questions about the fencing around selected aspen stands where park resource managers are assessing the affects of protecting vegetation from elk; almost all are curious rather than concerned (Langdon 2005c). Visitors surveyed in 1999 were evenly split on whether to use fencing to keep elk away from sensitive vegetation (Cordova 2000b). Three years later, another survey found support as high as 60% for small-scale fencing lasting five to 25 years, dropping to 40% support for large-scale fencing lasting 30 to 50 years (Fix et al. 2004).

Some visitors are aware of the impact that elk overpopulation has on the park’s flora; others place greater value on easy viewing of elk. In a 1999 survey, most visitors (72.4%) did not worry about the problems that elk may cause (Cordova 2000b). However, Fix et al. found that up to 90% of those surveyed in 2002 agreed with the statement “If natural conditions dictate there should be fewer elk in the park, the elk herd should be reduced,” and “It is acceptable to reduce the size of the elk herd to ensure that aspen and willow regenerate.” This would appear to indicate that visitors may not be readily aware of the physical evidence of vegetation damage, but when told by park managers that a problem exists, agree that management actions should be taken.

Many visitors want to see large groups of rutting elk in meadows near roads and listen to the bugling, despite complaints about the associated traffic congestion as visitors pull off the roads along these meadows. Some visitors express concern that the ratio of bulls to cows seems low; this condition is due primarily to hunters’ preferences and Colorado Division of Wildlife license policies, and is therefore beyond the park’s control. Visitors are increasingly aware of the threat posed to elk and deer by chronic wasting disease; Cordova found that 54.5% of visitors surveyed agreed or strongly agreed that large elk populations can easily transmit diseases (Cordova 2000b). This survey was conducted in September and October when many visitors are coming primarily to view elk. The attitudes expressed by these visitors are not necessarily representative of visitors in other times of the year.

Lethal removal methods (specifically use of firearms) received the least support among visitors surveyed in 1999 (21.3%), even with donation of the meat to charitable organizations (Cordova 2000b). Fix et al. found that all forms of reduction, including fertility control, lethal removal, and wolf release, were acceptable for up to 50% of the national and Colorado respondents, and up to 60% of the Estes Park and Grand Lake resident respondents. Visitors strongly supported trapping and relocating elk as a management tool (acceptable or very acceptable to 58.9% of those surveyed (Cordova 2000b), but state regulations prohibit transporting deer or elk out of infected areas (CDOW 2003a), including the area that encompasses the park.

While hunting is prohibited in Rocky Mountain National Park, many visitors to the surrounding area participate in big game hunting. Elk are the favorite game among hunters in the area, with deer a close second. As shown in Table 3.9, in the Socioeconomic section, between 1999 and 2004, the number of elk hunters and deer hunters more than doubled in Game Management Unit 20, east of the park (CDOW 2005b). During the same period, total recreation days (a recreation day is a visit by one person to a recreation area for any part of one day) associated with big game hunters in Game Management Unit 20 roughly tripled, as shown in Table 3.11, below (CDOW 2005b). In Game Management Unit 18, west of the park, the numbers of elk hunters has declined slightly during the same period, while deer hunter numbers have varied between a low of 1,167 and a high of 2,535 (see Table 3.10, above). Table 3.12 shows the variation in recreation days associated with big game hunting in Game Management Unit 18 for each of those years (CDOW 2005b).

TABLE 3.11: GAME MANAGEMENT UNIT 20 TOTAL RECREATION DAYS

Year	Elk	Deer	Bear	Mountain Lions
2004	16,469	9,181	34	—
2003	12,439	8,648	3	35
2002	10,486	6,608	53	12
2001	8,896	4,110	17	80
2000	7,690	3,759	58	—
1999	6,742	3,846	—	—

Source: Colorado Division of Wildlife website http://wildlife.state.co.us

TABLE 3.12: GAME MANAGEMENT UNIT 18 TOTAL RECREATION DAYS

Year	Elk	Deer	Bear	Mountain Lions
2004	24,526	11,211	42	—
2003	25,263	8,098	25	22
2002	18,935	5,679	14	7
2001	19,555	5,105	4	6

Source: Colorado Division of Wildlife website http://wildlife.state.co.us

PARK OPERATIONS

Management of elk and vegetation and the visitors that enjoy these resources within the park requires the participation of five park divisions: administration, facility management, resource management and research, interpretation, and resource protection. All divisions are overseen by the park superintendent and assistant superintendent. The administration division does not expend resources directly to manage elk and vegetation within the park, but provides support for the other divisions that manage park resources and other activities in the park.

Park staff work throughout the park, managing visitors, resources, and activities, as well as facilities including two park museums and five visitor centers (Beaver Meadows, Fall River, Kawuneeche, Alpine, and Lily Lake).

Park Staff and Management Divisions

The park staff consists of 394 employees, divided among seasonal, part-time, and full-time staff across six divisions of management (Schuster 2005). The allocation of park budget among the divisions is shown in Table 3.13.

The divisions that are directly related to elk and vegetation management activities are Resources Management and Research, Interpretation, and Resource Protection. However, elk and vegetation management accounts for only a small part of the overall responsibility for all but two Rocky Mountain National Park employees, who spend much of their time on elk and vegetation management issues (Johnson 2005).

TABLE 3.13: DIVISION OF PARK BUDGET AMONG SECTORS: YEAR 2004

Sectors	Percentage	Dollars
Visitor Services	36%	$7,429,280.00
Maintenance	31%	$6,341,140.00
Resources Preservation	23%	$4,673,580.00
Administration	10%	$1,949,200.00

Source: RMNP NPS Webpage

Resources Management and Research

The Resources Management and Research Division includes 69 employees (Schuster 2005). Various staff from this division conduct wildlife management activities, site restoration, fire management, park planning, exotic plant control, and biological monitoring throughout the park and extending into Estes Park and Grand Lake. This group also coordinates the work of outside scientists who conduct formal studies within the park, such as chemists, hydrologists, biologists, social scientists, and archeologists.

The staff in this division are also responsible for coordination with other state and federal agencies managing resources in the region. The NPS staff interact with the Colorado Division of Wildlife in several capacities. In regard to elk, the Colorado Division of Wildlife conducts hunting/poacher management and destroys violent animals, among other tasks. The two agencies communicate closely during management activities or when an injured animal enters the boundary of the national park. NPS staff contact the Division of Wildlife when elk, deer, or carcasses suspected of chronic wasting disease are observed just outside the park boundary. The

Division of Wildlife occasionally assists the National Park Service with poaching incidents inside the park boundaries. The resource management staff currently coordinates with the Division of Wildlife to monitor elk populations that use both the park and the surrounding areas. Shared activities such as these are carefully managed in conjunction with the Colorado Division of Wildlife (Ronca 2005b).

The Resources Management Division conducts elk monitoring along several ground and aerial routes at different times throughout the year. Paid or volunteer park staff perform population counts and classifications (bull, cow, yearling, calf) on the established five park ground routes and population counts on the established seven town ground routes. Park staff monitor the ground routes in the park and in town for three consecutive days in conjunction with the first day of aerial monitoring (described below) in winter and in some years at other times throughout the year. The monitoring activities inside the park require approximately four hours per person per day and each route generally utilized two people. The staff time required for monitoring in the town is nine hours per person, in both the winter and summer. The park staff and contractors are also responsible for the compilation of monitoring results and developing reports which takes roughly 40 hours total.

Aerial monitoring for elk is conducted annually, during a suitable weather window from January to March. The five survey routes correspond to the ground routes and are in the elk east-side winter range, within park boundaries. This information is plotted and then modeled to determine the park population. The staff time required for aerial monitoring is about 28 hours total, which includes the pilot's, helicopter manager's, and two observers' time (Ronca 2005c).

Year-round monitoring and mule deer live testing for chronic wasting disease-infected animals within the park requires the specially trained staff to respond to reports of animals suspected of having chronic wasting disease. The chronic wasting disease team typically includes four full-time biological science technicians for seven months (September through December and March through May), but the structure of the team varies by season. They are responsible for capturing and live-testing up to 200 mule deer annually, euthanizing deer that test positive for chronic wasting disease, responding to reports of deer and elk exhibiting clinical signs of chronic wasting disease, euthanizing chronic wasting disease clinical suspects, responding to reports of deer and elk carcasses that can be tested for the disease, and subsequent transport of animals to a facility for chronic wasting disease testing and disposal of carcasses.

The Resources Management division is also responsible for maintaining the park's 26 research exclosures, which cover approximately 12 acres (Ronca 2004). Although no biological science technicians are currently monitoring these exclosures, they are still actively maintained.

Fire management in Rocky Mountain National Park is conducted through the Natural Resources and Research Division; however, the cooperation of several divisions is critical for the successful implementation of fire management activities. The staff are responsible for preparedness, fire suppression, hazard fuel reduction, prescribed fire implementation, and managing wildland fires for resource benefits (NPS 2004a). Fire management activities are planned according to the management prescriptions set forth in the fire management plan (NPS 2004a). Prescribed burning operations usually involve fuels control of ponderosa and lodgepole pines. The plan includes no actions for burning willow or aspen in primary winter and summer elk range. This plan follows the ban on burning aspen, willow, and upland shrub communities except where they occur in proximity to the wildland-urban interface. The three fire management units that include primary winter and summer elk range are the Fall River, Estes Valley, and Forest Canyon Fire Management Units. In Fall River and Estes Valley, fuels management actions are only approved for fire suppression or protection. This could include hand pile burning, manual fuels reduction, or prescribed burning. In Forest Canyon, no fuels management actions are currently planned or approved.

Fifty National Park Service staff members participate in fire management efforts in Rocky Mountain National Park (NPS 2004a). The fire management staff in Rocky Mountain National Park is part of the Rocky Mountain Cluster of the National Park Service Intermountain Region, a shared cooperative of staff that also services Great Sand Dunes National Monument and Preserve and Florissant Fossil Beds National Monument.

Interpretation

The Interpretation Division maintains a staff of 37 employees. This includes 21 seasonal positions and 16 permanent positions including park operational staff, support staff, media staff, museum coordinator and park archeologist, and park volunteer coordinator. The interpretive staff provides information and education services at visitor centers and interpretive programs, as well as writing publications and creating exhibits. Visitor center hours and the number of programs that are offered by the park are directly related to the amount of staff available.

Interpretation programs are developed to convey the park's themes and core mission in a manner that is favorably received by the public; objective; and based on science, resources management, and park management goals. They include information that allows visitors to understand the relationships regarding the management of resources. Interpretive rangers are expected to keep current with issues related to their presentations, which constantly evolve.

The park's periodical educational materials contain information on the elk population and its effect on the vegetative habitat. The park newspaper, a significant information resource on the status of resource management issues in the park, is published four times per year. It is available at all visitor centers and is handed out at all park entrance gates. Additional materials available at the visitor centers are produced through a cooperating association. One of these documents specifically focuses on wildlife watching in the park, with a section devoted to elk. Other park publications containing elk information include the site bulletin, the *Elk Viewing Guide* (which highlights the park's fall elk viewing opportunities), and the *Guide*, a pre-visit informational handout produced by the cooperating association. The park Website is also frequently updated with information regarding the management of elk and their impact on the habitat. (Langdon 2005a).

Each interpretive program at the park integrates resource management information that reflects the themes defined in the park's comprehensive interpretive plan and various management issues. Permanent staff members meet each spring to decide the amount of interpretive programs that can be offered, based on budget, staff available, and scheduling for training (Langdon 2005a).

Some programs presented in the park address some aspects of the interaction of elk and vegetation in relation to other park resources. These programs include Moraine Park Nature Walk, Wildlife in Horseshoe Park, Alpine Aspects, and Importance of Being a Beaver.

Some evening campfire presentations in the summer also address elk management issues as part of the content. The only interpretive program that focuses completely on elk is "Elk Echoes," which is offered in the fall during the rut season.

Interpretive staff also develop and conduct educational programs for children, high school students, and adults that take place within the park. The interpretation done with K-16 educational groups and with youth and adult special interest groups use the elk/vegetation interaction as a context for the experiential study of ecosystem components (DeGregorio 2005).

Interpretation of elk management issues, including population and chronic wasting disease concerns, occur through informal contacts between the NPS staff and visitors at visitor centers or throughout the park grounds. The staff also educate the public beyond the boundaries of the park by outreach presentations to local service clubs, conservation organizations, and other interested groups.

Currently, no interpretive programs are dedicated solely to vegetative resources and loss of habitat, but these topics are included in the individual service plan objectives for the park that must be covered in the general interpretive programs for the public (Langdon 2005b). The existing programs that focus on ungulates in the park usually include a discussion of the condition of the habitat.

Another channel of information and education of elk management issues is the Lyceum program, which takes place at the Beaver Meadows Visitor Center. In this program, experts on various topics are invited to present information to the public related to park resource topics and the latest research, and to lead discussion of resource management issues. Elk management has been presented in the past and will continue to be a frequent topic in the Lyceum programming during the elk management plan/EIS process (Langdon 2005a). The Lyceum series has included the loss of vegetative habitat.

Park interpretive staff are also responsible for the training and oversight of the Elk Bugle Corps volunteer group. The 80-member group has been in existence since 1990. Volunteers in the Elk Bugle Corps are not NPS staff; however, they make an important contribution to the responsibilities of the interpretive staff and provide logistical support for the ranger staff during the elk rut season. Each night during the rutting season, two interpretive rangers assist in managing elk viewing visitors and present two nightly programs on the elk rut ("Elk Echos"), with assistance from 11 to 20 Elk Bugle Corps volunteers.

The primary tasks of the Elk Bugle Corps include:

- Patrolling areas of the park frequented by elk populations from August 29 to October 26.
- Provide information to park visitors about elk and the park.
- Provide visitor safety and traffic control.
- Help enforce restricted areas put into effect during the season.
- Report closure violations and other infractions.
- Observe and record visitor statistics information.

The Bugle Corps is a significant source of visitor contacts (28,000 to 30,000 per season), providing natural history facts and information regarding elk management issues. The volunteers receive training each year, including the most current status of management efforts to control the elk population. Collectively, the volunteers donate approximately 2,000 volunteer hours per fall season (Langdon 2004b). The Colorado River District of the park has recently begun a similar program of roving volunteers on elk patrol during the rut season to assist in educating visitors about elk and elk management in the park.

Resource Protection

The Resource Protection division supports 97 employees (Schuster 2005). This includes 20 seasonal and 15 permanent law enforcement rangers as well as 16 seasonal and one permanent backcountry rangers (Ronca 2005b). These employees protect the safety of park visitors and park resources. Most are law enforcement officers who perform search and rescue operations and manage activities in the backcountry as well as front-country roads. Law enforcement rangers are commissioned officers who police the park (including poaching, traffic control, and automobile accidents) but also provide education on the park's resources and chronic wasting disease reporting. The division of duties among rangers is shown in Table 3.14, below.

TABLE 3.14: DIVISION OF DUTIES AMONG RANGER STAFF, YEAR 2004

Specific Duty	Summer		Winter	
	Seasonal	Permanent	Seasonal	Permanent
Law Enforcement	20	15	2 to 4 (intermittent)	15
Backcountry (non-law enforcement)	5	0	0	0
Rehab/Wilderness	2	1	0	1
Backcountry Office	10	1	0	1
Total	80	26	4 to 8 (intermittent)	26

Source: Lani Pettibone, personal communication, February 28, 2005.

The ranger staff that deal with elk management includes law enforcement rangers, backcountry rangers, and wilderness rangers. Law enforcement rangers are responsible for addressing elk-human conflicts. Typically, three to five incidents per year are reported, usually regarding a charging bull during the fall rut or a cow charging visitors to protect her newborn calf in June, the calving season (Langdon 2004b).

In the past, poaching patrol has been conducted by rangers in the Resource Protection division, occasionally in cooperation with the Colorado Division of Wildlife, along boundaries of areas with a significant amount of land that borders U.S. Forest Service land (Oliver 2005). In recent years, poaching incidents reported in the national park have increased.

Another major duty of the rangers is crowd and traffic control associated with visitors who come to view the elk each October and November. The law enforcement and interpretive rangers control traffic flow with help from the Elk Bugle Corps volunteers. When the elk are easily visible along the roadway in meadows and visitor levels along the roadway and traffic become unsafe, rangers sometimes herd the elk away by horseback for visitor and traffic safety.

The decrease in Rocky Mountain National Park seasonal staff occurs in autumn due to budgetary constraints, when elk-related activities in the park increase due to the rut season. The second week in October is typically the week with the highest visitation for the year. Poaching also increases at this time of year, due to the hunting seasons, but poaching patrols are reduced. The rangers most needed during the fall elk season are law enforcement and interpretative rangers.

Facility Management

The Facility Management Division employs 83 staff members in the winter and 135 in the summer. They are responsible for general upkeep of the park, including maintenance of park roads, park vehicles, and park facilities. Their primary tasks include snow removal, care of park buildings (plumbing, painting, carpentry, electrical), maintenance of utility systems (water laboratory), repair of backcountry bridges, care of stock animals and stables, and maintenance of trails. They also are periodically involved in reporting elk that may have chronic wasting disease.

The increased amount of visitation to the park in fall causes an increase in the demands on maintenance staff, due to greater use of facilities such as restrooms, trash receptacles, and campgrounds.

This page intentionally left blank

Environmental Consequences

This page intentionally left blank

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This “Environmental Consequences” chapter analyzes both beneficial and adverse impacts that could result from implementing any of the alternatives described in this final elk and vegetation management plan and environmental impact statement (plan/EIS). This chapter includes a summary of laws and policies relevant to each impact topic, definitions of impact thresholds (negligible, minor, moderate, and major), methods used to analyze impacts, and the analysis methods used for determining cumulative effects. As required by the Council on Environmental Quality (CEQ), regulations implementing the National Environmental Policy Act (NEPA), a summary of the environmental consequences of each alternative is provided in Table 2.2 in the “Alternatives” chapter. The resource topics presented in this chapter and the organization of the topics correspond to the resource discussions contained in the “Affected Environment” chapter.

Summary of Laws and Policies

Three overarching environmental protection laws and policies guide the actions of the National Park Service (NPS) in the management of the park and its resources: the NPS Organic Act of 1916, NEPA and its implementing regulations, and the Omnibus Management Act. For a complete discussion of these and other guiding regulations, refer to the section “Laws, Regulations, and Policies” in the “Purpose of and Need for Action” chapter. Collectively, these guiding regulations provide a framework and process for evaluating the impacts of the alternatives proposed in this plan/EIS.

General Methodology for Establishing Impact Thresholds and Measuring Effects by Resource

The general approach for establishing impact thresholds and measuring the effects of the alternatives on each resource category includes the following elements:

- General analysis methods as described in guiding regulations
- Basic assumptions used to formulate the specific methods used in this analysis
- Thresholds used to define the level of impact resulting from each alternative
- Methods used to evaluate the cumulative impacts of each alternative in combination with unrelated factors or actions affecting park resources
- Methods and thresholds used to determine if impairment of specific resources would occur under any alternative

These elements are described in the following sections.

General Analysis Methods

The analysis of impacts follows CEQ guidelines and *Director's Order 12* procedures (NPS 2001c).

Extensive research has been conducted on the elk population and the condition of vegetation within the elk range in Rocky Mountain National Park. Researchers have also studied effects of elk and vegetation management on visitors and regional social and economic conditions within the park and within the Estes Valley. There is also extensive secondary research that relates elk and elk management to the environmental effects on other natural, social, and economic resources.

There are a number of agencies, universities, and other NPS units that have expertise and experience in or responsibilities for managing elk and wildlife populations and have extensive knowledge of the success of management methods. The internal EIS team consulted with these experts in the field of wildlife and vegetation management, as well as other experts in the resource management and the scientific communities, for the various resource topics addressed in this plan/EIS. Where conclusions are drawn without specific reference to the scientific literature, these are based on based best professional judgment gathered in EIS team workshops and through team consensus.

Alternative 2 and Alternative 3, the preferred alternative, involve the potential use of wolves as an adaptive management method to facilitate redistribution of elk if opportunities were present to cooperate with adjacent land managers and the State of Colorado and if supported by state and federal policy. If based on monitoring the park determines that other redistribution methods conducted by NPS staff or contractors are not effectively meeting management objectives for the recovery of vegetation, wolves may be released in the park according to the process detailed in Alternative 5. The analysis presented for Alternative 2 and Alternative 3 describes the impacts of specific elements under each alternative. For the impacts of the adaptive use of wolves under Alternative 2 and Alternative 3, the reader is referred to the Alternative 5 analysis.

Alternative 3, the preferred alternative, also includes the adaptive use of fertility control agents to manage the elk population size. If during the planning period a multi-year fertility control agent becomes available that is logistically feasible for the treatment of a free-ranging elk herd, the National Park Service could consider use of the agent to reduce and/or maintain the elk population size. For the impacts of the adaptive use of fertility control agent under Alternative 3, the reader is referred to the Alternative 4 analysis.

Alternative 3 would also involve the adaptive use of a capture facility if it is believed that it would increase effectiveness and efficiency of the lethal removal or fertility control. The effects of a capture facility would be the same as described in Alternative 2 and the reader is referred to that alternative analysis for a discussion of impacts.

For each resource topic addressed in this chapter, the applicable analysis methods are discussed under each resource section.

Assumptions

Several guiding assumptions were made to provide context for this analysis. These assumptions are described below.

Analysis Period

This plan/EIS establishes goals, objectives, and implementation actions needed to manage elk and vegetation in the park for the next 20 years.

Geographic Extent of Impact

Unless specified otherwise, the impact analysis area includes the elk primary winter and summer ranges within Rocky Mountain National Park and the Estes Valley. The terms used to define the extent of a particular effect or impact include the following:

Local effects of an action would affect the elk population within relatively small areas within the park, such as a particular valley, drainage, or stand of vegetation.

Range-wide effects would occur over all or most of the elk primary winter and summer ranges, including areas inside and outside the park.

Park-wide effects would affect resources within Rocky Mountain National Park.

Regional effects could occur over the entire park and extend to areas outside the park.

Assumptions about Elk Population, Distribution, and Behavior, and about Effects of Management Actions

The following general assumptions were used to analyze the effects of elk and vegetation management actions on elk population, distribution, and behavior.

> The elk subpopulation in the park is relatively stable. Recent observations suggest that the elk subpopulation outside the park could be stabilizing, but this has coincided with dry weather conditions and alterations in migration patterns. Thus the stability in elk numbers outside the park or changes in habitat use may not be a long-term trend and this subpopulation could potentially increase. With a continuation of current management, there would be no change in the number or density of elk over time in the park. It is predicted that the total Rocky Mountain National Park / Estes Valley elk population would continue to fluctuate between 2,200 and 3,100.
>
> Elk population reduction actions taken inside the park between November and February would result in the removal of elk from the park subpopulation, and those actions taken in September and October and in the summer months would proportionately affect each of the elk subpopulations (i.e., one-third of the elk affected would be from the population that stays in the park year round and two-thirds of the elk affected would be from population that uses habitat outside the park in winter).
>
> In general, lethal reduction actions with suppressed weapons and aversive conditioning actions would be implemented in ways not likely to drive elk out of the park, but would contribute to a redistribution of elk. These actions would result in localized (short-distance) movement of elk. In specific circumstances, such as on the west side during hunting season, aversive conditioning activities and lethal reduction activities with unsuppressed weapons could drive elk to areas open to hunting. Actions may change general elk behavior by instilling greater wariness of humans.
>
> The primary function of wolves in the park would be to redistribute elk. In response to the presence of wolves, elk would be more likely to move into the town of Estes Park. Wolves would prey primarily on elk, but they would not have a large effect in reducing the elk population in the early years of the plan.

To allow full analysis of Alternative 5, it was assumed that the use of wolves would successfully meet objectives and that both phases of the alternative would be implemented. It is further assumed that an increase in the number of wolves in Phase 2 would have greater effectiveness in the redistribution of elk and contribution to reduction in elk population size.

Given that changes in the elk range are unknown and that future changes could occur, it is assumed for purposes of analysis that the extent of the elk range identified in this plan/EIS would not substantially change, barring extreme weather or drought. The elk population would not disperse to areas beyond current bounds of population. There would be little movement of elk to areas such as Loveland.

Assumptions about Vegetation within the Primary Winter and Summer Range

The following general assumptions were used to analyze the effects of elk and vegetation management actions on vegetation within the primary winter and summer elk range.

The effects of elk use on vegetation on the primary winter range are also occurring on the primary summer range; however, the intensity of effect would be less in this portion of the range because the primary summer range is much larger, elk densities are lower, forage availability is higher, and elk spend less time in alpine areas.

With continuation of current management, overgrazing would continue and willow and aspen would be unable to regenerate or recover at the current number and density of elk.

Impact Thresholds

Determining impact thresholds is a key component of the *Management Policies* (NPS 2006b) and the *Director's Order 12 and Handbook* (NPS 2001c). These thresholds provide the reader with an idea of the intensity of a given impact on a specific topic. The impact threshold is determined primarily by comparing the impact to a relevant standard from state or federal regulations or scientific research. Because definitions of intensity vary by impact topic, intensity definitions are provided separately for each impact topic analyzed in this document. The following intensity levels are used throughout this analysis: no effect, negligible, minor, moderate, and major.

Cumulative Effects Analysis Method

The CEQ regulations implementing NEPA require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including Alternative 1, which would continue current management practices.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other past, ongoing, and reasonably foreseeable future actions within Rocky Mountain National Park and in the surrounding region. A description of other National Park Service and other agency actions and programs is provided in the "Purpose of and Need for Action" chapter under the "Relationship to Other Projects and Plans" section. All past, present, and reasonably foreseeable future actions that are considered in the environmental analysis include the following:

Trails Management Plan, 1982 – Ongoing

State of Colorado Conservation Strategy for Lynx and Wolverine, 1988 – Ongoing

Vegetation Restoration Management Plan, 2006

Denver International Airport – Thompson Three arrival route, 1996 – Ongoing

Estes Valley Comprehensive Plan, 1996 – Ongoing

Resources Management Plan, 1998 – Ongoing

Greenback Cutthroat Trout Recovery Plan, 1998 – Ongoing

Environmental Assessment for the Management of Snowmobiles in Rocky Mountain National Park, 2002 – Ongoing

Trail System Maintenance and Reconstruction Plan, 2000 – Ongoing

Captive breeding program of boreal toads / Reintroduction into Rocky Mountain National Park, 2001 – Ongoing

Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad (*Bufo boreas boreas*), 2001 – Ongoing

Backcountry and Wilderness Management Plan, 2001 – Ongoing

Wildland-Urban Interface Fuels Management Environmental Assessment, 2003 – Ongoing

Invasive Exotic Plant Management Plan and EA, 2003 – Ongoing

A Strategy for Accelerated Watershed/Vegetation Restoration on the Arapaho and Roosevelt National Forests and Pawnee National Grassland, 2004 – Ongoing

Forest Health and Fuel Reduction Project – Arapaho National Recreation Area, 2004 – Ongoing

Fire Management Plan, 2004 – Ongoing

Bark Beetle Management Plan, 2005 – Ongoing

Colorado State Wolf Management Plan – Future

Transportation Management Plan/EA – Future

Emergency Operations Center – Future

Reroute of the Continental Divide National Scenic Trail – Future

Moraine Park Stables Hay Barn – Future

Highway 7 Corridor Management Plan – Future

Bear Lake Road Reconstruction Phase II – Future

Lawn Lake Restoration Project – Future

Greenback Cutthroat Trout Management Plan – Future

Colorado River Cutthroat Trout Management Plan – Future

Lynx Conservation Agreement and Strategy, 2002 – Ongoing

Arapaho and Roosevelt National Forests and Pawnee National Grassland Revised Land and Resource Management Plan, 1997 – Ongoing

Interim Actions for Chronic Wasting Disease, 2001 – Ongoing

In addition to specific agency actions and programs, other activities would continue within the park and on lands adjacent to the park or in the region that would cumulatively impact resources. Most of these impacts are directly related to growth, land development in the Estes Valley, and recreational use in the park and in the Estes Valley. Activities associated with management of the park (building construction, resource management and monitoring, and transportation management) also contribute to adverse impacts on resources from loss of habitat, nonpoint source discharges of sediment and nutrients into waterways, and noise emissions.

Impairment Analysis Method

The "Purpose of and Need for Action" chapter describes the related federal acts and policies regarding the prohibition against impairing park resources and values in units of the national park system.

Management Policies Section 1.4.5 states that an action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2006b). To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS 2006b).

Because park units vary based on their enabling legislation, natural resources, cultural resources, and missions, the recreational activities appropriate for each unit and for areas within each unit vary as well. An action appropriate in one unit could impair resources in another unit. Thus, this plan/EIS analyzes the context, duration, and intensity of impacts of the alternatives as well as potential for resource impairment, as required by *Director's Order 12*: *Conservation Planning, Environmental Impact Analysis and Decision-making* and Handbook (NPS 2001c). An impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major adverse effect on a resource or value whose conservation is

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park
- Key to the natural or cultural integrity of the park
- Identified as a goal in a park's general management plan or other relevant NPS planning documents

A determination of impairment is included in the impact analysis section for all impact topics relating to the park's resources and values. The impact analysis includes findings of impairment of park resources for each of the management alternatives. Park management and operations, socioeconomics, and visitor use are not considered park resources; therefore, impairment findings are not included as part of the impact analysis for these topics.

ELK POPULATION

The elk population is one of the park's most notable resources, as the elk population plays a prominent role in the processes that affect many of the park's resources. Elk viewing is one of the primary attractions that draw visitors to the park. Rocky Mountain National Park is responsible for protecting the elk population as a park resource. This section analyzes the potential effects of the proposed alternatives on the Rocky Mountain National Park / Estes Valley elk population.

Summary of Regulations and Policies

The *NPS Organic Act* and *Management Policies* (NPS 2006b) provide the basis for resource protection, conservation, and management and are fully described in Chapter 1, "Purpose and Need."

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision-Making (NPS 2001c) offers the guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

Rocky Mountain National Park Enabling Legislation states that the park is created "for the preservation of the natural conditions and scenic beauties thereof" (38 Stat. 798). The elk population and its associated vegetation contribute to the natural conditions in the park and are mandated for preservation.

Director's Order #77-4: Use of Pharmaceuticals for Wildlife. This Director's Order and the accompanying Reference Manual #77-4 establish NPS operational policies and procedures for compliance with existing federal laws, regulations, and guidelines governing the use of pharmaceutical agents for wildlife in the National Park System. The administration of pharmaceuticals to wildlife is a necessary component of some management and research activities conducted in the National Park Service. NPS policy is to administer pharmaceuticals to wildlife in a manner that is safe for humans and animals, adheres to humane standards, and is in accordance with NPS wildlife management philosophy.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on the elk population includes the range of the Rocky Mountain National Park / Estes Valley elk population (see Figure 1.1 in the "Scope of Analysis" section in the "Purpose of and Need for Action" chapter for a more detailed description of the area evaluated in this document). The analyses focus on the primary elk winter and summer range areas, as these are the areas most affected by potential elk management activities and constitute the primary habitats of concern for elk and degraded vegetation in the park. Cumulative effects that would occur both within and outside of these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were identified during internal and public scoping regarding elk and vegetation management effects on the elk population include

The elk population size, particularly density and distribution, which can affect vegetation communities and other resources in the park.

The health of the elk population, including survival, mortality, recruitment, body condition, and potential for transmission of chronic wasting disease, may be affected by current management techniques.

The structure of the elk population, including age and sex ratios, may have effects on the long-term viability and ability of the population to stay within the natural range of variation.

The behavior of the elk population during the breeding season (the rut) is important for elk because of the effects on energy expenditures and fitness (i.e., capability of an individual to reproduce).

The elk population exhibits a high degree of habituation to human presence and development, which poses potential for human-elk conflicts.

Elk habitat is being degraded as a result of the high levels of herbivory in some portions of the range.

Assumptions

The following assumptions were used to analyze elk and vegetation management actions on the elk population:

The elk subpopulation in the park is relatively stable.

The elk subpopulation outside the park could potentially increase.

A lack of beaver contributes to changes in hydrology, which contributes to reduced willow cover, resulting in more herbaceous plant cover in riparian areas.

Chronic wasting disease prevalence for elk inside the park is similar to the rate outside the park.

Hunter harvest outside the park is the primary source of elk population reduction. Elk population reduction targets would be calculated after taking hunter harvest outside the park into consideration first.

The Colorado Division of Wildlife Data Analysis Unit management plan would continue to direct elk population management goals outside the park.

The presence of wolves in the park would redistribute elk from traditionally used winter range core areas and would likely cause elk to seek refuge in the town of Estes Park. Assume for the purposes of this analysis that migration between the park and town would continue to occur to some degree.

To minimize potential for transmission of chronic wasting disease, only the carcasses of calves, to the extent possible, would be left in the field following lethal reduction actions.

Fencing would only restrict the movements of elk, moose, and bighorn sheep; a unique fence design would not restrict other wildlife.

To allow a full analysis of Alternative 5, the wolf release alternative, management of the wolf population would be successful and stages subsequent to the initial phase would be implemented. The analysis of effects of Alternative 5 was based on the impacts of a functioning population of not more than 14 wolves in the park.

There is a high degree of uncertainty regarding the ability to manage wolves effectively (i.e., keep wolves in the park) and about the effects of wolves on elk population reduction.

Wolves (either a released or naturally dispersing population arriving from the north) would prey primarily on elk.

The extent of the elk range identified for purposes of this analysis is not expected to substantially change.

Assessment Methods

Each alternative was assessed to determine the effects of the actions relative to elk and their habitat requirements. The consequences of elk population and habitat management to other wildlife species and their habitat conditions are addressed in the "Wildlife" section.

Primary steps for assessing impacts included identifying 1) the location of areas likely to be affected by the proposed alternatives and 2) potential changes in the elk population, habitat, or behavior from current and future elk and vegetation management actions. NPS management of wildlife is not based on single animals but rather focuses on the role of animal populations and species within the ecosystem (NPS 2006b). As such, the objectives of the management plan address restoration and maintenance of the population, and the analysis and thresholds of impact intensity focus predominantly on the effects of management actions at the population level. The National Park Service recognizes that individuals within a population would be affected by management actions. Impacts on individuals are described in the analysis, and those individual effects collectively contribute to population level effects.

Predictions in the change in vegetation over time as a result of changes in elk numbers and densities as a result of a combination of management actions were based on ecosystem modeling and research conducted within the park as well as research and management results in other locations, focusing primarily on elk use in the core winter range. The park-specific scientific literature presented in the USGS open file report (Singer et al. 2002) and summarized in the NPS synthesis of park research on elk and vegetation (Monello et al. 2005) and the references therein were relied heavily upon in the assessment of effect on elk.

To understand the effects of elk and vegetation management methods on the elk population, park resource inventories and management plans, scientific literature, and published technical data were consulted to identify the information contained in this analysis.

The potential incremental effects of each of the action alternatives on elk were compared to the effects of Alternative 1, which would continue current management practices. The following steps were used to perform the analyses:

Identify the issues associated with possible elk population and habitat management approaches.

Establish a series of impact threshold definitions and conditions that would determine if and when a change to the current management practices occurs and the magnitude of that change.

Estimate or determine the change(s) in the elk population that would occur relative to the issues and as a result of implementing the different alternative actions.

Compare the changes identified for each action alternative to what the conditions would be under current management practices and assign appropriate intensity levels based on the impact threshold definitions.

The effects of mitigation measures are accounted for as part of the impact determination (i.e., reduced adverse effects as a result of mitigation are included in the final determination of overall impacts of a particular alternative).

Impact Threshold Definitions

Impact intensity thresholds defined to categorize the effects of the alternatives are presented below. In some cases, the effects of one alternative may be similar to those of another, but with differences small enough so that there is no distinction between intensity levels. To explain the difference, the phrase "similar to, but incrementally greater or less than" is used to state that the intensity level for the two alternatives is under the same category (i.e., negligible, minor, moderate, or major), but differences within that category exist between the two alternatives.

Refer to the "Purpose of and Need for Action" section for a detailed explanation of the "natural range of variation" concept and its derivation.

Intensity of Impact

Negligible: The elk population, its habitat, and the natural processes sustaining both would not be affected, or the effects would be at or below the level of detection. Effects would be well within the range of natural variation and would not be of any measurable or perceptible consequence to the elk population. Human-elk conflicts would be inconsequential. Elk behavior changes would not be detectable. Key ecosystem processes or habitat characteristics supporting the elk population would not be affected.

Minor: Effects on the elk population, its habitat, and the natural processes sustaining both would be detectable. Elk population size, density, structure (i.e., age or sex ratios), and other demographic factors may experience changes, but population characteristics would be relatively stable and within the natural range of variation. Human-elk conflicts would be infrequent and would not affect the population. Elk behavior changes would be detectable, but population-level effects would be small. Key ecosystem processes or habitat characteristics supporting the elk population would not likely change. Population level changes would be unlikely or inconsequential.

Moderate: Effects on the elk population, its habitat, or the natural processes sustaining both would be readily detectable, and would have consequences at the population level. Population size, density, structure, or other demographic factors would likely change, and population characteristics could be outside the natural range of variation. Human-elk conflicts could occur regularly and may affect the population. Elk behavior changes would be noticeable, and population-level effects would occur. Key ecosystem processes or habitat characteristics supporting the elk population may change.

Major: Effects on the elk population, its habitat, or the natural processes sustaining both would be obvious, and would have consequences at the population level. Population size, density, structure, and other demographic factors of the elk population would experience substantial changes that would have consequences at the population level and would be outside the natural range of variation. Human-elk conflicts could be frequent and would affect the population substantially. Elk behavior changes would be obvious, and population-level effects would occur and could affect key characteristics of the population. Key ecosystem processes or habitat characteristics supporting the elk population would change.

Type and Duration of Impact

Beneficial impacts would result in an elk population whose size, density, and other population characteristics (e.g., age and sex ratios, survival, mortality, recruitment) would be within normal parameters. Behavior, habitat**,** necessary resources, general body condition of elk, and natural migration or dispersal characteristics would be consistent with and contribute to meeting the management objectives.

Adverse impacts would cause the elk populations to experience negative effects with respect to size, density, and other population characteristics. The proposed action would restrict or limit behavior, habitat, necessary resources, migration, or dispersal characteristics in a negative manner. An adverse effect would not contribute to meeting the plan's management objectives. An adverse effect could result in the elk population parameters being outside of the natural range of variation.

Duration: Short-term effects would allow recovery in less than three years. Long-term effects would require more than three years for recovery.

Impairment

Impairment of elk population resources or values would occur if a permanent major adverse effect on elk or their habitat affected a large portion of the park. The effect would be highly noticeable, could not be mitigated, and would affect the elk population to the point that enjoyment of the elk resource by future generations would be precluded.

Alternative 1

This alternative would continue the existing park elk population management framework, which consists of allowing elk population size and distribution patterns to fluctuate in response to seasonal, annual, and long-term weather, forage, and other ecological processes in the park. No new management actions would be applied, and the park elk population would continue to be regulated primarily by forage availability and weather conditions. Under this alternative, the elk population would be expected to fluctuate between approximately 2,200 and 3,100 animals (Coughenour 2002), which is considered to be outside the natural range of variation of 1,200 to 2,100 elk. No formal vegetation management program in the park would be developed to address elk-caused effects on forage quantity, vegetative cover, and dominant plant species composition in elk habitat.

The Rocky Mountain National Park / Estes Valley elk population is composed of three subpopulations, one associated with habitats in Estes Park and the other two using habitats in the park. Generally 85% to 90% of the elk population moves seasonally from the relatively low-elevation primary winter range up to alpine habitats and the Kawuneeche Valley in the park. The other elk have become less migratory and stay on the primary winter range throughout the year. The increased browsing pressure of these less migratory elk, combined with the very high elk densities that are found on portions of the primary winter range, contribute to the degraded vegetation conditions that are driving the need for action.

Elk Habitat

Elk habitat is composed of a number of resources and components, including, but not limited to, vegetation (i.e., forage), surface water, topography, slope aspect, areal extent (i.e., space), and the type, density, and structural diversity of cover. Some of these resources are specifically addressed as separate impact topics elsewhere in this document, but elk habitat is analyzed for each of the alternatives holistically. Another way to understand the need to address elk habitat rather than the individual resources is that habitat is greater than just the sum of its parts (i.e., resources).

Elk habitat in the primary winter and summer ranges would continue to be affected by the large population and high densities of elk. This effect would be pronounced and adverse in those areas where elk densities are characterized as high and very high (greater than 78 elk/mile^2) (Singer et al. 2002) on the core winter range because of degraded forage conditions. Degradation of aspen and riparian willow communities would continue into the future, with the potential decline or loss of resources in these communities that are important parts of elk habitat. The components of aspen and riparian willow communities that contribute to the importance of these habitats include the structural diversity that provides hiding, resting, and thermal cover. The hydrological changes that have reduced surface water up to 69% on the primary winter range (Peinetti et al. 2002) would continue to adversely affect elk habitat in the future. Overall, the continuation of current management policies would result in long-term, local-to-range-wide, moderate-to-major, adverse effects on elk habitat. The range of effects would be moderate for much of the elk habitat, but would be major in localized portions of the primary winter range where habitat conditions would continue to be adversely affected.

Population Size and Density

Under Alternative 1, the size of the Rocky Mountain National Park / Estes Valley elk population would continue to fluctuate above the natural range of variation, at the food-limited carrying capacity of the system. Ecosystem simulation modeling (Coughenour 2002) predicts that the population would fluctuate between 2200 and 3100 elk, assuming no changes in recent weather patterns or habitat availability (e.g., development outside the park). Recent population estimates have indicated that changes in elk distribution, such as temporary or permanent emigration to areas east of the park and Estes Valley, as observed in 2002-2005, could result in years in which the population is less than model predictions. The natural range of variation of 1200 to 2100 elk was estimated based on research and modeling (Coughenour 2002, Singer et al. 2002, reviewed in Monello et al. 2005); refer to the “Purpose and Need” section for a more detailed explanation of the “natural range of variation” concept for the elk population as applied to this analysis.

The continuation of current management actions into the future would not directly change the existing population size. A population that exceeds the upper bound of the natural range would be expected to experience high levels of intraspecific competition. Research indicates that the population is at or approaching the carrying capacity of the elk range (reviewed in Monello et al. 2005). As a result, increased competition, combined with a population that is at or near the limits of its resource base (i.e., carrying capacity) has the potential to adversely affect population health. Population health can be evaluated by looking closer at parameters such as density, body condition of elk, fecundity rates, and other population characteristics. The following paragraphs evaluate some of these parameters in more detail; however, an elk population outside the defined natural range of variation would likely experience a long-term, range-wide, moderate, adverse effect.

Elk densities would continue to be high in the core winter range under Alternative 1. Density-dependent mechanisms that reduce fecundity (i.e., reproductive capability) and body condition (measured as rump fat) in female elk have been found to exist at densities of 52 elk/mile^2 (Stewart et al. 2005). The differing effects of density on male versus female elk is likely related to the wider-ranging movements of bulls, hence lower densities, compared to cows (Forchhammer et al. 1998). Lubow et al. (2002) report low recruitment and low juvenile elk survival associated with high elk densities. Low recruitment and low juvenile elk survival rates are likely in response to declines in physical condition of adult females (Stewart et al. 2005). The densities found on portions of the park's winter elk range are equivalent to more than 78 elk/mi^2 and have been reported as high as 285 elk/mile^2 (Singer et al. 2002). The areas with these reported densities are limited in size and are reported in terms of mile^2 and should not be interpreted as describing large areas of the park with elk densities at these levels. The association between the high elk densities that are found in specific portions of Moraine Park, Beaver Meadows, and Horseshoe Park and predictable reductions in fecundity, body condition, low recruitment, and juvenile survival would continue to represent a long-term, local, moderate, adverse effect on the elk population.

Elk Behavior, Distribution, and Movement

The elk population is less migratory, more sedentary, and less vigilant than it would be if it were exposed to the predation or hunting pressures experienced by elk populations in other locations (Monello et al. 2005). The absence of a predation threat from the gray wolf and grizzly bear has diminished the vigilance exhibited by elk, particularly for cows with calves (Laundré et al. 2001). Elk can forage for longer periods in locations that no longer pose threats or stress. This behavior represents a long-term, local to range-wide, moderate, adverse effect on the elk population and its habitat because elk foraging is more concentrated, affects specific locations to a much higher degree than if elk were more wary, and contributes to localized habitat degradation. This results in a reduction in overall wildness of the population.

With at least 10% to 15% of the elk population remaining on primary winter range year-round rather than migrating to the primary summer range, forage resources are stressed as a result of the high-intensity grazing and browsing pressure during the growing season (Monello et al. 2005). If the forage resource is degraded, a portion of the elk population using that resource would be adversely affected.

The elk have become habituated to humans as both the elk and human populations have grown and interactions between elk and humans have increased. Habituation to humans and development poses risks to the elk population, although these risks may be partially offset by benefits such as access to higher-nutrient forage (i.e., fertilized grasses) and security from hunters. Human-elk conflicts such as collisions with vehicles, elk cows calving in inappropriate areas (i.e., areas regularly occupied or used by people), or direct land use conflicts in areas such as the golf courses or residential properties in Estes Park represent a continuing adverse effect on the elk population. These adverse effects would be long term, regional, and negligible to moderate, depending on the location and degree of conflict contributing to the adverse population effects.

Population Sex Ratio

The bull:cow ratio could change during the 20-year life of the plan if the Colorado Division of Wildlife changes its management strategy by reducing the number of cow hunting licenses or some other management strategy. However, nothing at this time indicates that such a change would occur. Alternative 1 would have no effect on the continuing trends of sex ratios of the Rocky Mountain National Park / Estes Valley elk population.

Body Condition and Energetics

A continuation of current management of elk in the park would not likely change existing trends or rates of change in elk body conditions or energy expenditures over the 20-year life of the plan. The seasonal increase in energy expenditure and the stressed body condition associated with the rut would continue for bulls (Taber et al. 1982, Lubow et al. 2002). Existing general body condition for some cow elk would likely be less than optimal as a result of the high elk densities in portions of the core winter range. Competition for resources and density-dependent mechanisms would be responsible for the reduced body condition (Stewart et al. 2005). The effects on elk body condition and energy expenditures resulting from continued high elk densities of the core winter elk range would be long term, local, adverse, and moderate.

Park staff conduct an annual helicopter survey on the primary winter range to gather data to assess the size and composition of the elk population. The disturbance and dispersal of elk in reaction to the helicopter and the subsequent increases in energy expenditure would continue to have an annual short-term, winter-range-wide, minor, adverse effect on the elk population.

Chronic Wasting Disease

The continued high densities of elk would contribute to a higher likelihood of transmission of chronic wasting disease in the elk population. The sedentary nature of ungulates on their primary winter range and tendency to congregate in large populations (unlike many other wildlife species, which are behaviorally intolerant of high densities) may increase the probability of contact with sources of infection that reside in the environment (Miller et al. 2004). The increased potential for transmission of chronic wasting disease in the high densities associated with the existing elk population would be a long-term, regional, moderate, adverse effect.

Cumulative Impacts

The bans on low-flying commercial air tours over the park and the use of snowmobiles except on a two-mile-long access trail represent a long-term, range-wide, minor benefit to the elk population because disturbance from motorized noise can adversely affect wildlife as a result of behavioral and physiological effects (USAF and USFWS 1988). Elk in particular are stressed more in response to snowmobiles than by encounters with wheeled vehicles (Creel et al. 2002).

Fuels management and forest health projects in the park and on U.S. Forest Service lands adjacent to the park would affect elk habitat by managing forest fuels using mechanical thinning and prescribed fire and by controlling the pine bark beetle. The effects of these projects would be short-term, minor, and adverse because of temporary disturbance or displacement, but the long-term effect on the elk population would be minor, local, and beneficial as a result of improved habitat conditions.

Construction and trail maintenance and improvement projects would temporarily affect the elk population as small segments of potential habitat would be permanently altered. The effects of these projects on the elk population would be short-term, local, minor, and adverse because of disturbance and displacement and long term, local, negligible, and adverse as a result of the permanent loss of small areas of habitat.

Management plans and actions for protecting the park's natural resources would benefit the elk population by maintaining and restoring natural conditions, managing disease (e.g. chronic wasting disease), and limiting intrusive activities. The effects associated with these management plans would be long term, minor-to-moderate, local, and beneficial. Restoring vegetative communities and removing exotic plants in the park would also enhance elk habitat, a long-term, minor, beneficial effect on the elk population.

Hunting outside of the park would continue to be managed by the Colorado Division of Wildlife so that habitat conditions are not degraded by the elk population that may grow in the absence of predators. Game management outside the park would help maintain habitat quality for the elk that share habitat inside and outside the park and would represent a long-term, range-wide, minor-to-moderate benefit for the elk population. Illegal hunting or poaching would continue to adversely affect the elk population inside and outside the park, although exact numbers regarding the extent of this problem are not known. This would represent a long-term, range-wide, negligible-to-minor, adverse, impact on the elk population, assuming that illegal hunting may occur at a level that could have some population-level effects.

Continuing development on private lands outside the park would have effects similar to the specific construction projects referred to above, but the specific locations are not predictable. It is likely that some elk habitat that is currently used by the Rocky Mountain National Park / Estes Valley population would continue to be developed and fragmented as a result of the proliferation of homes and development in the region. Although development outside of the park would result in the permanent loss and fragmentation of native habitat, it results in the creation of artificial habitat which is often nutritionally enhanced and provides a refuge from hunting and predation. As a result, the elk population may then continue to grow to levels which are outside of the range of natural variation due to these artificial conditions. The overall effects, therefore, would be long-term, moderate, and adverse.

Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population, however, these benefits are outweighed by the moderate, adverse cumulative effects stated above.

Alternative 1 would generally contribute long-term, adverse effects on the elk population ranging up to major. The range of effects would be moderate for much of the elk habitat, but would be major in localized portions of the primary winter range where habitat conditions would continue to be adversely affected. These effects contribute to the overall adverse cumulative effects of other past, present, and future actions, but do not result in an adverse cumulative effect greater than moderate.

Conclusion

Overall, the continuation of current management policies would result in long-term, local-to-range-wide, moderate-to-major, adverse effects on elk habitat.

The size and density of the Rocky Mountain National Park / Estes Valley elk population would fluctuate under Alternative 1 as a result of habitat and forage availability, weather, and hunter harvest outside the park, generally higher than the natural range of variation. This would represent long-term, local and range-wide, moderate, adverse effects. The less migratory, more sedentary, and less vigilant elk population represents a long-term, local to range-wide, moderate, adverse effect on the elk population. Habituation to humans and the potential for human-elk conflict would continue to pose long-term, regional, and negligible-to-moderate effects on the elk population, depending on the location and degree of human-elk conflict that may arise. Alternative 1 would not affect population sex and age ratios, as current trends would continue.

High densities of elk on the primary winter range would continue to have adverse effects on body condition and energy expenditures, resulting in long-term, local, adverse, and moderate effects. Annual aerial monitoring of the elk population from helicopters would contribute to increased energy demands on elk physical conditions as they move away from helicopter flights that approach closely. This effect would be an annual, short-term, winter-range-wide, minor, adverse effect on the elk population.

The increased potential for transmission of chronic wasting disease in the locally high densities associated with the existing elk population would have a long-term, regional, moderate, adverse effect on the population.

The adverse effects of Alternative 1 would contribute to the overall adverse cumulative effects of other past, present, and future actions, but do not result in an adverse cumulative effect greater than moderate.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 1.

Alternative 2

Alternative 2 would involve agency removal of elk using lethal means, with aggressive reduction targets during the first four years of the plan to quickly reduce the size of the population, followed by less intensive yearly reductions to maintain target populations. The resulting elk population would fluctuate between 1,200 to 1,700 elk, which would be on the lower end of the target elk range of 1,200 to 2,100. Up to 160 acres of aspen (105 acres in winter elk range and 55 acres in summer elk range) would be fenced to protect the stands from elk herbivory and to allow regeneration of aspen if needed based on monitoring. Elk redistribution techniques would be used to better attain vegetation restoration objectives by dispersing high concentrations of elk.

Elk Habitat

The elk population using habitats in the primary winter and summer ranges would be reduced to 1,200 to 1,700 elk. Elk densities in these habitats would be lowered as a result of lethal reduction activities and by targeted redistribution actions that would focus on areas with high densities of elk. Because degraded habitat conditions result from an overabundant or overconcentrated elk population (Monello et al. 2005), these reductions would benefit elk habitat. The benefits would be the result of reduced forage intensities and a more migratory and less sedentary elk population. If based on adaptive management, fences are determined to be necessary, fencing of aspen in the park would restrict elk use of the habitat in the fenced areas. Elk would seek forage elsewhere, and use of aspen stands for cover would be reduced proportionally. Aspen and understory forbs are a minor component of the elk diet, so its restricted availability would offset benefits of this alternative on the elk population to a minor degree.

Overall, regeneration of aspen, restoration of riparian willow communities, and the return of beaver and a subsequent increase in surface water would represent a long-term, local to range-wide, moderate beneficial effect on elk habitat.

Population Size and Density

The actions taken to reduce the size of the elk population would also likely result in lower densities. The high densities and sedentary behavior of elk are primary factors contributing to degraded habitat conditions in the park. Lethal reduction activities could occur at any time of year and would affect elk from all subpopulations (i.e., Moraine Park / Beaver Meadows, Horseshoe Park, and the town subpopulation). However, most lethal reductions would be performed between November and February to allow the greatest opportunity to reduce the in park subpopulation. Lethal control actions would redistribute elk at differing degrees, depending on whether noise-suppressed weapons would be used or not. Using noise-suppressed weapons at night would help minimize the movement of elk outside the park but could result in localized redistribution. Weapons without noise suppression could be used in areas with high elk concentrations to achieve maximum redistribution effects. A smaller and less dense elk population would benefit from potential increases in fecundity, body condition, and calf survival as density-dependent population-limiting mechanisms would be relaxed (Stewart et al. 2005). The potential increase in reproductive capability accounts for the projected maintenance level of lethal control in elk populations in the last 16 years of the plan. Elk density reductions, achieved through direct population reduction and through redistribution actions, would represent a long-term, range-wide, moderate benefit to the elk population.

There is a degree of uncertainty regarding the ultimate response of elk to redistribution, but in general, benefits to the elk population would be long term, local, and moderate under Alternative 2.

Elk Behavior, Distribution, and Movement

Using redistribution techniques, the elk population that has become less migratory and stays on primary winter range through spring and summer months (Monello et al. 2005) would be forced off the primary winter range to ensure that all elk migrate to the primary summer range. This would represent a return to behavior more typically associated with seasonal elk movements in the Colorado mountains and would relieve foraging pressure on high-use winter range meadows and valley bottoms. An improvement in vegetative conditions would represent a long-term, local, moderate benefit to the elk population as a result of an improvement in the forage resource. The less migratory behavior of the elk population is one of the contributing factors for considering the population outside the natural range of variation (Monello et al. 2005). Encouraging migration, or reversing the trend, would represent a long-term, range-wide, moderate benefit for the elk population.

Redistribution actions and lethal control activities (using both noise-suppressed and unsuppressed weapons) would cause elk to be more wary of people and certain areas of the park. The effects of using noise-suppressed weapons would be less beneficial in terms of making elk more wary, but these techniques would aid in reaching the targeted levels of reduction because they would allow removal of more elk at one location by a reduction team. If a capture facility were needed, the effects on elk behavior for those elk that may be released would be similar to the negative experience associated with being trapped and would increase their wariness. The darting or capturing, anesthetizing, and handling of elk, done in concert with elk management activities, for a three-year research study evaluating procedures for testing live elk for chronic wasting disease and fertility control agent effectiveness in free-ranging elk would result in increased wariness in those subject elk.

In effect, the elk would be reacting to these management actions similarly to how they would react faced with an increased predation risk, namely, with increased vigilance (Laundré et al. 2001). Reducing the level of habituation to people and encouraging increased wariness in elk would represent more "normal" behavior, decreasing the sedentary nature of the elk population. An elk population with increased wariness and lowered habituation to people would reduce the potential for human-elk conflicts, increase population wildness, and contribute to the beneficial effect of the management actions. However, increased wildness achieved by lethal reduction and redistribution would be offset to a negligible degree for a short period as a result of the research study due to the treatment of elk with fertility agents and markings. Overall, Alternative 2 would have a long-term, range-wide, moderate, beneficial effect on elk population behavior.

Population Sex Ratio

Under this alternative, sex ratios would be managed so that bull:cow ratios would not exceed 80:100. This would represent a 4- to 16-fold increase over the ratios reported in the park between 2002 and 2005. Modelled ratios for the park have predicted a population structure that reaches a high of 60:100, which includes some hunting effects. Therefore 80:100 would not be unreasonable for populations in national parks that are not subject to hunting (Hobbs 2005).

The effects of increasing the proportion of bulls in the population are uncertain. Although portions of the Rocky Mountain National Park / Estes Valley elk population are controlled by the Colorado Division of Wildlife as a hunted population, the increase in the bull:cow ratio could theoretically benefit the elk population by reducing harem sizes. As bull:cow ratios increase, harem size generally decreases (Geist 1982, Bender 1996). Smaller harems would require less energy expenditures by bulls, which in turn would lead to better body condition in bulls and an increased potential to survive harsh winter conditions (Geist 1982). However, the increased ratios may also have adverse effects. For example, smaller harem sizes may not result in less energy expenditure, but be a result of more energy expenditure due to increase bull competition and bulls not being able to successfully defend harems. This could potentially translate into such effects as altered genetic structure of the population, as the largest, most dominant bulls do not breed with as many females as they would under natural conditions. In addition, other factors would also influence the sex structure of the population such as weather, food supply, and hunter harvest outside the park. Annual monitoring of the population would help determine the effects of an increased bull to cow ratio by assessing the survival rate of bull elk in the population.

Body Condition and Energetics

Lethal reduction management actions, including the use of firearms, redistribution activities, overflights, potential use of a capture facility (possibly not all elk captured would be killed if the sex ratio of the captured group did not meet population objectives), and research activities would increase energy expenditures and stress levels in the elk population. Elk responses to human activities could include elevated heart rate and metabolism, elevated stress hormones (i.e., glucocorticoids), reduced reproduction, and diminished health as a result of increased energy costs (Creel et al. 2002; Geist 1978; Picton 1999).

In the long-term, reductions in density would decrease intraspecific competition for resources such as forage and habitat. Decreased competition would reduce the amount of energy expended by elk for resources which would result in an overall long-term, range-wide, moderate net benefit.

Chronic Wasting Disease

Lowering the size and density of elk population could potentially lower the prevalence of chronic wasting disease (CDOW 2004c). Additionally, a less sedentary elk population and dispersal of highly concentrated elk would help lower the risk of disease transmission, as reduced movement and large congregations have been implicated in chronic wasting disease transmission rates because of the increased probability of contact with sources of infection, whether they be direct contact with an infected animal or residual environmental contamination (Miller et al. 2004). However, any use of a capture facility could increase transmission of chronic wasting disease.

The implementation of Alternative 2 would represent a potential long-term, range-wide, minor benefit to the elk population as a result of a reduction in the prevalence of chronic wasting disease.

Cumulative Impacts

The existing cumulative effects of other plans, projects, and actions on the elk population, both in and outside the park, would continue as described for Alternative 1. Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

The contribution of Alternative 2 cumulative effects on the elk population as a result of population and density reduction and the subsequent habitat improvements would be long term, range-wide, moderate, and beneficial and short-term, local, moderate, and adverse. The effects of Alternative 2 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 2 would have the following effects on the elk population.

Maintenance of aspen, restoration of riparian willow communities, and the return of beaver with a subsequent increase in surface water would represent a long-term, local-to-range-wide, moderate, beneficial effect on elk habitat. Fencing of aspen would represent a long-term, local, minor adverse effect.

The reduced elk population size and densities would represent a long-term, range-wide, moderate benefit to the elk population as density-dependent population regulation mechanisms would be relaxed.

Reversal of the trend toward a less migratory population would represent a long-term, range-wide, moderate benefit for the elk population. Redistribution actions, lethal reduction actions, and research activities would reduce the level of habituation to humans, resulting in a moderate beneficial effect, as would the effects associated with lethal reduction actions or the use of a capture facility. However, the beneficial effects of reduction actions using noise-suppressed weapons would be reduced.

Alternative 2 may support a theoretical minor benefit as a result of increased bull survival related to reduced energy expenditures due to smaller harem sizes, but this would be offset by increased competition for cows as well as other environmental factors that would reduce bull survivorship.

The short-term effects of management actions associated with lethal reduction activities, herding, overflights, research activities, and other potentially disturbing actions would increase energy expenditures and stress in elk. Nonetheless, in the long-term, the management actions would reduce competition and energy expenditures for forage that are associated with high densities and represent an overall net moderate benefit to the elk population.

Lastly, Alternative 2 would likely reduce the potential for transmission and prevalence rate for chronic wasting disease in the elk population, resulting in a minor benefit to the population.

Overall, Alternative 2 would have a long-term, local-to-range-wide, moderate, beneficial effect on the elk population.

The overall cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would be long-term, minor adverse impacts.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 2.

Alternative 3

Alternative 3 relies on gradual lethal reduction of elk over time to regulate the elk population and its distribution. Because this alternative would maintain the elk population at the higher end of the natural range (1,600 to 2,100 elk), up to 440 acres would be fenced in riparian willow communities on the primary summer and winter ranges, and elk redistribution techniques would be used to a greater degree to support vegetation maintenance and restoration objectives outside fenced areas. Aspen would be fenced as in all action alternatives (up to 160 acres). Within the analysis of this alternative, where impacts are described as the same as or similar to Alternative 2, those impacts would be realized more slowly than in Alternative 2 because of the gradual rate of population reduction.

Elk Habitat

The effects of Alternative 3 on elk habitat would be similar to those described for Alternative 2, with some important distinctions. Elk densities would be lowered as a result of increased use of redistribution actions, and riparian willow communities in portions of the primary elk range would be fenced. Fencing in willow habitat would be installed at a rate proportional to elk reductions, therefore, current ratios of elk to forage would be maintained and there would be no further reduction in available forage compared to Alternative 1.

Elk habitat in the fenced areas would benefit as a result of relief from foraging pressure, representing a long-term, local, major benefit. Any benefits to willow outside of fences would be realized later in the plan. Overall, elk habitat would be beneficially affected by Alternative 3 in a long-term, local, minor-to-moderate manner.

Population Size and Density

The effects of elk population reductions would occur for reasons similar to those described for Alternative 2. However, because there would be no high-intensity period of reductions in the initial years of the plan and the population would be reduced to the higher end of the target range, the intensity of the moderate benefit experienced by the elk population would be incrementally less than under Alternative 2.

Elk densities would experience declines as a result of the implementation of redistribution activities at a level greater than in Alternative 2. Nonetheless, the effects of actions taken to reduce elk densities would be reduced by a more gradual rate of population reduction over the 20-year life of the plan and by fencing in riparian willow habitat on the core winter range. The implications of the population rate reduction are relatively straightforward: the larger the elk population, the fewer benefits that would accrue.

The effects of fencing willow are more complex. Fencing willow would restrict access for elk (and moose) to preferred foraging habitat. Of necessity, the elk would be forced to forage elsewhere, which could increase density in proximity to the fenced areas, based on the assumption that elk would only go as far as needed to find adequate forage. Therefore, density reduction due to population reduction and redistribution activities would be slightly offset by locally increased densities outside fences. On balance, the adverse effect of fences around aspen and riparian willow community habitat would be long term, local, and minor because elk would be forced to move to and use alternative habitat.

Installation of fences would be a relatively intrusive operation that would require helicopters to transport fencing and ground crews that would work in elk habitat. The operations would be implemented when most elk were in the primary summer range, and the intrusion of humans would serve to move elk that have not retained seasonal migration behavior. The effects of these operations on the elk population would be short-term, local, negligible to minor, and adverse.

There is a degree of uncertainty regarding the ultimate response of elk to the combined effects of lethal reduction and redistribution, but in general, benefits to the elk population would be long term, local, and moderate, although slightly less than Alternative 2. The reasons for the beneficial determination would be generally the same as described for Alternative 2.

Elk Behavior, Distribution, and Movement

The effects of Alternative 3 on behavior in the elk population would be similar to those described for Alternative 2; long term, range wide, moderate, and beneficial. The similarities would include the effects on migration and habituation to humans and overall population wildness. Although the degree of population reduction would be less under this alternative, behavioral effects would be compensated for by the increase in the use of redistribution activities.

Population Sex Ratio

Alternative 3 would have effects on the elk population sex ratio similar to those described for Alternative 2 as the bull: cow ratio would increase over current conditions. The effects are uncertain: There may be a minor benefit for the elk population if increased bull survival results, but this would likely be offset by increased competition for cows as wells as other factors that affect population structure such as weather, food supply, and hunter harvest outside the park.

Body Condition and Energetics

The short-term adverse effects of redistribution activities, lethal reduction actions, and research activities under Alternative 3 on energy expenditure and the stress levels in individual elk would be similar to those described for Alternative 2 but incrementally greater. No capture facility would be used under Alternative 3, but the primary difference would be based on a greater reliance on redistribution actions under Alternative 3, which would increase stress and energy expenditures.

In the long-term, reductions in density would decrease intraspecific competition. Decreased competition would improve body condition as a result of reduced energy expenditures for habitat and forage and result in an overall long-term, range-wide, minor net benefit that may not be fully realized until riparian willow habitats are fully restored and the fences are removed.

Fencing may affect elk energy expenditures by restricting access to preferred foraging areas or interrupting traditional movement pathways. This could pose additional energetic demands on individual elk to find forage or by taking longer routes to find suitable resting, hiding, or thermal cover. This would represent a negative effect, depending on the areas fenced and the location of the fenced area in relation to preferred foraging areas or movement corridors. The effects would diminish in the long term as elk adapt to the presence of fences.

Chronic Wasting Disease

The effects of Alternative 3 on the prevalence of chronic wasting disease in the elk population would be similar to those described for Alternative 2. However, because the elk population target would be at the higher end of the target range, the long-term, range-wide, minor benefit associated with Alternative 3 would be incrementally less than with Alternative 2.

Cumulative Impacts

The existing cumulative effects of other plans, projects, and actions on the elk population, both inside and outside the park, would continue as described for Alternative 1. Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Alternative 3's contribution to cumulative impacts would be similar to Alternative 2's, although incrementally less. The overall cumulative effects of Alternative 3 would be similar to the short-term, minor adverse impacts and long-term, range-wide, moderate benefits of Alternative 2, with a small decrease in the benefits to the elk population because Alternative 3 would not realize benefits as quickly as Alternative 2. The effects of Alternative 3 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 3 would have the following effects on the elk population.

Fencing in riparian willow community would result in similar but fewer benefits to elk habitat than those described for Alternative 2. Overall, elk habitat would be beneficially affected by Alternative 3 in a long-term, local, minor-to-moderate manner as a result of decreased foraging pressure.

The reduced elk population size and densities would have effects similar to, but incrementally less, than the long-term, range-wide, moderate benefit described for Alternative 2.

The effects of fencing in aspen and riparian willow would be two-fold. Installation of the fences would have a short-term, local, negligible-to-minor, adverse effect on the elk population as a result of disturbance. Restricted availability of habitat would have a long-term, minor, adverse effect on the elk population.

Alternative 3's effects on elk behavior and the population's age and sex structure would be similar to those described for Alternative 2: offsetting minor effects as a result of potentially smaller harem sizes but increased male competition and other environmental factors that would reduce bull survivorship.

Body condition and energetics in the elk population would be affected similarly to Alternative 2; however, the negative effects would be incrementally greater because of a greater reliance on redistribution actions and fences, which would increase stress and energy expenditures. The negative effect of fences on elk energy expenditures would diminish as elk adapt to fences. In the long term, management actions would reduce competition and energy expenditures for forage and habitat, representing an overall minor net benefit to the elk population.

The effects with respect to the prevalence of chronic wasting disease would be incrementally less than the long-term, range-wide, minor benefit described for Alternative 2 because the population reductions would not be as great.

The overall beneficial effect of the management actions associated with Alternative 3 on the elk population would be long-term, local, and moderate.

The effects of Alternative 3 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 3.

Alternative 4

Alternative 4 would use fertility control agents (single-year, multi-year, or lifetime duration) on elk inside the park to reduce and maintain the size of the elk population. Currently, due to the high number of elk that would need to be treated annually, it is logistically infeasible to meet the elk population objectives of the plan using only available fertility control agents. Therefore, the alternative involves the use of lethal reduction methods to supplement fertility control actions. Because this alternative would maintain the elk population at the higher end of the natural range (1,600 to 2,100 elk), up to 260 acres of montane riparian willow would be fenced in the primary elk winter ranges and would be installed in a phased manner commensurate with reductions in the elk population, and elk redistribution techniques would be used to a greater degree than Alternative 2 in the early years of the plan to support vegetation restoration objectives outside fenced areas.. Aspen would be fenced as in all action alternatives (up to 160 acres).

Elk Habitat

The effects of Alternative 4 on elk habitat would be the same as those described for Alternative 3. Although the means to achieve elk population reductions would differ between these two alternatives, the ultimate effect would be the same, namely a long-term, local, minor-to-moderate benefit to elk habitat in the primary winter and summer ranges.

Population Size and Density

The effects on elk population size and density would be the same as those described for Alternative 3 with regard to lethal reduction and redistribution. Although the use of a fertility control agent would distinguish Alternative 4 from Alternative 3, redistribution and lethal reduction actions and their effects on population size and density would be similar for each of these alternatives. Alternative 4 would provide a long-term, range-wide, moderate, benefit with respect to the elk population size and density.

Elk Behavior, Distribution, and Movement

Lethal reductions, redistribution, and research activities would affect population behavior, including the degree of habituation to humans and/or migration tendencies, as under Alternative 3: a long-term, range-wide, moderate benefit would accrue through increased wildness in the population. The additional handling and close contact with humans as a result of fertility control activities would increase elk wariness and result in an incrementally greater long-term, range-wide moderate benefit. This benefit would be characterized by a decrease in habituation to humans as a result of the negative experience associated with capture and handling. However, increased wildness achieved by lethal reduction and redistribution would be offset by the treatment of elk with fertility agents and markings, which would reduce the intrinsic wildness in the population. Based on the criteria for the use of fertility control agents, they would have no recognizable affects on courtship, rutting, or breeding behavior of elk. Although the long-term effects of fertility control agents is uncertain, as part of the adaptive management approach, if adverse effects were identified, a new agent would be used or treatment would be stopped. The three-year research study evaluating the effectiveness of a multi-year fertility control agent would contribute to expanding the knowledge of effects of such controls on wild, free-ranging elk.

Population Sex Ratio

Alternative 4 would have effects on the elk population sex ratio similar to those described for Alternative 2 as the bull:cow ratio would increase over current conditions. The effects of this are uncertain: There may be a minor benefit for the elk population if increased bull survival results, but this would likely be offset by increased competition for cows as wells as other factors that affect population structure such as weather, food supply, and hunter harvest outside the park.

Body Condition and Energetics

The negative effects of Alternative 4 on body condition and energetics of individual elk would be similar to those described for Alternative 3 for the lethal reduction, redistribution, research activities, and fencing components. The use of a fertility control agent would have no long-term energetic cost or effect on body condition. However, if Leuprolide is used as the control agent, cows would remain in estrus for approximately two weeks longer than under natural conditions. This would increase energy expenditures by bulls as a result of the expanded breeding period (breeding would occur in elk treated with the fertility control agent although pregnancy would not result) and would represent a negative effect. This would have the potential to affect the ability of bull elk to withstand the rigors of winter if their energy stores were depleted by additional expenditures in a longer rut.

If a capture facility would be needed to treat elk with the fertility control agent, increased stress and energetic expenditures would have a negative effect on individual elk. Responses to human activities would be similar to those described for effects on body condition and energetics in Alternative 2, but potentially greater because of the increased stress associated with not only proximity to humans but from trapping, handling, darting, and administration of the control agent.

Cow elk treated with the fertility control agent would experience a benefit that would offset the negative effects of trapping and handling. The stress and energetic demands of pregnancy, lactation, and giving birth would be eliminated for treated cows, resulting in improved body condition.

In the long-term, reductions in density would decrease intraspecific competition. Decreased competition would improve body condition as a result of reduced energy expenditures for habitat and forage and result in an overall long-term, range-wide, minor, net benefit that may not be fully realized until riparian willow habitats are fully restored and the fences are removed.

Chronic Wasting Disease

The effects of Alternative 4 on the prevalence of chronic wasting disease in the elk population would be similar to those described for Alternative 3: a long-term, range-wide, minor benefit.

Cumulative Impacts

Cumulative effects of other plans, projects, and actions and the contribution of Alternative 4 to those effects would be the same as described for Alternative 3.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 4 would have the following effects on the elk population.

The effects of Alternative 4 on elk habitat would be the same as those described for Alternative 3: long-term, local, minor-to-moderate benefit.

Although Alternative 4 would use a fertility control agent to implement population regulation in the elk population (in addition to lethal reduction and redistribution activities), the long-term, range-wide, moderate, beneficial effects on population size and density would be the same as described for Alternative 3.

Lethal reductions, redistribution, research activities, and remote administration of the fertility control agent (i.e., darting) would affect population behavior, including the degree of habituation to humans, and migration tendencies, the same as Alternative 3: a long-term, range-wide, moderate benefit would accrue. However, behavior effects as a result of capturing elk to administer the control agent would be incrementally greater because the wariness of elk would increase and a reduction in habituation to humans would occur as a result to being trapped and handled.

Sex ratios of the elk population would be affected in the same manner as described for Alternative 2: a long-term, range-wide, minor benefit could accrue; however, it would likely be offset due to increased male competition and other environmental factors that would reduce bull survivorship.

The negative effects of Alternative 4 on body condition and energetics of individual elk would be similar to those described for Alternative 3 for the lethal reduction, redistribution, research activities, and fencing components. As a result of fertility control, energy expenditures by bull elk could be greater because of a two-week longer rut if Leuprolide were used as the control agent. Likewise, excess stress and energy expenditure associated with capture would represent a short-term, negative effect on individual elk. Negative effects of handling and treatment would be offset in cow elk as the stress of pregnancy, lactation, and birth would be eliminated. Negative effects would also occur to individual elk as a result of increased redistribution actions and use of fences. In the long-term, management actions would reduce competition and energy expenditures for forage and habitat, representing an overall minor net benefit to the elk population.

The effects of Alternative 4 on the prevalence of chronic wasting disease in the elk population would be similar to those described for Alternative 3: a long-term, range-wide, minor benefit.

Overall, balancing the various positive and negative effects of the management actions, the effects of Alternative 4 would be long term, local to range-wide, minor-to-moderate, and beneficial.

The effects of Alternative 4 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 4.

Alternative 5

This alternative would involve releasing a small population of gray wolves in Rocky Mountain National Park in a phased approach, in combination with lethal control of elk, to achieve an elk population that would fluctuate within the natural range of variation between 1,200 to 2,100 elk. Wolves would be established in the park in very small numbers in the early phase of the plan and gradually allowed to increase in later phases if it is determined that the wolves can be effectively managed and that plan management objectives are being met. Wolves would be monitored and their movements and activities restricted to the park. As wolf predation of elk in the park increases, and based on monitoring of the elk population, the intensity of lethal reductions by NPS staff and their authorized agents would be modified to meet elk population objectives. Wolves would effectively redistribute the population; therefore, no other elk redistribution techniques or fencing of riparian willow habitat would be required to support vegetation protection and restoration. Aspen would be fenced as in all action alternatives if needed based on monitoring of vegetation response (up to 160 acres).

Elk Habitat

The presence of wolves on the winter elk range would result in an increased distribution of elk as they avoid predation. Elk and wolves may alter their behavior over time with wolves changing their activity patterns over the landscape in response to the redistribution of elk. Elk would continue to forage on aspen and willow on the elk range, resulting in a patchy distribution types reflective of more natural conditions. Therefore, it is quite possible that increases in willow could fluctuate over time (Fortin et al. 2005). The effect of wolves in redistributing elk would result in recovery of vegetation through an increase in cover and structural diversity that would benefit a wide range of other wildlife species. Ripple et al. (2001) and Hebblewhite et al. (2005) have documented this type of response in Yellowstone and Banff National Parks, respectively. The benefits to elk habitat as a result of Alternative 5 would be long term, local to range-wide within the park, and moderate to major.

Population Size and Density

During the first phase of Alternative 5, lethal reduction actions would be the primary management tool that would affect the size of the elk population. Lethal reductions would have effects similar to those described for Alternative 2, although the effects would be incrementally less than the long-term, range-wide, moderate benefit under Alternative 2 because the target population would be 1,600 to 2,100 during the first four years and 1,200 to 2,100 during the last 16 years of the plan rather than 1,200 to 1,700.

The presence of wolves on the primary winter range would have a substantial effect on elk density. In Yellowstone National Park following the reestablishment of wolves (Laundré et al.

2001, Fortin et al. 2005) and in Banff National Park, Canada (Hebblewhite et al. 2005), elk use of habitat underwent a large shift as a result of the presence of a primary predator. Elk use of riparian and wet meadow communities decreased in Yellowstone in areas frequented by wolves (Ripple et al. 2001). Some of the highest reported densities of elk are found in the montane riparian and wet meadow community habitats in and around Moraine Park, Beaver Meadows, and Horseshoe Park in Rocky Mountain National Park (Monello et al. 2005). The presence of wolves in Rocky Mountain National Park would likely reduce the density of elk in these areas of the primary winter range, possibly to a greater extent than by the human means used in the other alternatives. However, the reluctance of wolves to use developed areas in and around the core winter range may reduce their effect on elk density. Reduced densities would offset the existing adverse effects described under Alternative 1, and compared to Alternative 1, represent a long-term, local, moderate benefit on the elk population.

Elk Behavior, Distribution, and Movement

The presence of wolves, combined with the effects of lethal reduction activities, would make elk in the park more wary. Increased wariness in the park would reduce habituation to humans and the sedentary behavior that contributes to degradation of habitat. However, the presence of wolves in the park may cause elk to use Estes Park as a refuge from predation because wolves would not be permitted to leave the park. The number of elk that might move from the park to town would not exceed current population movements because lethal reduction actions in the park would reduce the size of the population proportionally between the park and town subpopulations. Nonetheless, if elk move to the habitats in and around Estes Park, habituation to humans and development could increase for the segment of the population that moves out of the park. However, it should be noted that elk in areas surrounding Banff National Park in Canada are less habituated to humans because their natural instincts have been heightened by the presence of wolves in the area (Ronca 2006). The increased wariness, increase wildness, and reduced habituation in the park could be offset by the reverse effect outside of the park. Overall, the benefit in terms of elk behavior would be long term, local, and minor-to-moderate in the park and minor outside the park.

Wolves in the park would likely use montane areas and den in lower elevation portions of the primary winter range. The presence of wolves on the primary winter range in summer could encourage elk migration to traditional summer elk range at higher elevations. This effect would be similar to the human management actions taken under Alternative 2 to encourage migration, but would be incrementally greater than Alternative 2’s long-term, range-wide, moderate benefits because of the natural component that would drive the migratory elk behavior and the continuous presence of wolves versus scheduled, discrete human management actions.

Over time, elk would exhibit behavior to avoid predation as they adapt to the presence of the wolves. Elk with superior predator avoidance behaviors would survive and be more likely to reproduce. This would represent a long-term, range-wide, minor-to-moderate benefit as overall fitness (i.e., probability of producing offspring) of the elk population would increase as behavior that avoids predators is learned (Lind and Cresswell 2005).

Population Sex Ratio

Alternative 5 would have effects on the elk population sex ratio similar to those described for Alternative 2 in the initial stages of implementation because population regulation would be primarily accomplished using lethal reduction actions. The reduction targets would be adaptively managed to achieve the sex ratios associated with Alternative 2. The bull:cow ratio would increase over current conditions with potential minor benefits as described for Alternative 2; however, there would be predation on bulls by wolves to some degree, reducing bull survivorship in combination with environmental factors that affect the population structure offsetting the beneficial effects.

Body Condition and Energetics

Short-term effects on energy expenditures and stress levels in individual elk associated with lethal reduction activities and capture and handling of elk for a research study would be similar to those described for Alternative 2. Elk would experience an increase in their energy expenditure and stress levels as a result of the increased risk of predation by wolves.

In the long term, the effects of the population reduction and lower densities of elk would decrease intraspecific competition. Decreased competition would reduce the amount of energy expended for forage and habitat by elk. In addition, wolves would be expected to prey on the less fit individuals in the population, thereby improving the overall fitness of the population. The overall net benefit to the elk population under this alternative would be long-term, range-wide, and moderate.

Chronic Wasting Disease

Wolves would be more likely to prey on weaker, diseased elk than stronger, healthy elk (Mech et al. 1995), suggesting that wolves would preferentially prey on elk infected with chronic wasting disease in Rocky Mountain National Park. If such selective predation on elk with chronic wasting disease occurs, it would remove a higher proportion of diseased animals from the population than would be expected based on the current incidence of chronic wasting disease. This could lower the chronic wasting disease prevalence rate and would be a long-term, range-wide, minor-to-moderate benefit for the elk population.

Cumulative Impacts

The existing cumulative effects of other plans, projects, and actions on the elk population, both inside and outside the park, would continue as described for Alternative 1. Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

An additional cumulative benefit would be related to the Colorado Division of Wildlife's preparation of a statewide wolf management plan, based on the Colorado Wolf Management Working Group's December 2004 recommendations. This plan would incrementally add to the cumulative beneficial effects of other plans and projects because there would be a management plan developed to address the natural return of wolves to the state. Although modeling indicates that the Rocky Mountain National Park is less than optimal for long-term establishment of a free-ranging wolf population (Carroll et al. 2003), there is a possibility that wolves could naturally return to Colorado (CDOW 2003b, CWMWG 2004). Based on that possibility occurring within the 20-year life of this plan, a management plan to deal with wolf issues would benefit the elk population as a result of wolf-related habitat and ecosystem improvements and the resulting increased fitness of the elk population. These benefits would occur for the same reasons as those described in the analysis of a released wolf population in the park, although a naturally occurring wolf population would not be restricted within the park boundaries.

Alternative 5's contribution to the overall cumulative impacts on the elk population would be similar to Alternative 2's, although the release of wolves would have additional short-term and long-term adverse effects for elk, as well as long-term, range-wide benefits that would be incrementally greater than the benefits associated with Alternative 2. The effects of Alternative 5 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 5 would have the following effects on the elk population.

In general, the effects of Alternative 5 are similar to those described for Alternative 2, with some important differences. The benefits to elk habitat as a result of Alternative 5 would be long term, local to range-wide within the park, and moderate to major as a result of redistribution of elk by wolves and the range-wide effects that would improve habitat conditions throughout the elk range. The effects on elk population size and density would be similar to the long-term, range-wide, moderate benefits described for Alternative 2, but incrementally less because of the wider target range for the elk population. If their numbers and use of the elk primary winter range for predation are high enough, wolves would affect elk density, such that the effect would be long term, local, moderate, and beneficial as a result of dispersing concentrations of elk in montane riparian willow communities.

Lethal reduction and research activities, combined with the threat of predation, would decrease habituation to humans, increase the wariness and wildness of elk, and decrease elk sedentary behavior; all these behavioral effects would be long term, local, minor-to-moderate, and beneficial. This benefit would be minor-to-moderate rather than moderate because if elk respond to wolves by taking refuge in Estes Park, the benefit would be somewhat reduced because habituation to humans would increase.

Wolves would likely increase elk movements, including encouraging traditional migratory behavior. This would represent a long-term, range-wide, moderate benefit.

The overall fitness of the elk population would increase in the long term because natural selection processes would select those elk with superior predator avoidance skills. This would be a long-term, range-wide, minor-to-moderate benefit for the elk population.

Effects on the sex ratio of the elk population would be similar to those described for Alternative 2. With an increase in the bull to cow ratio, there may be minor benefits to bull survival as a result of smaller harem sizes, but these would be offset by increased bull competition, predation by wolves, and other environmental factors that reduce elk survivorship.

Short-term effects on body condition and energetics in individual elk associated with lethal reduction activities and research activities would be similar to those described for Alternative 2. The threat of wolf predation would also increase stress and energy expenditures in elk. However, in the long term, the elk population would be smaller and less dense, reducing energy expenditures for forage and habitat. Wolves would also increase the fitness of the population by removing the less fit. Overall, this would represent a range-wide, moderate net benefit to the elk population.

Wolves would preferentially prey on young, old, weak, and diseased elk. This has the potential to reduce the prevalence of chronic wasting disease in the elk population, resulting in a long-term, range-wide, minor-to-moderate benefit.

The effects of Alternative 5 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 5.

VEGETATION

Summary of Regulations and Policies

Management Policies states that the "fundamental purpose" of the national park system begins with a mandate to conserve park resources and values and provide for the public enjoyment of the park's resources and values to the extent that the resources will be left unimpaired for future generations. Section 1.4.6 identifies native vegetation as a park resource, and Section 4.4.2 provides general principles for the maintenance of natural resources in the park by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native species (NPS 2006b).

Riparian shrub and herbaceous vegetation are large components of the wetland habitat found within the park and are focal vegetative groups discussed in this analysis. The National Park Service must comply with Executive Order 11990, Protection of Wetlands, which requires federal agencies to avoid the short- and long-term, adverse impacts associated with the destruction or modifications of wetlands whenever possible and to preserve and enhance the natural and beneficial values of wetlands. NPS management policies and Director's Order 77-1: Wetland Protection requires parks to protect wetland habitat from degradation and to restore natural wetland functions and values where human activities have disturbed them.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

Issues and concerns regarding vegetation degradation within the park focus on the primary winter and summer ranges that the Rocky Mountain National Park / Estes Valley elk population inhabit. Therefore, the area of analysis of effects of elk and vegetation management actions focuses on vegetative communities within the elk range. The vegetative types within these ranges that are analyzed include non-conifer-associated aspen (referred to as aspen unless stated otherwise), riparian shrub (referred to as willow and including willow in the montane, subalpine, and alpine areas of the elk range), bitterbrush and sagebrush, riparian and upland herbaceous, and subalpine and alpine herbaceous. This vegetation that occurs on the elk range is most impacted by elk herbivory, has been well studied, and is expected to be most affected by the proposed management alternatives.

Issues

Issues regarding the effects of elk and vegetation management activities on vegetation were identified through internal and public scoping. These issues include the following:

- Areas of important aspen and willow are being lost and degraded because of direct and indirect effects of the park's elk population size and density.
- Long-term vegetation regeneration and reproductive processes are being substantially degraded in some locations to the degree that this vegetation could be lost from the park's landscape.
- High elk numbers and densities affect the reproduction and distribution of vegetative species, which results in changes in plant community structure and composition.

Vegetation diversity and associated habitat functions are being degraded and could be lost in areas of the park if current elk population size and densities and vegetation condition trends continue.

The changes in vegetation condition on the elk range are exacerbated by reduced water levels and the dramatic decrease in the beaver population in the park. Beaver activity helped maintain higher water levels in many of the streams and adjacent areas in the analysis area, encouraging and nurturing montane riparian willow growth. Elk grazing and a change in water table cause a shift from tall to short willow and culminate in a successional shift on the primary winter range from montane riparian willow to grassland areas or from early stage successional communities to later successional types.

High elk densities in some locations during certain times of the year may also lead to an increase in bare ground, which may increase exotic plants in the area.

Due to the degraded condition of the vegetation and the high level of elk herbivory on the range, the use of prescribed fire to stimulate regrowth in aspen and montane riparian willow habitats has been inhibited.

Adverse impacts on vegetation may occur as a result of elk-capture facilities, use of equipment and personnel to access areas of the park, removal of elk carcasses, and installation of exclosure/enclosure fences.

Adverse indirect effects may occur as a result of potential increases in mule deer and moose as a result of lowered abundance of elk.

Assumptions

All assumptions relevant to vegetation are presented in the "General Methodology" section.

Assessment Methods

Vegetation in the park was digitally mapped and the acreages of aspen, montane riparian willow, upland shrub, riparian and upland herbaceous communities, and subalpine and alpine vegetation that occur within the elk range were determined. The geographic information system (GIS) coverage of the vegetation and the elk range were overlayed, and each vegetation community was quantified by acreage. This provided information on the maximum amount of vegetation by type that was known to be affected by elk herbivory but not on how extensively the communities were used by elk.

Predictions in the change in vegetation over time as a result of changes in elk numbers and densities and a combination of management actions were based on ecosystem modeling and research conducted within the park as well as research and management results in other locations, focusing primarily on elk use in the core winter range. The park-specific scientific literature presented in the USGS open file report (Singer et al. 2002) and summarized in the NPS synthesis of park research on elk and vegetation (Monello et al. 2005) and the references therein were relied heavily upon in the assessment of effect of elk herbivory on vegetation. Ecosystem modeling by Coughenour 2002 and Weisberg and Coughenour 2003 evaluated response of aspen and montane riparian willow on the primary winter range to various management scenarios. The results presented in the action alternatives for montane riparian willow based on ecosystem modeling (Coughenour 2002) assumed that there were increased water table heights, and therefore the analysis impacts are a result of the actions in the alternatives as well as increased water availability.

Information on the specific effects of elk herbivory on vegetation in areas of the elk range outside the core winter range is limited. Where research has been conducted in these areas, it was relied on to assess effects. When area specific research was not available, effects of elk herbivory in these other areas of the elk range were extrapolated from core winter range studies. However, the intensity of effect was considered to be less because the current condition of the Kawuneeche Valley is changing less quickly than that of the core winter range due to the primary summer range being larger, elk densities being lower, and forage availability being higher.

Analysis of effects of elk herbivory on vegetation also relied on park research that involved the use of exclosures to show the condition of and response of vegetation when herbivory by elk and/or deer was excluded. Effects were assessed recognizing that some level of herbivory by both deer and elk is natural and would continue under all of the alternatives. This research, however, provided evidence of the potential vegetative response to herbivory from which to evaluate effects of management actions. The evidence of elk herbivory effects based on four-year and 35-year exclosure studies that excluded both elk and deer from foraging was included in the analysis of effects to illustrate the short- and long-term types of changes that would occur in vegetative communities when vegetation is not exposed to grazing. However, the degree of vegetative response was adjusted in the analysis qualitatively, considering that some natural level of herbivory to vegetation would occur to some degree under the alternatives and that the management actions being evaluated for this plan would only occur for 20 years.

In addition, relevant information obtained in the literature was used when park-specific studies were not available.

The analysis of the changes in vegetative condition under Alternative 1 was based on the continuation of the existing condition of the vegetation on the elk range and additional changes that would occur in this condition over time.

The following parameters were used to evaluate vegetation effects:

Community structure.

Species composition.

Age and class structure.

Stand vigor of vegetation.

Distribution of vegetation.

Abundance and rarity of a vegetation type within the park or region. If a community or species is rare, then impacts on that vegetation were considered to be greater.

Sensitivity of vegetation to disturbance due to environmental factors such as elevation, temperature, and soil condition, which inhibit recovery.

Ability of and time for a vegetation type to recover from herbivory and other effects.
Potential for exotic plant infestation.

Impact Threshold Definitions

Intensity of Impact

Negligible: Individual plants may occasionally be affected, but measurable or perceptible changes in the vegetation size, integrity, or continuity would not occur.

Minor: Effects on plants would be measurable or perceptible. The natural function and character of the vegetation would not be affected.

Moderate: A change would occur in the natural function and character of the vegetation in terms of growth, abundance, reproduction, distribution, structure, or diversity but not to the extent that the basic community properties change.

Major: Effects on community parameters would be readily apparent and would substantially change the natural function and character of the plant.

Type and Duration of Impact

Beneficial: Abundance, distribution, structure, and species richness of vegetation would increase, and potential for exotic plants species infestation would decrease.

Adverse: Abundance, distribution, structure, and species richness of vegetation would decrease, and potential for exotic plants species infestation would increase.

Duration: For short-term impacts, changes in vegetation would be apparent over two or three growing seasons or less. For long-term impacts, changes in vegetation would be detectable over multiple seasons and could persist over the next 20 years and beyond.

Impairment

Impairment to the vegetation would occur when the action(s) contributes substantially to deterioration of the vegetation in the park to the extent that the vegetation would no longer function as natural communities.

Alternative 1

Aspen

Aspen in certain portions of the elk range are disappearing from formerly occupied locations. Existing aspen stands are slowly shrinking in size and decreasing in overall stand health and vigor. The primary reason for these changes is suppressed aspen reproduction because elk browsing is removing the young age classes before they can mature into young trees that are resistant to elk browsing. Suppression of aspen stands and gradual decline or loss of historic aspen locations is undesirable because of aspen's role in supporting many other bird and plant species beside elk. Evidence of these effects are shown by the plant differences visible inside and outside the numerous research exclosures that are maintained throughout the park. Alternative 1 would continue this condition and gradual decline or loss of aspen. When aspen clones are lost in localized areas, they may serve as an indication that the system is outside of its range of natural variability. This decline or loss would be considered a long-term, major, adverse impact.

Aspen represent 2% of the total vegetation on the elk range. The effects of elk on aspen would continue to be a predominantly localized problem specific to areas within the core winter range (e.g., Moraine Park, Beaver Meadows, and Horseshoe Park) and the primary summer range in the Kawuneeche Valley (Suzuki et al. 1999). In these areas, elk herbivory would be expected to continue to prevent aspen from regenerating, as aspen suckers less than eight feet tall are currently unable to escape elk herbivory (Olmstead 1979 and 1997, Baker et al. 1997, Suzuki et al. 1999).

Elk herbivory on the primary winter range would continue to be high, thereby suppressing aspen regeneration in specific areas of the primary winter range. Aspen cohorts in core winter range do not regenerate at elk numbers higher than 600 (Olmstead 1979), and under this alternative with no management of the elk population, elk numbers on the primary winter range in particular would fluctuate around could range up to 1,000 animals. As a result, only 20% of the aspen within the winter range would be expected to regenerate (Suzuki et al. 1999; Kaye et al. 2003), and the annual percent offtake by elk in aspen would continue to be approximately 18% or higher. The inability of aspen to regenerate on the primary winter range would continue over time. As a result, the number of areas on the primary winter range that are composed of entirely dead standing and downed trees with no live trees would continue to increase.

Modeling has indicated that an elk population size fluctuating between 800 and 1,100 in the park on the primary winter range over the next 20 years would result in a further reduction in the percent cover of aspen by approximately 7 to 10% (Coughenour 2002). It is predicted that over 50 years, the tree aspen in some stands of the core winter range would likely die out or persist as shrub aspen as has been observed in Yellowstone (Renkin and Despain 1996).

Elk densities would also presumably continue to affect aspen regeneration. Currently, densities in some areas of the core winter range exceed 261 elk/mile^2 . Modeling has shown that densities would need to be below 26 elk /mile^2 on the elk winter range to allow aspen regeneration (Weisberg and Coughenour 2003), and the probability of regeneration is higher if younger aspen cohorts are present. Without management action to reduce and redistribute the elk population under this alternative, aspen ability to regenerate, particularly older stands in localized areas on the core winter range, would continue to be severely reduced.

High levels of elk herbivory and densities have also led to a decline in aspen stand structure that would continue under this alternative. As herbivory continues at approximately the same level of intensity over time, stands would continue to age with no regeneration. Olmsted showed that stands on the primary winter range that receive greater than 50% use by elk display a uniform age distribution (1979). On the core winter range, the number of large trees has declined by 42% over a 20-year study period (Olmsted 1997), and in high elk-use areas, the ratio of live to dead trees is half that of ungrazed sites (Baker et al. 1997). In highly grazed areas, aspen stands have also been shown to have more dead and fewer live branches (Baker et al. 1997). With the continued high level of grazing by elk, aspen would be unable to regenerate in high elk use areas of the primary winter range and over time, the older trees would continue to die, leading to further reductions in overall stand sizes on the primary winter range.

In contrast to the core winter range, the primary summer range is much larger, elk densities are lower, and forage availability is higher. There is limited documented evidence of the effects that elk have had on aspen in the primary summer range. A few studies have indicated a lack of regeneration of aspen in the Kawuneeche Valley, which has been attributed to locally heavy elk use in both the winter and summer (Suzuki et al. 1999, Kaye et al. 2003). On the primary summer range at elevations above 9,000 feet, there is evidence that nearly 70% of the aspen stands can regenerate (Suzuki et al. 1999). These conditions would continue under this alternative.

Because of the rarity of aspen within the range, the continued high level grazing by elk, particularly in localized areas on the core winter range and on the primary summer range, would be a long-term, major, adverse impact on aspen.

Under Alternative 1, prescribed fire would not be used as a tool to stimulate growth of vegetation. At current levels of elk numbers and densities, a combination of fire and elk grazing would negatively impact aspen (Nesvacil and Olmsted 2002). Fire is not necessary for the persistence of aspen stands on the elk range that are of management concern, as these stands are successional to grassland, although fire would stimulate some sucker production. An inability to use prescribed fire in these stands under this alternative would have a major, long-term, adverse effect.

Montane Riparian Willow

Under this alternative, approximately 1,190 acres of montane riparian willow on the primary winter range and in the Kawuneeche Valley would continue to be affected by high levels of elk herbivory in combination with drier conditions (see “Hydrology” section in Chapter 3 for more detail). Continued high levels of elk herbivory and reduced surface water that would continue to occur under this alternative would affect montane riparian willow reproduction and seedling establishment, distribution, productivity, and morphology.

Elk herbivory in the primary winter range would continue to lower willow seed production, dispersal, and survival. High elk population levels would continue to severely inhibit seedling establishment on the elk range by a lack of seed rain and seedling survival, primarily due to the effects of herbivory. Few willows in the core winter range would produce seed because the condition of willow stems would be poor due to heavy elk browsing. Elk herbivory and the lack of beaver and their associated habitats would continue to decrease available suitable seed establishment sites, willow reproduction, and growth (Zeigenfuss et al. 2002, Cooper and Gage 2003, B. Baker et al. 2005). Willow declines on the primary winter range have been correlated to a large reduction in surface water and a severe reduction (greater than 90%) in the beaver population in the area (Peinetti et al. 2002, Zeigenfuss et al. 2002).

Montane riparian willow growth and survival primarily depend on ground water from streams and snowmelt (Alstad et al. 1999); large expanses of montane riparian willow have died where streams have become totally dry and water tables have dramatically decreased. The decrease in water table on the primary winter range in particular has been attributed to the dramatic reduction in beaver (see “Water Resources” section of this chapter). Plants further removed from streams have a decreased ability for roots to reach groundwater sources due to high levels of elk browsing (Menezes et al. 2002). Elk browsing results in plants expending more energy in the development of aboveground stems and leaves and less allocation of energy in the production of roots (Menezes et al. 2002; Peinetti et al. 2001), decreasing the ability of the plants to reach deeper water sources. The relative effects of elk and water are further evidenced by findings that many streamside plants with excellent water availability are also in poor condition because of elk browsing (Peinetti et al. 2001, Zeigenfuss et al. 2002, Cooper et al. 2003).

Under Alternative 1, continuing current elk numbers and densities and absence of beaver would result in an inability of willow to establish on the core winter range, seed production would continue to be limited, and seedlings would continue to be over browsed. This would limit further the ability of montane riparian willow in these areas to reproduce, and therefore a continued decline in the amount of montane riparian willow would occur over the next 20 years.

One of the primary factors reducing the productivity in montane riparian willow on the primary winter range is elk herbivory (Schoenecker et al. 2004). Exclosure experiments suggest that elk are affecting willow production, as plots that did not experience elk grazing increased plant production up to 66% after four years and 98% after 35 years (Schoenecker et al. 2004 Zeigenfuss et al. 2002). Peinetti et al. (2001) found an increase in aboveground productivity as a compensation for tissue removal by elk. However, continuous browsing by elk at the high levels that occur under this alternative would result in willow compensating for this grazing pressure by reducing the belowground growth of roots, particularly under drier conditions that exist on the primary winter range.

Elk also affect the growth and size of the montane riparian willow community. Elk browsing levels on the primary winter range dramatically reduce willow height (Peinetti et al. 2001, Schoenecker et al. 2001, Zeigenfuss, Singer, Williams, et al. 2002) and volume (Peinetti et al. 2001, Schoenecker et al. 2001). Plants that are browsed are shorter and the canopies are smaller compared to unbrowsed plants. Willows that are protected from browsing have been shown to be 66% taller in a four-year period than those that are browsed (Schoenecker et al. 2004). Browsing over a longer period (35 years) reduced willow volume, height, and stem density, as indicated by willow not subject to browsing on the core winter range that increased in these measures by 98% compared to unbrowsed areas (Schoenecker et al. 2004). As a result, areas of the core winter range have experienced a transition of tall willow to short willow over the last 60 years; this transition would continue to occur under Alternative 1.

Elk herbivory and density are strongly correlated to willow growth, morphology, and size (Singer et al. 2002). Willow growth and size are negatively affected at elk consumption rate of 37%. The average annual willow consumption on the primary winter range has been at approximately 33% and would be expected to continue at this rate under Alternative 1. Elk densities greater than 83 elk/mile^2 have resulted in a 40% decline in willow size and growth parameters. Elk densities range from 26 to 286 elk/mile^2 in the grassland and montane riparian willow communities of the core winter range. Throughout the rest of the primary winter range, elk densities are less than 26 elk/mile^2. These areas primarily consist of forested areas that are not considered prime feeding habitats for elk (Singer et al. 2002).

As the number of plants declines and the morphology of the plants changes, the overall canopy cover would be reduced (Schoenecker et al. 2004). Modeling predicts that without any changes in management actions, which would allow continuation of the elk population wintering in the park between 800 and 1,100, and at current water table levels, willow cover within suitable montane riparian willow habitat would decline slightly from the 22% that exists on the primary winter range (Coughenour 2002).

Under this alternative, grazing at high levels by elk would produce morphological changes in the willow that would continue to constrain plant growth and development and would inhibit willow reproduction and establishment, particularly in areas on the primary winter range. High browsing levels by elk would continue to reduce the abundance, competitive ability, and survival of montane riparian willow, particularly under the drier conditions that would continue to occur on the primary winter range. Montane riparian willow would continue to transition from taller willow areas to shorter areas and be converted from shrub habitat to grasslands. In localized area of the core winter range where elk densities would continue to be excessive (up to 260 elk/mile^2), the long-term, adverse impacts on montane riparian willow would be major; in other areas of the range where densities are lower, the long-term, adverse effects would be minor to moderate.

Montane riparian willow are also present on the primary summer range (570 acres), and although limited data exist for elk herbivory effects on willow there, anecdotal observations by park staff and researchers have led to growing concern that elk are adversely affecting willow in this area much as described above for the primary winter range. Montane riparian willow establishment in the Kawuneeche Valley has also been depressed as a result of lower groundwater and consequent reduction in the moist soils (Cooper et al. 2000). This reduction in potential for establishment in combination with continued elk herbivory would result in impacts on willow reproduction, seedling establishment, height, volume, and cover similar to those on the primary winter range discussed above. The long-term, adverse effects that elk have on montane riparian willow on the primary summer range would range up to major over a 20-year period.

Under Alternative 1, the use of prescribed fire in the elk range would continue to be prohibited. Due to the degraded condition of montane riparian willow on the elk range, particularly in the core winter range, fire would not be used as a regenerative tool or to reduce fuel loads in the area because grazing pressure post-fire would further damage the montane riparian willow (Nesvacil and Olmsted 2003). Fire has not been shown to be necessary for montane riparian willow regeneration; however, it can speed regenerative processes (Baker et al. 2005). The continued inability to use prescribed fire under this alternative would have a long-term, major, adverse effect on montane riparian willow on the elk range.

Upland and Riparian Herbaceous Plants

Because a quarter of the elk remain on the primary winter range year round, they inhibit the regrowth capabilities of herbaceous species that provide important winter forage for wildlife species (Augustine and McNaughton 1998). Under this alternative, continuation of high levels of herbivory in these vegetation types may reduce herbaceous production and possibly lead to altered communities (Singer et al. 2002). Consumption rates of herbaceous vegetation are considered to be extremely high, with annual herbaceous offtake rates reported to be 55% in riparian and 60% in upland habitats (Singer et al. 2002). In similar systems, herbaceous vegetation cannot withstand offtake rates at or above 60%.

Offtake at these levels has resulted in an 18% to 29% reduction in herbaceous production in riparian communities on the core winter range. However, elk grazing may have greater effects when precipitation is average or below average, as grazed sites in years with above-average precipitation had higher levels of production compared to ungrazed sites (Zeigenfuss et al. 2002). Modeling results predict little effect of the continuation of a high level of elk herbivory over the next 20 years on herbaceous biomass (Coughenour 2002). However, the model did not take into account elk densities and distribution. Therefore, the current elk population level and over-concentration of elk on the primary winter range with resultant high levels of elk herbivory would probably have a greater-than-predicted effect on herbaceous production in areas of the primary winter range. The high level of consumption has not altered herbaceous coverage on the primary winter range, but comparison with consumption rates in similar type ecosystems indicates that herbaceous communities on the primary winter range may not be able to be maintained under such grazing pressures (Monello et al. 2005).

Continuation of the current level of elk herbivory under this alternative would not be expected to have large-scale effects on plant species richness or biodiversity in upland and riparian herbaceous communities (Schell and Stohlgren 1997, Stohlgren et al. 1999, Zeigenfuss et al. 1999, Zeigenfuss et al. 2002, Singer 1995, Singer et al. 2002). Singer (1995) did not observe any differences in the number of grass or forb species inside and outside exclosures. However some changes within the habitat did occur as browsing has been found to cause increases or decreases in the cover of some individual species (Singer 1995, Zeigenfuss et al. 1999). In grasslands, elk herbivory has resulted in *Carex* spp. More than doubling in ungrazed areas (Zeigenfuss et al. 2002). In riparian areas, grazed sites had more goldenrod species (*Solidago* spp.) and ungrazed sites had more bluebell (*Mertensia retens*) after four years (Singer et al. 2002).

Although large-scale changes in plant richness or diversity would not occur, the adverse effects of elk herbivory on herbaceous plant growth and production over the life of the plan would continue to have long-term, moderate, adverse effects in areas of the elk primary winter range where concentration of elk would remain high in both the summer and winter seasons.

Herbaceous vegetation on the primary summer range would be expected to experience similar effects from elk herbivory as described above, but to a lesser extent. The primary summer range is much larger, elk densities are lower, and forage availability is higher due to the summer growing season. As a result, the long-term, adverse effect that elk herbivory would have on riparian and upland herbaceous plant production, growth, and individual species abundance would be minor.

Bitterbrush and Sagebrush Upland Shrubs

Bitterbrush and sagebrush upland habitats are important forage for mule deer in the park and provide habitat for many bird and small mammal species (see *Wildlife* section of this chapter). High levels of herbivory that would continue under this alternative have affected bitterbrush and sagebrush production, morphology, and cover as well as species composition and abundance.

The continued level of herbivory under this alternative would continue to negatively affect total estimated annual shrub production and growth. Over the long term, studies indicate that herbivory would affect upland shrub production as bitterbrush protected from grazing increased over a 25-year period between 12% and 37% depending on amount of shrub originally present (Gysel 1960), and after 35 years, sagebrush current annual growth increased by 67% (Schoenecker et al. 2002).

Shrub volume and canopy would also be reduced in localized areas of high elk herbivory on the primary winter range under this alternative. Over a 35-year period when sagebrush was protected from elk herbivory, shrub volume and canopy increased by 300% and 178%, respectively (Singer et al. 2002).

Over the 20-year life of this plan, elk herbivory at high levels would be expected to continue to reduce bitterbrush and sagebrush production, abundance, and structure in localized areas to a moderate degree on the primary winter range. Alternative 1 would result in long-term, moderate, adverse effects on bitterbrush and sagebrush production and volume in localized areas of the primary winter range.

Elk herbivory under this alternative would not be expected to produce large-scale changes in species abundance or species diversity, although localized changes in habitat would occur as a result of continued high levels of elk herbivory. Elk herbivory has resulted in 14% and 56% increases in the height of bitterbrush and sagebrush habitat, respectively, as well as a 24% to 32% increase in the percent cover of grasses over the long-term. Increases in height of bitterbrush may have been a result of decreased use of by mule deer in both vegetation types (Zeigenfuss et al. 1999). In upland bitterbrush sites, percent cover of prairie sage (*Artemisia ludoviciana*) and sulphur buckwheat (*Eriogonum umbellatum*) in grazed sites was reduced after four years (Zeigenfuss et al. 1999). These changes in individual species abundance would continue to occur under this alternative without changes in the level of elk herbivory. Elk herbivory effects on individual species abundances and habitat changes within bitterbrush and sagebrush habitat would continue to have long-term, localized, minor, adverse impacts on the primary winter range.

Subalpine and Alpine Vegetation

Subalpine and alpine riparian and upland willow on the elk primary summer range cover 2,236 acres. Limited data exist for elk herbivory effects on willow in this area; however, anecdotal observations by park staff and researchers have led to growing concern that elk are adversely affecting willow in this area much as described above for the primary winter range. Recent analysis of 12 transects in subalpine and alpine plant communities collected over varying intervals between 1971 to 1996 found that flat-leafed willow showed a 48% cover and 37% height decline, and that short-fruit willow showed a 70% cover and 40% height decline over the 25-year period (Zeigenfuss 2005). These trends do not definitively correlate with elk herbivory; however, they do support general observations by park staff and researchers. Some evidence exists suggesting that elk are affecting willow morphology in the alpine, as willows protected from herbivory in the alpine were shown to be one-third taller than those that were grazed over an eight-year period (Stevens 1980b). The adverse effects on willow in this area over a 20-year period could range up to major.

Subalpine and alpine herbaceous vegetation are unique in that they can grow in very harsh climatic conditions. Species of plants in these environments are often considered sensitive to disturbance, as they are slow to recover due to the short growing season and low average temperatures. Limited research is available to assess the impacts of elk use of subalpine and alpine areas. In the past, elk use of the tundra has been shown to be minimal; however, there have been indications that various species of grasses (*Poa* spp.) have been heavily used. Data also indicated a trend toward less ground cover in tundra turf areas as all major cover species lost cover and frequency of occurrence in localized areas (Stevens 1980b); however, this was not quantified. Other studies, in contrast, have not indicated any lasting effects by elk (Marr and Willard as cited in Stevens 1980b). These studies do not indicate that elk herbivory is having long-term, community level impacts on subalpine and alpine herbaceous vegetation. The localized, adverse effects of elk herbivory would be minor and long term, due to the slow recovery of these vegetation types to disturbance.

Exotic Plants

Elk herbivory can have indirect effects on vegetation composition and abundance by increasing the amount of bare ground due to trampling and grazing, which reduce native plant cover and distribution. Increases in bare ground could result in increases in exotic plants in the area as exotic species thrive in disturbed areas where there is less or no competition from native plants. Only minor, localized increases in bare ground have been related to elk grazing on the primary winter range (see “Soils” section in this chapter), and no evidence shows that elk herbivory is increasing exotic plant species abundance or coverage on the elk range (Singer et al. 2002, Zeigenfuss et al. 2002). Landscape analyses have also failed to find evidence that grazing increases the spread of exotic plant species in the park or other Rocky Mountain grasslands (Stohlgren et al. 1999). A 54% increase in the exotic grass timothy (*Phleum retense*) was observed in park meadows from 1968 to 1992 (Zeigenfuss et al. 1999). However, the study could not confirm that this increase resulted in a decline of native vegetation (Zeigenfuss et al. 1999). After 16 years, Canadian thistle has increased by 57% in disturbed areas of the park. Although this increase cannot be attributed to elk, by nature exotic plants increase in disturbed areas, and continued degradation of montane riparian willow communities on the elk range, increase the potential for Canadian thistle invasion (McLendon 1996). The adverse impact of exotic plants on native vegetation on the elk range as a result of elk herbivory under this alternative would continue to be long term, localized, and negligible to minor.

Cumulative Impacts

Previous impacts on vegetation on the elk range were due to anthropogenic disturbances such as livestock grazing and haying, water diversions and irrigation, cultivation of grassland meadows, reduction of beaver populations, flood events, fire suppression, and recreational and park development activities that affected aspen and montane riparian willow in particular but other vegetation as well. The condition of aspen, willow, upland shrub, and herbaceous vegetation on the elk range has experienced moderate-to-major adverse effects as a result of these past disturbances. In other areas of the park, vegetation has also been affected by past development and use, although to a lesser degree. These past anthropogenic disturbances in other areas of the park varied considerably as to type, intensity, and duration before and after the park was established. The adverse effects of these disturbances on aspen, willow, upland shrub, herbaceous, and alpine vegetation have ranged from minor to moderate.

Fire management in the park after 1970 included the use of prescribed fire or the allowance for naturally caused fires to occur in designated areas of the park. These actions would not occur in the aspen, willow (see discussion in the analysis of Alternative 1), or bitterbrush habitat on the elk range due to the high level of ungulate herbivory.

In the park, it was found that total shrub canopy area and volume can recover after a burn in the absence of grazing, or if the levels of grazing are not at the current high levels (Nescavil 2003). However, bitterbrush and sagebrush upland shrubs, which occur predominantly on the elk range, would not be treated with prescribed fire due to the detrimental effects that high levels of elk and deer browsing would have on the vegetation post-burn. Intense ungulate herbivory following fire may result in a net loss of shrub habitat in the park. A wildfire in this habitat would have a high potential for loss of large portions of the upland shrub due to the continued high level of elk and deer herbivory that would occur following the fire, a major, long-term, adverse effect. The use of prescribed fire in portions of the montane riparian willow, aspen, and shrub habitat that exists outside the elk range in the park would benefit this vegetation in localized areas, as regeneration would improve and growth and production of these vegetative types would increase. Because of the small area of effect, the benefits would be long term and minor.

Pollution generated in areas outside the park results in nitrogen deposition within the park in rain or snow or as dry particles. It has been estimated that current nitrogen deposition levels in the park are 20 times higher than natural levels (NPS 2005g). High elevation areas of the park have been changed by the effects of nitrogen deposition (Barons et al. 2000, Burns 2003). Plants in the alpine have evolved under very low nitrogen conditions and therefore are more adapted to nitrogen limitation rather than nitrogen enrichment (Baron et al. 1994). Increases in nitrogen in the alpine result in rapid growth of grasses, which out-compete alpine plants. A shift from flowering alpine plants to grasses and sedges in the park could result in the potential decline or loss of alpine wildflower communities, reducing plant diversity (Blett and Morris 2004). Continued nitrogen deposition in the alpine areas of the park would result in long-term, major, adverse impacts on alpine vegetation.

Recent management plans have been implemented to protect vegetation within the park. The vegetation restoration management plan and the resource management plan establish broad objectives and a framework for managing vegetation within the park. The vegetation restoration plan in particular sets forth management actions to be implemented to restore vegetation in areas of past anthropic disturbance. These restoration efforts would recover abandoned roads and trails in the park, stabilize sites to minimize deterioration due to exposed soils and erosion, control the establishment of invasive species, and facilitate the recovery of late successional communities that would have been on the site prior to any disturbance through active restoration methods. In addition, an invasive species plan was developed to control invasive plants existing in the park and to prevent the establishment of new invasive species through establishment of management guidelines. The restoration of vegetation in the park to restore ecological integrity and the control and prevention of invasive plant species would provide long-term, minor-to-moderate, beneficial effects on vegetation throughout the park, depending on the size of the area and the rarity and sensitivity of the vegetation type being restored or treated.

Trails maintenance and management plans and a backcountry management plan have been developed that would have long-term benefits to vegetation. Establishing a designated trail system and defining appropriate backcountry use and proper maintenance of trails within the park and on the elk range would reduce off-trail use and resultant trampling and decline or loss of vegetation and would limit soil erosion and increased bare ground. These plans offer a long-term, negligible-to-minor benefit to most vegetation; however, in alpine areas where vegetation is slow to recover from disturbance, establishment of designated trails provides moderate benefits.

Future development of one-mile of the Continental Divide National Scenic Trail within the Kawuneeche Valley would result in the long-term decline or loss of montane riparian willow in this area. The adverse effects due to the small scale of the project would be minor.

Short-term adverse impacts would occur to vegetation as a result of management activities that occur within the park to maintain trails, treat invasive plants, and implement fire management actions. Access to sites to implement actions and the presence of personnel would cause trampling and decline or loss of vegetation. Chemical, cultural, biological, and mechanical techniques to control invasive plants would result in limited non-target damage to native plants. In non-alpine areas, these actions would be short term and negligible to minor, as most vegetation would recover within a few years and mitigation measures would restore disturbed areas where necessary. In alpine areas, the effects would be long term.

The continuation of high elk herbivory levels as a result of a high population size, high elk densities, and limited dispersal under Alternative 1 would continue to have moderate-to-major, adverse effects on vegetation on the elk range, particularly on the primary winter range and in the Kawuneeche Valley. The impacts of elk herbivory on the elk range outweigh beneficial management actions that would occur there. The overall cumulative adverse effects on vegetation on the elk range therefore would be long term and moderate to major. In other areas of the park, the effects of continuing the current management of elk and vegetation on the elk range would have little to no effect on vegetation. Management plans that would result in restoration of areas of the park that were previously disturbed, restoring fire as an element of the ecosystem that is necessary for maintenance of healthy vegetative communities, and providing protection to vegetation by limiting activities and use that disturb areas would offset to a large degree the adverse effects of other actions and would result in minor-to-moderate, beneficial, cumulative effects.

Conclusion

Continuation of high levels of elk herbivory due to a large elk population and high elk densities would continue to adversely affect the growth, reproduction, abundance, and distribution of vegetation on the elk range and continue to result in community level changes. There would be a continued inability of aspen and willow to regenerate, resulting in continued reductions in stand structure and vigor, dramatic declines in cover and distribution, and further conversion of these important habitat types to grassland in portions of the elk range.

Aspen

Aspen on the elk range may be permanently lost if the current level of elk herbivory continues. High levels of elk herbivory that are expected to continue under Alternative 1 would continue to reduce the ability of aspen to regenerate. Aspen stands would continue to become increasingly composed of taller, older trees that over time would begin to die, reducing the size and distribution of stands in areas of the elk range. Because of the rarity of aspen within the range, the continued high-level grazing by elk would have a long-term, major, adverse impact on aspen. Fire is not necessary for the persistence of aspen stands on the elk range; however, it can stimulate regeneration. An inability to use prescribed fire on the elk range under this alternative would be a major, long-term, adverse effect.

Montane Riparian Willow

High levels of elk herbivory and greater depth to ground water under this alternative would continue the conversion of montane riparian willow habitat to grassland and from taller to shorter willow areas on the elk range. High levels of elk herbivory would continue to affect willow reproduction and seedling establishment. As a result, montane riparian willow cover on the elk range would continue to decrease. Under Alternative 1, the continued degradation of montane riparian willow would result in long-term, major, adverse impacts on willow on the elk range. The continued inability to use fire to stimulate regeneration would have long-term, major, adverse effects on willow on the elk range.

Upland and Riparian Herbaceous Plants

Herbaceous species are important winter forage for wildlife species. Continuation of high levels of consumption by elk in upland and riparian herbaceous communities would result in moderate levels of reduction in annual aboveground production, although large-scale effects on plant species richness or biodiversity in upland and riparian herbaceous communities would not be expected. The adverse effects of elk herbivory on riparian and upland herbaceous vegetation would be long term and moderate in areas of the primary winter range where elk concentrate and less in other areas of the range where elk densities are less and forage availability is higher.

Bitterbrush and Sagebrush Upland Shrubs

Continued high levels of elk herbivory in upland shrub habitat would result in a reduction in annual biomass, shorter shrub heights, and decreased shrub volume and canopy, particularly in areas of the core winter range where elk densities are excessive. In these areas, the long-term effects on shrub species would be moderately adverse. Large-scale shifts in species abundance and species diversity would not occur, although changes in individual species abundance would continue to occur, resulting in long-term minor, adverse impacts on the primary winter range.

Subalpine and Alpine Vegetation

Under Alternative 1, the continued reduction in the abundance, competitive ability, and survivorship of willow in the subalpine and alpine areas of the primary summer range would range up to major over a 20-year period.

In herbaceous habitats, elk herbivory would reduce native plant species cover and abundance; however, community-level changes in vegetation would probably not occur. The adverse effects of elk herbivory on subalpine and alpine herbaceous vegetation that would continue to occur in areas would be minor and long-term, as these vegetation types are slower to recover from disturbance.

Exotic Plants

There has been no evidence that elk herbivory is increasing exotic plant species abundance within the elk range; however, continued degradation increases the potential for invasion and spread of exotic plants. The long-term, adverse effects of exotic plant species as a result of elk herbivory would be negligible to minor.

Cumulative effects on the elk range from past anthropic disturbance and continuation of high levels of elk herbivory proportionately influence vegetation to a greater degree than do management plans to restore and protect the vegetation. The cumulative, adverse effects on vegetation on the elk range therefore would be long term and moderate to major. In other areas of the park, the effects of continuing the current management of elk and vegetation on the elk range would have little to no effect. Management plans to restore vegetation in the park would offset, to a large degree, actions that result in short- and long-term, adverse effects and would result in minor-to-moderate, beneficial cumulative effects.

Since Alternative 1 would not reverse the expected long-term, continued degradation of montane riparian willow and aspen as a result of high levels of elk herbivory due to a large elk population and high elk densities, it is expected that impairment of vegetation, particularly aspen and montane riparian willow communities, would occur over the long term.

Alternative 2

Aspen

Under this alternative, up to 160 acres on the primary winter and summer ranges would be fenced and would remain fenced over the life of the plan. When elk grazing is eliminated, aspen have been shown to successfully regenerate, with multiple age classes of aspen present as well as more live branches and fewer dead branches. In comparing grazed versus ungrazed plots, the stocking rates inside and outside exclosures averaged 637,000 and 123,000 suckers/mile^2, respectively, and the ratio of live to dead suckers was approximately 16 time higher inside exclosures. The ratio of live to dead trees was also found to be twice as high for stands that are not subject to grazing compared to grazed areas (Baker et al. 1997). When grazing was eliminated, suckers were able to survive to reach heights above eight feet, the height below which elk browsing is most intense. As a result, suckers could survive to sapling and tree size (Baker et al. 1997).

Increased aspen regeneration on the elk range would result in increased aspen stand size and cover. Modeling has indicated that once aspen are protected from elk grazing pressure, aspen cover increases markedly. When aspen are fenced over a 20-year period, the canopy cover is projected to increase by nearly 20% (Coughenour 2002).

Protection of aspen with fences on the elk range under this alternative would result in increased regeneration, as suckers could develop into saplings and could then reach mature tree size. With increased regenerative ability, the complexity of stands would increase with multiple age classes persisting, and overall stand sizes would increase across the landscape. Because of the rarity of aspen on the elk range, the protection provided by fences that would prevent the decline or loss of aspen stands, allow complete aspen recovery, and bring aspen on the elk range within the natural range of variability, which would represent a long-term, major, beneficial effect.

Under this alternative, once stands are protected from high levels of herbivory, vegetation management actions (i.e., mechanical stem removal and prescribed fire) may be implemented to further stimulate regeneration. Aspen on the elk range grasslands are not successional to conifers, and therefore do not require fire to regenerate. Light surface burns can stimulate sucker production by allowing more solar radiation to warm the mineral soil (e.g., Romme et al. 1995), and the vegetation that is burned provides a nutrient pulse for new suckers (Sheppard 2001). Mechanical removal of overstory stems in aspen stands can result in successful regeneration (Sheppard 1996). Using large machinery to fell aspens has been shown to produce a high number of sprouts. When stumps are removed, lateral roots are isolated, which deprives them of any residual hormones to inhibit root growth that would be left if trees where felled by chainsaws (Sheppard 1996). These techniques to stimulate new growth of aspen on the elk range would have long-term, major, beneficial effects on the overall improvement of aspen on the elk range.

Montane Riparian Willow

Quicker reduction in the elk population and management actions to reduce densities would increase seedling establishment and seedling survival on the elk range. As the number of elk and grazing pressure decrease quickly under this alternative, montane riparian willow on the primary winter range that have been in poor condition would be able to reach maturity, and seed production on the range would increase. As a result, seed rain density within the range would be expected to increase, with a wider distribution of seed-producing willow stands on the range (Cooper et al. 2003).

As montane riparian willow would increase on the elk range, beaver would be expected to naturally recolonize areas on the elk range, or they could be reintroduced into areas once tall willow patches of 10 acres or more become established. An increase in beaver would increase the reproductive capabilities of willow either directly through vegetative propagation or indirectly through creating appropriate sites for seedling establishment (Cooper et al. 2003, Baker et al. 2005, reviewed in Monello et al. 2005). Beaver would be expected to increase the amount of surface water on the elk range and improve groundwater recharge (see "Water Quality and Hydrology" section of this chapter) and provide improved habitat over a larger area for willow establishment both naturally and through willow replanting that would occur under this alternative if needed. Montane riparian willows that are improving as a result of improved water conditions on the elk range would benefit further as a result of the large reduction in grazing pressure, which would result in increased willow reproduction, growth, and survival over nearly 2,400 acres of the elk range. These effects would be most prominent on the elk range where high elk browsing, reduced surface waters, and low beaver populations have severely depressed montane riparian willow growth.

A reduction in elk numbers and densities under this alternative would result in an increase in willow production and height on the elk range and thus an increase in cover over the landscape. This alternative would achieve meaningful increases in willow height or production across the elk range, lowering elk consumption rates below 27% or elk densities below 83 elk per square mile (Singer et al. 2002). In areas of the core winter range, reduced elk numbers and focused management actions to increase redistribution and movement of the population in this severely degraded area may result in even lower elk consumption rates, 21% or less, to allow optimal willow growth and size in the presence of elk herbivory. This would be an approximate 22% decrease in average use from conditions described in Alternative 1 on the core winter range. Monitoring of the montane riparian willow condition and responsiveness to adaptive management techniques would determine what consumption rates and/or densities are most appropriate for various locations on the elk range to achieve management objectives.

Productivity of willow would increase on the elk range with reduced elk herbivory levels. When elk are excluded from foraging on montane riparian willow, (short-term (four-year) increases in production have ranged from 18% to 66% (Schoenecker et al. 2004, Zeigenfuss et al. 2002), and long-term (35-year) increases have been nearly 100% (Schoenecker et al. 2004).

Reduced elk herbivory that would occur under this alternative would result in improvements in the growth and size of the montane riparian willow on the elk range. Short-term responses to protection from grazing have resulted in canopy volume, height, and stem density increases of 66%, and in long-term increases of up to 100% (Schoenecker et al. 2004). Willow stem height and densities can dramatically increase, as studies have shown these to have increased by 244% and 265%, respectively (Singer et al. 2002).

With elk numbers reduced to the lower end of the natural range and improvement of the water table, modeling predicts that over the next 20 years, montane riparian willow cover on the core winter range would increase from approximately 22% cover under Alternative 2 to approximately 42%. Reducing elk to the lower end of the natural range would reduce herbivory to a sufficient degree to allow short willow on rewatered sites to withstand herbivory (Coughenour et al. 2002). However, the modeling only considered reduction in elk numbers and not changes in elk densities or distribution. With this alternative, aversive conditioning and herding techniques to prevent elk from concentrating, particularly within the primary winter range, would result in larger increases in cover and willow height.

Because a low level of herbivory would continue to occur under this alternative, it is not expected that the same level of improvements in montane riparian willow growth, production, and distribution as shown when elk are completely, unnaturally, excluded would occur under this alternative. However with implementation of monitoring of vegetation response and of adaptive management to continually redistribute and move the population to prevent concentrating and over-grazing, willow restoration on the elk range would be expected to approach levels that are described in these studies to a large degree across a large area of the elk range. Community level changes would occur as montane riparian willows would transition from shorter to taller plants and would replace herbaceous vegetation as willow abundance, competitive ability, and survivorship across the elk range would improve.

With the decreased elk population and increased distribution that would occur under this alternative, montane riparian willow on the elk range would recover across the landscape in a patchy distribution that would be representative of natural conditions compared to alternatives where fences would be used (Alternatives 3 and 4). Effects would be expected to be greater on the primary winter range, particularly the core winter range, as management actions to redistribute elk would provide the greatest benefit to that degraded area of the range, resulting in long-term, major, beneficial effects.

Once monitoring determines that montane riparian willow on the elk range is adequately protected from elk herbivory (i.e., offtake levels are low enough for willow to withstand grazing pressures and still reproduce) and that suitable willow habitat exists, vegetative restorations techniques such as active willow replanting, prescribed fire, or mechanical thinning activities would be used to improve willow distribution, remove decadent willow stems, and stimulate resprouting in areas where hydrologic conditions are suitable to support willow. Fire has not been shown to be necessary for willow regeneration; however, it can speed regenerative processes (Baker et al. 2005). Use of vegetation recovery methods under this alternative would have long-term, minor, beneficial effects on montane riparian willow on the elk range.

Although the level of competition between elk and moose is not completely understood, the large and quick reduction in elk numbers to the low end of the natural range would be expected to result in a subsequent increase in the moose population on the primary summer range. There would be a number of years before the reaction in the moose population would be fully realized (see “Other Wildlife Species” section of this chapter). It is uncertain how large the response in the moose population would be and therefore difficult to assess the level of indirect effect on montane riparian willow. However, moose feed predominantly on montane riparian willow and therefore it is expected that benefits from elk management actions would be offset to some degree.

Upland and Riparian Herbaceous Plants

Under this alternative, the high level of elk consumption (>55%) of upland and riparian herbaceous vegetation that occur, particularly on the primary winter range, would be reduced. The faster reduction in the level of consumption by elk would increase herbaceous biomass in a short period. When montane riparian herbaceous vegetation was not subjected to grazing, biomass increased by 30% after four years of protection (Zeigenfuss et al. 1999). However, with the increase that would occur in montane riparian willow, riparian herbaceous vegetation would be expected to decrease slightly over time.

Upland herbaceous vegetation on the primary winter range would gradually increase by approximately 1% to 3% over the next 20 years with the elk population maintained at the lower end of the natural range (Coughenour 2002).

The reduction in elk numbers and density would change the cover of individual species but would not result in large-scale effects on species abundance, biodiversity, or composition in riparian and upland herbaceous communities. Studies have not observed any differences in the cover or number of grasses and forbs inside and outside grazing exclosures, although cover of individual species increased or decreased (Singer 1995, Zeigenfuss et al. 1999).

Because elk herbivory would still occur, production increases and changes in individual species abundance on the primary winter range would not be as great as was found when elk and deer were unnaturally excluded. However, maintaining the elk population at the lower end of the natural range over a 20-year period with decreased densities as a result of lethal reduction activities and redistribution methods would produce results approaching these levels. This would result in a long-term, minor-to-moderate benefit to upland herbaceous vegetation on the elk range. In montane riparian willow areas, the conversion from grassland back to montane riparian willow shrub habitat would have a minor-to-moderate, adverse effect on herbaceous vegetation; however, this conversion would be more reflective of natural conditions.

Bitterbrush and Sagebrush Upland Shrubs

Fast reductions in elk numbers and densities would affect bitterbrush and sagebrush biomass, morphology, cover, and habitat composition as a result of individual species abundance changes. Shrub production and current annual growth in the long-term would increase as a result of reductions in elk herbivory. When elk were excluded from grazing for 35 years, annual shrub production increased by 67% (Schoenecker et al. 2002). Shrub volume and canopy would also be increased in areas on the primary winter range if elk numbers and densities were reduced. Over a 25-year period, bitterbrush that was protected from grazing increased between 12% and 37%, depending on the amount of brush originally present (Gysel 1960). Over a 35-year period, shrub volume and canopy increased by 300% and 178%, respectively (Singer et al. 2002). Over the long term, large reductions in elk herbivory on the primary winter range would result in moderate beneficial effects on production, volume, and canopy in sagebrush and bitterbrush communities.

Elk herbivory has been shown to increase the height in sagebrush and bitterbrush communities by 14% to 56%. However, these results were attributed to a decreased use of the vegetation by deer (Zeigenfuss et al. 2002).

Large-scale shifts in plant species biodiversity in these habitats are also not expected to occur with reductions in elk herbivory levels, although changes in individual species could occur. When grazing pressure is eliminated in upland bitterbrush sites, cover of prairie sage and sulphur buckwheat in ungrazed sites increased after four years (Zeigenfuss et al. 2002). These changes in species abundances would have minor, beneficial impacts on the primary winter range.

Under this alternative, the large and quick reduction in elk numbers to the low end of the natural range would be expected to result in a subsequent increase in the mule deer population on the elk range. There would be a number of years before the reaction in the deer population would be fully realized. With a large increase in the deer population, the minor-to-moderate benefits to bitterbrush and sagebrush communities that would result from a large reduction in elk herbivory would be expected to be largely offset by increased deer browsing (see *Wildlife* section of this chapter). The diet of mule deer consists largely of upland shrubs, such as sagebrush and bitterbrush (Kufeld et al. 1971). With the potential for large increases in the mule deer population as a result of reduced competition with elk and with upland shrub being the main component of mule deer diet, the indirect effects on bitterbrush and sagebrush of large elk reductions would be long term, moderate to major, and adverse as deer browsing would increase, particularly on the elk primary winter range. Effects on the primary summer range would be adverse, long term, and minor to moderate.

Subalpine and Alpine Vegetation

Large elk reductions would have beneficial effects on subalpine and alpine riparian and upland willow and herbaceous vegetation. Reduced levels of herbivory would have the same long-term, major, beneficial effects as for montane riparian willow on the primary summer range.

Reducing elk herbivory through reductions in population size and densities by redistributing elk in the subalpine and alpine areas would increase cover and frequency of some species of grasses in localized areas; however, no community-level effects would occur. The reduction in elk herbivory that occurs would result in long-term, minor, beneficial effects on subalpine and alpine herbaceous vegetation.

Exotic Plants

With large reductions in elk numbers and densities, there would be less bare ground created and therefore less disturbed areas for establishment of exotic plants. There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

Management actions to install fences to protect aspen, redistribute elk, install a capture facility, and remove carcasses would result in localized impacts on vegetation as a result of trampling and individual plant removal. Under this alternative, fences would be installed to protect up to 160 acreas of aspen in various-sized patches on the elk range. This would result in localized, adverse effects from construction, as plants would be removed to install posts and the presence of machinery and personnel would cause local trampling and loss of individual plants. (The benefits to aspen as a result of being fenced have been discussed above.) Herding could be used to direct elk movements to capture facilities. Herding would be conducted using trained herding dogs, people on foot, or riders on horseback. This would result in impacts on vegetation as a result of trampling not only from the activity of people and horses, but also as a result of the concentrated movement of the elk being directed to a capture facility or from the primary winter range to the primary summer range. Use of a temporary capture facility would result in decline or loss of vegetation within a small area from trampling by elk that are herded into the facility. Carcass disposal would require elk carcasses to be dragged or carried out of a treatment area. This would result in the localized trampling and loss of individual plants.

Personnel accessing sites via trucks, off-road vehicles, or horses would result in trampling and decline or loss of vegetation in the local area. Actions that would occur in winter would have less effect, as the plants are in senescence and the ground may be frozen. Where actions have resulted in the decline or loss of vegetation and exposure of bare ground, mitigation measures would be employed to reseed areas with appropriate native vegetation.

Management activities would not result in population loss or community levels effects. The adverse effects would be short term, localized, and minor during the reduction phase of the plan, when a greater number of elk are being lethally removed and management activities are more intense. In the maintenance phase, when management actions are less intense as a lower number of elk are being removed, there would be no need for a capture facility and a lower number of carcasses would need to be removed; therefore, the impacts would be negligible to minor. In alpine areas where vegetation is slower to recover, the impacts would be long term. To reduce the level of impact in this sensitive habitat, management activities would not involve the use of horses or off-road vehicles, resulting in localized, minor, adverse effects.

Cumulative Impacts

The cumulative actions that affect vegetation would be the same as those described under Alternative 1.

The large and rapid reduction in the elk population to the lower end of the natural range and the increased distribution would result in large reductions of elk herbivory and its impacts on vegetation. This would result in moderate-to-major benefits on aspen, willow, and herbaceous vegetation on the primary winter range and in the Kawuneeche Valley and minor-to-major benefits to subalpine and alpine vegetation on the primary summer range. The beneficial effects of Alternative 2 on vegetation on the elk range combined with beneficial effects of management plan actions to restore and protect vegetation would have a moderate-to-major, long-term, cumulative benefit on aspen, willow, herbaceous, and alpine vegetation.

In other areas of the park, the effects of elk and vegetation on the elk range would have little to no effect on vegetation. Management plans that would restore areas of the park that were previously disturbed, restore fire as a necessary element of the ecosystem, and protect vegetation by limiting activities and use that disturb areas would offset to a large degree the adverse effects of other actions and would result in minor-to-moderate, beneficial, cumulative effects.

Conclusion

The rapid reduction in elk numbers, the increased distribution and migration of the population, and the protection of aspen stands of the elk range with fences would result in large reductions in elk herbivory on the elk range in a short period of time. This would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate community level changes toward a more natural condition. This alternative would prevent the loss of aspen and willow on the elk range and result in increased stand size, structure, vigor, and distribution of these important habitat types over large portions of the elk range.

Aspen

Protection of the aspen with fences on the elk range to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, and increased cover. Because of the rarity of aspen stands on the elk range, the protection provided from elk herbivory under this alternative would allow recovery of aspen on the range, which would be a long-term, major, beneficial effect. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit, as these methods would improve regrowth of aspen; however, they are not necessary for aspen regeneration.

Montane Riparian Willow

With a large reduction in elk population, increased dispersal of the population, and increased water table as a result of beaver recovery or reintroduction, willow reproduction, seedling establishment, and distribution on the elk range would increase. Lower levels of elk browsing would result in large increases in willow production, height, stem density, and canopy volume. The montane riparian willow would transform from shorter willow to taller willow, and montane riparian willow would replace herbaceous vegetation. The recovery of montane riparian willow across the landscape would be patchily distributed, reflective of natural conditions. The increase in abundance, competitive ability, and survivorship of montane riparian willow would prevent the conversion of willow to grassland in areas of the elk range, resulting in long-term, major, beneficial impacts, particularly in the core winter range. The benefits to willow would be offset to some degree due to the indirect effect of an increase in moose populations on the primary summer range. The use of vegetation recovery methods such as active willow planting, prescribed fire, and mechanical thinning to improve willow distribution and regeneration would have long-term, major, beneficial effects.

Upland and Riparian Herbaceous Plants

Rapid reductions in the elk population and increased elk distribution would result in increased upland herbaceous biomass and individual species abundances; however, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the elk range, the long-term beneficial effects would be minor to moderate. The conversion of herbaceous habitat to montane riparian willow shrub as willow coverage increases would represent a minor-to-moderate, adverse effect on herbaceous vegetation; however, this would reflect natural conditions.

Bitterbrush and Sagebrush Upland Shrubs

A large reduction in the elk population along with increased distribution would result in increased annual biomass, shrub heights, shrub volume, and canopy, particularly in areas of the core winter range where elk densities are excessive. The long-term, beneficial effects on shrub species would be moderate. Large-scale shifts in species abundance and species diversity would not occur, although increases in individual species abundances would occur, resulting in long-term, minor, beneficial effects on the primary winter range. With a large decrease in the elk population, the mule deer population and thus herbivory on upland shrubs would be expected to increase dramatically. This would offset the benefits of reduced elk herbivory and result on long-term, moderate-to-major, adverse effects, particularly in areas of the primary winter range.

Subalpine and Alpine Vegetation

Large reductions in the elk population and increased dispersal would reduce elk herbivory in subalpine and alpine riparian and upland willow and herbaceous habitats, resulting in increases in native plant species cover and abundance in localized areas. The reduction in disturbance from elk grazing would result in long-term, major, beneficial effect on riparian and upland willow and minor benefits to herbaceous vegetation.

Exotic Plants

There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of reduced elk numbers and densities on reducing the potential for exotic plant species infestation would be negligible to minor.

Management Activities

In the reduction phase of the plan, agency lethal reduction operations, herding, carcass disposal, installation of fences, and use of temporary capture facilities would result in localized trampling and loss of individual plants. The effects would be short- and long-term and minor, as the areas exposed would be reseeded with native plants. Effects would be reduced to negligible to minor during the maintenance phase of the plan, when management operations are less intense.

The large reduction in elk herbivory and protection of vegetation under this alternative in combination with plans and actions to restore and protect native vegetation would result in moderate-to-major, long-term, cumulative benefits on aspen, willow, herbaceous, and alpine vegetation. The increase in deer browsing upland shrub habitat that would occur rapidly under this alternative combined with the potential for high levels of degradation in areas where burning would occur on the elk range would have cumulative, long-term, major, adverse impacts on upland shrub vegetation. In other areas of the park, the effects of elk and vegetation management actions on vegetation on the elk range would have little to no effect. Management plans to restore vegetation in the park would off-set to a large degree actions that result in short- and long-term, minor, adverse effects and would result in overall minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 2.

Alternative 3

Aspen

The impacts of protecting the aspen on the elk range with fences would be the same as described under Alternative 2. The increase in aspen stand structural complexity, cover, and regenerative ability on the elk range as a result of fences and use of prescribed burning and mechanical activities to stimulate regeneration would be the same as described under Alternative 2. Because of the rarity of aspen on the elk range, the protection provided by fences that would allow aspen recovery on the elk range under this alternative would represent a long-term, major, beneficial effect.

Montane Riparian Willow

Under this alternative, up to 260 acres of montane riparian willow on the primary winter range and 180 acres on the primary summer range in the Kawuneeche Valley would be fenced in a phased approach to provide protection from elk grazing effects. The amount of fenced acreage would be commensurate with levels of elk reduction. Within the fenced area, changes in the montane riparian willow would be as described under Alternative 2; however, the restoration of willow would be faster and to a greater degree, as elk herbivory would be eliminated. Within these fenced areas, beaver would be expected to recolonize or be reintroduced to the area quicker, further increasing the potential for willow establishment on the primary winter range. Because the willow would be protected from elk herbivory quicker under this alternative, prescribed burning and thinning techniques to stimulate re-sprouting could be conducted sooner compared to Alternative 2.

Without herbivory by elk, montane riparian willow growth, canopy cover, distribution, and structure in fenced areas over the 20-year life of the plan would approach levels described in exclosure studies discussed in Alternative 2. Based on modeling, canopy cover of willow when fenced and with higher water tables would reach nearly 55%, a 30% increase over Alternative 1. Community-level changes would be more complete as willows transition from shorter to taller plants and montane riparian willow replace herbaceous vegetation due to improved willow abundance, competitive ability, and survivorship within fenced areas. Beneficial effects on montane riparian willow within fenced areas would therefore be long term and major, with complete removal of elk herbivory for the duration of fencing allowing a large area of the primary winter range to be restored. Elk herbivory is a natural component of the montane riparian willow, and excluding all elk herbivory would result in an unnatural pattern of willow recovery on the primary winter range.

Outside fenced areas, the improvements to montane riparian willow would be less and would not be evident until later in the plan. In the earlier years of the plan when elk numbers would still be relatively high, montane riparian willow outside fenced areas would be adversely affected as described under Alternative 1. Over time, as the elk population would be reduced to the higher end of the natural range and with employment of techniques to reduce densities, montane riparian willow on the elk range outside fenced areas would have somewhat increased ability to reach maturity, produce seeds, increase establishment and distribution, and increase height. Over the life of the plan, montane riparian willow on the elk range outside fenced areas would increase in abundance, and the ability of willow to compete and survive would increase. The benefits to willow on the primary summer range that would not be fenced would be offset to some degree due to the indirect effect of an increase in moose populations on the primary summer range. Because montane riparian willow recovery would not be as rapid under this alternative in unfenced areas, the recovery of beaver in unfenced areas on the primary elk range would be slower (see "Other Wildlife Species" section of this chapter). The ability to use prescribed fire or thinning techniques to stimulate re-sprouting in unfenced areas would also be delayed. Therefore, the benefits over the life of the plan to montane riparian willow outside of fenced areas on the elk range would be long term and moderate. However, applying adaptive management, with increased use of aversive conditioning in areas where elk concentrate and with the use of herding to move elk from the primary winter range in the summer, recovery of montane riparian willow across the elk range would be to the same level as described in Alternative 2.

Upland and Riparian Herbaceous Plants

Under this alternative, as elk numbers would gradually be reduced over the life of the plan to achieve an elk population at the higher end of the natural range, benefits to herbaceous vegetation on the elk range would take longer compared to Alternative 2. Because the population reduction would be gradual and fewer elk would be lethally removed annually, aversive conditioning and herding to move elk would be used more frequently under this alternative. On the primary winter range up to 260 acres of montane riparian willow habitat could be fenced. The amount of fenced acreage would be commensurate with levels of elk reduction. Within the fenced area, changes in the herbaceous vegetation would be as described under Alternative 2; however, the changes would be faster and to a greater degree, as elk herbivory would be eliminated. In these montane riparian areas, the conversion back to willow habitat would have a minor-to-moderate, adverse effect. However, this conversion would be representative of natural conditions.

As a result, production and biomass of upland and riparian herbaceous vegetation, as well as individual species abundances, would increase, but to a lower level than described in Alternative 2, due to the larger elk population.

Outside the fenced areas, montane riparian and upland herbaceous vegetation would continue to be grazed; however use of redistribution methods would reduce densities of elk. The benefit of management actions would be slightly less than under Alternative 2 as a result of the higher number of elk and would be negligible to minor outside fenced areas.

Bitterbrush and Sagebrush Upland Shrubs

Gradual reductions in elk numbers and densities would affect bitterbrush and sagebrush morphology, cover, and habitat composition as a result of individual species abundance changes in the same way as described in Alternative 2; however, benefits would be less and would take longer to achieve. The benefits would not be as great as described in Alternative 2 because the elk population reduction would be to a higher population level at the end of the planning period. On the primary winter range, the long-term beneficial effects would minor. The gradual reduction in the elk population over the 20-year life of the plan to achieve a population of elk at the higher end of the natural range would result in a slower increase in the mule deer population and to a lesser extent than described in Alternative 2. The benefits to bitterbrush and sagebrush upland vegetation due to reduced elk herbivory under this alternative would be offset to some degree by the gradual increase in the deer population. The long-term, adverse effects would be moderate, particularly on the primary winter range, where ungulate herbivory has been more severe. Effects of an increase in the deer population on upland shrubs on the primary summer range would be adverse, long term, and minor.

Subalpine and Alpine Vegetation

Gradual reductions in the elk population and redistribution of the population would have beneficial effects on subalpine and alpine herbaceous vegetation. Reducing elk herbivory through reductions in densities and lethal reduction activities that would redistribute elk in the subalpine and alpine areas would occur less frequently under this alternative, as the number of elk removed each year would be lower than in the initial phase of Alternative 2. Because of the gradual reduction over time, elk herbivory would be higher for a longer period of time and benefits would take longer to become evident. The benefits to subalpine and alpine forbs from an increase in cover and frequency of some species of grasses in localized areas would be minor and long term.

Exotic Plants

The reduction in the potential for exotic plant invasion in elk use areas on the elk range would be the same as described under Alternative 2.

Management Activities

Under this alternative nearly four times the area of vegetation would be fenced compared to Alternative 2, which would result in minor, localized, short- and long-term, adverse effects from construction as plants would be removed to install posts and the presence of machinery and personnel would cause local trampling and loss of individual plants. (The benefits of aspen protection through use of fences is described above.) The short-term effects of agency lethal reduction operations, herding, and carcass disposal would be the same as described above for the maintenance phase of Alternative 2, when fewer numbers of elk would be lethally removed. The adverse effects on vegetation in localized area where management actions would occur would be negligible to minor. In alpine areas, where vegetation is slower to recover, the impacts would be long term.

Cumulative Impacts

The cumulative actions that affect vegetation would be the same as those described under Alternative 2, although the adverse effects on upland shrub habitat would be moderately adverse and would take a longer time to manifest. Under this alternative, the deer population that would adversely impact upland shrub would increase gradually and to a lower population size than described in Alternative 2. Therefore, the cumulative, adverse effects of this alternative on upland shrub on the primary winter range and on bitterbrush in particular in combination with the effects of prescribed burning would be long term and moderate.

Conclusion

This alternative would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate gradual, community-level changes toward a more natural condition. It would also prevent the loss of aspen and willow on the elk range and would increase stand size and structure, vigor, and distribution of these important habitat types in large fenced areas on the elk range. However, the recovery of vegetation outside fenced areas would be less than described under Alternative 2 due to the higher elk population target.

Aspen

Protecting all aspen on the elk range with fences to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, increased cover, and prevention of aspen loss as described under Alternative 2. Long-term benefits to aspen on the elk range from prohibiting elk herbivory would be major. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit.

Montane Riparian Willow

In fenced areas of the primary elk range, montane riparian willow recovery would be more rapid than in Alternative 2 as a result of elk herbivory elimination, beaver recovery or reintroduction and the resulting increased water table levels, and the use of vegetative management tools. Increases in montane riparian willow height, volume, cover, and distribution would occur in fenced areas. Prevention of both the loss of montane riparian willow and the consequent conversion of willow to grassland in areas of the elk range would be a major, long-term benefit. Outside fenced areas on the elk range, elk herbivory would occur at a higher level compared to Alternative 2 as the population would be reduced gradually to the high end of the natural range; therefore, benefits to montane riparian willow would be less and slower to be achieved. With increased use of redistribution methods to reduce elk concentrations outside fenced areas and the potential for beaver recovery and vegetative management tools later in the plan, benefits to montane riparian willow would be long term and moderate. These benefits would be offset to some degree due to indirect effects of an increase in the moose population on the primary summer range. With adaptive management, the level of montane riparian willow recovery would be the same as Alternative 2 and the overall long-term benefit would be major. The recovery of montane riparian willow across the landscape however would not be representative of natural conditions, as recovery would be more complete in fenced areas.

Upland and Riparian Herbaceous Plants

Gradual reductions in the elk population to the high end of the natural range and increased use of methods to redistribute elk would result in increased herbaceous production and individual species abundances, although these benefits would be achieved gradually and become evident later in the plan. As in Alternative 2, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the primary winter range, the long-term, adverse effects on montane riparian herbaceous vegetation in fenced areas would be minor to moderate due to conversion from grassland to shrub habitat, although this would reflect natural conditions. Outside fenced areas, the long-term, beneficial effects would be negligible to minor.

Bitterbrush and Sagebrush Upland Shrubs

Gradual reductions in the elk population to the high end of the natural range and increased distribution would result in gradual increases in annual biomass, shrub height, shrub volume and canopy, and individual species abundances, particularly in areas of the core winter range where elk densities are excessive. The long-term beneficial effects on shrub species would be minor and would become evident later in the plan. With a gradual decrease in the elk population, mule deer population and thus herbivory on upland shrubs would increase gradually. This would offset the some of benefits of reduced elk herbivory and result in long-term, moderate, adverse effects, particularly in areas of the primary winter range.

Subalpine and Alpine Vegetation

Gradual reductions in the elk population to the high end of the natural range and increased dispersal would reduce elk herbivory in subalpine and alpine habitats, resulting in long-term, moderate-to-major, beneficial effects for montane riparian willow as described for montane riparian willow and localized increases in native plant species cover and abundance that would occur slowly over the life of the plan that would have localized, long-term, minor, beneficial effects.

Exotic Plants

There has been no evidence that elk herbivory results in the park in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

Installation of fences, agency lethal reduction operations, herding, and carcass disposal would result in localized trampling and loss of individual plants. The effects would be both short term and long term and negligible to minor, as the areas exposed would be reseeded with native plants.

The cumulative effects under this alternative on the elk range from a gradual reduction in elk herbivory and protection of vegetation in combination with plans and actions to restore and protect native vegetation would result in overall moderate-to-major, long-term benefits on aspen, willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat as a result of a gradual increase in deer browsing combined with the effects of burning on the elk range would be moderate. In other areas of the park, the effects of elk and vegetation management actions on the elk range would have little to no effect on other areas of the park. Management plans to restore vegetation in the park would offset to a large degree actions that result in short- and long-term, minor, adverse effects and would result in minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 3.

Alternative 4

The changes in aspen on the elk range as a result of fencing would be the same as described above under Alternative 2.

The impacts of a reduction in elk population size and a decrease in elk densities on willow, upland and riparian herbaceous vegetation, bitterbrush and sagebrush upland vegetation, and subalpine and alpine vegetation would be similar to those described in Alternative 3. Without fences to protect montane riparian willow on the primary summer range, willow recovery in this area would be slower compared to Alternative 3. Redistribution actions would be increased in unfenced areas to reduce elk herbivory and protect willow. Benefits as a result of a smaller elk population to willow on the primary summer range would be offset to some degree due to the indirect effect of an increase in moose populations on the primary summer range. With adaptive management, the level of montane riparian willow recovery on the primary elk range would be the same as Alternative 3, with overall long-term major benefits. The reduction in bare ground as a result of elk use of an area and potential for exotic plant establishment in areas of the elk range would result in benefits to vegetation as described in Alternative 3.

Management activities would have short-term and long-term, adverse, negligible-to-minor effects on vegetation in localized area of the elk range similar to those described in Alternative 3. Under this alternative, the adverse effects of installation of fences, lethal reduction operations, herding, and carcass disposal would be the same as described for Alternative 3. Under this alternative, however, particularly during the initial phase of the plan when more elk would be treated, capture facilities may be relied upon more to administer fertility control drugs, with minor adverse effects from trampling of vegetation and exposure of bare ground. Over time, as fertility control agents are relied upon more heavily and with the potential use of multi-year fertility control agents that require treating fewer elk annually, the short-term, localized impacts that result from implementation of lethal reduction activities, removal of carcasses, and capture facilities would decrease to negligible.

Cumulative Impacts

The cumulative effects of this alternative on vegetation on the elk range and in the park would be the same as described under Alternative 3.

Conclusion

This alternative would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate gradual, community-level changes toward a more natural condition. This alternative would prevent the loss of aspen and willow on the elk range and result in increased stand size and structure, vigor, and distribution of these important habitat types in large fenced areas on the elk range. However, the recovery of vegetation outside of fenced areas would be less than described under Alternative 2 due to the higher elk population target.

Aspen

Protecting all aspen on the elk range with fences to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, and increased cover as described under Alternative 2. Long-term benefits to aspen on the elk range from prohibiting elk herbivory would be major. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit.

Montane Riparian Willow

Montane riparian willow recovery under this alternative would be the same as described in Alternative 3. In fenced areas of the primary winter range, increases in willow height, volume, cover, and distribution would occur more rapidly. Montane riparian willow would transform from shorter willow to taller willow and would replace herbaceous vegetation, resulting in a major, long-term benefit. Outside fenced areas on the elk range, benefits to montane riparian willow would be long-term and moderate due to elk herbivory and the later establishment of beaver and ability to use additional vegetation management tools. These benefits would be offset to some degree due to indirect effects of an increase in the moose population on the primary summer range. With adaptive management, the level of montane riparian willow recovery would be the same as Alternative 2 and the overall long-term benefit would be major. The recovery of montane riparian willow across the landscape would not be representative of natural conditions, as recovery would be more complete in fenced areas.

Upland and Riparian Herbaceous Plants

Gradual reductions in the elk population to the high end of the natural range and increased use of methods to redistribute elk would result in increased herbaceous production and individual species abundances, although these benefits would be achieved gradually and become evident later in the plan. As in Alternative 2, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the primary winter range, the long-term, adverse effects on montane riparian herbaceous vegetation in fenced areas would be minor to moderate due to conversion from grassland to shrub habitat, although this would reflect natural conditions. Outside fenced areas, the long-term, beneficial effects would be negligible to minor.

Bitterbrush and Sagebrush Upland Shrubs

The effects of elk management would be the same as described in Alternative 3. Gradual reductions in the elk population to the high end of the natural range along with increased distribution would result in gradual increases in annual biomass, shrub height, shrub volume and canopy, and individual species abundances, particularly in areas of the core winter range where elk densities are excessive. The long-term, beneficial effects on shrub species would be minor and would be evident later in the plan. With a gradual decrease in the elk population, mule deer population and thus herbivory on upland shrubs would increase gradually. This would offset some of the benefits of reduced elk herbivory and would result in long-term, moderate, adverse effects, particularly in areas of the primary winter range.

Subalpine and Alpine Vegetation

The effects of elk management would be the same as described in Alternative 3. Gradual reductions in the elk population to the high end of the natural range and increased dispersal would reduce elk herbivory in subalpine and alpine herbaceous habitats, resulting long-term moderate to major beneficial effects for montane riparian willow as described for montane riparian willow and localized increases in native plant species cover and abundance that would occur slowly over the life of the plan that would have localized, long-term, minor, beneficial effects.

Exotic Plants

There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

Installation of fences, agency lethal reduction operations, herding, and carcass disposal would result in localized trampling and loss of individual plants. The effects would be both short term and long term and negligible to minor, as the areas exposed would be reseeded with native plants.

The cumulative effects under this alternative on the elk range from a gradual reduction in elk herbivory and protection of vegetation in combination with plans and actions to restore and protect native vegetation would result in moderate-to-major, long-term benefits on aspen, willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat as a result of a gradual increase in deer browsing combined with the effects of burning on the elk range would be moderate. In other areas of the park, the effects of continuing the current management of elk and vegetation on the elk range would have little to no effect. Management plans to restore vegetation in the park would offset to a large degree actions that result in short- and long-term, minor, adverse effects and would result in overall minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 4.

Alternative 5

The changes in aspen on the elk range as a result of fences and use of prescribed fire and thinning activities would be the same as described under Alternative 2.

The effects on vegetation associated with the release of wolves would be relatively small during the first phase of the alternative because only four wolves would be present in the park. Other elements of the alternative's management actions (lethal reduction, if necessary) would compensate for the small contribution of wolves in the initial stages of Alternative 5. Over time, as the wolf population in the park increased, the effects of wolves would be more fully realized with less reliance on other management tools. During all phases of the plan, wolves would be expected to effectively redistribute the elk population.

Research has found that elk population size or densities are reduced and elk decrease their use of areas that have predators (Hebblewhite et al. 2002, Ripple et al. 2001). Wolf predation models (Coughenour 2002, Garton et al. 1990, Mack and Singer 1993, Singer et al. 2003) and empirical evidence from Glacier National Park (Kunkel and Pletscher 1999) and Banff National park, Canada (Hebblewhite et al. 2002) indicate that wolves would limit the density and size of the elk population, particularly during the winter.

Elk in Yellowstone and Banff National Parks have been shown to decrease use of aspen and willow habitat, respectively, in areas with wolves (Nietvelt 2001, Ripple et al. 2001). In Yellowstone National Park, elk affinity for aspen stands was replaced by a preference for conifer forest areas (Ripple et al. 2001, Fortin et al. 2005). In addition, research suggests that when wolves are present, elk prefer to use open areas where they can see predators from afar (Dekker 1997) and that elk may prefer to graze in grassland areas and browse on the edge, not in the middle, of willow thickets.

As a result of changes in elk habitat use, the adverse effects of ungulate grazing on the growth of plants that are the focus of this analysis would be reduced. In Yellowstone National Park, research indicates that willow and aspen in the park that experience less grazing pressure have increased in stature (Ripple and Larson 2000, Ripple et al. 2001). In other areas where wolves have been introduced, the percent browsing by elk on willow stems has declined by 92% (Ripple and Beschta 2004b). Wolves would be expected to cause similar trophic cascading effects in other vegetation types on the elk range as well by reducing the elk population, increasing elk movements, and changing elk grazing patterns.

Elk herbivory would continue on the elk range; however, elk would not concentrate for extended periods in the same habitat, facilitating the increased abundance and growth of vegetation that are the focus of this analysis. Vegetation on the elk range would recover across the landscape in a patchy distribution that would be most representative of natural conditions compared to any of the other action alternatives. The reduced elk population size and decreased elk densities would have impacts on montane riparian willow, upland and riparian herbaceous vegetation, bitterbrush and sagebrush upland vegetation, and subalpine and alpine vegetation similar to those described in Alternative 2. As in Alternative 2, as montane riparian willow would recover across the elk range, beaver recolonization or reintroduction would occur, resulting in an increased water table, and implementation of prescribed burning and thinning activities would further improve montane riparian willow establishment and growth particularly, on the primary winter range. These benefits would be offset to some degree as a result of the indirect effects of an increase in the moose population on the primary summer range.

Bitterbrush and sagebrush upland shrub vegetation would benefit as described in Alternative 2 with the decrease in elk herbivory on the elk range. Unlike Alternative 2, however, there would be no large increase in the mule deer population to offset the beneficial effects. Wolves would be expected to increase mule deer dispersal as well as reduce deer numbers (see “Other Wildlife Species” section of this chapter). As a result, long-term, moderate benefits to bitterbrush and sagebrush upland vegetation would occur, where elk herbivory levels have had greater adverse effects.

As a result of the increased elk distribution, decreased elk herbivory, and less concentrated use of areas on the elk range, the reduction in bare ground and thus the potential for exotic plant establishment in areas of the elk range would result in benefits to vegetation as described in Alternative 2.

Management activities would have short-term and long-term, adverse, negligible-to-minor effects on vegetation in localized area of the elk range. The adverse effects of installation of fences, agency lethal reduction operations, herding, capture and holding facilities, and carcass disposal would be the same as those described above for Alternative 2. Over time, as the wolf population becomes established, the need for agency elk population reduction actions, carcass removal, and herding would diminish, and the adverse impacts associated with these activities would be reduced to short term, local, and negligible.

Cumulative Impacts

The cumulative actions that affect vegetation would be the same as those described under Alternative 2 except that the effects on upland shrub habitat would differ. Overall, the benefits to upland shrub habitat would be long term and moderate. As wolves would be permitted to use other areas of the park, increased distribution of grazers and browsers may also benefit vegetation in other locations. The degradation of vegetation as a result of herbivory has not been identified in other areas of the park as compared to what has occurred on the elk range. The overall benefit from release of wolves in the park to vegetation in the park therefore would be minor.

Conclusion

The reduction in elk numbers and increased distribution and migration of the population and the protection of all aspen stands of the elk range with fences would result in large reductions in elk herbivory on the elk range in a short time. This would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate community-level changes toward a more natural condition. Because this alternative would prevent the loss of aspen and willow on the elk range and would result in increased stand size, structure, vigor, and distribution of these important habitat types over large portions of the elk range, it would be most reflective of natural conditions.

Aspen

The presence of wolves would be expected to effectively distribute elk. In addition, the use of fences if necessary to protect aspen on the elk range to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, and increased cover as described under Alternative 2. Through reduced elk population size, increased elk movements, and changed elk grazing patterns, vegetation on the elk range would result in long-term major benefits. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit. With release of wolves, the recovery of vegetation across the elk range would result in a patchy distribution that would most reflect natural conditions.

Montane Riparian Willow

Lower levels of elk browsing would result in large increases in montane riparian willow production, height, stem density and canopy volume. Montane riparian willow would transform from shorter willow to taller willow and would replace herbaceous vegetation. The increased abundance, competitive ability, and survivorship of willow would result in long-term, major, beneficial impacts, particularly in the core winter range. The ability to use vegetative restoration tools to improve montane riparian willow regeneration would have long-term, major, beneficial effects. These benefits would be offset to some degree due to indirect effects of an increase in the moose population on the primary summer range.

Upland and Riparian Herbaceous Plants

Reductions in the elk population and more effective elk distribution would result in increased upland herbaceous biomass and individual species abundances; however, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the elk range, the long-term beneficial effects would be minor to moderate. The conversion of herbaceous to montane riparian willow shrub as willow coverage increase would represent a minor-to-moderate, adverse effect on herbaceous vegetation, however, this would reflect natural conditions.

Bitterbrush and Sagebrush Upland Shrubs

The effects would be similar to those described in Alternative 2. A reduction in the elk population and more effective distribution would result in increased annual biomass, shrub heights, shrub volume, and canopy, particularly in localized areas of the core winter range where elk densities are excessive. The long-term, beneficial effects on shrub species on the primary winter range would be moderate. Large-scale shifts in species abundance and species diversity would not occur, although increases in individual species abundances would occur, resulting in long-term, minor, beneficial effects on the primary winter range. Wolves would be expected to also reduce the mule deer population and increase mule deer distribution. As a result, the benefits of reduced elk numbers and increased dispersal would not be offset.

Subalpine and Alpine Vegetation

Effects would be the same as described in Alternative 2.

Reductions in the elk population and increased dispersal would reduce elk herbivory in subalpine and alpine riparian and upland willow and herbaceous habitats, resulting in localized increases in native plant species cover and abundance. The reduction in disturbance from elk grazing would result in long-term, major, beneficial effect on riparian and upland willow and minor benefits to herbaceous vegetation.

Exotic Plants

There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

In the reduction phase of the plan, agency lethal reduction operations, herding, carcass disposal, and use of temporary capture facilities would result in localized trampling and loss of individual plants. The short- and long-term effects would be minor, as the areas exposed would be reseeded with native plants. Effects would be reduced to negligible during the maintenance phase of the plan when management operations are less intense, as wolves would reduce the elk population and distribute the population.

The cumulative effects on the elk range from a reduction in elk herbivory and protection of vegetation under this alternative in combination with plans and actions to restore and protect native vegetation would result in overall, moderate-to-major, long-term benefits on aspen, willow, herbaceous, and alpine vegetation. The decrease in elk and deer herbivory on upland shrub habitat as a result of wolves and elk management actions in combination with benefits to upland shrub as a result of burning would have long-term, moderate, beneficial effects on this habitat. In other areas of the park, the release of wolves within the park would have minor benefits to vegetation by distribution of herbivores. This in combination with other management plans to restore vegetation in the park would offset to a large degree actions that result in short-and long-term, minor, adverse effects and would result in overall minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 5.

SPECIAL STATUS SPECIES

Rocky Mountain National Park is responsible for complying with the Endangered Species Act of 1973 and for conserving and protecting animal and plant species that are deemed to have special status by federal and state agencies. The analysis of effects on special status species and critical habitats includes those species listed by the U.S. Fish and Wildlife Service as endangered, threatened, proposed for listing, or considered candidates for listing and with potential to be affected by the elk and vegetation management plan. Designated critical habitats associated with listed species, if any, are also considered in the determination of effects. Species that are considered endangered, threatened or of special concern by the Colorado Division of Wildlife (state-listed species) and have potential to be affected by management actions associated with this plan are also evaluated. The federal- and state-listed species are referred to as "special status species" for this evaluation of effects.

Summary of Regulations and Policies

The *NPS Organic Act* and *Management Policies* (NPS 2006b) provide the basis for resource protection, conservation, and management and are fully described in Chapter 1, "Purpose of and Need for Action."

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision-Making (NPS 2001c) offers guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

The *Endangered Species Act of 1973* provides strict legal protection for endangered and threatened species, as well as those special concern species that may be in jeopardy of extinction, and for which special protection under federal and state law is afforded. The federal list of plants and animals is published in 50 Code of Federal Regulations 17.11-12 and is administered by the U.S. Fish and Wildlife Service. Special status species of plants and wildlife are included in this section. If the National Park Service determines that an action may adversely affect a federally listed species, consultation with the U.S. Fish and Wildlife Service is required to ensure that the action would not jeopardize the species' continued existence or result in the destruction or adverse modification of designated critical habitat.

The *Bald and Golden Eagle Protection Act of 1940*, as amended, provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, transport, export or import, or offer to sell, purchase or barter of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic boundaries for the analysis include the primary winter and summer ranges of the Rocky Mountain / Estes Valley elk population (see Figure 1.1), Rocky Mountain National Park, and areas beyond the park where the plan's management actions have the potential to affect listed species or their habitats. Actions in the park must be analyzed to determine if those actions would impact wide-ranging species or species that are found outside the park in addition to species known to use habitats in the park.

Issues

Issues that were identified during internal and public scoping regarding elk and vegetation management activity effects on listed species include the following:

- The potential for management actions in the park to produce downstream effects on special status species.
- Effects of elk population or vegetation alteration on special status species' breeding or foraging habitats.
- Changes in wildlife species composition affecting a special status species' prey base.
- Direct physical impacts on special status species' habitat (e.g., trampling or soil disturbance).
- Effects of lethal elk population reduction activities (especially firing weapons) or redistribution actions on special status species.

Assumptions

The following assumptions were used to perform the analysis of elk and vegetation management actions on special status species in addition to the more general assumptions associated with all impact topics that were presented earlier:

- Fencing would not restrict the movement of special status species or their access to resources or habitat.
- Wolves (either a released or naturally dispersing population) would prey primarily on elk.
- The gray wolf would retain its current listing as a federally listed endangered species, although the wolves released in the park would likely be classified as a non-essential experimental population. Wolves that naturally disperse to the park would have endangered status.

Listed Species to Be Evaluated

The listed species that were retained for a full evaluation of the effects of the elk and vegetation management plan are presented in Table 3.2, in Chapter 3, "Affected Environment." The rationale for retaining these species and their descriptions is also presented in that section. None of the species retained for evaluation has designated critical habitat in the park or within the elk primary winter or summer ranges. As a result, none of the alternatives would have any effect on any critical habitat.

Assessment Methods

Impacts on special status species include any activity that may be considered a "taking" or that may cause harm to a species as defined under the Endangered Species Act, including harassment and degradation or loss of habitat. Potential effects on a listed species are treated very conservatively to provide maximum protection. Long-range effects of seemingly beneficial actions must be evaluated for potential impacts on listed species.

Potential impacts on special status species or their habitat were evaluated based on the known presence of a species or its potential presence due to suitable available habitat. The methods used to evaluate the impacts on special status species used Alternative 1 as the baseline condition against which the action alternatives were compared because Alternative 1 represents current management conditions. The analysis focuses on the effects on special status species with respect to the implementation of the management actions described in Alternatives 2, 3, 5, and 5. To understand the effects of elk and vegetation management methods on listed species, park resource inventories and management plans, scientific literature, and published technical data were consulted to analyze different resource management approaches.

Impact Threshold Definitions

Intensity of Impact

Impact intensity level thresholds were defined to facilitate the determination of effects as follows:

Negligible: No special status species would be affected, or the action would affect an individual of a listed species or its critical habitat, but the change would be so small that it would not be of any measurable or perceptible consequence to the protected individual or its population; a discountable effect.

Minor: The action would result in detectable impacts on an individual (or individuals) of a listed species or its critical habitat, but the action would not be expected to result in substantial population fluctuations and would not be expected to have any measurable effects on species, habitats, or natural processes sustaining them.

Moderate: An action would result in detectable impacts on individuals or a population of a listed species, its critical habitat, or the natural processes sustaining them. Key ecosystem processes may experience disruptions that may result in population or habitat condition fluctuations that would be outside the range of natural variation but would return to natural conditions.

Major: Individuals or a population of a listed species, its critical habitat, or the natural processes sustaining them would be measurably affected, including mortality for special status individuals. Key ecosystem processes might be permanently altered, resulting in changes in population numbers or permanently modifying critical habitat.

Type and Duration of Impact

Beneficial effects are likely to protect or restore the abundance and distribution of a listed species. This could occur through increased survival, reproduction, or availability of habitat or required resources.

Adverse effects are likely to result in undesirable changes in the abundance or distribution of a listed species. This could occur through direct disturbance, mortality, decreased reproduction, or through destruction or alteration of habitat.

Duration: Short-term effects would last less than one year. Long-term effects would persist for one year or more.

Impairment

An impairment of a listed species would occur when the action contributes substantially to deterioration of the listed species or its critical habitat in the park to the extent that the listed species would no longer survive as a viable population. Impairment would "jeopardize the continued existence" of a listed species in that the action would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species [50

Code of Federal Regulations 402.02]. In addition, the adverse effects on listed species in the parks and their critical habitat

Alternative 1

This alternative would continue the existing management framework for special status species. These management activities include habitat improvements in the Kawuneeche Valley for the Colorado River cutthroat trout and in east slope-waters for the green-backed cutthroat trout, as well as maintenance of the reintroduced river otter population in the Colorado River drainage.

Boreal Toad

Continued degradation of montane riparian and wetland habitat by high numbers and concentrations of elk on the elk range would represent a long-term, local, moderate adverse effect on the boreal toad. In addition, elk concentrations in riparian meadows and wetland areas would continue to potentially trample the toad or its habitat. Trampling can kill toads or destroy egg masses, causing a long-term, local, moderate adverse effect on the boreal toad population.

Wood Frog

If montane riparian willow habitat degradation as a result of elk herbivory were to occur in the Kawuneeche Valley, wood frog habitat would be adversely affected. Degradation of willows is not well-documented on the west slope of the park, but there is the potential that as elk become more habituated to browsing in one place, as they do in eastern portions of the park, willows could become degraded in a similar fashion to those on the east side of the park. Effects on wood frog habitat from elk herbivory would likely be limited, though, due to decreased densities of elk on the primary summer range. Effects would be long term, local, minor, and adverse. Trampling by elk could also kill frogs or destroy egg masses but, again, would likely occur on a limited basis, resulting in long-term, local, negligible, adverse effects.

Greenback Cutthroat Trout

Degraded montane riparian vegetation conditions, specifically lack of willow overstory along stream banks, could cause an adverse effect on greenback trout and its habitat because lack of cover could warm water temperature and would not provide hiding cover for fish. The effect on greenback cutthroat trout as a result of habitat degradation would be long-term, local, negligible, and adverse. The characterization of the effect intensity is a result of the spatial separation between most of the streams inhabited by greenback cutthroat trout (NPS 2005b) and the core winter elk range, where montane riparian willow habitat has been adversely affected to the greatest degree. Most greenback cutthroat trout habitat in the park is upstream of the areas where elk foraging has adversely affected willow cover along streams. Hidden Valley Creek is within the elk range, and there is a remnant population of greenback cutthroat trout. In addition, this area has been identified as a restoration area to supplement the greenback cutthroat trout population. The potential for the continuation and spread of habitat degradation is the basis for the negligible, adverse effect finding.

Colorado River Cutthroat Trout

Effects on the Colorado River cutthroat trout would likely be similar to those described for greenback trout, although of negligible-to-minor intensity. Degradation of montane riparian habitat as a result of elk foraging behavior is not well documented in the Colorado River drainage (west slope of the park), although it is suspected. This elk population does not winter on the west slope, so the potential effects are substantially less than in the core winter range. Nonetheless, these effects could occur over the long-term, and identifying potential management actions that could forestall degradation would support resource management goals in the park.

Greater Sandhill Crane

Similar to the Colorado River cutthroat trout, the greater sandhill crane uses habitat in the Kawuneeche Valley on the west slope of the park. If montane riparian willow habitat degradation as a result of elk herbivory were to occur, nesting habitat in Kawuneeche Valley could be adversely affected. This effect would be long term, local, and negligible because only one pair of sandhill cranes are currently known to nest in the park and the amount and quality of montane riparian willow habitat (preferred nesting habitat for the crane) would be more than sufficient to support nesting cranes in the park.

Long-billed Curlew

Current management actions associated with elk and vegetation in the park would not have an effect on the curlew because it is considered a very rare migrant through the park (only one record of occurrence) and its preferred habitat is short-grass grassland (Andrew and Righter 1992). Continuing current NPS actions would not affect the long-billed curlew's breeding habitat at lower elevations in Larimer County.

Bald Eagle

Although bald eagles do forage on elk carcasses, continuing current management of elk and vegetation would have little effect on the bald eagle because the eagles that winter in the park, as well as the pair that forages in the park in summer, use habitat that is mostly outside the elk range of interest. Bald eagles primarily use habitats on the west side of the park between Shadow Mountain Dam and Columbine Bay on Lake Granby, which is not within the elk range being evaluated. If eagles do use habitats inside the elk range, Alternative 1 would not affect the availability of elk carcasses, with the exception of the removal of carcasses that test positive for chronic wasting disease. The potential adverse effect on the bald eagle would be long-term, local, and negligible.

River Otter

Effects on the river otter would potentially occur in the Colorado River drainage on the west slope of the Continental Divide in the Kawuneeche Valley basin. As described for the wood frog, Colorado River cutthroat trout, and the greater sandhill crane, there is little documentation regarding montane riparian habitat degradation on the west side of the park, although there are good reasons to suspect that elk foraging may be adversely affecting that habitat. Continuing current management would have a long-term, negligible to minor, local, adverse effect on the river otter because of the potential for degraded montane riparian conditions and adverse effects on fish populations, which could in turn affect the otter.

Wolverine

Although there is potential wolverine habitat in the park, intensive survey efforts (Seidel et al. 1998) have not confirmed the presence of wolverines in the park. Ten sets of wolverine tracks were found near the park, but none were confirmed in Rocky Mountain National Park (Seidel et al. 1998). Wolverines feed on carrion and would likely feed on elk carcasses. If the wolverine were present in the backcountry areas of the park, it is possible they would rely on elk carcasses for food. The removal of elk carcasses that test positive for chronic wasting disease would have a discountable and inconsequential effect on the wolverine. As a result, Alternative 1 would not affect the wolverine.

Canada Lynx

Current management actions related to elk and vegetation management in the park would not have any consequences, with the exception of the removal of elk carcasses that test positive for chronic wasting disease. Although lynx feed primarily on snowshoe hare, with a small percentage of voles, mice, squirrels, and birds in their diet when hares are scarce and in summer and fall, they will occasionally scavenge carrion (Koehler and Aubry 1994). As a result, the removal of elk carcasses that test positive for chronic wasting disease would have a negligible, adverse effect on Canada lynx. Although degraded montane riparian habitat conditions on the core winter elk range could affect lynx use of this habitat in summer, these areas are relatively close to development and are frequented by humans, thus minimizing the likelihood of use by lynx. Lynx do prey on snowshoe hare in riparian willow habitat, so this would offset, to some degree, their reluctance to approach developed areas. Alternative 1 would have long-term, local, negligible-to-minor, adverse effects on the Canada lynx.

Cumulative Impacts

In recent years, the use of low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned, a long-term, regional, negligible, beneficial effect on special status species. Wildlife vary in their responses to noise, but it can negatively affect many species through changes in behavior and physiological effects (USAF and USFWS 1988).

A number of actions in the park and on adjacent lands involve improving forest health, through controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. These activities would adversely affect special status species through temporary displacement and short-term alteration of habitat, a short-term, minor, adverse effect. However, these actions would result in long-term, minor, beneficial effects on special status species, particularly lynx, through improved habitat.

Management plans for protecting the park's natural resources would benefit special status species through maintaining and restoring natural conditions and limiting intrusive activities. Effects would be long term, minor-to-moderate, and beneficial. Restoring vegetative communities and removing exotic plants in the park would also enhance habitat, a long-term, minor, beneficial effect on special status species.

Restoration plans focused on special status species (greenback cutthroat trout, Colorado River cutthroat trout, boreal toad, and, potentially, lynx and wolverine) in the park, as well as conservation lands occurring outside the park, would enhance and conserve aquatic and terrestrial habitats in the long term, a moderate benefit to special status species.

Activities outside the park also affect special status species within the park, as individuals outside can be within the same population as those within the park. Development in the Estes Valley, on the west side of the park near Grand Lake, and in other areas outside of the park would continue to fragment and reduce habitat that could be used by special status species. On a regional scale, depending on the specific species, this would represent a long-term, moderate to major, adverse effect on special status species.

Effects from other plans, projects, and actions would vary according to the special status species, its habitat requirements, and the locations of the activities. The effects could range from short term, minor, and adverse to long term, moderate, and beneficial. Overall, Alternative 1 would have a long-term, negligible-to-moderate contribution to adverse cumulative effects on special status species. The overall cumulative effects of other plans, projects, and actions, combined with the effects of Alternative 1, would be short- and long-term, minor, and adverse.

Conclusion

Alternative 1 would have no effect on the long-billed curlew or wolverine. Changes in habitat would lead to negligible, adverse effects on the greenback cutthroat trout, greater sandhill crane, river otter, and bald eagle; negligible-to-minor, adverse effects on the Colorado River cutthroat trout and Canada lynx; and minor, adverse effects on the wood frog. The boreal toad could experience moderate, adverse effects as a result of continued degradation of montane riparian and wetland habitat on the elk range and the direct adverse effects of trampling by high concentrations of elk in boreal toad habitat.

The overall cumulative effects of other plans, projects, and actions combined with the effects of Alternative 1 would be short term and long term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 1.

Alternative 2

All Special Status Species

The lethal elk reduction activities; use of redistribution techniques to disperse high concentrations of elk; and research activities conducted in concert with elk management activities in the first three years of the plan could potentially disturb special status species in the vicinity of the actions. Lethal reduction actions using suppressed-noise weapons would mitigate this potential disturbance to a degree; the actions of the reduction team would still have some effect as carcasses were removed and teams moved through habitat. The actions taken would avoid sensitive periods of species' life cycles and sensitive locations, such as known breeding or nesting sites and seasons (see "Affected Environment" for special status species), to minimize the potential for disturbance during these sensitive periods. The potential for disturbance would be directly related to the likelihood that a special status species would use habitat where elk tend to congregate in high densities, such as meadows and montane riparian areas on the elk range and preferred foraging areas. The reduction, research, and redistribution activities would occur for relatively short periods, and some special status species could easily avoid the affected areas. The potential adverse effect of these activities with mitigations would be short term, local, and negligible.

Many of the special status species rely to one degree or another on montane riparian, wetland, or aquatic habitats. The restoration or reintroduction of beaver populations would support more of these habitats and, in turn, provide benefits for the special status species that use the habitats. This effect would be long term, minor-to-moderate, beneficial, and would extend from local areas to areas throughout the winter and summer elk ranges. The reintroduction of beaver would not cause downstream effects outside the elk range that would require analyses because the actions would be contributing to a restoration of former conditions.

Boreal Toad

Fewer elk and lower elk densities in combination with improved conditions in montane riparian habitat would benefit the boreal toad. The reduced potential for trampling of toads or toad egg masses as a result of greater structural complexity in a restored willow community would contribute to this beneficial effect. The restoration of montane riparian willow communities, beaver populations, and the aquatic habitats created and maintained by beaver would be especially beneficial for boreal toad habitat. This would represent a long-term, local, moderate benefit for the boreal toad.

Wood Frog

Improved conditions in montane riparian areas in the Kawuneeche Valley and reduced potential for trampling from decreased numbers and densities of elk and thicker, taller willow habitats would benefit the wood frog. This would represent a long-term, local, minor benefit for the wood frog.

Greenback Cutthroat Trout

Improvements in montane riparian habitat conditions would benefit the greenback cutthroat trout. The potential return of beaver and resulting enhancement of aquatic habitats would contribute to this benefit. As noted in the discussion of greenback cutthroat trout under Alternative 1, there is only a small overlap between existing and future greenback cutthroat trout habitat and the montane riparian willow habitats that are most likely to experience improvements. As a result, the long-term, local benefits for the greenback cutthroat trout would be negligible.

Colorado River Cutthroat Trout

The beneficial effects of Alternative 2 on the Colorado River cutthroat trout would be similar to those described for greenback cutthroat trout, although the long-term, local benefit would increase to moderate. The reason for the greater potential benefit is because summer elk range in the Kawuneeche Valley overlaps with streams and rivers used by Colorado River cutthroat trout to a greater degree than the intersection of core winter elk range and greenback cutthroat trout habitat on the eastern side of the park.

Greater Sandhill Crane

Enhanced montane riparian habitat along the Colorado River and tributaries in the Kawuneeche Valley as a result of management actions associated with Alternative 2 would benefit the greater sandhill crane. Restoration or reintroduction of the beaver population and the aquatic habitats created and maintained by beaver would be especially beneficial. The park is on the periphery of the crane’s breeding range, and migratory use of park habitats is limited (Andrew and Righter 1992). As a result, benefits to the greater sandhill crane would be long term, local, and negligible.

Long-billed Curlew

Although the likelihood of the long-billed curlew being affected by management actions associated with any of the action alternatives is very low, nevertheless, there is potential for migrating curlews to make use of habitat in the park. As a result, enhanced montane riparian habitat would present a long-term, local, negligible benefit to the long-billed curlew as additional structural cover would be present and could provide protection for the bird during migratory stops.

Bald Eagle

The number of elk carcasses that would be left in the environment during the first four years of the plan, when lethal elk reduction activities would be maximized, may be greater than under other alternatives. This would provide additional foraging opportunities for the bald eagle in those parts of the park where eagles forage and are found in the same areas where elk reductions would be implemented. The overlap between areas that eagles are known to use and where elk reduction activities would occur is small. Although the number of carcasses would decline in years five through 20, the overall benefit to eagles would remain negligible.

River Otter

Enhanced montane riparian habitat in the Kawuneeche Valley could provide additional terrestrial cover along stream and riverbanks for the river otter. Increased beaver populations and more beaver ponds would add to the benefits for the otter as a result of increased quality and quantity of preferred otter habitat. As described for the Colorado River cutthroat trout, montane riparian habitat restoration would potentially benefit fish populations, which in turn would increase the prey base for the river otter. Together, the improvements in habitat and prey base would represent a long-term, local, minor benefit for the river otter.

Wolverine

As described for the bald eagle, the number of elk carcasses left in the environment may increase during the first four years of Alternative 2. The potential benefit for the wolverine would be small because of the uncertainty associated with the potential for wolverine to even exist in the park. Nonetheless, the increase in a potential food source would represent a long-term, local, negligible benefit for any wolverine that would use the park. Although the number of carcasses would decline in years five through 20, the overall benefit to wolverines would remain negligible.

Canada Lynx

Increases in structural complexity and the areal extent of montane riparian habitat associated with restoration of montane riparian willow communities would benefit Canada lynx that frequent montane riparian habitat in summer. The benefit would primarily be associated with increased foraging conditions and opportunities. In addition, because lynx may consume carrion if other prey is limited or unavailable, the potential for an increase in elk carcasses left in the environment during the first four years of the plan would contribute to beneficial effects for the lynx. Overall, the beneficial effects on the lynx as a result of Alternative 2 would be long term, local, and minor. The intensity is minor because of the relatively little time that lynx would be expected to occur in the habitats of the core winter elk range.

Cumulative Impacts

Effects of other plans, projects, and actions on special status species would be the same as described for Alternative 1: long term, minor, adverse and short term, minor, and adverse. Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial as well as short term, negligible, and adverse. When the effects of other plans, projects, and actions are combined with those of Alternative 2, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Conclusion

Alternative 2 would be beneficial for special status species except for disturbance effects associated with lethal elk reduction and research activities and redistribution actions to disperse high concentrations of elk. The adverse effects of elk management and research activities would be temporary and negligible. The benefits that would accrue would be negligible for greenback cutthroat trout, greater sandhill crane, long-billed curlew, bald eagle, and wolverine (decreasing to no effect in the fifth through 20th years for bald eagle and wolverine); minor for river otter, Canada lynx, and wood frog; minor-to-moderate for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for boreal toad and Colorado River cutthroat trout.

When the effects of other plans, projects, and actions are combined with those of Alternative 2, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 2.

Alternative 3

All Special Status Species

The lethal elk reduction activities, use of redistribution techniques to disperse high concentrations of elk, installation of fences, and research activities could potentially disturb terrestrial special status species in the vicinity of the actions. Lethal reduction actions using suppressed-noise weapons would mitigate this potential disturbance to a degree; the actions of the reduction team would still have some effect as carcasses were removed and teams moved through habitat. The actions taken would avoid sensitive periods of species' life cycles and sensitive locations, such as known breeding or nesting sites and seasons, to minimize the potential for disturbance during these sensitive periods. The potential for disturbance would be directly related to the likelihood that a species would use habitat where elk tend to congregate in high densities, such as meadows and montane riparian areas on the core winter range and preferred foraging areas. Lethal elk reduction actions would be less intense than under Alternative 2, and the potential short-term, local, adverse effects would be negligible but incrementally less than with Alternative 2. Redistribution activities would occur more frequently than in Alternative 2, although the effect would be similar to but incrementally greater than the description of effects for Alternative 2.

The effects of beaver population restoration or reintroduction would have effects on special status species similar to those described for Alternative 2. Installation of fences would have local, short-term, adverse, negligible effects.

Boreal Toad

The effects of Alternative 3 on the boreal toad would be similar to those described for Alternative 2. Fencing of montane riparian willow habitat would protect much boreal toad habitat from the effects of high concentrations of elk; however, the target elk population would be higher than for Alternative 2. The net effect would be long-term, local, beneficial, and moderate.

Wood Frog

The effects of Alternative 3 on the wood frog would be similar to those described for Alternative 2. Although the total elk population would be higher under Alternative 3, 180 acres of willow habitat would be fenced in the Kawuneeche Valley, providing habitat for the frog that is free of disturbance by elk. Areas outside fences would be browsed at a higher level, reducing habitat quality, and frogs would continue to be at risk from trampling by elk and from redistribution efforts, reducing some of the beneficial effects of fences. Overall, this alternative would result in a long-term, local, minor benefit for the wood frog.

Greenback Cutthroat Trout

Assuming that montane riparian willow habitat in Hidden Valley Creek and other greenback cutthroat trout habitat in the core winter elk range would be fenced, the restoration of montane riparian vegetation and subsequent benefits to aquatic habitats would be similar to but incrementally greater than those described for Alternative 2 (i.e., minor benefits). If montane riparian willow habitat along streams containing greenback cutthroat trout in the core winter elk range were not fenced, the effects on the trout would be long term, local, negligible, and beneficial because the habitat improvements would not be as great, nor occur as quickly, as described for Alternative 2.

Colorado River Cutthroat Trout

Effects on the Colorado River cutthroat trout would occur as a result of habitat restoration similar to the reasons described for Alternative 2 and at a similar intensity. Protection of montane riparian habitat with fences in the Kawuneeche Valley would provide increased cover and shading along streams and rivers and provide habitat for beaver, resulting in further enhancement of aquatic habitats. In fenced areas, the benefit would be long-term and moderate. In montane riparian areas that were not fenced, the effects on trout would be long term, local, minor, and beneficial because the habitat improvements would not be as great nor occur as quickly as described for Alternative 2.

Greater Sandhill Crane

The restoration of vegetation would be to the same degree as described under Alternative 2 with the use of fences and increased redistribution actions to protect montane riparian willow in the Kawuneeche Valley. However, as the park is in the periphery of the crane's breeding range, the beneficial effects would be negligible.

Long-billed Curlew

The effects of Alternative 3 would be similar to (i.e., negligible benefits) but incrementally less than those described for Alternative 2 because the actions to restore habitat that the long-billed curlew may use under Alternative 3 would not achieve results as quickly nor to as great a degree.

Bald Eagle

The effects of Alternative 3 on the bald eagle would be related to the availability of carrion, as described for Alternative 2. Because Alternative 3 would employ a moderate, constant rate of lethal elk reduction throughout the 20-year life of the plan, it is not expected that carcasses would be left in the environment exceeding natural conditions. The effect on the bald eagle with respect to carrion availability would be long-term and negligible.

River Otter

Effects on the river otter would occur as a result of habitat restoration and benefits to fish populations similar to that described for Alternative 2. Enhancement of montane riparian habitat with fences in the Kawuneeche Valley would provide increased cover along streams and rivers. An increase in beaver populations that may result from restored vegetation would add increased quality habitat for otters. The improvements in habitat and prey base would represent a long-term, local, minor benefit for the river otter.

Wolverine

As described for the bald eagle, potential effects on the wolverine would be related to the availability of carrion, as described for Alternative 2. Because Alternative 3 would employ a moderate, constant rate of lethal elk reduction throughout the 20-year life of the plan, it is not expected that carcasses would be left in the environment exceeding natural conditions; thus there would be a long-term, negligible effect on the wolverine. Fencing would not be expected to affect the wolverine.

Canada Lynx

The effects of Alternative 3 on the Canada lynx would be similar to and occur for the same reasons as those described for Alternative 2. The difference between the alternatives would be related to the speed and magnitude of montane riparian habitat restoration. Under Alternative 3, vegetation restoration would be more a function of fenced protection from herbivory than elk population reduction. Because fencing would likely be used in greater proximity to humans and development (i.e., the core winter elk range) than the overall areas that would be affected by elk population reductions, and lynx would likely occur less often in proximity to development, the long-term, local, minor benefit to the lynx under Alternative 3 would be similar to but incrementally less than Alternative 2's effect.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 2.

Conclusion

Alternative 3 would benefit special status species except for disturbance effects associated with lethal elk reduction activities, redistribution actions to disperse high concentrations of elk, fence installation activities, and research study activities. Reduction actions would have a temporary, negligible, adverse effect on special status species, incrementally less than those under Alternative 2. Redistribution activities would also have a temporary, negligible effect incrementally greater than Alternative 2 because redistribution would be used more often. Alternative 3 would have negligible effect on the bald eagle or wolverine. The benefits that would accrue would be negligible for greenback cutthroat trout (in areas where montane riparian willow habitat would not be fenced), long-billed curlew, and greater sandhill crane; minor for greenback cutthroat trout and wood frogs (where habitat would be fenced), and Canada lynx; minor to moderate for Colorado River cutthroat trout in unfenced and fenced areas, respectively; minor to moderate for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for the boreal toad.

When the effects of other plans, projects, and actions are combined with those of Alternative 3, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 3.

Alternative 4

All Special Status Species

Lethal elk reduction, fencing aspen and willow communities on the primary winter range, actions taken to redistribute elk; and research activities would have effects on special status species similar to those described for Alternative 3. Because fences would not be erected to protect montane riparian willow on the primary summer range, the effects on special status species that occur in this portion of the elk range would differ from Alternative 3 as described below. Mitigation measures, such as avoiding sensitive breeding locations and times, would be implemented to minimize the potential to affect special status species.

If the fertility control agent for elk population management can be administered remotely (i.e., using darting methods without capturing and sedating elk), the effects on special status species would be associated with the potential presence of treatment teams in habitats used by special status species and the temporary disturbance the teams would create. This would represent a short-term, local, negligible, adverse effect on special status species if special status species were in the vicinity or, more likely, no effect if no special status species were in the vicinity of treatment actions. If an elk capture facility would be required for elk population management, the potential disturbance-related effects would last longer and likely be distributed over a larger area, leading to a short-term, local, negligible-to-minor, adverse effect on special status species that might be in the vicinity. As described in the "Wildlife" impact topic section, the need to capture elk could be met using a capture facility such as a corral trap. The potential impacts of these activities on special status species would be short term and local, but the adverse effect would be minor depending on the specific location, the method used, the habitat that would be affected, and the potential for being in the vicinity of habitat that might be occupied by special status species.

The fertility control agents used for population management or research purposes would have no effect on any special status species. One of the criteria for the control agent states, "A fertility control agent must not have any adverse effects on non-target animals that consume elk meat. These would include no toxicity, no change in fertility, and no genetic mutations that would interfere with life cycles or be passed on to subsequent generations." In the case of Leuprolide, the active hormone would not pass into the food chain because it would cleave to constituent amino acids (Becker and Katz 1993). Any other fertility control agent considered for use would be required to meet the "no effect on non-target species" criterion as well. As a result, there would be no food chain effects on special status species from the administration of fertility control agents to elk. The transport to waterways of the potential agents described in Chapter 2 is unknown at this time. If, based on monitoring or new scientific information, it is determined that fertility control agents are found to have affects on nontarget species, including fish, the use of the agent would be modified or stopped. Every effort would be made by staff to retrieve darts that have missed their target.

Boreal Toad

The effects of Alternative 4 on the boreal toad would be similar to those described for Alternative 3.

Wood Frog

The effects of Alternative 4 on the wood frog would be similar to those described for Alternative 2, although incrementally less because the total elk population, and therefore elk herbivory, would be somewhat higher.

Greenback Cutthroat Trout

The effects of Alternative 4 on the greenback cutthroat would be similar to those described for Alternative 3.

Colorado River Cutthroat Trout

Effects on the Colorado River cutthroat trout would occur as a result of habitat restoration similar to the reasons described for Alternative 3 and at a similar intensity. However, because there would be no fencing of montane riparian willow habitat in the Kawuneeche Valley under Alternative 4 and the lethal elk reduction targets would result in elk populations higher than in Alternative 2, benefits for the Colorado River cutthroat trout would be minor rather than moderate because of slower restoration of montane riparian vegetation and a higher elk population.

Greater Sandhill Crane

The restoration of vegetation would be slower than under Alternative 2 because the elk population target is higher. No fencing to protect montane riparian willow vegetation would be installed in the Kawuneeche Valley. Thus, the effects on the greater sandhill crane would occur for the same reasons described for Alternative 2 but would accrue as a negligible benefit.

Long-billed Curlew

The effects of Alternative 4 would be similar to (i.e., negligible benefits) but incrementally less than those described for Alternative 2 because the actions to restore habitat that the long-billed curlew may use under Alternative 4 would not achieve results as quickly nor to as great a degree.

Bald Eagle

The effects of Alternative 4 on the bald eagle would be related to the availability of carrion, as described for Alternative 3. The effect with respect to carrion availability would be long term and negligible.

River Otter

The enhancement of montane riparian habitat in the Kawuneeche Valley would not be as great as described for Alternative 2 because the elk population target would be higher. No montane riparian willow habitat would be fenced on the west side of the park and as a result, vegetation restoration in montane riparian willow habitat would proceed relatively slowly in the Colorado River basin. The long-term, local, beneficial effects on the river otter as a result of Alternative 4 would be negligible.

Wolverine

As described for the bald eagle, potential effects on the wolverine would be related to the availability of carrion, as described for Alternative 3. There would be a long-term, negligible effect on the wolverine.

Canada Lynx

The effects of Alternative 4 on the Canada lynx would be similar to and occur for the same reasons as those described for Alternative 2. The difference between the alternatives would be related to the speed and magnitude of montane riparian habitat restoration. Under Alternative 4, vegetation restoration would be more a function of fenced protection from herbivory than elk population reduction. Because fencing would likely be used in greater proximity to humans and development (i.e., the core winter elk range) than the overall areas that would be affected by elk population reductions, and lynx would likely occur less often in proximity to development, the long-term, local, minor benefit to the lynx under Alternative 4 would be similar to but incrementally less than Alternative 2's effect.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 3.

Conclusion

Alternative 4 would benefit special status species except for disturbance effects associated with lethal elk reduction activities, redistribution actions to disperse high concentrations of elk, fence installation activities, and research activities. Reduction actions would have a temporary, negligible, adverse effect on special status species, incrementally less than those under Alternative 2. Redistribution activities would also have a temporary, negligible effect incrementally greater than Alternative 2 because redistribution would be used more often.

Administering fertility control agents remotely would have negligible, short-term, adverse effects on special status species in the vicinity of activities. Use of a capture facility for elk population management would have greater adverse effects up to minor in intensity due the area disturbed and length of disturbance.

Alternative 4 would have negligible effects on the greater sandhill crane, bald eagle, and wolverine. The benefits that would accrue would be negligible for greenback cutthroat trout (in areas where montane riparian willow habitat would not be fenced), long-billed curlew, and river otter; minor for greenback cutthroat trout (where habitat would be fenced), Colorado River cutthroat trout, wood frog, and Canada lynx; minor to moderate for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for the boreal toad.

When the effects of other plans, projects, and actions are combined with those of Alternative 4, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 4.

Alternative 5

All Special Status Species

The effects of Alternative 5 on special status species would be similar to those described for Alternative 2. However, because benefits would primarily occur as a result of the improvement in montane riparian willow and aspen habitat quality and quantity, the benefits would mostly accrue for the greenback cutthroat trout, Colorado River cutthroat trout, boreal toad, wood toad, greater sandhill crane, lynx, and river otter. The primary mechanism supporting the habitat restoration would be the constant risk of predation posed to elk by wolves and the resulting trophic cascade that would benefit vegetative communities (Ripple et al. 2001, Ripple and Beschta 2004b, Hebblewhite et al. 2005). Because of the relatively small wolf population that would be present in the early stages of this alternative, lethal reduction of elk would augment wolf disturbance and predation to achieve the reductions in the elk population and the subsequent drop in herbivory levels.

There would be small differences from Alternative 2 in the benefits for special status species that rely on carrion for food. Because wolves would prey on elk throughout the year, more carcasses would be available in all seasons, rather than peaking in the late fall and winter when the majority of the lethal control actions would be implemented. This would provide an incrementally greater benefit than the local, negligible benefit described under Alternative 2 for special status species that scavenge carrion.

Another difference from the effects of Alternative 2 would be the potential for competition between wolves and Canada lynx and wolverine. Although there is potential for these carnivores to compete for prey, the small number of wolves would make the potential adverse effects of competition for resources for the lynx and wolverine negligible. Furthermore, temporal and spatial avoidance or differences in hunting and foraging strategies would likely minimize the effects of competition between the wolf, wolverine, and lynx (Carroll et al. 1999, Turbak 2005). In Rocky Mountain National Park, wolves preying on elk would provide a food source for wolverines after feeding on the carcass, while the lynx would likely prey on the snowshoe hare.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 2.

Conclusion

The effects of Alternative 5 on special status species would be similar to those described under Alternative 2. Disturbance effects associated with lethal elk reduction and research activities would be short-term and negligible. Beneficial effects associated with montane riparian willow and aspen habitat recovery would be long-term, park-wide, and negligible. Slight differences might occur for special status species that feed on carrion as a result of wolves providing carcasses throughout the year, compared to the spike in carcass availability that would occur under Alternative 2 when lethal control efforts would peak in late fall and winter.

When the effects of other plans, projects, and actions are combined with those of Alternative 5, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species values or resources as a result of the implementation of Alternative 5.

OTHER WILDLIFE SPECIES

Rocky Mountain National Park is responsible for protecting wildlife (including fish, invertebrates, and all native wild animal species) as a park resource. The wildlife section does not include elk because the elk population, as the primary resource addressed by this management plan, was addressed as an independent impact topic. Wetlands and montane riparian communities are important wildlife habitats. This section addresses general changes to wildlife habitat, while specific effects on wetland vegetation and water quality in the park are addressed in each of those topics' respective sections.

Summary of Regulations and Policies

The *NPS Organic Act* and *Management Policies* (NPS 2006b) provide the basis for resource protection, conservation, and management and are fully described in Chapter 1, Purpose and Need.

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis and Decision-Making (NPS 2001c) offers the guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

The *Fish and Wildlife Coordination Act of 1934*, as amended, requires consultation with the U.S. Fish and Wildlife Service and the fish and wildlife agencies of states to prevent "loss of and damage to wildlife resources." A key point of this act is that it pertains to water resource modification projects as described by the following:

> The Act provides that whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources.

The *Migratory Bird Treaty Act of 1918*, as amended, prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests except as authorized under a valid permit (50 CFR 21.11). Additionally, the act authorizes and directs the Secretary of the Interior to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take (for example, hunting seasons for ducks and geese). "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

The *Bald and Golden Eagle Protection Act of 1940*, as amended, provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, offer to sell, purchase or barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on wildlife includes the primary winter and summer ranges of the Rocky Mountain National Park / Estes Valley elk population (see Figure 1.1 in the

"Scope of Analysis" section in the "Purpose of and Need for Action" chapter for a more detailed description of the area evaluated in this document) including the core elk winter range areas, Kawuneeche Valley, and alpine areas, as these are the areas most affected by potential activities and primary habitats for elk in the park. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were identified during internal and public scoping regarding elk and vegetation management activity effects on other wildlife include the following:

- The long-term response of other wildlife species' populations to the foraging effects of the present elk population sharing/cohabiting the elk primary winter range portions of the park.
- The potential for transmission of disease (e.g., chronic wasting disease) to mule deer or moose may be related to the prevalence of chronic wasting disease in elk.
- Changes in species diversity, abundance of wildlife, and biodiversity in the habitats within the elk primary winter and summer ranges, particularly in those portions of the range that are degraded as a result of elk foraging.
- Availability and alteration of habitat for wildlife species on the elk primary winter and summer ranges.
- Behavior of wildlife species as a reaction to the existing conditions or the actions associated with any of the alternative's management actions.

Also, the public identified a need to address restoration of an intact ecosystem in addition to focusing on elk and vegetation. Within this context, the issue of habitat restoration to benefit all species rather than just elk was recognized. The public expressed a desire for actions taken under this plan to consider an ecosystem restoration-approach as a goal rather than addressing problems based on a species- or community-specific approach.

Assumptions

The following assumptions were used to assess elk and vegetation management actions on other wildlife species:

- The lack of beaver would contribute to changes in hydrology, which contributes to reduced willow, resulting in more herbaceous plant cover in montane riparian areas.
- The conversion of willow habitat to grassland results in a decline or loss of montane riparian corridor biodiversity.
- The limited number of carcasses that would be left in the field following lethal reduction actions of the elk populations would consist of calves only to minimize to the extent possible the potential for transmission of chronic wasting disease (Wild 2005).
- Fencing would only restrict the movements of elk and moose; other wildlife would not be restricted by fences.
- The management of the released wolf population would be successful and stages subsequent to the initial phase would be implemented. The analysis of effects of Alternative 5 was based on the impacts of a functioning population of not more than 14 wolves in the park.
- Wolves (either a released or naturally dispersing population) would prey primarily on elk.

Actions that would result in an increase in the coyote population would be representative of non-natural conditions as the coyote population remains high due to a lack of a natural competitor.

Assessment Methods

Each alternative was assessed to determine the impacts of the actions on other wildlife species.

Primary steps for assessing impacts included identifying (1) the location of areas likely to be affected by the proposed alternatives and (2) potential changes in wildlife populations, habitat, or behavior from current and future elk and vegetation management actions. NPS management of wildlife is not based on single animals but rather focuses on the role of animal populations and species within the ecosystem (NPS 2006b). Therefore, the analysis and thresholds of impact intensity focus predominantly on the effects of management actions at the population level. The National Park Service recognizes that individuals within a population would be affected by management actions, and this is described in the analysis but without an associated intensity of effect. Impacts on individuals are described in the analysis, and those individual effects collectively contribute to population level effects.

To understand the effects of elk and vegetation management methods on other wildlife, park resource inventories and management plans, scientific literature, and published technical data were consulted to identify the information contained in this analysis.

Impact Threshold Definitions

Impacts intensity level thresholds were defined and evaluated as follows:

Negligible: Native wildlife species, their habitats, and the natural processes sustaining them would not be affected or the effects would be at or below the level of detection. Effects would be well within the range of natural fluctuations and would not be of any measurable or perceptible consequence to wildlife populations. Habitats would retain adequate ecological integrity to support native fish and wildlife species.

Minor: Effects on native species, their habitats, and the natural processes sustaining them would be detectable. Population numbers, structure, and other demographic factors may experience small changes, but the changes would not likely affect population viability. Habitats would retain adequate ecological integrity to support native fish and wildlife species.

Moderate: Effects on native species, their habitats, or the natural processes sustaining them would be readily detectable and likely have consequences at the population level. Population numbers, population structure, and other demographic factors for species may change, and the changes may affect the viability of a population. Habitats would retain adequate ecological integrity to support native fish and wildlife species.

Major: Effects on native species, their habitats, or the natural processes sustaining them would be easily detectable and would have consequences at the population level. Population numbers, structure (i.e., age or sex ratios), and other demographic factors would experience changes that would have an effect on the viability of a species. Habitats would be affected in a way that would change support for native wildlife.

Type of Impact

Beneficial impacts would result in wildlife populations whose size, density, and other population characteristics (e.g., age and sex ratios, survival, mortality, recruitment) would be within normal parameters and in ecological balance with other resources. Behavior, habitat**,** necessary resources, migration, or dispersal characteristics would be supported by the action in question.

Adverse impacts would cause wildlife populations to experience negative effects with respect to size, density, and other population characteristics, as identified above. The proposed action would restrict or limit behavior, habitat, necessary resources, migration, or dispersal characteristics.

Duration: Short-term impacts would allow recovery in less than one year. Long-term impacts would require one year or more for recovery.

Impairment

Impairment of wildlife resources or values would occur if a permanent major adverse effect on wildlife and habitats affected a large portion of the park. The effect would be highly noticeable, could not be mitigated, and would affect wildlife and habitats to the point that enjoyment of the wildlife and habitat resource by future generations of park visitors would be precluded.

Alternative 1

This alternative would continue the existing management framework. No new management actions would be applied, and the park elk population would continue to be regulated by natural, currently existing processes, primarily forage availability and weather conditions. Under this alternative, the elk population is expected to fluctuate between 2,200 and 3,100 animals, which would be outside the natural range of variation estimated to be optimal. No formal framework for management of vegetation associated with elk (i.e., forage, cover, dominant species in elk habitat) within the park would be developed.

Wildlife Habitat

Under Alternative 1, the elk population would continue to forage on the core winter range at densities that would have an adverse effect on montane riparian habitat. Reductions in water availability, in combination with continued intense elk browsing, is contributing to a decline or loss of montane riparian willow and an increase in grassland (Coughenour 2002, Peinetti et al. 2001). This trend would continue and result in a long-term, local-to-regional, minor-to-major adverse effect on other wildlife species that use montane riparian willow habitat. If breeding populations of wide-ranging species are affected, the impacts could extend regionally, although it is more likely that the effects would be local in the case of range-limited species such as amphibians and small mammals. Those generalist species that do not rely exclusively on montane riparian willow habitats would experience effects at the minor end of the range, while species that rely on montane riparian willow, such as beaver, would be adversely affected to a major degree.

Biodiversity, including the ecological processes associated with the complement of species present (e.g., niche occupation, foraging effects on primary productivity), would experience a long-term, local-to-park-wide, moderate, adverse effect as a result of habitat changes associated with Alternative 1. The adverse effect is primarily related to degradation of montane riparian willow and aspen communities in high-use areas on the elk primary winter range and in the Kawuneeche Valley. The changes of the montane riparian willow and aspen communities in these areas (see the "Vegetation" section for more detail about conditions in those communities) no longer provide for all the resource needs of a full complement of species associated with these habitat types (e.g., reduction in nesting habitat for songbirds, lack of vegetation to support butterfly species, insufficient forage for beaver).

Currently, fenced research exclosures limit habitat availability for wildlife in approximately 12 acres. This represents a long-term, local, negligible, adverse effect on large wildlife species whose movements are restricted by the fences as a result of loss of habitat. Small mammals, birds, amphibians, and insects that can easily move through the fences would not be affected.

Ungulates

Competition with elk for forage and habitat can restrict the population size and distribution of other ungulates (i.e., mule deer, bighorn sheep, moose) in the park (Coughenour 2002). In particular, competition with elk may be limiting the availability of browse for mule deer (Hobbs et al. 1996a, Hobbs et al. 1996b, CDOW 1999), resulting in a park-wide, long-term, moderate, adverse effect on deer.

Competition between elk and bighorn sheep is limited and does not likely affect bighorn to an appreciable degree, although elk are capable of displacing sheep from preferred foraging areas in the park (Goodson 1978). Such displacement could result in long-term, local, negligible adverse effects on bighorn sheep if sheep are restricted from preferred foraging grounds.

There is uncertainty regarding the potential impact of elk on moose. The species do share common diet items, and they share foraging habitat in summer, especially in the Kawuneeche Valley. However, the historical presence of moose and their ecological role within the park is not well understood (Monello et al. 2005). Competition between elk and moose for habitat and forage does occur, but more research is necessary to determine the ultimate effects of continuing current elk management on moose. Studies in other locations have shown that moose are not tolerant of large groups of elk and maintain separation in their distribution (Peek and Lovaas 1968, Jenkins and Wright 1987). This would be true in Rocky Mountain National Park only if summer forage is a limiting factor.

High concentrations of elk would likely contribute to direct intraspecific, and potential interspecific environmental transmission (Miller et al. 2004) of chronic wasting disease to deer or moose. This would represent a long-term, park-wide, minor-to-moderate, adverse effect on ungulates susceptible to chronic wasting disease.

Predators and Scavengers

The effects of elk and vegetation management actions on mountain lion, black bear, coyote, red fox, bobcat, common raven, black-billed magpie, turkey vulture, and other carnivorous species and scavengers are addressed in this subsection.

The current elk population in the park provides prey for the mountain lion, although the lion’s preferred prey is mule deer (Hornocker 1970, Kunkel et al. 1999). The availability of elk as a prey item with a large, easily located population represents a negligible-to-minor, long-term, regional benefit to the mountain lion.

Black bears are omnivorous and primarily scavenge elk although they are capable of taking live elk calves (Knight et al. 1999, Smith and Anderson 1996). Research has not found elk to be a part of the black bear diet in the park (Zeigenfuss 2001). As a result, current management of elk and vegetation would not have an effect on black bear.

Coyotes are abundant in the park and eat a mixed diet, with small mammals predominant, but the coyote diet does include birds, carrion, and large mammals (Nowak 1991). In a study of elk calf mortality in the park and the vicinity of Estes Park, Bear (1989) reported that 17% of calf mortality could be attributed to coyote predation. While the presence of a large elk population appears to benefit the coyote in the form of an easily accessible prey source, the decline or loss of willow habitat in the core winter range has affected small mammal and songbird populations as willow habitat has been converted to grassland. In combination these would result in no net effect.

Red foxes would be affected in similar fashion because of the adverse effect on small mammal and bird populations. The impact of continuing current management would likely have a negligible adverse effect on the red fox.

Although a bobcat may occasionally take an elk calf or an unhealthy adult elk, it is neither typical nor likely. The bobcat's preferred diet consists of small mammals, such as rabbits and rodents, and birds. Although the reduced populations of small mammals and songbirds as a result of habitat changes in the montane riparian willow community could have a long-term adverse affect on prey availability for the bobcat, the effect would likely be local and negligible.

Scavengers rely on carrion as a primary diet item. The relatively high elk population in the park winter core range provides numerous carcasses for bears, coyotes, ravens, black-billed magpies, turkey vultures, jays, and other species that consume carrion. The continued high elk population in the park would represent a long-term, regional, minor benefit to scavenger species' populations as a result of an easily available food source.

Small Mammals

The high elk population and high rates of herbivory, in combination with a lower water table and less aquatic habitat in areas where montane riparian communities once thrived, has caused a shift in small mammal populations. Generally, specialist species that make use of wetlands and montane riparian habitats have been displaced by species that rely more on grassland habitat as community types have changed. The change in community type as a result of elk foraging has reduced the structural complexity of available habitat and in turn reduced available resting, breeding, and hiding cover for small mammals (Medin and Clary 1989, Medin and Clary 1990b). This would represent a long-term, local, minor, adverse effect on small mammals.

Beaver

The effects on beaver are addressed here separately from other mammals because of the interactions between beaver, elk, willow, and hydrology on the elk primary winter range and the Kawuneeche Valley, and because of the beaver's role as a keystone species (Naiman et al. 1988). The relationships between elk and beaver, or more specifically, the lack of beaver in the elk primary winter range, have contributed, in part, to the ongoing changes and degradation of the willow community (Baker et al. 2005). The low beaver population in the park has reduced the ecosystem manipulation effects typically associated with beaver (i.e., dams, ponds, and elevated water table) that has in turn led to a reduction in suitable willow habitat. At the same time, high elk densities in the core winter range and the associated high rates of willow herbivory by elk have limited willow availability for beaver. This has led to a negative feedback loop where continued high elk densities inhibit the potential for the beaver population to rebound from past effects of trapping (Baker et al. 2005). The effect of continued high elk densities and high rates of willow and aspen herbivory by elk on beaver would be long term, local, moderate to major, and adverse.

Birds

Avian species affected by elk and vegetation management activities are grouped into the following categories to facilitate the discussion of effects: white-tailed ptarmigan, raptors, songbirds and cavity nesters, and waterfowl/shorebirds.

Continued limitations on aspen regeneration and a conversion of willow habitats from mixed tall and short willow to predominantly short willow would result in a local-to-regional, long-term, moderate adverse effect on avian biodiversity. Once again, the extent of the effect would depend on the range of the species affected and its degree of reliance on aspen and willow. This effect is primarily related to the decline or loss of habitat and habitat structure. In the case of aspen, as stands age without regeneration, the proportion of dead trees to live ones increases, with a commensurate loss of preferred cavity-nesting habitat (Zaninelli and Leukering 1998; Duberstein 2001). As willow stands become shorter, avian species that typically prefer a mix of tall and short willow structure would be adversely affected (Zaninelli and Leukering 1998, Leukering and Carter 1999, Duberstein 2001).

White-tailed Ptarmigan could be affected by high elk populations and a continuation of current management if elk herbivory limits the forage available to ptarmigan in alpine habitats as postulated by Braun et al. (1991). This would represent a long-term, local, minor-to-moderate, adverse effect on the ptarmigan population in the park. However, Wang (2002a) reports that fluctuations in ptarmigan populations in the park are a result of local weather patterns rather than effects of competition with elk. Based on the later research, there may be no direct effect of continued elk populations on ptarmigan. Additional research is necessary to determine the potential future effects of current elk management on ptarmigan populations in the park.

Raptors, including several species of hawks, accipiters, owls, and eagles, would primarily be affected by elk and vegetation management activities as a result of actions that affect their prey base. In addition, improvements in habitat would provide increased roosting and nesting habitat for small owls, particularly those in aspen. The most common prey items for raptors include small mammals and songbirds, with a low incidence of scavenging on carrion in the park by bald and golden eagles. As a result of the changes in habitat structure, the conversion of montane riparian willow habitat to grassland would benefit raptors that prey on small mammals. Foraging would be more efficient in open grassland compared to dense willow thickets. This would represent a long-term, local, negligible-to-minor benefit for raptors preying on small mammals that use grassland habitats. On the other hand, accipiters that prey on birds, especially songbirds that nest or use willow habitats, would experience a long-term, local, minor-to-moderate, adverse effect because their prey base would be reduced as the result of the continued degradation and conversion of montane riparian willow habitat. Scavenging raptors, including bald and golden eagles, would continue to find carrion in the park, resulting in a long-term, local-to-park-wide, minor benefit.

Songbirds and cavity nesting birds use aspen, montane riparian willow, and ponderosa pine habitat in the park (Connor 1993, Turchi et al. 1994), with montane riparian willow habitat having high avian species diversity compared to its areal extent (less than 4% of the park). Leukering and Carter (1999) found that different bird species in the park used different sizes and densities of willow, indicating that short and tall willow are both important. Bird species richness is especially high in aspen (Turchi et al. 1994), and Zaninelli and Leukering (1998) and Duberstein (2001) suggested live aspen trees are more important to cavity nesting birds than dead aspen, and that different bird species used different sizes and densities of aspen. The conversion of tall willow to short willow, and the concurrent change from willow community to grassland associated with continued high elk foraging rates (and in combination with a lower water table) has an adverse effect on bird species richness and abundances for the species that rely on montane riparian willow habitat for breeding, foraging, and roosting (Medin and Clary 1990b). Additionally, conditions in aspen, where regeneration is restricted by elk foraging and the age distribution of trees has shifted toward older trees, would also contribute to some loss of potential habitat for songbirds and cavity nesting species that prefer aspen. These adverse effects on songbirds and cavity nesting birds and their supporting habitat would be long term, local, and moderate to major.

Waterfowl and shorebirds rely on aquatic and montane riparian habitats during much of their life history (Terres 1980). The effects of a depressed beaver population and the commensurate decrease in beaver ponds, high elk foraging rates, and a conversion of montane riparian willow habitat to grassland all contribute to a decline or loss of habitat for waterfowl and shorebirds in the core winter elk range and may result in an increase in predation of nests due to a decline or loss of cover. This represents a long-term, local, minor-to-moderate, adverse impact on waterfowl and shorebirds.

Upland shrub birds would be affected by current management of elk and vegetation to the degree that elk herbivory, combined with foraging by other ungulates, primarily mule deer, affects the integrity of upland shrub habitat. Singer et al. (2002) found that annual herbaceous consumption rates in upland shrub communities averaged 60%, which has the potential to alter herbaceous communities in the park. As a result, because of changes to upland shrub communities, there would be long-term, local, minor-to-moderate, adverse effects on bird species that rely on that habitat.

Fish

The continued degradation of montane riparian willow habitat would affect aquatic habitat that supports several trout species, primarily on the elk primary winter range where the impacts on montane riparian willow habitat are greatest, although the effects would likely occur in the elk primary summer range in the Kawuneeche Valley as well. The decline or loss of montane riparian willow cover along waterways can raise stream temperature, reduce litterfall, and contribute to streambank erosion, all of which would adversely affect fish species inhabiting creeks and rivers in the elk primary winter and summer ranges (Schulz and Leininger 1990, Fleischner 1994). These adverse effects would be long term, local, and minor.

Amphibians and Reptiles

The loss and conversion of wetland, aquatic, and riparian habitats to habitats (i.e., grassland or upland) would continue under current management. The lowered water table, partly a result of the depressed beaver population, and continued high levels of elk foraging would contribute to these habitat losses and conversions. Each of these habitat types provide the resources that amphibian species rely on. The effects on amphibian habitat would represent a long-term, local, moderate, adverse effect on amphibians in the elk range. Physical impacts on individual amphibians could include trampling as a result of high elk densities in wetlands and riparian habitats.

Continuing current management would affect montane riparian habitat as described above. As a result, the only reptile species in the park, the Western terrestrial garter snake, would experience long-term, local, minor, adverse effects as a result of habitat loss and conversion.

Butterflies

The continued degradation of montane riparian willow habitat, conversion of willow to grassland, and the adverse impacts high levels of elk herbivory on aspen would result in a long-term, local, minor-to-moderate, adverse effect on butterflies. Butterfly species diversity, richness, and uniqueness would likely decline as a result of the habitat changes that continue to take place in aspen and willow (Simonson et al. 2001).

Cumulative Impacts

In recent years, low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned. Wildlife vary in their responses to noises, but it can negatively affect many species through changes in behavior and physiological effects (USAF and USFWS 1988). These bans represent a long-term, regional, minor, beneficial effect for wildlife.

A number of actions in the park and on adjacent lands are targeted on improving forest health by controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. These activities would adversely affect wildlife as a result of temporary displacement and short-term alteration of wildlife habitat, representing a short-term, minor, adverse effect. With mitigation measures in place, some, but not all, snags would be left in place for cavity nesters, resulting in a long-term, minor, adverse effect. However, overall, these actions would result in long-term, minor, beneficial effects on wildlife, as a result of improved habitat.

A series of construction and trail projects would temporarily displace wildlife and permanently remove relatively small portions of habitat. The effects of these projects would be both short term, minor, and adverse and long term, negligible, and adverse.

Management plans for protecting the park's natural resources would benefit wildlife, by maintaining and restoring natural conditions and limiting intrusive activities. Effects associated with these management plans would be long term, minor-to-moderate, and beneficial. Restoring vegetative communities and removing exotic plants in the park would also enhance wildlife habitat, a long-term, minor, beneficial effect on wildlife. Although some bird species may use exotic species (e.g., songbird use of thistle seed), control of exotic plant species would restore ecosystem integrity and provide a cumulative benefit.

Restoration of a native fish species in the park would reduce non-native species and enhance aquatic habitats in the long term, a minor-to-moderate benefit, but would also potentially involve the use of piscicides, which could remove aquatic life in short reaches of streams, resulting in a short-term, moderate, adverse effect.

Activities outside the park also affect wildlife species within the park, as individuals outside can be part of the same population as those within the park. Development in the Estes Valley and in other areas outside the park would continue to fragment and reduce wildlife habitat outside the park, a long-term, regional, moderate-to-major, adverse effect. Hunting and fishing outside of the park would continue to be managed so that habitat conditions are not degraded by overpopulation of species that may grow in the absence of predators. Game management outside the park would help maintain habitat quality for wildlife populations that share habitat inside and outside the park and would represent a long-term, regional, minor-to-moderate benefit for wildlife.

Alternative 1 would generally contribute long-term, moderate, adverse effects on the cumulative impacts on wildlife as a result of adverse effects on habitats affected by elk. In general, over the area addressed in this plan, the cumulative effects on wildlife from these other plans, projects, and actions and from Alternative 1 would be short-term and long-term, regional, minor-to-moderate, and adverse, primarily as a result of changes to, and losses of, wildlife habitat.

Conclusion

Wildlife species on the elk primary winter and summer ranges in Rocky Mountain National Park would be affected by Alternative 1 in various ways and degrees. Effects would vary extensively depending on species and locations. The most common and widespread effect within the core winter range would be related to loss of and changes to montane riparian willow and aspen communities and the wildlife habitat resources in those communities. These adverse effects would be expected to continue into the future under Alternative 1.

The range of adverse effects associated with habitat changes would be negligible for bighorn sheep, moose, and bobcat; minor for most small mammals, and fish; minor to moderate for mule deer, butterflies, upland shrub birds, waterfowl and shorebirds; moderate for amphibians and reptiles; and moderate to major for beaver and for songbirds and cavity nesters. Adverse effects associated with forage competition between elk and white-tailed ptarmigan may occur at a minor-to-moderate intensity; however, some research indicates that ptarmigan populations are not affected by elk herbivory and that other factors (e.g., weather) may be more decisive in regulating ptarmigan populations.

Beneficial effects on wildlife that result from continuing current management would range from negligible to minor for mountain lions and for raptors that forage in grasslands to minor for scavenger species that rely on carrion, including bald and golden eagles.

The small scale of the long-term, moderate, adverse effects of Alternative 1 would have little effect on the overall short- and long-term, minor, adverse, cumulative effects on wildlife that would occur under Alternative 1.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 1.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of implementing Alternative 1 are summarized in Table 4.1.

TABLE 4.1: SUMMARY OF IMPACTS OF ALTERNATIVE 1 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Mule deer	Adverse	Moderate
Moose	Adverse	Negligible
Bighorn sheep	Adverse	Negligible
Mountain lion	Beneficial	Negligible to minor
Coyote	No effect	No effect
Red fox	Adverse	Negligible
Black bear	No effect	No effect
Bobcat	Adverse	Negligible
Scavengers	Beneficial	Minor

TABLE 4.1: SUMMARY OF IMPACTS OF ALTERNATIVE 1 FOR WILDLIFE (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Small mammals (most)	Adverse	Minor
Beaver	Adverse	Moderate to major
Ptarmigan	Adverse (uncertain)	Minor to moderate (uncertain)
Songbirds	Adverse	Moderate to major
Cavity nesting birds	Adverse	Moderate to major
Raptors	Adverse (accipiters) Beneficial	Minor to moderate Negligible to minor
Waterfowl and shorebirds	Adverse	Minor to moderate
Upland shrub birds	Adverse	Minor to Moderate
Fish	Adverse	Minor
Amphibians and reptiles	Adverse	Minor to moderate
Butterflies	Adverse	Minor to moderate

Alternative 2

Alternative 2 would involve agency removal of elk using lethal means, with aggressive reduction targets within the first four years of the plan to quickly reduce the size of the population, followed by less intensive yearly reductions to maintain target populations. The target elk population would fluctuate between 1,200 to 1,700 elk, which is on the lower end of the natural range of variation of 1,200 to 2,100 elk. Up to 160 acres of aspen (105 acres in winter elk range and 55 acres in summer elk range) would be fenced in a phased manner as needed based on monitoring of vegetation response to protect the stands from elk herbivory and to allow regeneration of aspen. Elk redistribution techniques would be used to better attain vegetation restoration objectives, primarily in montane riparian willow communities, by dispersing locally high concentrations of elk. A research study would be undertaken in the first three years of the plan to evaluate procedures for testing live elk for chronic wasting disease.

Wildlife Habitat

Fencing aspen in elk primary winter and summer ranges would represent a moderate, local, long-term benefit to wildlife as the reduction of elk herbivory would allow aspen to regenerate and would restore the diversity of tree size in aspen stands. The proportion of live to dead aspen trees would increase as new trees regenerate. This diversity is important to avian species (Zaninelli and Leukering 1998, Duberstein 2001) that use aspen for cavity nesting as well as species that forage and nest in the canopies of aspen trees. Moose access to the fenced aspen stands on the primary summer range would be restricted by the fences, resulting in a long-term, local, negligible adverse effect on moose, as some preferred foraging areas would not be available. Redistribution actions that would target concentrations of elk have some potential to negatively affect individuals of other wildlife, but the disturbance would be short term and localized. Redistribution actions would be restricted during known sensitive portions of species' life cycles or in sensitive locations (e.g., breeding or nesting seasons, migration corridors, nesting habitat) to avoid and minimize potential adverse effects.

Biodiversity would experience a long-term, local, moderate-to-major benefit as a result of habitat restoration, particularly in aspen and willow communities.

The use of a capture facility to round up large numbers of elk for lethal reduction would require baiting or herding to get the elk into the facility. Herding could be accomplished using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices (such as sticks with streamers), or helicopters as an adaptive tool if necessary. The noise generated by these activities would negatively affect individuals of other wildlife species. The adverse effect of the capture facility on wildlife habitat would be short term, local, and up to minor, depending on the specific location and the habitat affected.

Wildlife would be affected by helicopter overflights that would transport fence material into the park, although wildlife would be expected to return to pre-disturbance numbers once the disturbance ends. This disturbance would represent a short-term, negative effect on wildlife species within the area of activity.

The research activities associated with evaluating procedures to test for chronic wasting disease in live elk would involve the capture or darting, anesthetizing, and handling of elk, which would be conducted in coordination with elk management activities and would have effects on wildlife similar to those associated with lethal control through darting. Wildlife would be disturbed as a result of noise associated with human presence and activities to capture, mark, test, and treat elk. These activities would have short-term, negative effects on individuals of a species but would not have effects at the population level. Research activities may also be accomplished when elk are captured through use of a capture facility or corral trap during elk management activities.

Ungulates

The aggressive reductions in the elk population during the first four years of this alternative would likely result in an increase in the mule deer population as a result of reduced competition (Coughenour 2002, Stevens 1980a) with elk. There would be a number of years before the reaction in the deer population would be fully realized and during the life of the plan, there would be a point when there would be no adverse effects on mule deer as the the forage base for deer would improve and competition for forage would be lessened. However as forage continues to improve, particularly in upland shrub communities, the deer population would increase to a level that would eventually result in overuse of forage and increased intraspecific competition. In the long-term, larger deer populations and higher densities would contribute to an increased risk of transmission for chronic wasting disease. This would represent a long-term, park-wide, minor-to-moderate adverse effect on the mule deer population. Redistribution actions that would target concentrations of elk have some potential to adversely affect mule deer, but the disturbance would be short-term, local, and negligible to minor. The effects on deer would not be substantial because mule-deer-preferred habitat would not likely be targeted by redistribution efforts.

Although the level of competition between elk and moose is not completely understood, it is likely that a substantially reduced elk population and an accompanying reduction in foraging in montane riparian willow habitat would improve the amount and quality of willow forage. This would result in a long-term, local, minor benefit to moose.

Redistribution actions taken to reduce concentrations of elk have the potential to affect moose. Although redistribution techniques would target high concentrations of elk, the actions may inadvertently affect moose because they may share montane riparian habitats with elk, particularly in the elk primary summer range. Similarly, lethal control actions could affect moose because of the presence of control personnel and the activities. If helicopters were needed to facilitate removal of carcasses from remote locations due to disease management concerns, the negative effect on moose would be short term and would occur over a wider area than what would be affected by ground crews only. These activities would result in short-term, negative effects while the activities were occurring.

Generally, competition between elk and bighorn sheep is minimal with respect to the use of range and in terms of each species' preferred forage (Capp 1967, Capp 1968, Harrington 1978, Singer et al. 2002). However, the elk population has grown considerably since Capp and Harrington's research, and Goodson (1978) did report that elk can displace bighorn sheep from preferred foraging areas. As a result, large and relatively quick (i.e., in the first four years) reductions in the elk population associated with Alternative 2 would benefit bighorn sheep in a long-term, local, negligible manner.

Lethal control activities, as well as redistribution techniques to disperse high concentrations of elk, would not take place in areas where bighorn sheep are present. Because sheep are relatively sensitive to disturbance, and other factors such as disease increase sheep's susceptibility to adverse effects of disturbance, lethal control and redistribution actions targeting elk could have negative effects on individual sheep. After the first four years, the potential for control activities to have negative effects on individual sheep would decrease incrementally as the magnitude of lethal elk control declined to maintenance levels.

If the intense elk reduction actions require the use of corral traps, there could be negative effects on bighorn sheep as a result of baiting techniques used to attract elk to the traps. These potential negative effects would be mitigated by limiting the baiting locations to avoid areas known to be frequented by bighorn sheep, and implementing lethal elk reduction actions quickly to minimize the number of days that bait would be used. This potential for negative effects would only exist during the first four years of the plan, as reduction efforts would not likely need traps during the maintenance phase (years five through 20) of the plan.

Fences around aspen stands would have a long-term (for the duration of this plan or as long as fences remain), local, negligible-to-minor, adverse effect on moose, and possibly bighorn sheep, if they have difficulties passing under the lowest strand of wire, because areas that contain preferred forage or habitat may be inaccessible.

Predators and Scavengers

The large and relatively rapid reduction in the size of the elk population associated with Alternative 2 would likely result in an increase of the mule deer population over time as competition between deer and elk declined. This would provide an increased deer prey base for individual mountain lions with territories in the park and result in a long-term, local-to-park-wide, negligible benefit to the mountain lion population, as deer would be easier for lions to prey on than elk. This benefit could be offset by a reduction in the prey base for those mountain lions that have come to rely on elk as a substantial portion of their diet, although the availability of habitat likely has more effect on mountain lion populations when prey is abundant (Hunter 2005), as is the case in the park. On balance, the elk reductions would offset the increase in deer, resulting in no effect with regard to prey availability for mountain lions in the park. However, the general improvement in habitat across the elk primary winter and summer ranges would provide some benefit to mountain lions and result in a long-term, local-to-park-wide, negligible benefit. The presence of fences around aspen stands would not have an appreciable effect on the mountain lion, nor would lethal reduction activities, because of the lion's wide-ranging nature and the low lion densities in the park.

Black bear would not be affected by the reduction in elk in terms of prey availability, although lethal reduction activities could disturb individual bears and result in temporary displacement from habitat. There could be a long-term, local, negligible-to-minor benefit to bears as a result of an increase in carrion as elk calf carcasses would be left in the field following lethal reductions. As the intensity of lethal reduction activities would decrease after year four, the effects of disturbance (adverse) would diminish to a negligible level.

Red fox would experience a range of effects as a result of the implementation of Alternative 2. With the restoration of montane riparian willow habitat, there would likely be more foraging opportunities for foxes, as the willow habitat would likely support more small mammal and bird species than grasslands. This would have a long-term, local, minor benefit for these predators. There could be offsetting adverse effects if increased prey availability results in an increase in coyote populations because of competition between the species. An increase in carrion as a result of intensive lethal reduction actions would have a local, minor benefit for the red fox and other scavenger populations during the first four years of the plan. The benefit would become undetectable after the first four years of the plan, as lethal control actions to maintain the elk population at target levels would decrease substantially. An increase in foraging opportunities with the restoration of montane riparian willow habitat and an increase in available carrion in the first four years of the plan as described above could result in an increase in the coyote population. This increase in population, however, could be outside the range of natural conditions expected in the presence of a natural competitor (wolves) and therefore would represent a long-term, local, minor, adverse impact.

Small mammal prey in restored montane riparian willow habitat would have a long-term, local, negligible benefit for bobcat because the species diversity and availability of structural cover would likely increase foraging opportunities.

Scavengers rely on carrion as a primary diet item. The elk population provides carcasses for bears, ravens, black-billed magpies, turkey vultures, jays, and other species that consume carrion. Leaving some elk carcasses in the field would represent a long-term, park-wide, minor benefit to scavenger species' populations as a result of an easily available food source.

Small Mammals

Small mammal populations other than those that use grasslands would benefit from the restoration of montane riparian willow habitat as more vegetation and structural diversity would provide additional cover for hiding, resting, and breeding. This would result in long-term, local, minor benefits for small mammals. Fencing of aspen and lethal elk reduction activities would not likely have an effect on small mammals.

Beaver

The relatively rapid reduction in elk population would aid in achieving the vegetation restoration objectives of the management plan. As montane riparian willow habitat in the elk primary winter range recovers, recovery of the beaver population would be possible, either as a natural process (albeit slow as beaver reproduction rates are slow) or by reintroduction of beaver when at least 10 acres of restored willow has been sustained for two seasons. This would represent a long-term, local, moderate benefit for beaver. Likewise, an increase in the beaver population and their alteration of aquatic, wetland, and montane riparian habitats would result in long-term, local, minor-to-moderate benefits for wildlife species associated with those habitats.

Birds

In general, fences around aspen could potentially negatively affect individual birds as a result of collisions and entanglement.

White-tailed ptarmigan would experience a long-term, local, minor-to-moderate benefit as a result of the reduced elk population. The benefit would be associated with a reduction in competition for forage on alpine habitat. This beneficial effect may be undetectable if competition for forage between elk and ptarmigan is not an important factor as a population-regulating mechanism for ptarmigan (Wang 2002a).

Raptors would benefit from the reduction in elk population indirectly, as the restoration of montane riparian willow habitat would contribute to a more natural and complete ecosystem. The restoration of montane riparian willow habitat would enhance diversity and robustness of potential prey populations. Although foraging may be more challenging in the more structurally complex willow habitat than in grassland, the overall improvement in prey species diversity and richness would be a long-term, local, minor-to-moderate benefit for raptors.

Scavenging raptors, including bald and golden eagles, would benefit from some carcasses left in the field as a result of lethal elk reduction actions; the benefit would be long term, local to park-wide, and minor.

Songbirds and cavity nesting birds would benefit from the restoration of montane riparian willow habitat as elk herbivory would decrease with the intensive elk population reductions. The fencing of aspen would, over time, allow regeneration of aspen and a more even distribution of age classes that would benefit cavity nesting birds that prefer live aspen trees (Zaninelli and Leukering 1998, Duberstein 2001). The increases in availability of habitat as willow communities recover would represent a long-term, local, moderate-to-major benefit to songbirds. Similarly, the benefits to cavity nesting birds would also be long-term, local, and moderate to major as the proportion of live to dead trees would increase in aspen stands as a result of regeneration.

Waterfowl and shorebirds that rely on aquatic and montane riparian habitats during much of their life history would benefit from the restoration of montane riparian willow habitat and the eventual recovery or reintroduction of beaver. A recovered beaver population would increase the areal extent of ponds and of aquatic and montane riparian habitat, providing more breeding and foraging habitat. The benefits would be long term, local, and minor to moderate.

Upland shrub birds would be affected under Alternative 2 by levels of elk herbivory, combined with foraging by other ungulates, primarily mule deer, and the resulting effect on upland shrub habitat. In the short-term, the reduction in elk foraging pressure may have a minor, local beneficial effect on upland shrub habitat and the bird species that rely on that habitat because of reduced foraging pressure. However, a reduction in the size and density of the elk population would likely result in an increase in the deer population. This could, in turn, increase herbivory pressure on upland shrub habitat, likely causing a long-term, local, minor-to-moderate, adverse effect on upland bird species. This effect may not occur during the initial stages of management, as the increase in the deer population may be delayed.

Fish

Restoration of montane riparian willow along the streams in the core winter elk range would lower stream temperatures, provide additional cover (which may decrease sediment in streams), and stabilize banks. These effects would represent a long-term, local, minor benefit to fish as the habitat variables would be better suited to the life history needs of native fish species.

Amphibians and Reptiles

The restoration of montane riparian willow habitat and eventual recovery or reintroduction of beaver would enhance aquatic, wetland, and montane riparian habitat. This would represent a long-term, local, minor-to-moderate benefit for amphibians and the Western terrestrial garter snake, the only reptile species in the park. These benefits would accrue as a result of increased habitat and resources that these species rely on.

Butterflies

Management actions associated with Alternative 2 would increase plant species richness in aspen and riparian herbaceous communities. This increase would lead to a corresponding increase in the diversity and species richness of butterflies. Restoration of willow communities also would provide additional foraging opportunities for butterflies. These effects would be long term, local, and moderately beneficial for butterflies.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife would be the same as described for Alternative 1: short- and long-term, moderate, and adverse. Overall other wildlife populations are affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, forest management activities, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to wildlife populations; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Some of Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial, while others would be short term, moderate, and adverse. The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would continue to be long-term, moderate, and adverse.

Conclusion

Relative to Alternative 1 (future baseline condition), this alternative would have the following effects on wildlife resources.

Wildlife species on the elk primary winter and summer ranges in Rocky Mountain National Park would be affected by Alternative 2 in numerous ways and to varying degrees. The most common effects would be related to restoration of montane riparian willow, aquatic, wetland, and aspen communities.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, localized, negative effect on individuals of wildlife species in the area of activity.

Negative effects associated with lethal elk reduction actions and carcass removal would result in short-term impacts on wildlife in the form of potential disturbance and temporary displacement. Additional long-term, local, negligible-to-minor adverse effects would be associated with fences around aspen stands for moose and possibly bighorn sheep. Minor-to-moderate, adverse effects on mule deer and upland shrub birds would be associated with increases in the deer population. The adaptive use of helicopters to remove elk carcasses due to disease management concerns would have negative effects on individuals of all wildlife species in the vicinity of operations during the first four years of the plan.

Restored habitats would benefit wildlife species, with the magnitude of the benefits being negligible for bighorn sheep, mountain lion, and bobcat; negligible to minor for black bear; minor for moose, red fox, scavengers, small mammals, raptors, upland shrub birds, and fish; minor to moderate for ptarmigan, waterfowl and shorebirds, and amphibians and reptiles; moderate for beaver and butterflies; and moderate to major for songbirds and cavity nesters. There would be minor adverse effects on coyotes as the population would increase outside of natural conditions as result of increased prey and carrion.

Research activities done in concert with elk management actions would negatively affect individuals of wildlife species while activities were taking place but would not have population level effects. Use of a capture facility under this alternative for elk management activities would have up-to-minor adverse effects on wildlife habitat.

The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would continue to be long-term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 2.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of implementing Alternative 2 are summarized in Table 4.2.

TABLE 4.2: SUMMARY OF IMPACTS OF ALTERNATIVE 2 FOR OTHER WILDLIFE SPECIES

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Biodiversity	Beneficial	Moderate to major
Mule deer	Adverse	Minor to moderate
Moose	Adverse (aspen fencing, reduction and redistribution actions) Beneficial (habitat restoration)	Negligible to minor Minor
Bighorn sheep	Beneficial (habitat restoration)	Negligible
Mountain lion	Beneficial	Negligible
Red fox	Beneficial	Minor
Coyote	Adverse	Minor
Black bear	Beneficial	Negligible to minor

TABLE 4.2: SUMMARY OF IMPACTS OF ALTERNATIVE 2 FOR OTHER WILDLIFE SPECIES (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Minor
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer in long-term) Beneficial (reduced elk in short-term)	Minor to Moderate Minor
Fish	Beneficial	Minor
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Moderate

Alternative 3

Alternative 3 relies on gradual lethal reduction of elk over time to regulate the elk population and its distribution. Because this alternative would maintain the elk population at the higher end (1,600 to 2,100 elk) of the natural range of elk population variation (1,200 to 2,100), up to 260 acres of fencing would be installed in montane riparian willow communities on the primary winter range and 180 acres on the primary summer range. Fence installation would be done in a phased approach commensurate with elk reductions, and elk redistribution techniques would be used to a greater degree to support vegetation restoration objectives outside fenced areas. Aspen would be fenced as in all action alternatives (up to 160 acres). A research study would be undertaken in the first three years of the plan to evaluate procedures for testing live elk for chronic wasting disease and evaluating the efficacy of a fertility control agent in free-ranging elk.

Wildlife Habitat

The installation of fencing in montane riparian willow communities and in areas where willow communities would have the potential to become reestablished would restrict access to preferred foraging areas for elk and moose. The fence design would allow other species, including deer, to pass under the fence, thus having only a short-term, local, minor, adverse effect on most wildlife species as a result of potential problems in passing under the fence or possible entanglement. Fencing in willow habitat would represent a long-term, local, minor, adverse effect for moose because they would need to find other suitable areas to forage. However, the ultimate effect would result in range-wide, negligible benefits for moose as fencing was removed and willow habitat was restored in the park.

Redistribution actions would be restricted during known sensitive portions of species' life cycles or in sensitive locations (e.g., breeding or nesting seasons, migration corridors, nesting habitat) to avoid and minimize potential adverse effects. Redistribution actions targeting concentrations of elk would be used to a greater degree than in Alternative 2 because the target elk population would be larger. These actions have the potential to adversely affect all other wildlife, but the disturbances would be short-term, local, and minor and only incrementally greater that the effects described for Alternative 2.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, negative effect on individual animals in areas of activity.

The research activities associated with evaluating procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent would be conducted within the framework of this alternative and would have effects similar to those described in Alternative 2. The administration of a fertility control agent to a small number of female elk by hand injection would have no effect on non-target animals.

General Effects of Alternative 3 on Wildlife

Lethal reduction of the elk population to the higher end of the range of natural variation would have effects on ungulates in the park similar to but incrementally less than Alternative 2 because of the less intense nature of the operations. Fewer crews would be needed to implement the reduction, and the effects of carcass removal would be substantially reduced. Ultimately, the negative effect of elk reduction actions on individuals of other wildlife species would be short term and localized. Unlike Alternative 2, the effects would not diminish after four years because the reduction actions would continue at the same level throughout the 20-year life of the plan. Helicopters would not likely be used because the number of carcasses to be removed could be handled using teams on the ground; however if due to disease management concerns it is found necessary to remove carcasses from remote locations, the impacts of helicopters on wildlife would be as described in Alternative 2.

Effects on bighorn sheep would be similar to those described for Alternative 2, although the lower elk reduction targets would cause a slightly smaller benefit with respect to lessened competition with elk for habitat. A capture facility would not likely be used to capture elk; thus, there would be no effect on bighorn sheep from baiting or to other wildlife from herding activities.

Fencing in willow habitat would represent a long-term, local, minor, adverse effect for moose because they would need to find other suitable areas to forage. However, the ultimate effect would result in park-wide, negligible benefits for moose when fencing was removed and the willow habitat restoration objective was achieved.

The effects of aspen fencing on wildlife would be the same as described for Alternative 2, as would the effects of fences around willow communities on avian species as a result of the potential for entanglement and collisions.

The effects of moderate lethal elk reductions and a corresponding increase in the deer population would have effects on the mountain lion similar to those described for Alternative 2. There would still be an adequate prey base for the lion and there would likely be no direct effect on the mountain lion, although the restoration of montane riparian habitat would represent a long-term, local, negligible benefit.

The overall effects of Alternative 3 on black bear, coyote, red fox, bobcat, other predators and scavengers, beaver, small mammals, ptarmigan, songbirds, cavity nesting birds, raptors, upland shrub birds, fish, amphibians, and reptiles would be similar to but incrementally less than those described for Alternative 2. This slightly lower increment would apply to adverse impacts as well as benefits, because while lethal elk reduction actions and the associated impacts would not be as intense or great, the degree of vegetation and habitat restoration would be neither as large nor as quick as under Alternative 2.

Exceptions to the similarity to Alternative 2 would be inside fenced areas of willow habitat, where the elimination of elk foraging would rapidly support vegetation restoration and quickly provide long-term, local, minor-to-moderate benefits to species reliant on and strongly associated with montane riparian willow habitat. Also, the beneficial effects on butterflies would be long term, local, and minor to moderate as overall willow habitat improvement would not be as widespread as under Alternative 2. Similarly, the benefits to waterfowl and shorebirds would be long-term, local, and minor to moderate as the amount of new aquatic, wetland, and montane riparian habitat created and the speed of the restoration would not be as great as under Alternative 2.

Biodiversity, measured using species richness parameters and including the ecological processes associated with the complement of species present (e.g., niche occupation, foraging effects on primary productivity, interactions between species), would experience a long-term, local-to-park-wide, moderate benefit as a result of habitat restoration, particularly in aspen and willow communities.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife would be the same as described for Alternative 1: short- and long-term, moderate, and adverse. Overall other wildlife populations are affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, forest management activities, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to wildlife populations; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Alternative 3’s contribution would be similar to Alternative 2’s, although less intense: long term, minor, and beneficial and short term, negligible to minor, adverse. The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 3 would be continue to be long-term, moderate, and adverse.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 3 would have the following effects on wildlife resources.

The effects on wildlife would be similar to, but in most cases incrementally less than, those described for Alternative 2 because the degree and speed of restoration would be less than under Alternative 2. Small decreases in the intensity of the benefit were predominant, although increased benefits were forecast for species that are reliant on or strongly associated with montane riparian willow habitat that would be fenced, where benefits would be long-term, local, and minor to moderate as a result of the relatively rapid habitat restoration.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, localized, negative effect on individuals of all wildlife species.

Research activities associated with procedures to test for chronic wasting disease in live elk and effectiveness of a fertility control agent would negatively affect individuals of wildlife species while activities were taking place but would not have population-level effects. There would be no effect on other wildlife from fertility control agents administered by hand to test subjects.

The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 3 would be continue to be long term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 3.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of Alternative 3 are summarized in Table 4.3.

TABLE 4.3: SUMMARY OF IMPACTS OF ALTERNATIVE 3 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Larger wildlife	Adverse (fencing)	Minor
Species reliant on riparian willow	Beneficial	Minor to moderate
Biodiversity	Beneficial	Moderate
Mule deer	Adverse	Moderate to major
Moose	Adverse (aspen and willow fencing) Beneficial (habitat restoration)	Minor Negligible
Bighorn sheep	Beneficial (habitat restoration)	Negligible
Mountain lion	Beneficial	Negligible
Red fox	Beneficial	Minor

TABLE 4.3: SUMMARY OF IMPACTS OF ALTERNATIVE 3 FOR WILDLIFE (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Coyote	Adverse	Minor
Black bear	Beneficial	Negligible to minor
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Minor
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer in long-term) Beneficial (reduced elk in short-term)	Moderate Minor
Fish	Beneficial	Minor
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Minor to moderate

Alternative 4

Alternative 4 would use fertility control agents (single-year, multi-year, or lifetime duration) on elk inside the park to reduce and maintain the size of the elk population. Currently, due to the high number of elk that would need to be treated annually, it is logistically infeasible to meet the elk population objectives of the plan using only available fertility control agents. Therefore, the alternative involves the use of lethal reduction methods to supplement fertility control actions. Because this alternative would maintain the elk population at the higher end (1,600 to 2,100 elk) of the natural range of elk population variation (1,200 to 2,100), up to 260 acres of fencing would be installed around willow in the primary elk winter range in a phased approach commensurate with elk reductions, and elk redistribution techniques would be used to a greater degree to support vegetation restoration objectives outside of fenced areas. Aspen would be fenced as in all action alternatives (up to 160 acres). A research study would be undertaken in the first three years of the plan to evaluate the procedure for testing live elk for chronic wasting disease and evaluating the efficacy of a fertility control agent in free-ranging elk.

Wildlife Habitat

Fencing in aspen and willow communities would have effects on wildlife habitat and wildlife species similar to those described for Alternative 3.

General Effects of Alternative 4 on Wildlife

The effects of lethal reduction and redistribution actions would be the similar to those described for Alternative 3, although the level of lethal reduction used in Alternative 4 and the associated effects would be incrementally less because of the population-reducing effects of fertility control. The effects of research activities on wildlife and wildlife habitat would be the same as those described in Alternative 3.

The application of fertility control agents would depend on the effective duration of the control agent (i.e., single-year, multi-year, or lifetime) and whether the agent could be remotely delivered by dart or if the target elk would need to be captured and handled for treatment and possibly marking. If darting methods to administer the agent are available and effective, the effects on other wildlife would be associated with the presence of treatment teams in wildlife habitat and the short-term disturbance they would create. This would represent a short-term, local, negative effect on individuals of other wildlife species. If elk would need to be captured, the disturbance-related effects would last longer and likely be distributed over a larger area as elk would likely be more dispersed. The need to capture elk could be met using a capture facility such as a corral trap. Elk would be herded into the capture facility using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices (such as sticks with streamers), and helicopters as an adaptive tool if necessary. The impacts of these activities on individuals of other wildlife species would be negative. The effect of the capture facility on wildlife habitat would be short term and local, and the adverse effects would be up to minor, depending on the specific location and the habitat that would be affected.

The fertility control agents would have no effect on non-target species. One of the criteria for control agents states, "A fertility control agent must not have any adverse effects on non-target animals that consume elk meat. These would include no toxicity, no change in fertility, and no genetic mutations that would interfere with life cycles or be passed on to subsequent generations." In the case of Leuprolide, the active hormone would not pass into the food chain because it would cleave to constituent amino acids (Becker and Katz 1993). Any other fertility control agent considered for use would be required to meet this criterion as well. As a result, there would be no trophic pathway (i.e., food chain) effects on other wildlife species from the administration of fertility control agents to elk. The transport to waterways of the potential agents described in Chapter 2 is unknown at this time. If monitoring or new scientific information show that fertility control agents have affects on nontarget species, including fish, the use of the agent would be modified or stopped. Every effort would be made by staff to retrieve darts that have missed their target. Exposure of any special status species to a dart left in the field may have an effect on an individual but not would result in population-level effects.

The effects of lethal reduction activities redistribution activities, and installation and maintenance of fences on wildlife species and on biodiversity would be the same as described for Alternative 3.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 3.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 4 would have the following effects on wildlife resources.

The effects of implementing Alternative 4 on wildlife would be similar to Alternative 3 on the primary winter range. On the primary summer range without the use of fences to protect montane riparian willow, small decreases in the intensity of the benefit would predominate. Areas on the primary winter range would see increased benefits for species that are reliant on or strongly associated with montane riparian willow habitat that would be fenced, where benefits would be long term, local, and minor to moderate as a result of the relatively rapid habitat restoration.

The administering of fertility control agents for population management and research purposes via darting methods would have negative effects on individuals of other wildlife populations in the vicinity of the activity. The use of a capture facility to treat a high number of elk would have short-term, adverse effects on wildlife habitat up to minor in intensity.

The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 4 would continue to be long-term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 4.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of Alternative 4 are summarized in Table 4.4.

TABLE 4.4: SUMMARY OF IMPACTS OF ALTERNATIVE 4 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Larger wildlife	Adverse (fencing)	Minor
Species reliant on riparian willow	Beneficial	Minor to moderate
Biodiversity	Beneficial	Moderate
Mule deer	Adverse	Moderate to major
Moose	Adverse (aspen and willow fencing) Beneficial (habitat restoration)	Negligible to minor Minor
Bighorn sheep	Beneficial (habitat restoration)	Negligible
Mountain lion	Beneficial	Negligible
Red fox	Beneficial	Minor
Coyote	Adverse	Minor
Black bear	Beneficial	Negligible to minor
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Minor
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate

TABLE 4.4: SUMMARY OF IMPACTS OF ALTERNATIVE 4 FOR WILDLIFE (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer in long-term) Beneficial	Moderate Minor
Fish	Beneficial	Minor
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Minor to moderate

Alternative 5

This alternative would involve releasing a small population of gray wolves in Rocky Mountain National Park in a phased approach, in combination with lethal control of elk, to achieve an elk population that would fluctuate within the natural range of variation of 1,200 to 2,100 elk. Wolves would be established in the park in very small numbers in the early phase of the plan and gradually be allowed to increase in later phases if it is determined that the wolves can be effectively managed and that plan management objectives are being met. Wolves would be monitored and their movements and activities restricted to the park. As wolf predation of elk in the park would increase, and based on monitoring of the elk population, the intensity of lethal reductions by NPS staff and their authorized agents would be modified to meet elk population objectives. It is assumed that wolves would effectively redistribute the elk population; therefore, no other redistribution techniques or fencing of montane riparian willow habitat would be required to support vegetation protection and restoration. Aspen would be fenced as in all action alternatives (up to 160 acres). A research study would be undertaken in the first three years of the plan to evaluate procedures for testing live elk for chronic wasting disease in free-ranging elk.

General Effects of Alternative 5 on Wildlife

The presence of wolves would benefit wildlife habitat as a result of trophic cascade effects. The trophic cascade concept addresses the effects that a top-level carnivore, the wolf, has on herbivore populations and their behavior, which in turn affects vegetation communities, which support various wildlife populations and ecological processes (Wilmers et al. 2003, Hebblewhite et al. 2005). Wildlife habitats would experience ecosystem-level beneficial effects as a result of the carnivore-herbivore interactions and how those interactions affect montane riparian functions, beaver populations (a keystone species), and vegetative communities (Ripple et al. 2001, Ripple and Beschta 2003, Ripple and Beschta 2004b). Dispersion of high concentrations of browsing ungulates by wolves would have a cascading effect that would benefit montane riparian willow, aspen (Fortin et al. 2005), and meadow grassland habitats in the core winter elk range. This benefit would improve habitat resources for some wildlife species and would represent a long-term, range-wide, moderate-to-major beneficial effect for wildlife species dependent on willow and aspen areas and commensal species (species that benefit from the activities of another species with no harm or return affect).

Lethal reduction of the elk population would have similar effects as a result of reduced foraging pressure. The effects would be long term, moderate, park wide, and beneficial. The effects of lethal reduction activities (i.e., crews traveling through wildlife habitat, removing carcasses) on wildlife would be adverse and similar to the effects described for Alternative 3, although as the wolf population became established over time, the need for elk population reduction would lessen, as would the impacts of reduction activities.

Fencing in aspen communities would have effects on wildlife habitat and wildlife species similar to those described for Alternative 2. No other fencing or redistribution techniques would occur because these elements would not be needed under this alternative; wolves would provide the redistribution and disperse high concentrations of ungulates in montane riparian habitats.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, negative effect on wildlife.

The effects on biodiversity would be similar to those described for Alternative 2, although incrementally greater as a result of the release of an extirpated species, the gray wolf.

The effects associated with research activities evaluating procedures to test for chronic wasting disease in live elk would be similar to Alternative 2.

Ungulates

The effects associated with the release of wolves would be relatively small during the first phase of the alternative because only four wolves would be present in the park. Other elements of the alternative's management actions (i.e., lethal reduction and redistribution actions, if necessary) would compensate for the small contribution of wolves in the initial stages of Alternative 5. Over time, assuming successful wolf management, the wolves would be allowed to reproduce and the effects identified below would be more fully realized as a result of greater reliance on wolves and less reliance on other management tools.

Wolves would potentially prey on deer and moose, although it is expected that elk would be the primary wolf prey. Predation would increase stress levels and energy use by ungulates, although in the long-term, this would represent a return to natural conditions, with the return of a top trophic-level predator reestablishing a natural population regulation mechanism for ungulates. In the long-term, natural selection forces (e.g., wolves preying selectively on young, aged, weakened, or otherwise susceptible animals) would improve the overall fitness of ungulate populations as those animals better able to escape predators would have a higher likelihood of surviving and passing on learned behavior or genetic traits. Although the release of the wolf would have negative effects on individuals, the effect on ungulate populations would ultimately be a benefit, as an integral element of the ecosystem was restored. This would represent a long-term, minor, park-wide benefit to ungulates. With deer and elk in particular, there could be reduced intraspecific competition and the risk of chronic wasting disease transmission could be lowered, a long-term, regional, minor benefit.

The effect on bighorn sheep as a result of the presence of wolves would be similar to that discussed above for deer and moose with an improvement in overall fitness and a benefit as a result of a return to natural conditions. However, bighorn sheep numbers from the Mummy Range population have declined in recent years below what would be expected under natural conditions due to a variety of other issues. Wolves could potentially kill bighorn sheep from this herd during the summer months when the sheep come down to Horseshoe Park and when wolves would be denning in these low elevation areas. Bighorn sheep could experience a local, long-term, moderate, adverse effect. During the winter, bighorn are generally up high or outside the park, when wolves would be on the primary winter range.

Predators and Scavengers

Wolves compete with and often kill coyotes (Crabtree and Sheldon 1999). Coyote population numbers would decrease as a result of the direct competition with wolves, which would represent a minor, long-term, park-wide benefit because this would be representative of more natural conditions. Foxes would benefit as a result of a reduced coyote population because foxes compete more closely with coyotes (Smith et al. 2003). The beneficial effect would be long term and minor.

Black bears may be adversely affected due to competition with wolves for forage. Wolves may compete with black bears for forage but this would represent a return to natural conditions. Black bears would benefit from scavenging the carcasses of elk left by wolves as documented to occur in Yellowstone National Park (Smith et al. 2003). There could be a long-term, negligible to minor benefit to black bears as a result of increased availability of carcasses.

Mountain lions and wolves both rely on ungulates as a primary food source. There has been little documented about the interaction of wolves and mountain lions, likely due to the separation of habitat use by the two species, as cougars use rocky outcrops and cliffs. Research in Yellowstone National Park suggest that mountain lions avoid wolves, are subordinate at kill sites, and are at risk of predation by wolves (Smith 2005). These interactions represent a natural condition and are beneficial. An increase in deer and small mammals would benefit mountain lions. The overall effect on mountain lions would be negligible beneficial. Other scavengers would benefit from wolf-kill carrion because wolves often only partially consume their prey (Wilmers et al. 2003). The beneficial effect would not only be related to the biomass of available carrion, but the year-round availability would be an important factor that would benefit scavengers (Wilmers et al. 2003). Alternative 5 would represent a long-term, park-wide, minor-to-moderate benefit for scavengers.

Small Mammals

The restoration of montane riparian willow habitat as a result of direct elk population reduction activities, wolf predation pressure, and the dispersion of high concentrations of elk by wolves would enhance willow habitat and provide additional hiding, resting, and breeding cover for small mammals. The likely reduction in coyote populations as a result of competition with wolves would have a beneficial impact on small mammals, which coyotes primarily prey on. These effects would represent a long-term, park-wide, negligible -to-moderate benefit for small mammals. The range of benefits would be related to the relatively low influence of wolves in the early stages of the plan and would increase over time as the plan objectives were achieved.

Beaver

The combination of elk population reductions and wolf release would enhance the likelihood of successful beaver recovery because the competition between elk and beaver for forage would be reduced. These effects are similar to the effects attributed to Alternative 2. Although wolves would likely prey on individual beaver, which would partially offset the potential benefit for beaver, the predominant effect of wolves would more likely be a trophic cascade (Hebblewhite 2005, Smith 2005). With wolves present, elk may avoid some of the riparian areas on the primary elk range, reducing herbivory on woody vegetation such as willow and aspen that would enhance the recruitment and structural diversity of these species in the riparian area and the availability of forage. The habitat changes would be the basis for the beneficial impact on beavers (Baker et al. 2005). Overall, the effect of Alternative 5 on beaver would be a long-term, park-wide, moderate benefit.

Birds

In general, the effects of wolf release and elk population reductions on avian populations would be similar to those described for Alternative 2. Some key differences would include incrementally greater benefits associated with trophic cascade factors related to wolves. Raptors would benefit as small mammals populations would become more diverse, and songbird populations may increase as riparian habitats would be restored (Smith 2005). The potential, moderate, adverse impacts on upland shrub birds as a result of increased deer populations, as described under Alternative 2, would be reduced to minor because wolves would redistribute elk and deer in all habitats, including upland shrubs, and would prey on deer.

Fencing around aspen would have the same effects on birds as described under Alternative 2.

Fish

The restoration of riparian willow habitats as a result of elk population reductions and the redistribution effects of wolves would enhance aquatic habitat conditions and, in turn, benefit fish populations. Trophic cascade factors (Smith 2005) would be responsible for the “trickle-down” of benefits. The benefits to fish would be long term, local, and minor to moderate, depending on the existing condition of a stream’s riparian habitat.

Amphibians and Reptiles

The effects of Alternative 5 on amphibians and reptiles would be similar to those described for other wildlife as a result of the reduction in the elk population and the trophic cascade effects of wolf release. Habitat restoration, particularly in riparian willow and aquatic habitats, would be achieved as a result of the actions associated with this alternative, and the increase in area and quality of habitat would represent a long-term, local, minor-to-moderate benefit for amphibians and reptiles.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife would be the same as described for Alternative 1: short- and long-term, moderate, and adverse. Overall other wildlife populations are affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, forest management activities, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to wildlife populations; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Alternative 5’s contribution to the overall cumulative impacts on wildlife would be similar to Alternative 2’s, with minor to major, long-term benefits to wildlife. The release of wolves would create additional short-term and long-term, minor to moderate, adverse effects for some individual species of wildlife. The cumulative effects of other plans, projects, and actions, combined with Alternative 5's contribution, would continue to be long-term, moderate, and adverse.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 5 would have the following effects on wildlife resources.

In general, the effects of Alternative 5 are similar to those described for Alternative 2, with some important differences. Primarily, the effects related to a trophic cascade that would occur with the release of wolves would enhance ecosystem functions and benefit many wildlife species. Ranges of long-term benefits for a particular species or species group would be related to changing effects as this alternative progresses from the first phase, with a relatively large elk reduction component and small wolf population, to later phases, where the wolf population would be the primary component driving the effects. The benefits would range from negligible to moderate for small mammals; minor for ungulates; negligible to minor for other predators; minor to moderate for scavenger species, numerous avian species, fish, amphibians, and reptiles; moderate for beaver; and moderate to major for songbirds, cavity nesting birds, and wildlife habitat in general.

Characterization of adverse effects associated with Alternative 5 would be short-term and minor for all wildlife as a result of elk population reductions, although as the alternative progresses, the need for reduction actions by humans would diminish and the adverse effects would eventually decrease to negligible. The effects of wolf predation would be negative for individual ungulates, but ultimately, ungulate populations would benefit from a more complete ecosystem. Coyote would experience a decrease in population size, but this would be more reflective of natural conditions and would be a minor-to-moderate, beneficial effect as a result of competition with wolves. Minor adverse impacts on upland shrub birds would occur as deer populations would increase (although to a lesser degree than under Alternatives 2) and continue foraging pressure on upland shrub habitats.

Research activities evaluating procedures to test for chronic wasting disease in live elk would negatively affect individuals of wildlife species while activities were taking place but have no population-level effects. Use of a capture facility under this alternative for lethal reduction activities would have up-to-minor adverse effects on wildlife habitat. There would be no effect on other wildlife from fertility control agents administered by hand to elk subject to research actions.

The cumulative effects of other plans, projects, and actions, combined with Alternative 5's contribution, would continue to be long term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 5.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of Alternative 5 are summarized in Table 4.5.

TABLE 4.5: SUMMARY OF IMPACTS OF ALTERNATIVE 5 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Species reliant on riparian willow	Beneficial	Minor to moderate
Wildlife habitat in the elk primary winter range	Beneficial	Moderate to major
Biodiversity	Beneficial	Moderate to major
Mule deer	Beneficial	Minor
Moose	Adverse (aspen fencing) Beneficial (predation) Beneficial (habitat restoration and improved fitness)	Negligible Minor Minor
Bighorn sheep	Adverse (predation) Beneficial (habitat restoration)	Moderate Negligible
Mountain lion	Beneficial	Negligible
Coyote	Beneficial	Minor
Red fox	Beneficial	Minor
Black bear	Beneficial	Negligible to minor
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Negligible to moderate
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer) Beneficial (habitat improvement)	Minor Moderate
Fish	Beneficial	Minor to moderate
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Minor to moderate

WATER RESOURCES

Summary of Regulations and Policies

Federal Guidance

The objective of the Clean Water Act and amendments is to "restore and maintain the chemical, physical and biological integrity of the nation's waters." The overall goal of the Clean Water Act is to produce waters of the United States that are "fishable and swimmable." A primary means for evaluating and protecting water quality is the establishment and enforcement of water quality standards. Under the *Clean Water Act*, the federal government delegated responsibility for establishing water quality criteria to each state, subject to approval by the U.S. Environmental Protection Agency. Water quality standards consist of three parts: (1) designated beneficial uses of water (e.g., drinking, recreation, aquatic life); (2) numeric criteria for physical and chemical characteristics for each type of designated use; and (3) an "antidegradation" provision to protect uses and water quality.

In accordance with the Clean Water Act, states and territories define the uses for waters occurring within their borders, and each water body must be managed in accordance with its designated uses. Water quality standards are established for each designated use. Standards must be at least as stringent as those established by the U.S. Environmental Protection Agency, and in most cases, states have adopted the U.S. Environmental Protection Agency standards.

Under section 313 of the Clean Water Act, the National Park Service and all other federal agencies and departments must comply with all federal, state, interstate, and local requirements regarding the control and abatement of water pollution. This includes management of any activity that may result in the discharge or runoff of pollutants.

National Park Service Guidance

Section 4.6.3 of the *Management Policies* states that the National Park Service will "take all necessary actions to maintain or restore the quality of surface waters and ground waters within the parks consistent with the *Clean Water Act* and all other applicable federal, state, and local laws and regulations" (NPS 2006b). The service has also established general goals for water quality, and in accordance with these goals, works cooperatively with Colorado to protect and enhance the quality of water in Rocky Mountain National Park.

The National Park Service manages the waters in Rocky Mountain National Park in accordance with the Clean Water Act and Colorado water quality standards. Therefore, the service must meet state antidegradation provisions, which means the existing quality of state waters must not be degraded. This ensures that park waters can serve their intended purposes, as defined by the assigned beneficial uses.

State of Colorado Guidance

The Water Quality Control Commission of the Colorado Department of Public Health and Environment (CDPHE) released an amended water quality standards regulation in 2001. Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31) provides basic water quality standards, an antidegradation rule and implementation process, and a system for classifying state surface waters, water quality standards, and granting temporary modifications and periodic reviews of the classification and standards.

According to the antidegradation rule, "the highest level of water quality protection applies to certain waters that constitute an outstanding state or national resource. These waters, which are those designated outstanding waters pursuant to section 31.8(2)(a), shall be maintained and protected at their existing quality." All waters in Rocky Mountain National Park are considered "Outstanding Waters" (CDPHE 2005). Beneficial use is the use of a reasonable amount of water necessary to accomplish the purpose of the appropriation, without waste (Colorado Division of Water Resources n.d.). Beneficial uses for the waters of Rocky Mountain National Park include aquatic life (Class 1: Cold Water Biota), recreation, water supply, and agriculture (CDPHE 2005).

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on hydrology and water quality includes the primary winter and summer elk ranges, as these locations are the most affected by potential activities and are the primary habitats for elk in the park.

Streams and rivers within the elk primary winter range include Fall River, Big Thompson River, Roaring River, Beaver Brook, Mill Creek, Glacier Creek, and Hidden Valley Creek. The core winter range includes Moraine Park, Horseshoe Park, and Beaver Meadows, which include the streams of Beaver Brook, Cow Creek, Big Thompson River, and Fall River. Streams and within the elk primary summer range include the Colorado River, Cache la Poudre River, Big Thompson River, Chapin Creek, Onahu Creek, Tonahutu Creek, Fall River, and Willow Creek.

Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on soils included runoff effects on water quality, water quality as related to high wildlife density (e.g., bacteria, ammonia, nitrates, fecal matter) and alteration of hydrology from beaver reintroduction.

The public also identified a need to address restoration of an intact ecosystem in addition to focusing on elk and vegetation.

Assumptions

For the purposes of this evaluation, it was assumed that a reduced beaver population would contribute to changes in hydrology (e.g., lowered water table, reduced ponding, higher velocity of flows).

Potential effects of elk on water quality and hydrology were also assumed to occur predominantly in the elk core winter range, because that is where elk densities are high and also where the majority of surface waters associated with willow occur. It is assumed for analysis purposes that effects of elk use on the primary winter range are also occurring in the Kawuneeche Valley; however, the intensity of effects would be smaller because in the Kawuneeche Valley elk densities are lower, and forage availability is higher during the summer growing season.

Assessment Methods

Primary steps for assessing impacts included identifying 1) the location of surface water in areas likely to be affected by the proposed alternatives and 2) potential changes in surface water and hydrology from current and future elk and vegetation management actions.

To understand the effects of elk and vegetation management methods on the hydrology and water quality in specific areas of concern, park resource inventories and management plans, scientific literature, and published technical data were consulted to identify the information contained in this analysis. Primary data sources included Peinetti et al. 2001, Baker et al. 2005, and NPS 2001. Research of elk herbivory, a high elk population level, and beaver reduction's effects on hydrology and water quality has occurred in the elk core winter range (i.e., Moraine Park, Horseshoe Park and Kawuneeche Valley). In other streams research was not available (i.e., in the primary summer range), but effects were assumed to be similar.

Analysis of effects of elk herbivory and reduction in beavers on hydrology relied heavily on aerial photography and digital imagery that compared changes in stream length and sinuosity over time in Moraine and Horseshoe Parks, partially as a result of a reduced beaver population (Peinetti et al. 2002). Research about the relationship between hydrology and vegetation is discussed in the "Vegetation" section.

The analysis of the changes in hydrology, stream function, or water quality condition under Alternative 1 was based on the existing condition of surface waters and groundwater on the elk range and the change in this condition over time.

The data from the baseline water quality data inventory and analysis indicated that surface waters within the park were generally of good quality but had some localized impact from natural and human activities. However, because effects from wildlife and other natural sources of nutrients have not exceeded water quality standards within the park, the use of water quality standards is a threshold too coarse for this evaluation; therefore, the impact thresholds below do not include specific mention of Water Resources Division or State of Colorado Water Quality Standards.

Under all action alternatives, a research study would be conducted in coordination with elk and vegetation management activities. The study would be conducted over a three-year period and would involve approximately 120 elk. During this study, the National Park Service would evaluate procedures to test for chronic wasting disease in live elk and the effectiveness of a fertility control agent and would involve the capture or darting, anesthetizing, and handling of elk within the framework of an alternative. It is expected that research activities would not have any effect on water quality and hydrology due to the short time period involved, the type of activities would not appreciably disturb vegetation or soils, and actions would not be conducted in aquatic habitats. The study would treat approximately half of the female elk captured with a fertility control agent. Concerns have been raised about whether excreted elk waste from elk treated with fertility control agents could contain harmful products that could be transported into the water and affect water quality. Due to the low number of female elk treated for this study over a short-period, no effect on water quality is expected as a result of fertility control agents used in this study.

Impact Threshold Definitions

Impacts were evaluated using the following thresholds.

Intensity of Impacts

Hydrology and Stream Structure

Negligible: Hydrology or stream structure would not be affected or the effect would be below or at levels of detection. Changes to sinuosity, bank stability, groundwater levels, or flow velocity would not be detectable.

Minor: The effects on hydrology or stream structure would be detectable, but effects on sinuosity, bank stability, groundwater levels, or flow velocity would be small.

Moderate: The effect on the sinuosity, bank stability, groundwater levels, or flow velocity would be readily apparent and would result in a notable change in stream function or hydrology of the area.

Major: The sinuosity, bank stability, groundwater levels, or flow velocity would greatly change and would substantially alter stream function or hydrology of the area.

Water Quality

Negligible: Chemical, physical, or biological changes to water quality would not be detectable, and effects would be well within natural or desired water quality conditions and would not contribute to degradation.

Minor: Chemical, physical, or biological changes to water quality would be detectable but would not contribute to degradation, and would be within natural or desired water quality conditions.

Moderate: Chemical, physical, or biological changes to water quality would be detectable but would not result in degradation. Water quality would be altered compared to natural baseline or desired water quality conditions.

Major: Chemical, physical, or biological changes to stream water quality would be readily measurable and would be frequently altered from the natural baseline or desired water quality conditions.

Type and Duration of Impact

Beneficial impact would contribute to the restoration of natural hydrologic conditions (e.g., increase surface area of water and water table levels, stabilize riverbanks), improve water quality (e.g., reduce sedimentation, bacteria levels), or improve or maintain aquatic habitat.

Adverse impact would contribute to the alteration of natural hydrologic conditions (e.g., reduce surface area of water and water table levels, cause unnatural erosion or deposition), degrade water quality (e.g., increase sedimentation, temperature, or bacteria levels), or degrade aquatic habitat.

Duration: Short-term impacts would allow recovery in less than one year. Long-term impacts would require one year or more for recovery.

Impairment

An impairment of water resources would occur when actions contribute substantially to deterioration of stream structure, hydrology, and/or water quality to the extent that the surface waters throughout the park would no longer function as natural systems. The impacts would involve deterioration of the park's water quality and hydrology to the point that park purposes could not be fulfilled, or resources could not be experienced and enjoyed by future generations

Alternative 1

Hydrology and Stream Structure

Historically, beaver have had a large influence on hydrology and stream structure within low-gradient streams in Rocky Mountain National Park. Beaver activities include creating dams and canals, which increase river complexity by slowing water current velocity, elevating the groundwater level, equalizing the water discharge rate by retaining runoff during high flows and slowly releasing it, altering waterway gradients by creating a stair-step profile, and increasing resistance to disturbance within the waterway (Gurnell 1998, Naiman et al. 1988, Baker et al. 2005). While trapping practically removed beaver from Estes Valley, beaver were still abundant in the park in 1915, when the park was first established (Zeigenfuss et al. 2002 and Baker et. al 2005). However, beaver have since declined in the eastern portions of the park. For example, beaver have declined from 315 in 1939 to 12 in 1994-1998 on the Big Thompson River, located in the core elk range (Zeigenfuss et al. 2002 and Baker et. al 2005).

These declines in beaver correlate with changes in hydrology and vegetation. In a comparison of 1937 and 1996 aerial photographs, Peinetti et al. (2002) found a reduction in sinuosity and in total surface water in Moraine Park and Horseshoe Park. In Moraine Park, stream lengths (and, therefore, sinuosity) were reduced by 56%; in Horseshoe Park, that number was 44%. Total surface water also decreased, by 69% and 44% for Moraine and Horseshoe Parks, respectively. Well-defined beaver dams were detected in the 1937 aerial photos, especially at the upgradient entrances to the meadows, which play a large role in the stream structure in the meadows below, but the majority of the beaver dams had disappeared by 1996.

Based on research of willow, elk, and beaver interactions in Rocky Mountain National Park, Baker et al. (2005) concluded that the mutual relationship between beaver and willow collapses in the face of heavy browsing by elk. In riparian systems where elk are abundant, they will outcompete and exclude beaver. These conditions would continue under Alternative 1. Thus, the changes in hydrology observed on the core winter range in the park are likely to continue as a result of the high densities of elk that browse in these areas and the correlated reduction or suppression of the beaver population.

Continued high densities and numbers of elk on the core winter range under Alternative 1 would continue to outcompete beaver, preventing vegetation recovery necessary for beaver to recolonize (see "Vegetation" section for a discussion on elk herbivory). Thus, hydrological conditions would remain changed from recent natural conditions (e.g., straighter streams, lower water tables), representing a long-term, major, adverse effect on hydrology in the core winter range. While data on beaver populations and hydrological changes in the Kawuneeche Valley are limited to personal observations, elk, willow, and beaver are interacting in the same manner, although to a lesser degree because of reduced elk densities and increased forage. Therefore, hydrological conditions would also be adversely affected in the Kawuneeche Valley elk range, but less so, resulting in long-term, moderate effects. This would be expected to progress to major later in the plan as the effect of elk on beaver increases.

Runoff Effects on Water Quality

As described in the "Soils" section, erosion and, therefore, sediment entering streams under Alternative 1 would be long term, local, minor, and adverse in the elk core winter range and Kawuneeche Valley and negligible in other areas of the elk range. Sediment entering streams due to bank destabilization resulting from high elk densities in the core winter range would be negligible and adverse.

Based on visual observations in Rocky Mountain and Yellowstone National Parks (see "Soils and Nutrient Cycling" for details), it is likely that increases in turbidity from destabilization of banks by elk is minimal. The baseline water quality data inventory and analysis did not identify turbidity as exceeding water quality standards anywhere within the park (NPS 2001b). Because this is total turbidity, including effects of geologic erosion, erosion by other wildlife, and by human use of the park, it is unlikely that the elk population contributes much to erosion. Effects on water resources would therefore be long term, negligible to minor, and adverse in the core winter range, where elk densities are high. For other portions of the winter and summer elk range, effects would be negligible.

Water Temperature

Elk would continue to degrade willow under Alternative 1, and already degraded willow would be unable to recover in the presence of the same elk population level and herbivory levels (see "Vegetation" section for further explanation). These changes in the montane riparian community, such as decreases in tall willow along streams, would continue to result in reduced shading of streams, as vegetative cover of surface waters has been reduced, although no water quality measurements in the park have exceeded standards for temperature. This effect on water temperature would represent a long-term, local, minor, adverse effect on water resources on the elk core winter range and Kawuneeche Valley, because it has likely altered stream temperature from recent natural conditions. Because data on temperature for the streams in the core elk primary winter range are limited, it is unknown what the level of change from natural conditions has been. However, high elevation streams in areas with a short summer season, such as on the core winter range, typically have water temperatures that would remain cold through the summer. Because natural conditions had stream shading, it can be assumed that the ideal conditions for aquatic communities in these stream reaches would be the temperature that occurs with stream shading. Therefore, the reduction in stream shading as willow has been replaced with grasses along montane riparian areas in the core elk winter range and Kawuneeche Valley would cause minimal effects that would be difficult to detect among other confounding factors such as climate change. Therefore, effects would be long term, local, negligible, and adverse for water resources in the core winter range and in the primary summer range.

Contaminants

Contributions from ungulate waste can be an important source of contamination to surface waters. In Virginia, multiple streams' total maximum daily loads for fecal coliform were exceeded by wildlife (primarily deer) alone (Mostaghimi et al. 2002). However, the baseline water quality data inventory and analysis by the NPS Water Resources Division described in "Affected Environment" did not identify wildlife as a primary source of contamination (NPS 2001b). Aside from fecal coliform, no other water quality parameters potentially related to wildlife were exceeded within the park. Fecal coliform only exceeded standards near developed areas in the park, which is likely due to human waste rather than wildlife excreta. Based on this information, the current elk population may introduce bacteria, ammonia, nitrates, and fecal matter to surface waters, but only at an undetectable level. Therefore, effects on water quality from continuing current management of elk and vegetation would be long term, negligible, and adverse.

Cumulative Impacts

Hydrology and Stream Structure

Hydrology and stream structure would be affected by a restoration project that includes installation of Fan Lake fencing, which would eliminate elk use in a small area, thereby allowing conditions conducive to beaver to return and alter the hydrology of the area, a long-term, local, negligible-to-minor, beneficial effect on water resources.

Alternative 1 would have a long-term, major, adverse impact from the reduced effect of beaver on hydrology and stream structure. The Fan Lake project would not have an appreciable impact on the cumulative environment and cumulative impacts would be long term, major, and adverse.

Water Quality

Nitrogen deposition occurring as a result of agricultural fertilizers and combustion in vehicles and factories has been altering and will continue to alter surface waters in Rocky Mountain National Park. The introduction of additional nitrogen to nitrogen-limited systems can affect water's natural buffering abilities and contribute to acidification. Also, the addition of nitrogen to surface waters is an adverse effect on water quality. Nitrogen deposition is having a long-term, moderate-to-major, adverse effect on water quality throughout the park, especially in high-elevation areas.

Prescribed burns that are conducted could affect water quality, although the effect would only be negligible, because of mitigation measures that are implemented. Fencing of willows at Lawn Lake would reduce erosion, thereby reducing turbidity of streams, a negligible, beneficial effect. Herbicides used for exotic plant removal and insecticides could potentially affect water quality, although with mitigation measures, the resulting adverse effect would be short term, local, and minor (NPS 2003c). However, piscicides that could potentially be used instream for removing fish would have short term, local, moderate, adverse effects, as they would affect the water quality of a particular stream reach in a very detectable manner.

Effects from other plans and projects on water quality would be long term, moderate, and adverse. Alternative 1 would make a long-term, negligible-to-minor, adverse contribution, resulting in overall cumulative effects that would be long term, moderate, and adverse.

Conclusion

Hydrological changes as a result of a reduced beaver population in the park would continue to represent a long-term, local, major, adverse effect on hydrology and stream structure in the winter elk range. Effects would be moderate, but progress to major later in the plan in the summer elk range. Sediment entering streams from erosion of bare ground would be long term, local, minor, and adverse in the winter elk range and Kawuneeche Valley, but negligible in other areas of the primary summer range, due to lower densities of elk. Bank destabilization from the degradation of willows by elk would cause a slight increase in turbidity, resulting in long-term, local, negligible to minor, adverse effects on water quality in the core winter range and Kawuneeche Valley and negligible adverse effects on water quality in the remainder of the winter and summer elk range. Slight increases in water temperature during the summer months as a result of elk herbivory of willow would represent a long-term, local, negligible, adverse effect on water quality. Effects on water quality from elk introducing bacteria, ammonia, nitrates, and fecal matter to surface waters would be long term, negligible, and adverse.

Cumulative effects on hydrology would be long term, major, and adverse, with Alternative 1 contributing long-term, major, adverse effects. Cumulative effects on water quality would be long term, moderate, and adverse, with Alternative 1 making a long-term, negligible to minor, adverse contribution.

Impairment of water resources within the park would not occur under Alternative 1.

Alternative 2

Hydrology

A large reduction in the elk population would reduce the total number of elk that would occur on the core winter range. Redistribution effects would help to ensure that these elk do not continue to congregate in high densities. The combination of these activities would increase willow size and cover, which would allow beaver to recolonize on the core winter range and in the Kawuneeche Valley. The recolonization or reintroduction of beaver would, in the long term, raise groundwater elevations, increase stream sinuosity, and, overall, increase the quantity of surface water, as described by Naiman et al. (1988). Willow and aspen will not be fully recovered within the 20-year time frame of the plan, so only partial beaver recovery would be supported. Thus, the resultant long-term change in hydrology from the actions of Alternative 2 would represent a moderate, beneficial effect on waters on the core winter elk range and possibly Kawuneeche Valley, if willow conditions improve, and a minor, beneficial effect in other portions of the primary winter range and the primary summer range.

Runoff Effects on Water Quality

Under Alternative 2, the maximum reduction of elk would result in an increase in willow cover over time because of reduced elk herbivory, willow replantings, and prescribed burns and mechanical methods for stimulating new plant growth. Decreases in erosion as a result of increased willow cover and the subsequent soil retention would decrease turbidity. However, because exclosure data show only a 4.6% difference in areas completely excluded from elk and areas with current levels of elk (Singer et al. 2002), it is likely that a 50% decrease in the elk population would have little effect on and would represent a long-term, local, negligible, beneficial impact on water quality.

Potential short-term impacts associated with lethal control and vegetation management activities (e.g., vehicle use near waterways, removing carcasses through water, prescribed burns, mechanical thinning) would be minimized or avoided by restricting control activities that could potentially affect water quality to the extent possible. The effects, considering mitigation measures, would be short term, local, negligible to minor, and adverse.

Mechanical thinning would be unlikely to affect water quality because removal of aboveground vegetation would not remove litter or disturb the soil, which could increase chances of erosion. Vehicle use near waterways would not affect water quality or hydrology because banks and the stream would remain undisturbed. Removing carcasses through water could potentially affect banks and add contaminants to streams, but because this would occur on a limited basis, adverse effects on water resources would be local and negligible to minor.

Prescribed burns can alter stream chemistry by releasing calcium and increased soil pH, but effects in the Sierra Nevada have been shown to last only three months for more extensive burns than what would likely occur under this alternative (Stephens et al. 2004). This would indicate that the effects of prescribed burns on water resources, small burns conducted in montane riparian areas and aspen stands would have limited effects on turbidity and changes in stream chemistry. Therefore, the short-term, adverse effects would be local and negligible to minor.

Water Temperature

Changes in the montane riparian community (i.e., increased willow growth and cover along and over aquatic habitats) would result in decreased water temperatures as a result of shading by vegetative cover. Because the natural range of variation in the core winter elk range included more extensive willow vegetation than occurs now, this return to more stream shading would be beneficial. Beneficial effects would be negligible along stream reaches in the core winter range.

Contaminants

Reduced elk population levels would reduce introduction of bacteria, ammonia, nitrates, and fecal matter by elk to park surface waters. However, this effect would be slight and likely undetectable, resulting in a local, negligible, beneficial effect. Prescribed burns could potentially introduce contaminants into surface waters, but only for the short term and in limited amounts (Stephens et al. 2004; Elliott and Vose 2005), resulting in local, minor, adverse effects.

Cumulative Impacts

Hydrology and Stream Structure

Effects of other plans, projects, and actions on hydrology and stream structure would be the same as described for Alternative 1: long term, negligible to minor, and beneficial. Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial. Cumulative effects would be long term, minor to moderate, and beneficial.

Water Quality

Effects on water quality from other plans, projects, and actions would be the same as for Alternative 1: long term, negligible to minor, and adverse. Alternative 2 would contribute long-term, negligible-to-minor, beneficial effects, overall resulting in no cumulative effect.

Conclusion

Recolonization or reintroduction of beaver would cause long term, local, moderate, beneficial effects on hydrology by altering the hydrology of streams in the elk core winter range and possibly Kawuneeche Valley, if willow conditions improve, and minor benefits in other portions of the primary winter range and the primary summer range. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial impact on water quality. Short-term adverse impacts from lethal control and vegetation management activities would be local and negligible to minor with mitigation measures in place. Increases in willow cover would also increase stream shading, a long-term, local, negligible, beneficial effect on water temperature throughout the elk primary winter and summer ranges. Reduced elk populations would result in slightly less contamination from the introduction of bacteria, ammonia, nitrates, and fecal matter by elk to surface waters in the elk range, a local, negligible, beneficial effect; but prescribed burns could potentially alter stream chemistry in the short term, a local, minor, adverse effect.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 2 contributing long-term, moderate, beneficial effects. On balance, there would be no cumulative effects on water quality, although Alternative 2 would contribute long-term, negligible-to-minor, beneficial effects that would offset adverse effects of other projects and plans.

Impairment of water resources within the park would not occur under Alternative 2.

Alternative 3

Hydrology

Reduction in elk population and fencing of montane riparian willow on the primary elk range would facilitate recovery of the montane riparian willow. Fenced areas would impart long-term, local, moderate benefits to stream structure in areas of the primary summer and winter ranges as montane riparian vegetation would recover and beaver would likely recolonize the areas where habitat is appropriate. However, in unfenced areas elk grazing would continue and, as a result, there would be less potential than fenced areas for beaver recovery and resultant improvements in stream structure. Because elk numbers would be reduced to upper levels of the natural range of variation, the improvement of unfenced stream reaches would be long term, local, minor, and beneficial. Long-term benefits to hydrology would be moderate in areas of the primary elk range where willows are fenced.

Runoff Effects on Water Quality

As stated in Alternative 2, because exclosure data show only a 4.6% difference in areas completely excluded from elk and areas with current levels of elk (Singer et al. 2002), a reduction in the elk population would not have much effect on bare ground and erosion. This decrease would represent a long-term, local, negligible, beneficial impact on water quality. For areas that are fenced from elk, bare ground would be expected to be reduced similar to the exclosure data (4.6%). However, because slopes are relatively flat in areas of the primary summer and winter range where fences would be installed, it is unlikely that this minimal decrease in bare ground would result in detectable differences in turbidity. Therefore, beneficial effects on water quality from reduction in sediments transported to streams from a reduction in bare ground would be negligible.

Potential short-term impacts associated with lethal control and vegetation management activities (e.g., vehicle use near waterways, removing carcasses through water, prescribed burns, mechanical thinning) would be the same as those described for Alternative 2.

Water Temperature

Effects on water temperature would be the same as those described for Alternative 2.

Contaminants

Effects on water quality through a slight reduction in contaminants entering surface waters and potential contaminants from prescribed burns would be the same as those described for Alternative 2, but would occur potentially sooner.

Cumulative Impacts

Hydrology and Stream Structure

Effects of other plans, projects, and actions on hydrology and stream structure would be the same as those described for Alternative 1: long term, negligible to minor, beneficial. Alternative 3's contribution to cumulative effects would be long term, minor to moderate, and beneficial. Cumulative effects would be long term, minor to moderate, and beneficial.

Water Quality

Effects on water quality from other plans, projects, and actions would be the same as those described for Alternative 1: long term, negligible to minor, and adverse. Alternative 3 would contribute long-term, negligible, beneficial effects, resulting in a cumulative effect that would be long term, negligible, and adverse.

Conclusion

Recolonization or reintroduction of beavers would result in overall effects on hydrology similar to those described for Alternative 2: long term, local, moderate, and beneficial, although changes in hydrology would vary between fenced and unfenced areas. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial effect on water quality. Short-term impacts from lethal control and vegetation management activities would be the same as those described for Alternative 2: local, negligible to minor, and adverse. Increases in willow cover would also increase stream shading similar to Alternative 2, although effects would vary slightly between fenced and unfenced areas: long term, local, negligible, and beneficial. Reduced elk populations would result in slightly fewer contaminants from elk entering surface waters in the elk range, a local, negligible, beneficial effect; but prescribed burns could potentially introduce contaminants (e.g., excessive nutrients) in the short term, representing a local, minor, adverse effect.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 3 contributing long-term, minor to moderate, beneficial effects. Cumulative effects on water quality would be negligible and adverse, with Alternative 3 contributing long-term, negligible, beneficial effects.

Impairment of water resources within the park would not occur under Alternative 3.

Alternative 4

Hydrology

The recolonization or reintroduction of beaver would have the same beneficial effects as those described for Alternative 3 in fenced areas of aspen and montane willow (long-term moderate benefits). In the primary summer range where montane riparian willow would not be fenced, the benefits would be minor.

Runoff Effects on Water Quality

The negligible, beneficial effects on water quality would be the same as those described for Alternative 3.

Water Temperature

The negligible, beneficial effects on water quality would be the same as those described for Alternative 3.

Contaminants

Effects on water quality through a slight reduction in contaminants entering surface waters and potential contaminants from prescribed burns would be the same as those described for Alternative 2.

Concerns have been raised about whether excreted elk waste from elk treated with fertility control agents could contain harmful products that could be transported into the water and affect water quality. The transport to waterways of the potential agents described in Chapter 2 is unknown at this time. Nonsteroidal hormones (including GonaCon™ and Leuprolide), once administered to the animal, are metabolized into basic amino acids and, therefore, would not likely pass through the food chain or present a hazard to water quality via elk urine (Becker and Katz 1993). If based on monitoring or new scientific information it is determined that fertility control agents are found to have affects on water quality or nontarget species the use of the agent would be modified or stopped.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 3.

Conclusion

Recolonization or reintroduction of beavers would result in overall effects on hydrology similar to those described for Alternative 3: long term, local, moderate, and beneficial in the core winter elk range, but minor and beneficial in the primary summer range, although changes in hydrology would vary between fenced and unfenced areas. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial effect on water quality. Short-term impacts from lethal control and vegetation management activities would be the same as those described for Alternative 2: local, negligible to minor, adverse. Increases in willow cover would also increase stream shading similar to Alternative 2, although effects would slightly vary between fenced and unfenced areas: long term, local, negligible, and beneficial. Reduced elk populations would result in slightly less contaminants from elk entering surface waters in the elk range, a local, negligible, beneficial effect; but prescribed burns could potentially introduce contaminants (e.g., excessive nutrients) in the short term, a local, minor, adverse effect. No effect on water quality would occur from the use of fertility control agents.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 4 contributing long-term, minor, beneficial effects. Cumulative effects on water quality would be negligible and adverse, with Alternative 4 contributing long-term, negligible, beneficial effects.

Impairment of water resources within the park would not occur under Alternative 4.

Alternative 5

Hydrology

The recolonization or reintroduction of beaver would have the same beneficial effects as those described for Alternative 2.

Runoff Effects on Water Quality

The negligible, beneficial effects on water quality would be the same as those described for Alternative 2.

Water Temperature

Water quality changes in the montane riparian community would result in the same effects as those described for Alternative 2.

Contaminants

Effects on water quality, as a result of a slight reduction in contaminants entering surface waters and potential contaminants from prescribed burns, would be the same as those described for Alternative 2. The number of wolves under Alternative 3 would be limited and would therefore have no effect on water quality from fecal matter.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 2.

Conclusion

Recolonization or reintroduction of beavers would result in overall effects on hydrology similar to Alternative 2: long term, local, moderate, and beneficial in the elk core winter range, but minor and beneficial in the primary summer range. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial effect on water quality. Short-term impacts from lethal control and vegetation management activities would be the same as Alternative 2: local, negligible to minor, and adverse. Increases in willow cover would also increase stream shading similar to Alternative 2, although effects would vary slightly between fenced and unfenced areas: long term, local, negligible, and beneficial. Reduced elk populations would result in slightly less contamination from elk entering surface waters in the elk range, a local, negligible, beneficial effect, but prescribed burns could potentially introduce contaminants (e.g., excessive nutrients) in the short term, a local, minor, adverse effect. The release of wolves would have no effect on water quality.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 5 contributing long-term, moderate, beneficial effects. Cumulative effects on water quality would result in no effect, with Alternative 5 contributing long-term, negligible-to-minor, beneficial effects.

Impairment of water resources within the park would not occur under Alternative 5.

SOILS

Soil depth, texture, and fertility are important components of a productive natural system and indirectly determine the type of vegetation that an area can support and the productivity of the wildlife populations dependent on those plant resources.

Summary of Regulations and Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. Current laws and policies require that soils in national park units function as naturally as possible as specified in *Management Policies*. The National Park Service will "seek to prevent the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resource" (NPS 2006b). Management goals for soils are included in section 4.8.2.4 of *Management Policies*. Management actions will be taken to prevent or minimize adverse, potentially irreversible impacts on soils. The park's general management plan and resource management plans support preserving the natural character of resources, including soils. Soil resources should be monitored regularly and mitigation provided.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on soils and nutrient cycling includes the primary elk primary winter and summer ranges, as these locations are the most affected by potential activities and are the primary habitats for elk in the park. The soils analysis focuses on those portions of the elk range, particularly the core winter range, where elk concentrations have the potential to affect soils far more than elsewhere in the range. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on soils included impacts such as erosion of topsoil and subsoil as a result of exposed bare ground, compaction, changes in fertility and nutrients, long-term sustainability and productivity (alteration of fungi and the carbon/nitrogen ratio), flooding, and soil composition.

Assumptions

Potential effects of elk on soils and nutrient cycling were assumed to occur predominantly in the elk core winter range, because that is where elk densities are high and also where most surface waters associated with willow and aspen occur in the primary winter range. It is assumed for analysis that effects of elk use on the primary winter range also occur on the primary summer range; however, the intensity of effects would likely be smaller in the primary summer range because the primary summer range is much larger, elk densities are lower, and forage availability is higher during the summer growing season. An exception to this would be in the alpine areas, where if elk do concentrate, soils may be affected more severely because vegetation is slower to recover in alpine areas.

Assessment Methods

The technique used to assess impacts on soils from management activities in this document is in accordance with *Management Policies* (NPS 2006b). General soil types, erosion potential, structure, and function were discussed and impacts were analyzed based on reference information, anticipated impacts of management actions by alternative, and professional judgment.

Primary references for this analysis included Binkley et al. 2003, Schoenecker et al. 2001, Schoenecker et al. 2004, Singer et al. 2002, Singer and Schoenecker 2003, and Gehring and Whitman 2002. Future trends used in this analysis were based on modeling by Coughenour (2002) and Schoenecker et al. (2002).

Primary steps for assessing impacts include identifying 1) potential changes in soils from elk and vegetation, 2) whether soil resources are in areas likely to be affected by elk and vegetation management measures, and 3) potential changes in soil productivity, erosion rates, and other soil properties caused by the management actions.

Impact Threshold Definitions

Intensity of Impact

Impacts were evaluated using these thresholds:

Negligible: Soils and nutrient cycles would not be affected, or the effects on soils or nutrient cycles would be below or at levels of detection. There would be no discernable effect on the rate of soil erosion or the ability of the soil to support native vegetation.

Minor: The effects on soil productivity or fertility or nutrient cycles would be detectable. There would be detectable effects on the rate of soil erosion or the ability of the soil to support native vegetation expected in the area.

Moderate: The effect on soil productivity or fertility would be readily apparent and would result in a change to the soil. The rate of soil erosion or the ability of the soil to support native vegetation expected in the area would be appreciably changed. The effect on nutrient cycles would be readily apparent and would change aspects of nutrient cycles.

Major: The effect on soil productivity or fertility would be readily apparent and would substantially change the character of the soils. The actions would have substantial, highly noticeable influences on the rate of soil erosion or the ability of the soil to support native vegetation expected in the area. The effect on nutrient cycles would be substantial and would change aspects of nutrient cycles.

Type and Duration of Impact

Beneficial effects would increase productivity, reduce erodibility, accelerate nutrient cycling, or otherwise enhance the ability of soils to support vegetation.

Adverse effects on soils would reduce productivity, increase erodibility, decelerate nutrient cycling, or otherwise diminish the natural ability of soils to support vegetation.

Duration: Short-term impacts would allow recovery in less than one year. Long-term impacts would require one year or more for recovery.

Impairment

Impairment to soil resources would occur when chemical, physical, or biological changes to soils would reach the point that park purposes could not be fulfilled, or resources could not be experienced and enjoyed by future generations

Alternative 1

Compaction and Bare Ground

Ungulate grazing and hoof action can result in increases in bare ground in Rocky Mountain National Park. Singer et al. found that elk grazing has increased the percent of bare ground by 4.6% and increase bulk density of soils by 1.7% on the elk primary winter range (riparian willow and upland shrub/grassland sites) in an exclosure study in the park (2002).

The potential for bare ground would be expected to continue over time and may increase slightly as elk continue to graze and concentrate in different areas where forage is available on the core winter range. The adverse effect on soils from compaction and bare ground would be long term, local, and minor in the elk core winter range, where densities are the highest of any population that is not artificially fed (Coughenour 2002), because the difference in bare ground between an area without elk and an area with elk is measurable (i.e., 4.6%, when using exclosures). In other areas of the elk primary winter and summer ranges, where elk occur in lower densities, effects would be negligible and adverse.

Erosion

Slight increases in bare ground in willow and upland shrub/grassland communities could lead to increases in erosion in those areas where erosive forces are sufficient (i.e., water flow, wind exposure, slope). However, the majority of the winter ground is on relatively flat slopes; therefore, erosion would only occur on a limited basis from high elk densities in the core winter range. Because the primary summer range would have lower densities of elk, erosion from elk hooves would be limited as well, although effects on small areas on steeper slopes could occur. Effects on soils from erosion under Alternative 1 would be long term, local, and minor in the elk core winter range because of high densities. For other areas of the elk primary winter and summer ranges, where densities are lower, effects would be negligible and adverse.

Observations in Moraine Park show increased bank instability due to less willow cover. No research on elk's effects on bank destabilization has been conducted in Rocky Mountain National Park, although visual observations of bank destabilization in the core winter range and in the Kawuneeche Valley have been made by park staff and researchers. In Yellowstone National Park, a similar system to Rocky Mountain National Park with high numbers of elk, "erosion rates in riparian areas have not yet been comprehensively studied, though it is visually obvious that ungulate use of these areas likely contributes to the movement of soil on some streamside banks through their trailing, wallowing, and rubbing" (NPS 1997). While it is likely that elk make some contribution of erosion through bank destabilization, it is unclear how much. Based on this information, it is likely that increases in erosion from destabilization of banks by elk is minimal; effects on soils would therefore be long term, local, negligible, and adverse throughout the elk range.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Ungulates and their grazing can alter any of the main components of nutrient cycling: pools, fluxes on an annual basis inside and outside their primary winter and summer ranges, or fluxes on a daily basis to habitats within a summer or winter range (Singer and Schoenecker 2003). A pool is the total amount of a given nutrient (e.g., nitrogen) that is found in a given area (e.g., a 5-acre aspen stand); a flux is the amount of a given nutrient that is transferred from one area to another via processes (e.g., elk consuming willow, which is a source of nitrogen, then traveling to mixed conifer habitats and defecating, thereby depositing nitrogen in the mixed conifer habitat).

Because elk numbers are currently at high levels in the park, elk have a greater potential to influence nutrient cycling than if they were at lower numbers. A number of research projects have investigated the effects that elk may be having on nutrient cycling in Rocky Mountain Park under current conditions in different vegetative communities.

Willow and Aspen Communities

Schoenecker et al. (2004) calculated net movement of nitrogen away from aspen and willow communities in the park by tracking elk activities (i.e., feeding or bedding) in aspen, willow, upland shrub, meadow, and mixed conifer communities. Long term losses of soil nitrogen and carbon in willow and aspen communities are predicted to be minimal under current elk population levels, as "the sizes of the soil organic matter C and N pools were also very large relative to annual plant uptake and grazing offtake, which provided a large buffering capacity" (Coughenour 2002). Coughenour's model predicts a 2% loss of soil nitrogen and 6% of soil carbon in the willow vegetation in 50 years. This reduction in available soil nitrogen and carbon over time would be a long-term, local, minor, adverse effect in the core elk winter range, as 2% and 6% are detectable but not substantial reductions. Elk's effects on soils in the primary summer range and the remainder of the elk primary winter range are likely even less, because elk do not congregate in the same densities in these areas, resulting in a negligible, adverse effect.

Singer et al. concluded that nitrogen process and pools were being reduced by elk herbivory in willow and aspen types in the elk primary winter range (2002). Grazed willow areas had half the input of nitrogen when compared to ungrazed exclosures, as well as a 79% lower mineralization rate and a 78% lower nitrate pool (Singer et al. 2002). Annual nitrogen inputs (herbaceous biomass; shrub/leaf litterfall; and elk urine and feces) on grazed short willow sites were 60% of ungrazed sites; on aspen grazed sites, nitrogen inputs were 44% of ungrazed sites. Singer et al. also stated that "at some point, the depletions might result in declines in plant growth and changes in species composition" (2002). Based on this information, the reduction of nitrogen inputs in willow and aspen communities could be considered substantial in the park. This reduction in pools and fluxes in short willow and aspen communities would be considered a long-term, local, moderate, adverse effect in the primary winter range. Due to lower elk densities and increased forage availability during the summer months, effects of elk on nutrient cycling on the primary summer range are likely less than on the primary winter range. Therefore, effects on the primary summer range would be long-term, minor, and adverse.

Upland Shrub

Singer et al. (2003) concluded that nitrogen and carbon abundances were being maintained in the upland grass/shrub type. But in an exclosure study on the elk primary winter range, there has been a decrease in availability of calcium, magnesium, potassium, and phosphorus in the soil by 30% in upland shrub habitats compared to ungrazed exclosure sites (Binkley et al. 2003). Upland shrub habitats are already cation-poor, so grazing in upland shrub could be the cause for this depletion, as plants respond to herbivory by increasing their uptake of nutrients from soils. This depletion would, over time, affect soil productivity in upland grass/shrub in a measurable, noticeable manner. Therefore, continuation of high elk numbers under this alternative would result in long-term, local, minor-to-moderate, adverse impacts on soils in the elk primary winter range by continuing this depletion of extractable cations and phosphorus. Effects would be minor in the primary summer range due to lower densities and higher available forage.

Mixed Conifer

Nitrogen pools are likely slightly increasing in mixed conifer habitats because elk are transferring it out of willow and aspen areas through feeding in willow and aspen areas and bedding and defecating in mixed conifer areas in the elk primary winter range in the park (Schoenecker et al. 2004). This increase in nitrogen would be beneficial to soils in the mixed conifer habitat, because it would increase soil productivity. Effects on soils on the elk primary winter range would be long term, local, and minor because effects would be readily apparent but would not be large enough to substantially change soil productivity in the mixed conifer habitat. It is assumed that this would also occur on the primary summer range, but because the primary summer range is larger and elk densities are lower, nitrogen inputs would be more widely distributed in the mixed conifer habitat, resulting in long-term, negligible-to-minor benefits.

Microbial Activity

Herbivory has been shown to reduce mycorrhizal levels in the soil and alter species composition (Gehring and Whitham 2002). High levels of elk herbivory in the core winter range on willow and aspen would likely continue to reduce mycorrhizal levels in the soil and change mycorrhizal species composition. This would result in a long-term, local, minor, adverse effect on soils in the core winter range because reductions would be readily apparent if measuring mycorrhizal levels in the soil. Because elk densities and therefore rates of herbivory are lower in other portions of the primary winter range and in the primary summer range, effects would be negligible in these areas.

Flooding, such as that caused by beaver activity, increases microbial action (e.g., nitrogen fixation) in soils (Songster, Alpin and Klotz 1995, Naiman and Melillo 1983). The lowered water table associated with the reduced beaver population in the park would continue to degrade soils by decreasing microbial action in the soil (see “Water Resources” for a more detailed explanation of beaver’s role in hydrology). Reduction in microbial activity would reduce soil productivity at a measurable level, but would only occur in localized areas that were previously flooded by beavers. This continued lack of flooding represents a long-term, local, minor, adverse effect on soils and nutrient cycling, as microbial activity is now somewhat reduced in areas where it was naturally higher.

Cumulative Impacts

Bare Ground, Compaction, Erosion, and Flooding

Other actions occurring in the park that could have effects on bare ground, compaction, and erosion include erosion prevention from trail management activities and a willow fencing project in the area of the former Fan Lake. Trail management activities would protect trail soils from eroding, a long-term, local, minor, beneficial effect; willow fencing in a small area would prevent further creation of bare ground by elk, a negligible benefit. Constructing a barn would compact soils and negatively affect soil productivity in a local area by covering the soil with a foundation, long-term, minor, adverse effects. Revegetation and other vegetation restoration activities would control erosion and reduce bare ground, a long term, minor-to-moderate, beneficial effect on soils. Actions as a result of resource management planning would protect and improve soil characteristics in the park, a long term, regional, moderate, beneficial effect. Exotic vegetation management activities would involve the use of steam and hot water applications, and chemical and mechanical removal of vegetation (which increase erosion locally), a long term, local, minor, adverse effect.

The combination of effects of these plans, projects, and actions on bare ground, compaction, and erosion issues of soils would be long term, park-wide, minor to moderate, and beneficial. Alternative 1 would contribute long-term, minor, adverse effects, for an overall cumulative effect that would be long term, minor, and beneficial.

Nutrient Cycling

Nitrogen deposition from poor air quality would continue to negatively affect nutrient cycling by introducing additional nitrogen into nitrogen-limited systems in the park, such as willow and aspen communities. This change in the nitrogen cycle would result in long-term, regional, moderate, adverse effects on soils. Prescribed fire actions are occurring and will continue to occur in the elk primary winter and summer ranges in the park, causing short-term, minor, adverse effects and long-term, negligible, beneficial effects on soils as a result of the change in soil composition (i.e., reduction in organic matter) and increases in nutrient availability in the soils. Mechanical thinning actions would remove carbon stocks from local areas, a long-term, negligible, adverse effect. Fencing a small area of willows would restrict elk from the area, resulting in a long-term, minor, beneficial effect on nutrient cycling. Constructing a barn would have a long-term, local, minor, adverse effect on soil productivity, as soils would be covered with a permanent structure.

The combination of effects of these plans, projects, and actions would be long term, moderate, and adverse. Alternative 1 would contribute long-term, minor-to-moderate, adverse effects on cumulative effects. When effects of other plans, projects, and actions are combined with effects of Alternative 1, cumulative effects on soils would be long term, moderate, and adverse.

Conclusion

Because the potential for bare ground and increases in bare ground would be slight, the adverse effects on soils from compaction and bare ground would be long term, local, and minor in the core winter range but negligible elsewhere in the elk range. Effects from erosion on soils would be long term, local, negligible to minor, and adverse, again depending on the slope of the local area of the primary elk range. Increased bank instability from reduced willow cover would result in a long-term, local, negligible, adverse effect on soils. In upland shrub areas, a 30% decrease in calcium, magnesium, and other cations would continue to result in a long-term, local, minor-to-moderate, adverse impact on soils in the primary winter range but minor in the primary summer range. Reduction in available soil nitrogen and carbon over time in aspen and willow communities would be a long-term, local, minor, adverse effect. A reduction in overall pools and fluxes of nitrogen and carbon in short willow and aspen areas would be a long-term, local, moderate, adverse effect. Increases in nitrogen inputs to mixed conifer habitats from elk transferring nitrogen from feeding in willow and aspen areas to mixed conifer areas where they bed and defecate, would have long-term, local, minor, adverse effects on mixed conifer on the elk core winter range but negligible-to-minor effects in other portions of the elk range from lower densities and therefore lower nitrogen inputs. Continued high levels of elk herbivory would likely continue to reduce mycorrhizal levels and change species composition, a long-term, minor, adverse effect on soils in the core winter range, and a negligible adverse effect on the remainder of the elk range. The continued lack of flooding from a reduced beaver population represents a long-term, local, minor, adverse effect on soils from reduced microbial activity.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor, and beneficial, with Alternative 1 making a long-term, minor, adverse contribution. Cumulative effects on nutrient cycling would be long term, moderate, and adverse, with Alternative 1 contributing long-term, minor-to-moderate, adverse effects.

Impairment of soils within the park would not occur under Alternative 1.

Alternative 2

Compaction and Bare Ground

A large reduction from current population size, fencing of aspen, and redistribution measures would reduce elk densities and grazing pressure in the core elk range, resulting in reduced compaction and less bare ground, based on a documented 4.6% difference in bare ground in ungrazed versus grazed sites in the core winter range (Singer et al. 2002). This reduction in bare ground and compaction would represent a long-term, local, minor, beneficial effect on soils because while the change would not be as great as 4.6%, given that elk would still occur in these areas, it would still be detectable. However, where elk densities are already low in other parts of the primary winter range and the primary summer range, effects of a reduced elk population on bare ground and compaction would be negligible and beneficial.

Short-term effects associated with lethal control activities and research activities conducted in coordination with elk and vegetation management, including temporary capture facilities, herding activities, use of vehicles or horses, and the removal of carcasses, would increase soil compaction and bare ground, although it would be barely noticeable, localized, and recovery would be rapid as long as routes were not reused every year. A temporary capture facility would disturb vegetation and expose some bare ground in a small area. Removal of carcasses could expose bare ground if dragging was necessary. However, again, if routes were not repeatedly used, effects should be minimal. Use of all-terrain vehicles during the summer months and herding with trained dogs and horses could result in some compaction of soils, but because vehicles would not be consistently traveling over the same area, it is unlikely effects would be detectable. Overall, effects would be local, minor, and adverse in both the elk primary winter and summer ranges in the park.

Activities related to mechanical thinning and burning would occur in willow and aspen communities in both the primary winter and summer ranges, causing compaction of soils from vehicles and the exposure of bare ground from prescribed burns. These actions would take place infrequently and in small areas. Effects would be short term (as areas would quickly revegetate), local, minor to moderate (depending on the size of the area), and adverse.

Erosion

Under Alternative 2, the reduction in elk population would be extensive and quick. Bare ground would be replaced with vegetative cover rapidly in the elk core winter range from decreased browsing and increased willow and aspen as a result of fencing of aspen and subsequent beaver reintroduction or recolonization, thereby decreasing the potential for erosion. This benefit to soils would be long term, local, and minor in the core winter range but negligible in other areas of the elk range, where elk densities would be lower.

Because the current elk population is only having a negligible adverse effect on erosion from bank destabilization, a reduction in the elk population and a related reduction in browsing pressure would negligibly reduce erosion of streambanks.

As mentioned in the "Compaction and Bare Ground" subsection, effects associated with lethal control and vegetation management activities would be short term, local, minor, and adverse. Horses, vehicles, and carcass removal would have the potential to increase erosion, but this would be very limited in extent and would rapidly recover. Also, the temporary capture facility and prescribed burns would likely be on land with a low slope, thereby reducing erosion potential.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Willow and Aspen Communities

If the elk population at Rocky Mountain National Park were reduced by 40%, Schoenecker et al. predict that total soil carbon and nitrogen, net mineralized nitrogen, total shrub carbon, and coarse and fine root carbon would be relatively stable in the long term for uplands and willow communities (2002), instead of the slight decrease predicted with the current elk population level. Coughenour's modeling also reports little change in carbon and nitrogen pools with reduced elk grazing and abundance (2002), again, because soil pools largely outweigh annual plant uptake and grazing offtake. Therefore, effects on nutrient cycling aspects of soils from the maximum reduction of elk would be long term, local, minor, and beneficial in willow communities in the core elk winter range. Effects on nutrient cycling in willow communities in other portions of the primary winter range and the primary summer range would be less because elk effects on nutrient cycling would be spread out over larger areas.

However, nitrogen inputs to short willow communities alone and aspen communities would be expected to increase with a reduction in the elk population and elk densities (from elk redistribution activities). Nitrogen inputs would be less than if there was no elk herbivory in these communities, but would be substantially greater than currently occur. If current nitrogen inputs are 60% of ungrazed sites, a 50% reduction in the elk population could result in nitrogen inputs that are up to 80% of ungrazed sites, a large increase from 60% (Singer et. al. 2002). Therefore, effects on short willow and aspen communities' nitrogen inputs would be long term, local, moderate, and beneficial on the elk primary winter range. Effects of a reduced elk population on the primary summer range would be expected to be less, as elk have less of an influence on nitrogen inputs in the primary summer range due to lower densities; therefore, effects would be long term, minor, and beneficial.

Mechanical thinning of willow and aspen sites would result in increases in nitrogen mineralization and nitrification (Kaye and Hart 1998). This increase in nitrogen cycling rates would occur in small portions of the willow and aspen stands in the elk primary winter and summer ranges. Effects would be detectable; Kaye and Hart measured a more than doubling of nitrogen from nitrogen mineralization in ponderosa pine and bunchgrass that was thinned (1998). Therefore, effects from mechanical thinning would be long term, local, minor, and beneficial.

Prescribed burns would release nitrogen and other nutrients in woody vegetation back into the soils for other plants to readily uptake (Colorado State Forest Service n.d.). This would result in a long-term, minor, beneficial effect on soils by improving access to soil nutrients but it would also temporarily adversely affect soil composition through the removal of topsoil, resulting in short-term, local, minor, adverse effects.

Willow replantings would slightly increase pools of nitrogen and carbon in small areas under Alternative 2 but would be unmeasurable, a local, negligible, beneficial effect on soils.

Upland Shrub

In upland shrub area soils, increases in availability of calcium, magnesium, potassium, and phosphorus would occur as a result of reduced grazing by elk. This would result in a minor (as increases would be no greater than the 30% elk currently take from upland shrub areas; Binkley et al. 2003), beneficial effect in upland shrub area soils.

Microbial Activity

Reduced levels of elk herbivory on willow and aspen would increase mycorrhizal levels in the soil. This would result in long-term, local, minor, beneficial effect on soils.

Increases in the water table associated with a recolonized or reintroduced beaver population would result in improved retention of water (i.e., flooding and soil saturation) and would increase microbial action in soils (Songster-Alpin and Klotz 1995, Naiman and Melillo 1984), representing a long-term, local, minor, beneficial effect on soils in the core winter range because the increase in microbial activity and subsequent improvement in soil productivity would begin to return to natural productivity levels.

Cumulative Impacts

Bare Ground, Compaction, Erosion, and Flooding

Effects of other plans, projects, and actions on bare ground, compaction, erosion, and flooding would be the same as described for Alternative 1: long term, regional, minor to moderate, and beneficial. Alternative 2's contribution to cumulative effects would be long term, minor, and beneficial from improvements from flooding of soils and slight reductions in bare ground and erosion. Therefore, overall cumulative effects would be long term, minor, and beneficial.

Nutrient Cycling

Effects of other plans, projects, and actions on bare ground, compaction, erosion, and flooding would be the same as described for Alternative 1: long term, moderate, and adverse. Alternative 1 would contribute long-term, minor, beneficial effects on cumulative effects. When effects of other plans, projects, and actions are combined with effects of Alternative 1, cumulative effects on nutrient cycling aspects of soils would be long term, minor, and adverse.

Conclusion

A 60% to 70% reduction of the elk population and redistribution measures would reduce bare ground and compaction and, therefore, erosion, resulting in a long-term, local, minor, beneficial effect on soils. Reduced browsing pressure along riparian areas would likely result in improved bank stabilization, a long term, local, negligible, beneficial effect. Short-term effects associated with the plan's activities would be local, minor, and adverse to soils, except for mechanical thinning and prescribed burning, which would have local, minor-to-moderate, adverse effects on soils. Effects on nutrient cycling aspects of soils in willow and aspen areas from the maximum reduction of elk would be long term, local, minor, and beneficial, based on Schoenecker et al.'s (2002) and Coughenour's (2002) modeling. Increases in nitrogen inputs would be expected from a reduction in the elk population, resulting in a long-term, local, moderate benefit in the elk core winter range, but minor benefits would occur locally on the remainder of the primary winter range and the primary summer range. In upland shrub areas, increases in cation availability would occur, resulting in a minor, beneficial effect on upland shrub area soils.

Mechanical thinning of willow and aspen sites would result in increased nitrogen mineralization and nitrification in local areas on the elk primary winter and summer ranges where the thinning occurs, a long-term, minor, beneficial effect. Prescribed burns would result in long-term, minor benefits by improving access to soil nutrients, and short-term, local, minor, adverse effects from affecting soil composition. Willow replantings would slightly increase nitrogen and carbon pools, a local, negligible beneficial effect. Upland shrub area soils would experience local, minor benefits. Reduced levels of elk herbivory on willow and aspen would increase mycorrhizal levels in the soil, a long-term, local, minor, beneficial effect on soils. Increases in the water table associated with increases in beaver would represent a long-term, local, moderate, beneficial effect on soils.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor, and beneficial, with Alternative 2 contributing long-term, minor beneficial effects. Cumulative effects on nutrient cycling would be long term, minor, and adverse, with Alternative 2 contributing long term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 2.

Alternative 3

Compaction and Bare Ground

A 30% to 50% reduction of the current elk population size, fencing of both aspen and riparian willow areas, and elk redistribution would reduce grazing pressure and result in less bare ground (based on a measured difference of 4.6% less bare ground in ungrazed compared to grazed sites) than what currently is present and would be incrementally less than what would occur under Alternative 2. Elk would be restricted from using the fenced areas and would be redistributed, thereby reducing densities and impacts in a given area. This would represent a long-term, local, negligible, beneficial effect on unfenced soils and a long-term, local, minor, beneficial effect on fenced soils in areas of aspen and montane riparian willow on the primary winter and summer ranges, as more elk would congregate in a smaller total area than under Alternative 2.

Short-term effects associated with lethal control activities, research activities, and vegetation management activities, including herding activities, use of vehicles or horses, removal of carcasses, and fencing installation would be the same as those described for Alternative 2.

Erosion

Under this alternative, there would be less recovery of vegetation in areas of the primary summer and winter ranges than under Alternative 2, as elk would continue to forage in unfenced areas and elk numbers would be reduced gradually to the higher end of the natural range. Therefore, soils would continue to be exposed and elk would continue to cause erosion in unfenced areas. A reduction in bare ground and in exposure of soils to erosion would be limited to aspen and willow areas that would be fenced. Based on Singer et al. (2002), a 4.6% reduction of bare ground would be expected within the fenced areas, which would result in long-term, local, minor benefits to soil from reduced erosion. Negligible, beneficial effects would occur outside of the fenced areas in both the primary winter and summer ranges.

Because the current elk population is having a negligible, adverse effect on erosion from bank destabilization, a reduction in the elk population, fences in aspen and montane riparian willow communities, and a related reduction in browsing pressure would negligibly reduce erosion of streambanks.

Short-term effects associated with lethal control and vegetative management activities would be the same as those described for Alternative 2.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Overall impacts on nutrient cycling would be similar to those described under Alternative 2, although incrementally less due to a higher elk population. However, with regard to carbon and nitrogen transfer out of willow and aspen areas, elk would not contribute to transferring nitrogen and carbon away from the area in fenced areas of aspen and montane riparian willow.

Effects on soils from changes in nutrient cycling from mechanical thinning activities, prescribed burns, and willow replantings would be the same as those described for Alternative 2.

Microbial Activity

Effects on mycorrhizae would be the same as those described for Alternative 2.

Alternative 3 would allow beaver recovery in areas that are fenced, as they would not be competing with elk in these areas and willow would be more likely to recover in these areas. However, unfenced areas would have less potential for beaver recovery and thus would have a smaller area overall where flooding and microbial activity would be increased compared to Alternative 2. Overall benefits to soils from flooding would be long term, local, and minor.

Cumulative Impacts

Bare Ground, Compaction, Erosion, and Microbial Activity

Effects of other plans, projects, and actions on bare ground, compaction, erosion, and flooding of soils would be the same as described for Alternative 1: long term, regional, minor to moderate, and beneficial). Alternative 3's contribution to cumulative effects would be long term, minor, and beneficial from flooding and reductions in bare ground and erosion inside fencing. Therefore, overall cumulative effects would be long term, minor to moderate, and beneficial.

Nutrient cycling

Effects of other plans, projects, and actions on nutrient cycling would be the same as described for Alternative 1: long term, moderate, and adverse. Alternative 3's contribution to cumulative effects would be long term, minor, and beneficial from reductions in elk-related transfer of nitrogen and carbon away from willow and aspen systems in the park. Overall cumulative effects on nutrient cycling would be long term, minor, and adverse.

Conclusion

A 30% to 50% reduction in the elk population in the park, fencing of montane riparian willow and aspen, and elk redistribution would reduce bare ground, compaction, and erosion, resulting in a long-term, local, minor benefit to fenced soils and a local, negligible, beneficial effect on unfenced soils in the elk primary winter and summer ranges. Short-term effects from the plan's activities would result in minor, local, adverse impacts on the primary elk winter and summer ranges, except for mechanical thinning and burning, which would be minor to moderate and occur locally in montane riparian willow and aspen communities, primarily in the winter range. Reduced browsing pressure and fencing would improve bank stabilization, a long-term, local, negligible, benefit in both fenced and unfenced areas.

Overall impacts on nutrient cycling would be similar to those described under Alternative 2: long term, local, minor, and beneficial from increases in soil nitrogen and carbon across the elk primary winter and summer ranges; long term, local, moderate, and beneficial on the elk primary winter range; and minor on the elk primary summer range, although effects would be incrementally greater in fenced areas. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2: a long term, local, moderate benefit in the elk primary winter range but minor in the primary summer range. Effects on soils from changes in nutrient cycling from mechanical thinning activities would be the same as described for Alternative 2: long term, local, minor to moderate, and beneficial. Effects from prescribed burns would be the same as described for Alternative 2: long term, minor, and beneficial and short term, local, minor, and adverse. Effects from willow replantings would also be the same as described for Alternative 2: long term, local, negligible, and beneficial.

Effects on mycorrhizae would be the same as described for Alternative 2: long term, local, minor, and beneficial. Overall benefits from increased flooding of soils would be long term, local, and minor.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor to moderate, and beneficial, with Alternative 3 contributing long-term, minor, beneficial effects. Cumulative effects on nutrient cycling would be long term, minor, and adverse, with Alternative 3 contributing long-term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 3.

Alternative 4

Compaction and Bare Ground

Effects on soils would be similar to those described for Alternative 3. Elk would be restricted from using the fenced areas and would be redistributed, thereby reducing densities and impacts in a given area. This would represent a long-term, local, negligible, beneficial effect on unfenced soils and a long-term, local, minor, beneficial effect on fenced soils in areas of aspen on the primary elk range and montane riparian willow on the primary winter range. Effects associated with lethal control activities, research activities, and vegetation management activities would be the same as those described for Alternative 2.

Erosion

Effects on soils would be similar to those described for Alternative 3. Effects on soils from reduced browsing pressure would be the same as described for Alternative 3. Effects associated with lethal control activities and potential beaver recovery or reintroduction would be the same as those described for Alternative 2.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Effects on soils would be the same as those described for Alternative 3.

Microbial Activity

Effects on mycorrhizae would be the same as those described for Alternative 2. Effects on soils from increased flooding would be similar to those described for Alternative 3.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 3.

Conclusion

A 30% to 50% reduction in the elk population in the park, fencing of willow and aspen, and elk redistribution would reduce bare ground, compaction, and erosion, resulting in a long-term, local, minor benefit to fenced soils in the winter elk range and a local, negligible, beneficial effect on unfenced soils in the primary winter and summer elk range. Short-term effects from the plan's activities would result in minor, local, adverse impacts on the winter and summer elk ranges, except for mechanical thinning and burning, which would be minor to moderate and occur locally in willow and aspen communities in both the primary winter and primary summer ranges. Reduced browsing pressure and fencing would improve bank stabilization, a long term, local, negligible benefit in both fenced and unfenced areas in the winter and summer elk ranges.

Overall impacts on nutrient cycling would be similar to those described under Alternative 2 (long term, local, minor, and beneficial from increases in soil nitrogen and carbon across the elk primary winter and summer ranges; long term, local, moderate, and beneficial on the elk primary winter range; and minor on the elk primary summer range), although effects would be incrementally greater in fenced areas. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2: a long term, local, moderate benefit in the elk primary winter range but minor in the primary summer range. Effects on soils from changes in nutrient cycling from mechanical thinning activities would be the same as described for Alternative 2: long term, local, minor to moderate, and beneficial. Effects from prescribed burns would be the same as described for Alternative 2: long term, minor, and beneficial as well as short term, local, minor, and adverse. Effects from willow replantings would also be the same as described for Alternative 2: long term, local, negligible, and beneficial.

Effects on mycorrhizae would be the same as described for Alternative 2: long term, local, minor, beneficial. Overall benefits from increased flooding of soils would be long term, local, and minor.

Cumulative effects on bare ground, compaction, erosion, and flooding on soils would be long term, minor to moderate, and beneficial, with Alternative 4 contributing long-term, minor, beneficial effects. Cumulative effects on cycling on soils would be long term, minor, and adverse, with Alternative 4 contributing long-term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 4.

Alternative 5

Compaction and Bare Ground

Effects from elk population reduction would be similar to those described for Alternative 2.

Short-term effects associated with vegetation management and lethal control activities and research activities implemented primarily during the initial phase of wolf release, including temporary capture facilities, herding activities, use of vehicles or horses, removal of carcasses, and fencing installation, would result in the same effects as those described for Alternative 2. In the long term, the impacts of these actions would be reduced to negligible or even no effect as wolves would become the primary management tool to disperse and regulate the elk population.

Erosion

Effects on soils would be similar to those described for Alternative 2. Effects on soils from reduced browsing pressure would be the same as those described for Alternative 2. Effects associated with lethal control and vegetation management activities would be the same as those described for Alternative 2.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Effects from elk population reduction would be similar to those described for Alternative 2. The release of wolves would likely directly contribute negligible, beneficial effects on nutrient cycling and soil productivity because their numbers would be too few to detect any changes.

Microbial Activity

Effects on mycorrhizae would be the same as those described for Alternative 2. Effects from elk population reduction would be similar to those described for Alternative 2.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 2.

Conclusion

Effects from elk population reduction on bare ground, compaction, and erosion would be similar to those described for Alternative 2: long term, local, minor, and beneficial as well as short term, minor, and adverse. Overall impacts on nutrient cycling for aspen and willow would be similar to those described under Alternative 2: long term, local, minor, and beneficial from increases in soil nitrogen and carbon across the elk primary winter and summer elk range; long term, local, moderate, and beneficial on the primary winter range; and minor on the elk primary summer range. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2: a long term, local, moderate benefit in the winter elk range but minor in the primary summer range. Effects from mechanical thinning and burning on nutrient cycling would be the same as described for Alternative 2: long term, minor, benefits. Effects on mycorrhizae would be the same as described for Alternative 2: long term, local, minor, beneficial. The release of wolves would likely directly contribute negligible, beneficial effects on nutrient cycling and soil productivity because their numbers would be too few to result in detectable changes. Effects from increased microbial activity from flooding of soils would be similar to those described for Alternative 2: long term, local, minor, and beneficial.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor to moderate, and beneficial, with Alternative 5 contributing long-term, minor-to-moderate, beneficial effects. Cumulative effects on nutrient cycling would be long term, minor, and adverse, with Alternative 5 contributing long term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 5.

NATURAL SOUNDSCAPE

Summary of Regulations and Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in Section 1.4.6 of *Management Polices* (2006b), natural soundscapes are recognized and valued as a park resource in keeping with the NPS mission.

The natural soundscape, sometimes called natural quiet, is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Management goals for soundscapes are included in Section 4.9 of *Management Policies* (NPS 2006b) and in *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000).

Management Policies requires restoration of degraded soundscapes to the natural condition whenever possible and protection of natural soundscapes from degradation. The National Park Service is directed to "take action or prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2000).

Director's Order 47: Soundscape Preservation and Noise Management requires, "to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources" (NPS 2000). It also states that "the fundamental principle underlying the establishment of soundscape preservation objectives is the obligation to protect or restore the natural soundscape to the level consistent with park purposes, taking into account other applicable laws" (NPS 2000). Noise is generally considered appropriate if it is generated from activities consistent with park purposes and at levels consistent with those purposes.

Director's Order 47 provides the following policy direction: "Where natural soundscape conditions are currently not impacted by inappropriate noise sources, the objective must be to maintain those conditions. Where the soundscape is found to be degraded, the objective is to facilitate and promote progress toward the restoration of the natural soundscape" (NPS 2000). Where legislation provides for specific noise-making activities in parks, the soundscape management goal would be to reduce the noise to the level consistent with the best technology available, which would mitigate the noise impact but not adversely affect the authorized activity. When a noise-generating activity is consistent with park purposes, "soundscape management goals are to reduce noise to minimum levels consistent with the appropriate service or activity" (NPS 2000).

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on natural soundscapes includes the elk primary winter and summer ranges, as these are the areas most affected by potential activities and primary habitats for elk in the park. Cumulative effects that would occur both within and outside of these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on natural soundscapes included impacts from management activities that create noise, such as firearms, vehicle use, and helicopter overflights, and the addition of natural sounds if wolves were released. Because 95% of the park is managed as wilderness, activities associated with lethally removing elk would introduce human-caused noise into the soundscape in undeveloped, sensitive areas of the park. Releasing wolves to the park could potentially change the range of natural sounds in the soundscape.

Assessment Methods

The technique used to assess noise impacts from management activities in this document is in accordance with *Management Policies* (NPS 2006b) and *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000). The evaluation method considered noise context, sound characteristics including audibility, and time factors, such as duration and frequency of occurrence. These all interact to determine the degree of impact for an activity. Additional primary references included Kyttala no date, Free Hearing Test no date, LHH 2005, and NIDCD 2005 for decibel level information. Known decibel levels of activities were compared against baseline natural sound levels, measured by Harris, Miller, Miller, and Hanson to determine the effects of the actions on soundscapes (1998). No additional sound measurements were collected, nor was any noise modeling conducted. Because of this, the following analysis can only evaluate sounds on an individual level, and its ability to assess additive impacts on the overall soundscape is limited.

The analysis evaluates only the effects of the alternative actions on the baseline natural soundscape. The effects of all other human-caused noises that occur in or affect the park are considered in the cumulative impact analysis. As described in the "General Methodology" section, the cumulative impact analysis evaluates the effects of the alternative actions in combination with all other past, present, and future actions (in this section, all other human-caused noise) within the geographic area of analysis.

Each element of the alternatives is evaluated for its effect on the baseline natural soundscape in both developed and undeveloped areas. The baseline natural soundscape is the same for both developed and undeveloped areas; however, the acceptable noise context and sound characteristics are different for each of these two settings. The sounds of motorized equipment or large congregations of visitors, for example, are more acceptable in developed areas than in undeveloped areas. The impact thresholds discussed below are different for developed and undeveloped areas to account for the differences in acceptability.

Primary steps for assessing impacts would include 1) identifying existing activities that may be affected by noise from the actions, 2) determining the potential noise levels and duration caused by actions under each alternative, and 3) identifying the impacts on the natural soundscape in potential areas where noise concentrations and the effects of sounds may be of concern.

Context

Rocky Mountain National Park resources most likely to be affected by activities related to elk and vegetation management activities include the park's natural soundscape, wilderness areas, and noise-sensitive wildlife. Potential impacts of noise on wildlife and wilderness are presented in those sections of the document. Impacts on visitor experience are presented in the "Visitor Use and Experience" section. Analysis in this section is intended to disclose impacts on the natural soundscape specifically, recognizing that sound is an intrinsic part of other resources and values in Rocky Mountain National Park.

Sound Characteristics

Duration and frequency of occurrence of a noise affect the impact that a noise would produce. For example, a loud noise that occurs infrequently and for short time periods may have less of an impact than a quieter noise that occurs over longer time periods and at frequent intervals. Examples of common noise levels would be a firecracker as 150 dBA and quieter noise would be rainfall as 50 dBA (LFHH 2003).

On average, noise levels decrease 6 dBA for every doubling of distance (Mcsquared System Design Group n.d.). For the purposes of this document, noise levels are presented at the source and additionally at 1,000 feet and 1 mile, using this rule to calculate decibel levels at farther distances.

These factors were addressed qualitatively in the impact analysis.

Impact Threshold Definitions

Impacts were evaluated for developed and undeveloped areas of the park using the following thresholds. Developed areas are the areas of the park with facilities and resulting larger concentrations of visitors. Examples are the Beaver Meadows Visitor Center, the Glacier Basin Campground, and the Bear Lake parking area and related facilities. Undeveloped areas lack park facilities other than roads or trails, and concentrations of visitors are usually low. Decibel levels in the thresholds were selected qualitatively by grouping a list of activities ranging from 40 to 140 dBA into rough categories of very low, low, medium, and high noise.

Intensity of Impacts

Undeveloped Areas of Rocky Mountain National Park

Negligible: Natural sounds predominate, although human-caused noise is audible in local areas. Human-caused noise is rarely audible 1000 feet or more from the noise source. When noise is present, it is at very low levels (< 70 dBA at the source) and occurs only for short durations in most of the area.

Minor: Natural sounds predominate. Human-caused noise is present only infrequently and occurs only at low levels (<80 dBA at the source) and for short durations in most of the area. When noise is present, it is rarely audible from 1,000 feet or more from the noise source.

Moderate: Human-caused noise is present infrequently to occasionally at low-to-medium levels (<110 dBA at the source) and durations. Human-caused noise is occasionally audible more than a half mile from the source.

Major: Natural sounds commonly are masked by human-caused noise at low or greater levels for extended periods of time. Human-caused noise can be experienced within a half mile of the source at medium levels (80 to 110 dBA at the source) and durations, and noise levels in these areas occasionally are high (>110 dBA). More than half a mile from the source, the natural soundscape free from human-caused noise can be experienced less than half the time during the day.

Developed Areas of Rocky Mountain National Park

Negligible: Natural sounds predominate. Human-caused noise is rarely audible from a quarter mile or more from the noise source. When noise is present, it is at low levels (<80 dBA at the source) and occurs only for short durations in most of the area.

Minor: Natural sounds usually predominate. Human-caused noise is present only infrequently and occurs only at low to medium levels (<110 dBA at the source) and for short durations in most of the area. When noise is present, it is rarely audible from one mile or more from the noise source.

Moderate: Human-caused noise is present infrequently to occasionally at medium levels (80-110 dBA at the source) and durations. Human-caused noise is occasionally audible more than one mile from the source.

Major: Natural sounds commonly are masked by human-caused noise at low or greater levels for extended periods of time. Human-caused noise can be experienced within a mile of the source at medium levels (80 -110 dBA at the source) and durations, and noise levels in these areas occasionally are high (>110 dBA at the source). More than a mile from the source, the natural soundscape free from human-caused noise can be experienced less than half the time during the day.

Type and Intensity of Impact

Beneficial impacts would reduce levels of human-created noise in the park or would increase natural sounds in the soundscape.

Adverse impacts would result in higher levels of human-created noise in the park's soundscape.

Duration: Short-term impacts of noise intrusion would last less than two hours in a given 24-hour period. Long-term effects would last longer than two hours in a given 24-hour period.

Impairment

Impairment of the natural soundscape would occur when the action contributes substantially to deterioration of the natural soundscape in the park to the extent that the natural soundscape would be almost completely or completely masked by human-caused noises.

Alternative 1

As described in the "Affected Environment" for Natural Soundscapes, natural background noises range from 30 to 45 dBA (Harris, Miller, Miller, and Hanson 1998). Natural sounds that occur in addition to unidentifiable background noise range from 25 (wind) to 55 (elk bugling) dBA in forested areas; in meadow areas, 26 (wind) to 38 (other animals); and 27 (wind) in tundra areas (Harris, Miller, Miller, and Hanson 1998).

Elk themselves create the largest level of natural sounds in the park (from 46 to 90 dBA). The acoustic study was recorded during September, during the elk rut, when elk bugling is commonly heard. Elk would likely contribute lower levels of natural sounds to the soundscape during other times of the year.

Actions that would occur related to elk and vegetation management with the potential to have effects on soundscapes are discussed below. The conclusion discusses an additive effect on soundscapes that includes all of these actions.

Fencing

Under Alternative 1, fencing activities would be limited to maintaining research plot fencing. Noise intrusions would occur very infrequently and would be likely limited to vehicle use and hand tools. Vehicle use and hand tools other than hammering are less than baseline sound levels at 1,000 feet (30 dBA). Hammering is detectable at 1,000 feet (80 dBA), but would not necessarily be required for maintenance. Therefore, maintenance of research plot fencing would continue to have a negligible, adverse effect on soundscapes in developed and undeveloped areas.

Redistribution Techniques

Minimal redistribution techniques such as pepper spray or mace, cracker rounds, rubber buckshot, rubber slugs, or slingshot, depending on the situation (NPS 2002e), would continue to be used under Alternative 1. They would typically occur in developed areas of the park, although they could occur in undeveloped areas as well.

Cracker shot has a decibel level of up to 150 dBA at the source and would be 90 dBA at 1,000 feet, 84 dBA at one-half mile, and 78 dBA at one mile (LHH 2005). Rifles (.308 caliber used by the park) have a decibel level of up to 156 dBA at the source (Free Hearing Test n.d.) and would be up to 96 dBA at 1,000 feet, up to 89 dBA at one-half mile, and up to 82 dBA at one mile. Shotguns used to fire rubber shot have an equivalent level to that of the rifle. Duration time would be a few seconds for each of these techniques. Pepper spray and slingshot would introduce very little noise to the soundscape.

Effects of redistribution techniques on soundscapes would continue to be short-term, local, negligible, and adverse because of the relative infrequency that the techniques are used.

Aggressive or Injured Animals

Injured animals or elk suspected of having chronic wasting disease would be immobilized with a dart rifle and then lethally injected, or occasionally elk are lethally removed using a rifle or shotgun slug. This occurs minimally and could occur in both developed and undeveloped areas of the park. For animals in accessible areas suspected of having chronic wasting disease, carcasses would be removed, sampled, and disposed of. Activities could occur during the day. Dart rifles are only heard when the gun is fired (up to 94 dBA at the source, depending on model, Straight Shooters n.d.). Current models in the park can only be heard only up to 70 yards away (Watry 2005d). The duration is less than a second.

Removing carcasses would continue to introduce additional noise into the soundscape for short periods of time, from human voices in the forest moving the carcasses and vehicle and winch use.

Because these actions would occur infrequently, dart rifles can only be heard from 70 yards away, and other associated noises would have lower decibel levels, overall effects would continue be short-term, local, negligible, and adverse in both developed and undeveloped areas. Effects, although short-term, would occur periodically for the duration of the plan.

Monitoring

Monitoring elk and vegetation would continue to involve one or more aerial flights during the winter season and several days during the year people would be conducting ground surveys.

Several times during the year, people would be in undeveloped areas of the park for the ground surveys, with activities occurring during daylight hours.

Aerial overflights under Alternative 1 would last one day each, with a potential of at least one overflight to many overflights during the winter season. Helicopters have a decibel level of 105 dBA at the source, can be heard from more than one mile away at lower levels, and the duration can last a few minutes if the helicopter is moving or longer if the helicopter is hovering.

Ground surveys would involve human voices being introduced into undeveloped areas of the park and vehicle use to access survey areas. Vehicles have a decibel level of 70 dBA at the source and can be heard up to 1,000 feet away.

Monitoring would result in short-term, parkwide, negligible-to-major, adverse effects on the natural soundscape depending on the distance from the noise source in undeveloped areas and developed areas. Helicopters would create far-reaching and enduring noises. Short-term effects would periodically occur for the length of the plan.

Cumulative Impacts

Recorded noise intrusions within the park vary from 50 to 105 dBA (Harris, Miller, Miller, and Hanson 1998), and include people, jets, and helicopters. Over the course of one hour, in developed areas, such as Beaver Meadows and a tundra site along Trail Ridge road near Sundance Mountain, only natural sounds could be heard from 1% to 76% of the time. For sites north of Grand Lake and in wilderness (Green Mountain and Big Meadow, near Tonahutu Creek), natural sounds without intrusion could be heard from 75% to 95% of the time. These measurements were all taken during daylight hours, from 11 a.m. to 6 p.m.

These sound measurements demonstrate that depending on where an area is located in the park, natural sounds and existing noise intrusions vary. Tundra areas have the lowest background soundscape; therefore, noise intrusions are more notable. Also, whether an area is located near a developed area or roads can cause considerably more noise intrusions to occur within the area.

A number of ongoing activities occurring within the park involve mechanical thinning operations (for bark beetle and fuels management), which would introduce noise from chain saws and potentially heavy equipment, in the primary winter and summer ranges of the elk population at the same time elk and vegetation management activities would be occurring, causing short-term and long-term, local, moderate, adverse effects. Treating exotic plants on the elk primary winter range outside of wilderness would involve using ATVs, mowers, and trimmers, resulting in short-term, minor-to-moderate, adverse effects. Search and rescue operations can use helicopters. Trail management activities would involve the use of hand tools, chain saws, and potentially, dynamite blasting, and helicopters for inaccessible areas, which would cause short-term, adverse effects on the soundscape that would range from negligible to major.

The Park Omnibus Appropriations Act of 1998 banned the use of low-flying commercial air tours over the park, a short-term, regional, major, beneficial effect. However, a dominant additional noise intrusion would continue to occur from 30 to 70 low-level jets (between 19,000 and 15,400 feet, up to 90 dBA at those distances) flying over the park en route to Denver International Airport, on a daily basis, a short-term, major, adverse effect.

The park's backcountry and wilderness plan provides long-term, regional, moderate, benefits to the natural soundscape by encouraging the limitation of noises into the backcountry, but it is limited to actions on the ground in the park.

Effects of these thinning operations, exotic vegetation management, trail activities, and daily overflights combined with the beneficial aspects of the backcountry plan and the air tour ban, would result in continued long-term, local and regional, major, adverse effects on soundscapes. While beneficial effects from the air tour ban are major, the introduction of noise into the soundscape would still have major, adverse effects from the other noises introduced into the soundscape. At any given time, Alternative 1 could contribute a short-term and long-term, local and regional, minor-to-major, adverse effect, although the actions would occur infrequently. When effects from other actions occurring in the past, present, and foreseeable future that impact soundscapes are combined with actions from Alternative 1, the cumulative effect on soundscapes would be short-term, local and regional, minor-to-major, and adverse.

Conclusion

Maintenance of research plot fencing would have a negligible, adverse effect on soundscapes, as it would continue to occur very infrequently. Effects of redistribution techniques on soundscapes would continue to be short-term, local, negligible, and adverse. Short-term effects would continue to periodically occur for the length of the plan for all management actions of the alternative. Because actions to manage aggressive and injured animals would occur infrequently, dart rifles can only be heard from 70 yards away, and other associated noises would have smaller decibel levels, overall effects on soundscapes would continue to be short-term, local, negligible, and adverse in both developed and undeveloped areas. Monitoring would continue to result in short-term, negligible-to-major, adverse effects on the natural soundscape in undeveloped areas and developed areas. Helicopters would create far-reaching and enduring noises the would occur periodically throughout the life of the plan.

Overall, noise intrusions would continue to be very infrequent and only on occasion would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds).

Cumulative effects of other plans and projects and the actions of Alternative 1 would continue to be short-term, local and regional, minor-to-major, and adverse.

Impairment of natural soundscape within the park would not occur under Alternative 1.

Alternative 2

Gunshots from suppressed-noise and unsuppressed weapons would occur in the park fairly frequently during the first four years of implementation of Alternative 2 and would decrease in occurrence for the remainder of the plan. Noise intrusions from the use of all-terrain vehicles and snowmobiles, along with road vehicle use, would occur frequently throughout the year during the first four years of the plan and, like the use of weapons, would decrease in occurrence thereafter. Helicopter use would increase from current levels, due to the need to distribute fencing materials to remote locations of both the primary winter and summer elk ranges. The use of helicopters for fencing would occur as needed based on monitoring of vegetation conditions. Thinning and burning activities would increase noise throughout the entire day on occasion for the life of the plan, due to chainsaw use.

A research study evaluating procedures for a live test for chronic wasting disease in elk would be conducted in coordination with elk management activities in the first three years of the plan.

Effects on soundscapes from the capture or darting, anesthetizing, and handling of elk would be the same as those described below for lethal control activities involving darting and use of a capture facility.

Impacts from these activities of Alternative 2 that affect soundscapes are discussed below.

Lethal Removal

Effects from lethal elk removal using subsonic -noise rifles, which have a sound level of 116 dBA at source, 66 dBA at 1,000 feet, 60 dBA at one half mile, and 54 dBA at one mile (Free Hearing Test n.d., Kyttälä n.d., Yeary 2005), would result in short-term, local, negligible-to-minor, adverse effects on soundscape in undeveloped and developed areas. The duration of each noise intrusion would be less than one second, and few noise intrusions from subsonic suppressed-noise weapons would occur. While these effects would be short-term, they would occur periodically for the duration of the plan. These actions would occur more often in the first four years of the plan and would decline over time.

Unsuppressed rifles (156 dBA at source, 96 dBA at 1,000 feet, 89 dBA at one half mile, and 82 dBA at one mile) would be used infrequently under this alternative, but would still have (even though for a brief moment) short-term, local, negligible-to-major depending on the distance from the shooter, adverse effects in undeveloped areas and short-term, local, minor, adverse effects in developed areas. Effects would occur periodically for the duration of the plan.

Effects of darting activities (less than 94 dBA at source; up to 70 yards away; Watry 2005b) would be short-term, local, negligible to minor, and adverse for developed areas of the park and negligible to moderate and adverse for undeveloped areas of the park. Effects would occur periodically for the duration of the plan.

Removal of carcasses (e.g., by foot, use of a litter or sled over frozen ground, pack animal, all-terrain-vehicle, winch, or truck) would create low levels of noise from human voices, animals, and vehicle use, resulting in short-term, negligible, adverse effects in developed areas and negligible to minor, adverse in undeveloped areas that could occur periodically throughout the park. If helicopters were used to remove carcasses from remote areas due to disease management concerns or adaptively to herd elk, effects on soundscapes (105 dBA at the source and can be heard from more than one mile away) would be short-term, potentially parkwide, negligible-to-major, and adverse, depending on the distance from the helicopter. The duration would be brief point-to-point flights.

Capture Facility

Erecting a capture facility with a temporary fence and corral would be a minor disturbance in the short-term. Because installation noises would be less than 80 dBA at 1,000 feet away, and these noises would likely occur for at least two hours in a given day, effects on soundscape would be short-term, local, minor, and adverse in both developed and undeveloped areas.

Once the capture facility, which would likely be located near existing roads, is complete, associated noise would be primarily from vehicles, voices (60 dBA at source), and movement noises of both elk and people. If only road-based vehicles are used (i.e., pickup trucks or jeeps), noise levels would be 70 dBA at the source, dropping to virtually undetectable at a half-mile. If snowmobiles or all-terrain vehicles were needed to access the capture facility, noise levels would be up to 100 dBA at the source, up to 70 dBA at 1,000 feet, and up to 55 dBA at one mile. The combined noise in this area would be relatively low to medium and infrequent, resulting in a short-term, local, minor, adverse effect on soundscape in undeveloped areas during the summer.

Effects on the soundscape would be short-term, local, minor, and adverse in developed areas during the winter, assuming that snowmobiles would be used infrequently. These short-term effects would occur for the duration of the plan.

Vegetation Management

Installing fencing to protect aspen, transporting materials, and vehicle use under Alternative 2 would have a decibel level of 120 dBA at the source; vehicle use would be 70 dBA at the source (NIDCD 2005, LHH 2005). Because noise levels decrease an average of 6 dBA for every doubling of distance, the fencing noise would be approximately 80 dBA at 1,000 feet and vehicle use would be approximately 30 dBA at 1,000 feet.

Noise would be introduced into the soundscape for a short period during the spring, summer, or fall from transporting materials (including potentially by helicopter for backcountry areas) and installing fences.

Because fencing installation would be 80 dBA or greater at 1,000 feet from the noise source, effects on soundscape would be short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas. Effects would occur periodically throughout the plan commensurate with the amount of fence installed. If helicopters were used to deliver fencing materials to undeveloped areas of the park, this would have negligible-to-major, and adverse effects, depending on the distance from the helicopter. The duration would be brief point-to-point flights. The effects would occur in both undeveloped and developed areas each day that helicopters transported fencing.

Prescribed fires could occur in either undeveloped or developed areas of the park. They would involve vehicles (70 to 85 dBA at the source, 30 to 55 dBA at 1,000 feet, undetectable at one mile), water pumps such as a Mark III pump (may exceed 120 dBA at source, 60 dBA at 1,000 feet, 45 dBA at one mile), and human voices (60 dBA at the source, undetectable at 1,000 feet). Noises from a prescribed fire could continue for a few days or weeks, although not continuously, and could be detectable for extended periods within a day. Effects on soundscape would be minor to major, short-term, local, and adverse in undeveloped and developed areas of the park and would occur for the duration of the plan.

Mechanical thinning activities could also occur in developed or undeveloped areas of the park. They would involve use of chainsaws (120 dBA at source, 60 dBA at 1,000 feet, 45 dBA at one mile) and vehicles (up to 85 dBA at source, 30 to 55 dBA at 1,000 feet, undetectable at one mile). These thinning activities, depending on the size of the treatment area, could continue for a few weeks at a time in a given area. Chainsaws and heavy equipment could create noise for hours at a given time. Effects of thinning on soundscapes would be short-term, local, moderate, and adverse in undeveloped and developed areas. These effects could occur for the life of the plan.

Redistribution Techniques

Redistribution techniques involving rubber bullets or cracker shells would produce short-duration, localized noise, and would have short-term, local, adverse, and minor effects in developed areas and short-term, local, adverse, and moderate effects in undeveloped areas.

Herding with trained dogs would have negligible impacts in both developed and undeveloped areas. Noise from herding elk by people using noise makers (i.e., pyrotechnic streamers, whistles) and yelling could result in noise levels varying from 50 to 156 dBA at the source (up to 96 dBA at 1,000 feet, up to 90 dBA at a half mile, up to 84 dBA at one mile), and these noises would likely increase in frequency and duration during the maintenance phase of this alternative.

They would occur in local areas across the park, focused on the elk primary winter and summer ranges, and would result in short-term and short-term, local, minor-to-moderate, adverse effects if in an undeveloped area and short-term and short-term, local, negligible-to-moderate, adverse effects if in a developed area. These effects would occur for the duration of the plan and could occur frequently throughout the day.

Use of helicopters as an adaptive management tool for herding would have short-term, negligible-to-major, adverse impacts in both developed and undeveloped areas, as described for carcass removal and fence installation.

Aggressive or Injured Animals

Effects on soundscapes would be the same as described for Alternative 1.

Monitoring

Because monitoring under Alternative 2 would occur more frequently but the individual monitoring events would be similar to what currently occurs, effects on soundscapes would be the same as for Alternative 1.

Cumulative Impacts

Cumulative effects would be similar to what was described for Alternative 1, except that Alternative 2's contribution of noise would be somewhat more frequent, due to increases in helicopter use and redistribution techniques and the addition of unsuppressed weapons and mechanical thinning for elk and vegetation management.

Conclusion

Overall, noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but predominantly noise intrusions would range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds), primarily in localized areas of the elk primary winter and summer ranges. The exception would be helicopter use for fencing and monitoring, which would add noise intrusions to areas adjacent to the elk range. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

Effects from lethal removal of elk using suppressed-noise weapons would result in short-term, local, minor, adverse effects on soundscape in undeveloped and developed areas. This action would occur more often in the first four years of the plan and would decline over time. Unsuppressed weapons would be used infrequently under this alternative, but would still have short-term, local, negligible-to-major adverse effects (even though for a brief moment) on undeveloped areas and short-term, local, minor adverse effects on developed areas. Effects of darting activities associated with lethal reduction activities or research activities would be short-term, local, and negligible to minor for developed and negligible to moderate for undeveloped areas. Removal of carcasses would create low levels of noise from human voices, animals, and vehicle use, resulting in short-term, negligible, adverse effects in developed areas and negligible to minor, adverse in undeveloped areas that could occur periodically throughout the park. If helicopters were used to remove carcasses from remote areas, effects on soundscapes would be short-term, negligible-to-major, and adverse, depending on the distance from the helicopter, and would occur periodically particularly in the first four years of the plan.

Erecting a capture facility with a temporary fence and corral for lethal reduction activities would have short-term, local, minor adverse effects on soundscapes in either developed or undeveloped areas, because installation noises would not carry long distances. Noises from vehicles, including potentially snowmobiles or all-terrain vehicles, accessing the capture facility would have short-term, local, minor, adverse effects on soundscapes in developed and undeveloped areas.

Effects from fencing installation would be short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas because of infrequent hammering noises. However, if helicopters were used also, effects would increase to short-term, negligible-to-major, and adverse. These effects would occur periodically throughout the life of the plan.

Effects on the soundscape from prescribed burns would be minor to major in intensity and short-term, local, and adverse in both developed and undeveloped areas. Mechanical thinning activities could occur for days up to weeks, and noises would continue for hours at a time, resulting in short-term, local, moderate, adverse effects on soundscapes in developed and undeveloped areas.

Effects from redistribution techniques would be short-term, local, moderate, and adverse in undeveloped areas; short-term, local, minor, and adverse in developed areas. Herding would have short-term and short-term, local, negligible to major, adverse impacts in developed and undeveloped areas, depending on the type of herding (trained dogs, people, or helicopters as an adaptive tool). Effects on soundscapes from actions to manage aggressive or injured animals would be the same as described for Alternative 1: short-term, local, negligible, and adverse. Effects from monitoring would be the same as for Alternative 1: short-term, parkwide, major, and adverse.

Aside from installing the capture facility, all other actions could occur periodically for the duration of the plan.

Cumulative effects would be similar to those described for Alternative 1: short-term, local and regional, minor to major, and adverse, although Alternative 2's contribution of adverse effects would be more frequent.

Impairment of natural soundscape within the park would not occur under Alternative 2.

Alternative 3

Lethal reduction activities using firearms would occur less frequently than under Alternative 2, due to the higher population target for elk of this alternative. Noise intrusions from the use of all-terrain vehicles and snowmobiles, along with road vehicle use, would occur frequently throughout the year during the first four years of the plan and, like the use of weapons, would decrease in occurrence thereafter. Helicopter use would increase from current levels and from Alternative 2, due to the need to distribute a larger amount of fencing materials to remote locations of both the primary winter and summer elk ranges. The use of helicopters for fencing would occur for the first four years of the plan in a phased approach. Thinning and burning activities specific to this alternative would increase noise throughout the entire day on occasion for the life of the plan due to chainsaw use.

Research activities conducted in coordination with elk reduction activities would have similar effects on natural soundscapes as described for Alternative 2.

Impacts from these activities of Alternative 2 that affect soundscapes are discussed below.

Lethal Removal

Effects from lethal removal using subsonic ammunition and suppressed-noise weapons would have the same effect as described for Alternative 2. However, noise-suppressed weapons would be used less frequently, as lethal removal levels would be lower. The use of unsuppressed weapons under this alternative in the first four years would have short-term, local, negligible to major effects in undeveloped areas and short-term, local, minor, adverse effects in developed areas. Effects would occur at this level, though, for the duration of the plan on a periodic basis.

Darting activities for lethal reduction activities and research activities would have the same effect as under Alternative 2.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 2 but the effects would not decline after the first four years.

Vegetation Management

Under this alternative fences would be installed to protect 160 acres of aspen and 440 acres of willow on the primary summer and winter ranges. Fencing under Alternative 3 would be more extensive than under Alternative 2, as willows would also be fenced, resulting in a nearly four-fold increase in the amount of fencing. The intensity of individual short-term effects would be the same, but would occur more frequently throughout the first four years of the plan, when fencing installation would occur.

Effects on soundscapes from prescribed fire and mechanical thinning would be the same as described for Alternative 2.

Redistribution Techniques

Redistribution techniques under Alternative 3 would have the same intensity level as under Alternative 2 but would occur more frequently.

Effects of herding on soundscapes would be the same as described in Alternative 2 but would occur more often throughout the year.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Cumulative Impacts

Cumulative effects would be similar to what was described for Alternative 2.

Conclusion

Overall, noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but noise intrusions would generally range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds), primarily in localized areas of the elk primary winter and summer ranges. The exception would be helicopter use for fencing and monitoring, which would add noise intrusions to areas adjacent to the elk range. The more extensive use of helicopters for transporting materials for fencing than under Alternative 2 would cause effects with the same intensity level but occurring more frequently. Use of helicopters would be much greater than currently occurs for elk and vegetation management. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

Effects from lethal removal using subsonic suppressed-noise weapons would have the same effect as described for Alternative 2: short-term, local, minor, adverse effects in developed and negligible to minor in undeveloped areas. Unsuppressed weapons would be used frequently under this alternative, because of the reduced level of lethal removal compared to Alternative 2, and would have short-term, local, negligible to major effects in undeveloped areas (depending on the distance from the shooter), and short-term, local, minor, adverse effects in developed areas. Darting activities for lethal reduction activities and research activities would have the same effect as under Alternative 2: short-term, local, negligible to moderate, and adverse. Removal of carcasses would have the same effects on soundscapes as described for Alternative 2: short term, negligible, and adverse.; or short-term, negligible to major, and adverse if helicopters were used.

Fencing under Alternative 3 would be more extensive than under Alternative 2, as willows would also be fenced, but overall effects would be the same: short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas; if helicopters were used, effects would be short-term, parkwide, negligible to major, and adverse. Effects on soundscapes from prescribed fire (short-term, local, minor to major, and adverse) and mechanical thinning (short-term, local, moderate, and adverse) would be the same as described for Alternative 2.

Redistribution techniques under Alternative 3 would have the same intensity level as under Alternative 2: short-term, local, minor, and adverse in developed areas; short-term, local, moderate, and adverse in undeveloped areas, but would occur more frequently. Effects of herding on soundscapes would be the same as described in Alternative 2, but they would occur more often throughout the year: short-term, negligible-to-major impacts from herding with trained dogs or people with noisemakers, or helicopters as an adaptive management tool. Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2: short-term, local, negligible, and adverse. Effects of monitoring would be the same as described for Alternatives 1 and 2: short-term, parkwide, negligible to major, depending on the distance from the helicopter, and adverse.

Cumulative effects would be similar to those described for Alternative 2: short-term, local and regional, minor to major, and adverse, with Alternative 3 contributing a long-term, regional, major, adverse effect.

Impairment of natural soundscape within the park would not occur under Alternative 3.

Alternative 4

Levels of effect of actions from Alternative 4 on soundscapes would be essentially the same as described for Alternative 3, although use of dart guns for fertility control would contribute additional periodic, short-term, negligible, adverse effects by adding human-caused noise to the soundscape.

Research activities conducted in coordination with elk reduction activities would have similar effects on soundscapes as described for Alternative 2.

Impacts on soundscapes from these activities of Alternative 4 that affect soundscapes are discussed below.

Lethal Removal

Effects from lethal removal using suppressed-noise weapons would be the same as described for Alternative 3. Effects from using unsuppressed weapons would also be the same as described for Alternative 3.

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 3.

Fertility Control

Targeted female elk would be injected with fertility treatments via dart rifles for elk population management. Dart rifles are only heard when the gun is fired and only up to 70 yards away (Watry 2005d). Depending on whether annual or multi-year fertility treatment would be used, treatments could occur every year in the summer months. Annual treatments would involve increased effort and, therefore, increased noise introduced into the environment. If annual fertility treatments were used on elk, effects on soundscape would be short-term, local, and negligible to moderate, depending on the distance from the activity, in developed and undeveloped areas. These effects would occur on a yearly basis for the life of the plan. Were multi-year fertility treatments to be chosen, effects on soundscapes would be also be short-term, local, negligible to moderate, and adverse in developed and undeveloped areas. These effects could occur on a yearly basis for some targeted elk or every three years for all targeted elk.

Capture Facility

Erecting and using a temporary capture facility for fertility control actions would have the same effects as described for Alternative 2.

Vegetation Management

Under this alternative fences would be installed to protect 160 acres of aspen on the primary winter and summer ranges and 260 acres of willow habitat on the primary winter range. Effects on soundscape from fencing would be the same as described for Alternative 3.

Effects on soundscape from prescribed fire and mechanical thinning would be the same as described for Alternative 2.

Redistribution Techniques

Aversive conditioning techniques under Alternative 4 would have the same intensity level as under Alternative 3.

Effects of herding on soundscapes would be the same as in Alternative 3.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Cumulative Impacts

Cumulative effects would be similar to those described for Alternative 2.

Conclusion

As stated for Alternative 3, overall noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but predominantly noise intrusions would range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds), primarily in localized areas of the elk primary winter and summer ranges. The exception would be helicopter use for fencing and monitoring, which would add noise intrusions to areas adjacent to the elk range. The more extensive use of helicopters for transporting materials for fencing than under Alternative 2 would cause effects with the same intensity level but occurring more frequently. Use of helicopters would be much greater than currently occurs with regards to elk and vegetation management. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

Effects from lethal removal using suppressed-noise weapons would be the same as described for Alternative 3: short-term, local, minor, adverse effects in developed and negligible to minor in undeveloped areas. Effects from using unsuppressed weapons would also be the same as described for Alternative 3: short-term, local, negligible to major effects in undeveloped areas and short-term, local, minor, adverse effects in developed areas.

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2: short-term, local, negligible to moderate, and adverse for developed and undeveloped areas of the park.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 3: short-term, negligible, and adverse. If helicopters were used the adverse effect would be short-term, parkwide, and negligible to major.

With fertility control, dart gun use, human activity, and annual treatments would result in short-term, local, and negligible to moderate effects, depending on the distance from the activity, on soundscapes in both developed and undeveloped areas.

Erecting and using a temporary capture facility for fertility control activities would have the same effects as described for Alternative 2: short-term, local, minor adverse effects in developed and undeveloped areas. Redistribution techniques under Alternative 4 would have the same intensity level as Alternative 3: short-term, local, adverse, and minor in developed areas and moderate in undeveloped areas. Effects of herding on soundscapes would be the same as in Alternative 2: short-term, negligible-to-major impacts from herding with trained dogs or people with noisemakers, and helicopters if used adaptively.

Effects on soundscape from fencing would be the same as described for Alternative 3: short-term, local, minor, and adverse in undeveloped areas; short-term, local, negligible, and adverse in developed areas; if helicopters were used, effects would be short-term, parkwide, major, and adverse. Effects on soundscape from prescribed fire (short-term, local, minor to major, adverse) and mechanical thinning (short-term, local, moderate, and adverse) would be the same as described for Alternative 2.

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2: short-term, local, negligible, and adverse.

Effects of monitoring would be the same as described for Alternative 2: short-term, parkwide, negligible to major, depending on the distance from the helicopter, and adverse.

Cumulative effects would be similar to those described for Alternative 2 (short-term, local and regional, minor to major, and adverse), with Alternative 4 contributing a long-term, regional, major, adverse effect.

Impairment of natural soundscape within the park would not occur under Alternative 4.

Alternative 5

Levels of effect of actions from Alternative 5 on soundscapes would be similar to those described for Alternative 2, although the release of wolves would introduce additional human noises, herding and aversive condition activities would not take place, and wolves would restore the natural sound of howling to the soundscape.

Research activities conducted in coordination with elk reduction activities would have similar effects on soundscapes as the use of darting to anesthetize animals as described for Alternative 2.

Impacts on soundscapes from activities of Alternative 5 that affect soundscapes are discussed below.

Wolves

The first phase of wolf release, would involve releasing a small number of wolves into the park. The initial release process would likely involve vehicles and human voices (60 dBA), a short-term, local, negligible, adverse effect on either the developed or undeveloped area the wolves are released in. If wolves are recaptured for whatever reason, the effect of vehicles and humans would be the same as the initial release. Were wolves to be adversely conditioned or lethally removed by dart gun or rifle, effects on soundscapes would be short term, local, negligible to moderate, and adverse for developed or undeveloped areas.

After the first phase, the wolf population would be allowed to increase in the park. Depending on the number of wolves present in the park, effects of wolves' howling on the park's soundscape could vary from minor to moderate in intensity; would be short-term, parkwide, and beneficial; and would occur at least for the length of the plan. Effects would be beneficial because the National Park Service views restoration of the natural soundscape to be a goal of soundscape management (NPS 2000).

Wolf monitoring could involve the use of helicopters to retrieve wolves if wolves approached the boundary of the park. This would result in a short-term, major, adverse effect on soundscapes.

Lethal Removal

Effects from lethal removal using suppressed-noise weapons would be similar to what was described for Alternative 3. Effects from using unsuppressed weapons would also be the same as described for Alternative 3.

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 2.

Capture Facility

Erecting and using a temporary capture facility for lethal reduction actions would have the same effects as described for Alternative 2.

Vegetation Management

Effects on soundscape from fencing would be the same as described for Alternative 2. Effects on soundscape from prescribed fire and mechanical thinning would be the same as described for Alternative 2.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternative 2.

Monitoring

Aside from wolf monitoring (described above under the "Wolves" subsection), effects of monitoring would be the same as described for Alternative 2.

Cumulative Impacts

Cumulative effects and Alternative 5's contribution would be similar to those described for Alternative 1. However, Alternative 5's contribution of noise would be more frequent due to redistribution techniques and the addition of unsuppressed weapons and mechanical thinning for elk and vegetation management and due to increases in helicopter use for wolf monitoring and adverse conditioning. Also, under Alternative 5, wolves would be released in the park, a short-term, minor to moderate, benefit for the soundscape.

Conclusion

As stated for Alternative 2, overall noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but noise intrusions would generally range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels, including natural sounds, primarily in localized areas of the elk primary winter and summer ranges. The exceptions would be the beneficial effect of restoring the sound of wolves to soundscape and the noise intrusions in more extended areas of the park from helicopter use for fencing and monitoring. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

The initial release process would have a short-term, local, negligible, adverse effect on soundscapes from introducing vehicle and human voice noises. Were wolves to be adversely conditioned or lethally removed, effects on soundscape would be short-term, local, negligible to moderate, and adverse for developed and undeveloped areas. Depending on the number of wolves present in the park, effects of wolves' howling on the park's soundscape could vary from minor to moderate in intensity; would be short-term, parkwide, and beneficial; and would occur at least for the length of the plan. Wolf monitoring and recapture efforts would result in a short-term, major, adverse effect on soundscapes, if helicopters were used.

Effects of lethal removal using suppressed-noise weapons would be the same as described for Alternative 3 but last throughout the life of the plan: short-term, local, minor, and adverse in developed and negligible to minor in undeveloped areas. Effects from using unsuppressed weapons would also be the same as described for Alternative 3: short-term, local, and negligible to major in undeveloped areas and short-term, local, minor, and adverse in developed areas).

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2: short-term, local, negligible to moderate, and adverse for developed and undeveloped areas of the park.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 2: short-term, negligible, and adverse or short-term, parkwide, negligible to major, and adverse if helicopters were used as an adaptive management tool. All lethal removal actions would end after the first four years of the plan.

Erecting and using a temporary capture facility for lethal reduction actions would have the same effects as described for Alternative 2: short-term, local, minor, and adverse in developed and undeveloped areas. Effects of herding on soundscapes would be the same as in Alternative 2: short-term, negligible to major impacts from herding with trained dogs or people with noisemakers, and helicopters if used adaptively.

Effects on soundscapes from fencing would be the same as described for Alternative 3: short-term, local, minor, and adverse in undeveloped areas; short-term, local, negligible, and adverse in developed areas; if helicopters were used, effects would be short-term, parkwide, negligible to major, and adverse, depending on the distance from the helicopter. Effects on soundscape from prescribed fire (short-term, minor to major, local, and adverse) and mechanical thinning (short-term, local, moderate, and adverse) would be the same as described for Alternative 2.

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2: short-term, local, negligible, and adverse.

Effects of monitoring would be the same as described for Alternative 2: short-term, parkwide, negligible to major, and adverse.

Cumulative effects would be similar to those described for Alternative 1 (short-term, local to regional, minor to major, and adverse), although Alternative 5's contribution (long-term, regional, major, and adverse) would be more frequent.

Impairment of natural soundscape within the park would not occur under Alternative 5.

WILDERNESS

Summary of Regulations and Policies

Wilderness Act

The Wilderness Act, passed on September 3, 1964, established a national wilderness preservation system, “administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness” (16 United States Code Section 1131). The Wilderness Act further defined wilderness as “an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, and which is protected and managed to preserve its natural conditions” (16 United States Code Section 1131). The Wilderness Act gives the agency managing the wilderness responsibility for preserving the wilderness character of the area and devoting the area to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use (16 United States Code Section 1133). Certain uses are specifically prohibited, except for areas where these uses have already become established. The act states that “there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and except as necessary to meet minimum requirements for the administration of the area . . . , there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area” (16 United States Code Section 1133).

NPS Management Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in section 1.4.6 of *Management Polices* (NPS 2006b), wilderness is recognized and valued as a park resource in keeping with the NPS mission.

Management Policies states that “the National Park Service will take no action that would diminish the wilderness suitability of an area possessing wilderness characteristics until the legislative process of wilderness designation has been completed…All management decisions affecting wilderness will further apply the concepts of “minimum requirements” for the administration of the area regardless of wilderness category” (NPS 2006b).

Director’s Order #41: Wilderness Preservation and Management

Director’s Order #41: Wilderness Preservation and Management was developed to provide accountability, consistency, and continuity to NPS wilderness management efforts and to otherwise guide NPS efforts in meeting the requirements set forth by the Wilderness Act of 1964. Director’s Order #41 interprets the Wilderness Act and consolidates its requirements and all applicable *Management Policies* to set guiding principles for all NPS units to determine wilderness suitability and appropriately manage those lands. Lands identified as being suitable for wilderness designation, wilderness study areas, and recommended wilderness (including recommended and potential wilderness) must also be managed to preserve their wilderness character and values in the same manner as "designated wilderness" until Congress has acted on the recommendations (NPS 1999a). Director's Order 41 sets forth guidance for applying the minimum requirement concept to protect wilderness and for the overall management, interpretation, and uses of wilderness. With regards to natural resource management in wilderness, it states, "Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries" (NPS 1999a).

Backcountry and Wilderness Management Plan and Environmental Assessment

Rocky Mountain National Park developed a backcountry and wilderness management plan in 2001 to define wilderness management policies and actions at the park; to have a method of identifying the park's wilderness vision, long range management goals, intermediate objectives, and actions and options to meet those objectives; and to serve as a working guide for staff who manage the wilderness resource. This plan include standards for using motorized equipment and mechanical transport in non-emergency actions, which are in part based on season of year, day of week, and time of day.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on wilderness includes designated and recommended wilderness that occurs in the elk primary winter and summer ranges. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on wilderness included

- Using vehicles to access areas and mechanical equipment where lethal control actions and carcass removal would be implemented could affect wilderness and wilderness values.
- Fencing could adversely affect the character of wilderness.
- The redistribution of the elk population has affected wilderness character.
- The condition of the vegetative communities that comprise wilderness has been degraded.
- High levels of elk herbivory would continue to alter vegetative conditions within wilderness.
- Wildlife species composition found in wilderness has changed.

Assumptions

Assumptions specific to the impact topic of wilderness are the following:

- Actions that would be taken in wilderness would attempt to be consistent with the park's backcountry management plan (NPS 2001).

Actions not consistent with the plan would require preparation of a minimum requirement and minimum tool analysis.

Assessment Methods

As directed by Director's Order 41, lands identified as being suitable for wilderness designation, wilderness study areas, and recommended wilderness must be managed to preserve their wilderness character and values in the same manner as designated wilderness. Therefore, this analysis regards all lands identified as suitable for wilderness designation as the same and offers no distinction in the impact analysis.

The technique used to assess wilderness from management activities in this document is in accordance with *Management Policies* (NPS 2006b) and *Director's Order 41: Wilderness Preservation and Management* (NPS 1999a). The evaluation method considered primeval character and the influence of wilderness, preservation of natural conditions (including lack of manmade noise), primitive and unconfined recreation for the public, and outstanding opportunities for solitude. These all interact to determine the degree of impact for an activity.

Steps for assessing impacts included: 1) identifying wilderness areas in the park that may be affected by actions of the plan and 2) determining the potential impacts on wilderness caused by actions under each alternative.

These analyses of impacts on wilderness are qualitative and are assessed given the degree to which elk and vegetation management actions would change compared to existing management conditions.

Minimum Requirement / Minimum Tool Analysis

The implementation of some actions associated with the action alternatives of the elk and vegetation management plan would require a minimum requirement analysis. The rationale for the use of chainsaws, off-road vehicles, rifles, noisemakers, trained herding dogs, horses below timberline, fencing, helicopters, and other motorized tools in and over wilderness is included in the minimum requirement analysis provided in Appendix G. The primary reasons for using motorized tools are access concerns, worker safety, and minimization of implementation time, thus resulting in a shorter period of potential effects on wilderness values. Final determination of what methods would be used for site-specific actions to manage elk and vegetation will be further evaluated and determined when the National Park Service completes the minimum tool analysis prior to implementation of actions of this plan/EIS.

Impact Threshold Definitions

Intensity of Impact

Impacts were evaluated using these thresholds:

Negligible: Impacts would have no discernable effect on wilderness resources. Natural conditions would prevail, including a lack of human-made noise. Primeval character and the influence of wilderness would remain unchanged. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Minor: Impacts would be slightly detectable within areas of the wilderness. Natural conditions would predominate, with minimal human-made noise. Primeval character and the influence of wilderness would be slightly affected. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail.

Moderate: Impacts would be readily apparent within areas of the wilderness. It would be apparent that natural conditions have changed within such areas, including to the level of human-made noise. Primeval character and the influence of wilderness would be noticeably affected. Opportunities for solitude or a primitive and unconfined type of recreation would be altered in limited areas of the wilderness.

Major: Impacts would substantially alter the wilderness resource in the elk primary winter and summer ranges. Natural conditions would have been substantially changed, including the level of human-made noise. Primeval character and the influence of wilderness would be substantially affected. Opportunities for solitude or a primitive and unconfined type of recreation would be altered throughout the wilderness.

Type and Duration of Impact

Beneficial impacts would improve wilderness or wilderness values.

Adverse impacts would introduce human-caused changes to wilderness or wilderness values.

Duration: With short-term impacts, wilderness values or resources would recover in less than one year after human intrusion. With long-term impacts, wilderness values or resources would take one year or more to recover to recover after human intrusion.

Impairment

Impairment to wilderness would occur when the action contributes substantially to deterioration of the wilderness in the park to the extent that the characteristics that meet the criteria for consideration and classification as wilderness would be eliminated within the park.

Alternative 1

Elk Management

As stated in the "Purpose of and Need for Action" section of this document, the Rocky Mountain National Park / Estes Valley elk population is larger, less migratory, and more concentrated than it was under natural conditions (prior to the mid-1800s). As a result, aspen and willow communities that support high levels of biodiversity are declining, and herbaceous vegetation is grazed at high levels in areas on the elk range where elk are concentrating. A large portion of this elk population's primary winter and summer ranges occurs within the proposed, recommended, and designated wilderness of Rocky Mountain National Park. Elk have been documented to have degraded vegetation within their primary winter range, nearly half of which lies within wilderness areas in the park. Modeling by Coughenour shows that under current management, the elk population would remain at around the same level as currently exists in the park and that degradation of aspen and willow communities would continue (2002). Thus, continuing current management conditions under Alternative 1 would result in the continuing degradation of vegetation in portions of wilderness in the primary winter range, and in the Kawuneeche Valley, although to a lesser degree because of lower elk densities. Changes in vegetation are highly noticeable and have reduced wilderness values in areas of wilderness where aspen and willow vegetation is heavily degraded. Because wilderness values would be degraded by continuing current management at a level that is readily apparent to those visiting the area in search of untrammeled wilderness, effects on wilderness under Alternative 1 would be long term, moderate, and adverse and would occur range-wide in localized areas of wilderness in the elk primary winter and summer ranges where elk have degraded vegetative conditions.

Fencing

Under Alternative 1, fencing activities would be limited to maintaining research plot fencing. In wilderness areas, hand tools would be used for repairs per the minimum requirement concept, which would have no discernable effect on wilderness values. This action would result in local, negligible, adverse effects on wilderness.

Redistribution Techniques

Minimal redistribution techniques (pepper spray or mace, cracker rounds, rubber buckshot, rubber slugs, or slingshot, depending on the situation; NPS 2002e) would continue to be used under Alternative 1. They would typically occur throughout the elk range, which includes wilderness. The infrequent use of techniques that would create loud, but short-term, human-made noises and visual intrusions in wilderness would be slightly detectable to a human visitor to wilderness, resulting in short-term, local, minor, adverse effects on wilderness in the elk primary winter range. These short-term effects would occur periodically for the duration of the plan.

Aggressive or Injured Animals

Injured animals, or elk suspected of having chronic wasting disease, would be immobilized with a dart rifle and then lethally injected or lethally removed via firearm. This would occur minimally and could occur in wilderness in the park. For animals suspected of having chronic wasting disease, carcasses would be removed if possible, sampled, and disposed of. Because under current management practices only a few elk per year would be removed from the park for this reason, and humans visiting wilderness would rarely detect this activity due to its short term and relatively quiet nature, effects on wilderness from the presence of staff in remote areas would be short term, local, minor, and adverse.

Monitoring

Monitoring elk and vegetation would continue to involve one or more aerial flights during the winter season and several days during the year people would be conducting ground surveys in wilderness.

In the winter, these surveys would occur in the wintering grounds in the eastern portion of the park; in the summer, they would occur in the alpine areas and the Kawuneeche Valley. For five days on the ground, people would be in undeveloped areas of the park for the ground surveys, with activities occurring during daylight hours. Aerial overflights would last one day each, with potential for at least one overflight to many overflights during the winter season. These short-term intrusions into the wilderness would limit outstanding opportunities for solitude on the days that overflights would occur, but only in portions of the park’s wilderness, resulting in a short-term, regional, negligible-to-major, adverse effect on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusion on wilderness.

Cumulative Impacts

The Park Omnibus Appropriations Act of 1998 banned the use of low-flying commercial air tours over the park, which had a long-term, regional, major, beneficial effect on wilderness through the prevention of low-level, reoccurring flights over the wilderness. In 1996, the Thompson Three arrival route to Denver International Airport caused 30 to 70 low-flying jets (as close as 15,400 feet in the air) to fly over portions of Rocky Mountain National Park's wilderness, an ongoing short-term, regional, major, adverse effect on wilderness, due to the frequency of occurrence.

The park's backcountry and wilderness plan benefits wilderness through establishing long term management goals for wilderness management, which, if absent, would be readily apparent to a visitor to wilderness, resulting in a long-term, regional, moderate benefit. Many ongoing park resource management plans involve potential short-term, adverse effects on wilderness, with frameworks for guiding actions that would protect natural resources. By protecting natural resources, these plans would also protect wilderness values, which would provide long-term, beneficial effects on wilderness. Fire and forest management activities, such as mechanical thinning, prescribed burns, and fire suppression, could potentially involve mechanized tool use in wilderness, which would affect wilderness noticeably but in small areas, a short-term, moderate, adverse effect. Removal of non-native fish would create visual and noise intrusions from work crews and affect natural conditions with associated tools in small areas (i.e., introducing piscicides into streams) that could in the short term adversely affect wilderness values on a measurable scale, creating minor-to-moderate, adverse effects on wilderness. Controlling exotic vegetation in the wilderness would cause short-term, minor, adverse effects on wilderness through adversely affecting resources, and therefore wilderness character, such as soils, water quality, and soundscape in a manner that would be apparent to observant visitors to wilderness. Construction of small fences would also temporarily affect wilderness through visual intrusion of work crews and fencing material, which alter wilderness character in a noticeable way, creating long term, moderate, adverse effects. Overall, these natural resource management actions would result in vegetation conditions closer to natural conditions than currently exist, which benefits wilderness character. Actions would be readily apparent, as the landscape would look more like it would have naturally, before exotic plant invasion and fire suppression. This would have a long term, regional, moderate, beneficial effect on wilderness.

Trail maintenance of existing trails would use hand tools where necessary in wilderness areas and would prevent erosion of trails, a long-term, minor, beneficial effect that would be detectable to human visitors if trails were not maintained. Noise generated by trail crews using tools and periodically blasting rock would generate short-term, localized, negligible to major impacts.

The general intrusion of humans into the wilderness, which can be in large numbers in some areas, would create a long-term, minor to moderate, adverse effect on wilderness character.

U.S. Forest Service wilderness areas that are adjacent to or near the park's wilderness benefit the park's wilderness by improving wilderness character and by protecting it from non-compatible land uses, a long term, minor, beneficial effect. However, some development pressure in other areas near the park is occurring, resulting in long-term, negligible-to-minor, adverse effects.

Nitrogen deposition on soils and in surface waters is occurring through atmospheric deposition of pollution from agricultural and populated areas to the east and south of the park. This has the potential to alter how wilderness appears in the park throughout the entire wilderness, but especially alpine areas by changing vegetation communities over time, including wildflowers, grasses and sedges. This would have a long-term, range-wide, moderate, adverse effect on wilderness, as it has the potential to noticeably change the appearance of vegetation within the park in a widespread manner.

The effects of these plans, projects, and actions, when combined, would have long-term, moderate, adverse effects, through combining the long-term, adverse effects of overflights and nitrogen deposition with the long-term, beneficial effects of resource management plans, nearby wilderness, and the ban on commercial air tours. Combined short-term effects of these plans, projects, and actions would be minor to moderate and adverse.

Alternative 1 would continue to have long-term, moderate, adverse effects on wilderness in localized areas of the elk primary winter range, primarily from noticeable degradation of willow and aspen communities. Short-term effects of Alternative 1 would be minor to moderate and adverse, primarily from monitoring elk by helicopter over wilderness areas. When the long-term effects of other plans, projects, and actions are combined with the overall effects of Alternative 1 on wilderness, cumulative long-term effects would be minor to moderate and adverse. Cumulative short-term effects would be minor to moderate and adverse.

Conclusion

Noticeable levels of vegetation degradation in willow and aspen communities in the elk primary winter range in the park would continue to have a long-term, local, moderate, adverse effect on wilderness because the degradation of vegetation would negatively affect wilderness values.

Limited fencing activities would only use hand tools in wilderness, resulting in local, negligible, adverse effects. Minimal redistribution techniques (i.e., pepper spray, mace, cracker rounds, rubber buckshot, and slingshot) would be used infrequently, if at all, in wilderness, resulting in short-term, local, minor, adverse effects on wilderness. The action of removing animals suspected of having chronic wasting disease would occur infrequently and potentially in wilderness under this alternative, a short-term, local, minor, adverse effect. Monitoring of elk and vegetation would include ground surveys and helicopter surveys that would occur at least one day per year, a short-term, regional, negligible-to-major, adverse effect on wilderness, depending on the distance from the helicopter.

Cumulative effects on wilderness would be long-term, minor to moderate, and adverse as well as short-term, minor to moderate, and adverse. Alternative 1 would contribute long-term, moderate, adverse effects and short-term, minor-to-moderate, and adverse effects on these overall cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 1.

Alternative 2

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness. Wilderness values would be noticeably improved through the recovery of vegetation in localized areas, resulting in a long-term, moderate, benefit to wilderness. Actions would be taken following the completion of a wilderness minimum requirements and minimum tool analysis.

The following actions taken within wilderness under Alternative 2 would occur to correct the results of past management actions, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Lethal Removal

Lethally removing elk using primarily subsonic ammunition and suppressed-noise rifles, with some unsuppressed rifles to aid in redistribution, would be readily apparent in limited areas of the wilderness, although no permanent effects would occur. However, because shooting typically is not allowed in national park wilderness, gunshots and the visual intrusion of staff with guns would affect wilderness character. Effects on wilderness would be moderate because shooting would not substantially alter the wilderness resource throughout the wilderness area, and, after a gun was fired, wilderness conditions would not have been substantially changed.

Darting with lethal injection would be used infrequently in wilderness in the park and does not introduce human-made noise, but the presence of humans would be slightly detectable, resulting in local, minor, adverse effects on wilderness.

Removal of carcasses (e.g., by foot, litter or sled [over frozen ground], pack animal, all-terrain-vehicle, winch, or truck) would create limited visual and noise intrusions into the wilderness from people, animals, and vehicles, resulting in short-term, local, minor, adverse effects on wilderness that could occur periodically throughout the park. If helicopters were used to remove carcasses from remote areas due to disease management concerns, effects on wilderness could occur anywhere within the elk range and would be negligible to major, and adverse, depending on the distance from the helicopter. The duration would be brief point-to-point flights.

Capture Facility

Erecting a capture facility with a temporary fence and corral in wilderness in the park would be a short-term, local, moderate, adverse effect on wilderness from visual and noise intrusions. The facility would only be present in wilderness for a few weeks at a time. Wilderness conditions would still prevail, and outstanding opportunities for solitude would still exist everywhere in the wilderness except within approximately a quarter mile of the capture facility, which would be readily apparent to visitors to wilderness in that area.

Access

Noise and other human intrusions into wilderness associated with access to the temporary capture facility, areas to be fenced, and other elk and vegetation management activities could involve both road and off-road vehicle use. Road use would have negligible effects on wilderness adjacent to roads because it would contribute no detectable addition to other road noise in the park, but off-road vehicle use in the wilderness would affect the primeval character of wilderness in the park, as it is not a noise associated with wilderness. While off-road vehicles would be used infrequently as a result of the minimum requirement analysis, effects on wilderness would be short term, local to range wide (depending upon the length of the route needed for access), minor to moderate, and adverse because effects would be noticeable to visitors to wilderness. If helicopters are used to remove carcasses from remote areas due to disease management concerns, there would be short-term, regional, moderate, adverse impacts in wilderness because this would be highly noticeable but likely only occur in limited areas at a time.

Vegetation Management

Installing fencing to protect aspen under Alternative 2 would introduce disturbances into wilderness, including the visual intrusion of human-made features in wilderness. Fences would be constructed in a phased approach and removed within 20 years of the implementation of this plan or earlier if communities are determined to be restored. If based on monitoring aspen fencing is necessary, then up to 160 acres of temporary fences would be installed in wilderness with up to 105 acres of aspen community on the elk winter range and 55 acres of aspen community on the summer range. However, fences would not be installed at one time but would be installed commensurate with the changes in vegetation. Effects on wilderness from the presence of fences around aspen stands would be long term, local, moderate, and adverse, as they would be readily apparent but would be less noticeable due to being well dispersed and would only occur in 0.1% of the total park's wilderness. If helicopters were used to deliver fence material into remote areas of the park, the impact would be short-term, adverse, negligible to major, depending on the distance from the helicopter.

Prescribed fires could occur in wilderness under this alternative. Noise and human intrusions into wilderness in the elk primary winter and summer ranges during the course of the fires would be short term, local, moderate, and adverse, because impacts would be noticeably detectable from the fire, humans, and noise intrusions. Fire would restore a natural process into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated.

Mechanical thinning activities could also occur in wilderness in the park, altering the viewshed with the presence of vehicles and work crews. These thinning activities, depending on the size of the treatment area, could continue for a week or more at a time in a given area. Chainsaws and brush cutters could create noise for hours at a given time. Effects of thinning on wilderness would be short term, local, moderate, and adverse in portions of the elk primary winter and summer ranges within wilderness, negatively affecting wilderness character at a noticeable level. These short-term effects could occur periodically for the life of the plan.

Redistribution Techniques

Redistribution techniques would occur at the same level of intensity as under Alternative 1 but would occur more frequently.

Herding with trained dogs would have short-term, localized, minor, adverse effects in wilderness in the elk primary winter and summer ranges because dogs are not allowed in park wilderness areas except for rescues or specialized research activities and would, therefore, have visual and noise impacts on wilderness. Their presence would be detectable, but would not alter the condition of the wilderness.

Noise from herding elk by people using noisemakers (i.e., pyrotechnic streamers, whistles), horses, and yelling could result in short-term, moderate, adverse effects, as the visual and noise intrusions would be rather noticeable and would affect solitude in the park. Horses would not be used above timberline; therefore, there would be no additional effect on wilderness from their use, as they are currently allowed in certain areas of wilderness.

If helicopters are used as an adaptive management tool they would have short-term, regional, moderate, adverse impacts in wilderness because this would be highly noticeable but likely only occur in limited areas at a time.

Aggressive or Injured Animals

Effects on wilderness would be the same as described for Alternative 1.

Monitoring

Because monitoring under Alternative 2 would be more frequent than what currently occurs. The short-term intrusions into the wilderness would limit outstanding opportunities for solitude on the days that overflights would occur, but only in portions of the park's wilderness, resulting in a short-term, regional, negligible-to-major, adverse effect on wilderness.

Research Activities

A research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. Effects on wilderness from the capture or darting, anesthetizing, and handling of elk would be the same as those described above for lethal control activities involving darting and access into wilderness.

Elk behavior of those subject to the fertility control study would not be altered by fertility treatments; therefore, this would have no observable effect on wilderness. However, the tagging and/or collaring of elk subject to the research study and use of a chemical that results in disruption of the natural functioning of elk (i.e. pregnancy) would affect wilderness values by creating visual intrusions that would be slight and disrupt natural biological processes while the study was occurring. The effects on wilderness from research activities would be short term, range wide, negligible to minor, and adverse.

Cumulative Impacts

Effects of other plans, projects, and actions on wilderness would be the same as described for Alternative 1: long term, moderate, and adverse as well as short term, minor to moderate, and adverse. Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial from returning to more natural conditions and short-term, moderate, and adverse from using helicopters and off-road vehicles for access, shooting elk by park staff, and constructing temporary fencing around aspen stands. Therefore, long-term, cumulative effects would be minor to moderate and adverse. Short-term, cumulative effects would be moderate and adverse.

Conclusion

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness, representing more natural conditions. Wilderness values would be noticeably improved through the recovery of vegetation in localized areas, resulting in a long-term, moderate, benefit to wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise, resulting (even though from brief moments) in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Darting for lethal reduction or research activities would be used infrequently in wilderness and would be almost undetectable, resulting in local, minor, adverse effects on wilderness. Carcass removal would create limited intrusions from human voices, animals, and vehicle use, resulting in short term, local, minor, adverse effects on wilderness. Erecting a temporary capture facility for lethal reduction activities with a fence and corral would be a short-term, local, moderate, adverse effect on wilderness. Effects of accessing wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse. Effects on wilderness from installing fencing and the presence of fences around aspen would be long term, local, moderate, and adverse, as fences would be removed within 20 years of the implementation of this plan. Prescribed fires would have short-term, local, moderate, adverse effects on wilderness; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness. Fire would restore a natural process into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated.

Use of helicopters for various activities (e.g., fencing and monitoring or if necessary, carcass removal and herding) would have short-term, range-wide to regional, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusions on wilderness.

Effects of redistribution techniques would be short term, local, minor, and adverse.

Herding with trained dogs, noisemakers, and horses would result in short-term, local, adverse effects that would vary from minor to moderate in intensity, as noise intrusions would be rather noticeable and would affect solitude in the park.

Effects on wilderness from the action of removing animals suspected of having chronic wasting disease would be the same as for Alternative 1: short term, local, minor, and adverse.

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness, a long-term, moderate benefit to wilderness.

The tagging or marking of study elk and disruption of natural biological processes in a small number of elk treated with a fertility control agent would negatively affect wilderness values; these effects on wilderness would be short-term, range wide, negligible to minor, and adverse.

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate, and adverse. Alternative 2 would contribute long-term, moderate, beneficial effects and short-term, moderate, adverse effects on these overall cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 2.

Alternative 3

The reduction of elk under Alternative 3 would cause similar beneficial effects on wilderness as those described in Alternative 2, although the elk population would not be reduced as much in the park.

The following actions taken within wilderness under Alternative 3- would occur for the purposes of correcting the results of past management actions, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Lethal Removal

Effects from lethal elk removal using subsonic suppressed-noise and unsuppressed weapons would have the same effect as described for Alternative 2 but would remain at a constant annual level of intensity throughout the plan. However, suppressed-noise weapons would be used less frequently, as lethal removal levels would be lower.

Darting with lethal injection would have the same effects on wilderness as described for Alternative 2. Removal of carcasses would have the same effects on wilderness as described for Alternative 2.

Access

Effects from accessing elk and vegetation management activities in wilderness would have the same effects as described for Alternative 2. Activities associated with installing fences would occur more frequently because more fence would be installed, but the intensity of impact would be the same during installation activity as for Alternative 2.

Vegetation Management

Fences would be installed over the 20 years of this plan to protect up to 600 acres of willow and aspen with 235 acres fenced in the primary summer range and 365 acres in the primary winter range of the elk population. Fencing around willows would be highly noticeable and would affect small to moderate sized areas of the elk primary summer and winter ranges, thereby substantially changing wilderness character at a local level. Because fencing would be more extensive (nearly four times the area of effect) and more concentrated in local areas under Alternative 3 than Alternative 2, effects on wilderness from the presence of fencing would also be greater: long term, local, major, and adverse.

Effects on wilderness from prescribed fire and mechanical thinning would be the similar to those described for Alternative 2, but would take place earlier due to the improved vegetation conditions within the fences.

Redistribution Techniques

Redistribution techniques under Alternative 3 would have the same intensity level as under Alternative 2, but would occur more frequently.

Effects of herding on wilderness would be the same as described in Alternative 2, but herding would occur more often.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Research Activities

The use of darting to anesthetize animals and access into wilderness during research activities conducted in coordination with elk reduction activities would have the same effects on wilderness as described for Alternative 2.

Elk behavior of those subject to the fertility control study would not be altered by fertility treatments; therefore, this would have no observable effect on wilderness. However, the tagging and/or collaring of elk subject to the research study and use of a chemical that results in disruption of the natural functioning of elk (i.e. pregnancy) would affect wilderness values by creating visual intrusions that would be slight and disrupt natural biological processes in a small number of elk while the study was occurring; therefore, effects on wilderness would be short term, range wide, negligible to minor, and adverse.

Cumulative Impacts

Effects of other plans, projects, and actions on wilderness would be the same as described for Alternative 1: long term, moderate, and adverse as well as short term, minor to moderate, and adverse. Alternative 3's contribution to cumulative effects would be long term, moderate, and beneficial from a return to more natural conditions and short term, moderate to major, and adverse from using helicopters and off-road vehicles for access, shooting elk by park staff, and constructing temporary fencing around aspen and willow stands in concentrated areas. Therefore, long-term cumulative effects would be minor to moderate and adverse. Short-term cumulative effects would be moderate to major and adverse.

Conclusion

Reduction of elk over time would result in more natural conditions for vegetation and ecosystems, a long-term, range-wide, moderate, benefit to wilderness. Fencing, prescribed fires, and mechanical thinning would, over time, result in more natural conditions than currently occur, with regard to vegetation and ecosystem processes. These changes as a result of management actions would have long-term, range-wide, moderate, beneficial effects on wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise the as in Alternative 2, resulting in short-term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Effects from darting for lethal reduction activities and research activities would be the same as in Alternative 2: local, minor, and adverse. Carcass removal would have the same effects as described for Alternative 2: short term, local, minor, and adverse. Effects of accessing the wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse.

Effects on wilderness from installing fencing and the presence of fences around aspen and willow would be long term, local, major, and adverse because the larger extent and grouping of fencing around willow would cause more of an intrusion into wilderness than under Alternative 2. As described for Alternative 2, prescribed fires would have short-term, local, moderate, adverse effects on wilderness; restoring natural processes into wilderness areas would result in a long-term, moderate, local beneficial effect in areas treated; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness.

Use of helicopters for various activities (e.g., fencing or monitoring and if necessary, carcass removal and herding) would have effects as described for Alternative 2: short term, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusions on wilderness.

Effects of redistribution techniques would be short term, local, minor, adverse.

Herding with trained dogs, noisemakers, and horses would have the same effects as described for Alternative 2: short-term, local, adverse effects that would vary from minor to moderate in intensity.

Effects on wilderness from the action of removing animals suspected of having chronic wasting disease would be the same as for Alternative 1: short term, local, minor, and adverse.

The tagging or marking of study elk and disruption of natural biological processes in a small number of elk treated with a fertility control agent would negatively affect wilderness values; these effects on wilderness would be short term, range wide, negligible to minor, and adverse.

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate to major, and adverse. Alternative 3 would contribute long-term, moderate, beneficial effects and short-term, moderate-to-major, and adverse effects.

Impairment of wilderness within the park would not occur under Alternative 3.

Alternative 4

The reduction of elk under Alternative 4 would cause similar effects as those described in Alternative 3. The following actions taken within wilderness under Alternative 4 would occur for the purposes of correcting the results of past management actions, a provision in Director's Order 41, *Wilderness Preservation and Management.*

Lethal Removal

Effects from lethal removal using suppressed-noise and unsuppressed weapons would be the same as described for Alternative 3. Effects of darting activities would be the same as described for Alternative 3. Removal of carcasses would have the same effects on wilderness as described for Alternative 3.

Fertility Control

Targeted female elk would be injected with fertility treatments via dart rifles. Dart rifles are only heard when the gun is fired and only up to 70 yards away (Watry 2005d Fertility control activities where humans and human noise would intrude into the wilderness would have short-term, local, minor, adverse effects from the presence of park staff and vehicles.

Elk behavior would not be altered by fertility treatments; therefore, this would have no observable effect on wilderness. However, the tagging and/or collaring of injected elk and use of a chemical that results in disruption of the natural functioning of elk (i.e. pregnancy) would affect wilderness values by creating visual intrusions that would be slight and disrupt natural biological processes; therefore, effects on wilderness would be long term, range wide, minor, and adverse.

Access

Effects from accessing elk and vegetation management activities in wilderness would be same as described for Alternative 3.

Capture Facility

Erecting and using a temporary capture facility would have the same effects as described for Alternative 2.

Vegetation Management

Effects on wilderness from fencing would be the same as described for Alternative 3, however these effects would occur less frequently as fencing of montane riparian willow would occur only on the primary winter range. Effects on wilderness from prescribed fire and mechanical thinning would be the same as described for Alternative 3.

Redistribution Techniques

Redistribution techniques under Alternative 4 would have the same intensity level as under Alternative 3.

Effects of herding on wilderness would be the same as in Alternative 3.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Research Activities

The use of darting to anesthetize animals and access into wilderness during research activities conducted in coordination with elk reduction activities would have similar effects on wilderness as described for Alternative 2. Tagging or marking of a small number of elk and the use of fertility control agent for research purposes would have negligible to minor adverse effects on wilderness.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 3. The effects of fertility control on wilderness would be long term, range wide, minor, and adverse, but would not alter the overall cumulative conclusion described in Alternative 2.

Conclusion

Reduction of elk over time would result in more natural conditions for vegetation and ecosystems, a long-term, range-wide, moderate, benefit to wilderness. Fencing, prescribed fires, and mechanical thinning would, over time, result in more natural conditions than currently occur, with regard to vegetation and ecosystem processes. These changes as a result of management actions would have long-term, range-wide, moderate, beneficial effects on wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise, resulting (even though from brief moments) in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Effects on wilderness from darting for lethal reduction actions and research activities would be the same as in Alternative 2: local, minor, and adverse. Carcass removal would have the same effects on wilderness as described for Alternative 2: short term, local, minor, and adverse). Erecting a temporary capture facility for lethal reduction actions with a fence and corral would have the same effects on wilderness as described for Alternative 2: short-term, local, moderate, and adverse.

Effects on wilderness from installing fencing and the presence of fences around aspen and willow would be long term, local, major, and adverse because of the large extent and grouping of fencing in the elk primary winter range.

Use of helicopters for various activities (e.g., fencing or monitoring, and if necessary, carcass removal or herding) would have the same effects as described for Alternative 3: short term, regional, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. The use of helicopters for fence installation would have this same range of effects although they would occur less frequently than Alternative 3. Helicopters would create far-reaching and enduring intrusions on wilderness.

As described for Alternative 2, prescribed fires would have short-term, local, moderate, adverse effects on wilderness; restoring natural processes into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness.

Effects of redistribution techniques would be similar to Alternative 2: short term, local, minor, adverse, but would occur more frequently.

Herding with trained dogs, noisemakers, and horses would have the same effects as described for Alternative 2: short-term, local, adverse effects that would vary from minor to moderate in intensity.

Effects on wilderness from the action of removing animals suspected of having chronic wasting disease would be the same as for Alternative 1: short term, local, minor, adverse.

Effects of accessing the wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse. The tagging or marking of treated or study elk and disruption of natural biological processes would also negatively affect wilderness values; these effects on wilderness would be long term, range wide, minor, and adverse.

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate to major, and adverse. Alternative 4 would contribute long-term, moderate, beneficial effects and short-term, moderate-to-major, adverse effects on these cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 4.

Alternative 5

The reduction of elk under Alternative 5 would cause similar effects as those described in Alternative 2. The following actions taken within wilderness under Alternative 2 would occur to correct past mistakes, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Wolves

The first phase of wolf release, would involve releasing a small number of wolves into the park. The process of wolf release would involve wolf pens, vehicles, and humans, all creating limited visual and noise intrusions into wilderness, which would have short-term, local, minor effects on wilderness. The wolves would wear global positioning system collars, which would allow for passive monitoring which would reduce intrusions into wilderness by helicopters or humans on foot for monitoring purposes.

After the first phase, the number of wolves in the park would be allowed to increase. The presence of wolves would improve wilderness character throughout the wolves' range by improving the experience for visitors to the wilderness who heard wolves howling and by restoring conditions to what naturally occurred in wilderness. Effects would be long term, park wide, and major beneficial, and would occur at least for the length of the plan.

Wolf monitoring could involve the use of helicopters to retrieve wolves if wolves approached the boundary of the park. This would result in a short-term, moderate, adverse effect on wilderness.

Lethal Removal

Effects from lethal removal using suppressed-noise and unsuppressed weapons would be similar to those described for Alternative 2, although somewhat less in the latter years.

Effects of darting activities would be the same as described for Alternative 2.

Removal of carcasses would have the same effects on wilderness as described for Alternative 2.

Access

Effects from accessing elk and vegetation management activities in wilderness would be the same as described for Alternative 2.

Capture Facility

Erecting and using a temporary capture facility would have the same effects as described for Alternative 2.

Vegetation Management

Effects on wilderness from fencing, prescribed fire, and mechanical thinning would be the same as described for Alternative 2.

Redistributive Techniques

Effects of herding on wilderness would be the same as in Alternative 2.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternative 2.

Monitoring

Aside from wolf monitoring (described above), effects of monitoring would be the same as described for Alternative 2.

Research Activities

The use of darting to anesthetize animals and access into wilderness during research activities conducted in coordination with elk reduction activities would have similar effects on wilderness as described for Alternative 2. Tagging or marking elk and the use of fertility control agent for research purposes would have the same effect on wilderness as described in Alternative 2.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 2. The presence of wolves in wilderness would result in a minor-to-moderate, beneficial impact on wilderness. This would not alter the overall intensity of cumulative impacts as described for Alternative 2.

Conclusion

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness. Wilderness values would be noticeably improved through the recovery of vegetation in localized areas, resulting in a long-term, moderate, benefit to wilderness. Effects of releasing wolves in wilderness would be long term, park wide, and major beneficial, and would occur at least for the length of the plan. The process of releasing wolves would cause noise and visual intrusions from humans, wolf pens, and vehicles, which would have short term, local, minor, adverse effects on wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise as in Alternative 2, resulting (even though from brief moments) in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Effects from darting for lethal reduction actions and research activities would be the same as in Alternative 2: local, negligible, and adverse. The effects of carcass removal activities would have the same effects as described for Alternative 2: short term, local, minor, and adverse. Effects of accessing the wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse. Erecting a temporary capture facility for lethal reduction actions with a fence and corral would have the same effects as described for Alternative 2: short term, local, moderate, and adverse.

Effects on wilderness from installing fences and the presence of fences around aspen would be the same as described for Alternative 2: long term, local, moderate, and adverse.

Use of helicopters for various activities (e.g., fencing or monitoring and if necessary, carcass removal) would have the same effects as described for Alternative 2: short term, regional, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusions on wilderness.

As described for Alternative 2, prescribed fires would have short-term, local, moderate, adverse effects on wilderness; restoring natural processes into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness.

Effects of redistribution techniques would be similar to Alternative 2: short term, local, minor, and adverse, but would occur more frequently.

Herding with trained dogs, noisemakers, and horses would have the same effects as described for Alternative 2: short-term, local, adverse effects that would vary from minor to moderate in intensity.

Effects on wilderness from actions of removing animals suspected of having chronic wasting disease would be somewhat less than for Alternative 1 because it is speculated that wolves would do some collection of chronic wasting disease-infected elk, thus reducing the numbers of carcasses to be removed through human activity: short term, local, negligible-to-minor, and adverse.

Effects from the reduction of elk, addition of fencing, prescribed fires, and mechanical thinning on natural conditions would be the same as described for Alternative 2: long term, range wide, minor, and beneficial.

The tagging or marking of study elk and disruption of natural biological processes for those treated with fertility control agent would negatively affect wilderness values; these would result in short term, range wide, negligible to minor, and adverse effects on wilderness. .

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short-term, moderate, and adverse. Alternative 5 would contribute long-term, moderate, beneficial effects and short-term, moderate, adverse effects on these cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 5.

SOCIOECONOMICS

Summary of Regulations and Policies

The National Environmental Policy Act requires analysis of social and economic impacts resulting from proposed major federal actions in an environmental impact statement. From this requirement, the National Park Service has identified conditions that it wants to achieve in association with its management of national parks. These conditions are described in *Management Policies* (NPS 2006b).

Park activities often involve impacts that extend beyond park boundaries. In planning for the management of park resources, *Management Policies* (NPS 2006b) directs the National Park Service to "work cooperatively with others to anticipate, avoid, and resolve potential conflicts; protect park resources and values; provide for visitor enjoyment; and address mutual interests in the quality of life of community residents, including matters such as compatible economic development and resource and environmental protection (sec. 1.6)." Such local and regional collaboration might include other federal agencies, tribal, state, and local governments, neighboring landowners, and non-governmental organizations.

Furthermore, section 2.3.1.4 of *Management Policies* (NPS 2006b) requires that decisions documented in planning products, such as environmental analyses, will be based on current scientific understanding of park ecosystems, the cultural context, and the socioeconomic environment.

Methodology and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The description of the affected socioeconomic environment for this elk management plan and environmental impact statement requires a careful definition of the geographic area of effect. The primary impact area considered includes Rocky Mountain National Park and Estes Park, Colorado, with additional consideration of the Estes Valley. This area of effect was limited to these places because this is the region in which the concentrations of elk are highest, the presence of elk has the most influence on visitation in these areas, and the proposed actions would be confined to Rocky Mountain National Park. Changes in elk population or vegetation also could affect the socioeconomic circumstances of Larimer County. Effects of the alternatives on the businesses and economies of these locations were considered both quantitatively and qualitatively.

Perceptions of Rocky Mountain National Park's attractiveness as a place to visit could have implications for Grand Lake, the park's other gateway town, but these effects would be very small and possibly not measurable.

Issues

Socioeconomic issues identified during internal and public scoping related to elk and to management activities for elk and vegetation include

Both retail sales and the service industry in the Estes Valley depend on tourism.

Any action that affects socioeconomics includes effects on local employment, both permanent and seasonal.

Hunting is an economic contributor to the Estes Valley economy.

Property values and property damage are related to the actions of the elk population in town. Elk are currently affecting private property by consuming vegetation used for landscaping, damaging golf courses, causing automobile accidents, and reducing the fall foliage that many visitors come to Estes Park to view.

The overpopulation of elk has had an impact on local agricultural operations. The elk forage on both natural vegetation and supplementary feed intended for livestock.

Assessment Methods

Elk located in and adjacent to the park impact human behavior revolving around elk-related activities and economic conditions of government agencies, private homeowners, businesses, and ranchers. Tourists and other visitors, hunters, and residents of the areas surrounding the park (the Estes Valley and Grand Lake areas) are impacted by elk. The socioeconomic categories included in this section that may be affected by current elk and vegetation management or by a change in management include elk-related tourism and recreation draw, hunting activity, fiscal conditions of government entities, landscaping and property, agriculture, traffic accidents, human-elk interactions, and property values. The impacts on each of these categories under each management alternative, including current management, are discussed in detail below.

Socioeconomic impacts are based on the following analysis criteria: the target elk population for the area, the distribution of elk inside and outside the park on the east and the west sides, the behavior of the elk around humans and during mating season, and public perception of specific alternative details. For example, tourism and recreation draw may be enhanced by the possibility of seeing a wild elk, the possibility of which might decrease if elk numbers decrease. Hunting activity might be affected by the number and distribution of elk. In addition, public perception of elk management activities could impact a variety of socioeconomic categories. The public receives information on park management and activities from a variety of sources, including television, newspapers and magazines, the Internet, and word of mouth. The way a given activity is discussed and the way the public perceives it may impact the way they view the park and whether they want to visit it. For example, if the public does not like the idea of reducing the elk population through lethal reduction or fertility treatments, they may be less likely to visit the park. There is evidence that public perception does impact human behavior. Public perception of forest fires in Colorado negatively impacted overall visitation to Colorado in 2001 and 2002. Media coverage of the fires caused people to think that Colorado would be an unpleasant place to visit at that time and they changed their travel plans. Historical drops in visitation to the park have also been attributable to events such as gas shortages and war.

Many of the socioeconomic impact categories are related to one another and affect each other. When a category is impacted due to one of the analysis criterion, another category may also be impacted. For example, the number of elk may affect the tourist draw, and a change in the number of tourists drawn to the area would affect the fiscal conditions of the National Park Service, the Town of Estes Park, and the Estes Valley Recreation and Park District. A change in the number of elk may impact hunting activity, which would then affect fiscal conditions for the Colorado Division of Wildlife.

Changes in fiscal conditions of government entities due to changes in elk and vegetation management in the park focus on entities in the Estes Valley (the National Park Service, the

Colorado Division of Wildlife, the town of Estes Park, and the Estes Valley Recreation and Park District). It is assumed that, because of the smaller elk population compared to the east side of the park, any financial impacts on the Town of Grand Lake would be minimal, so its fiscal conditions are not analyzed. Changes in revenues are based on changes in visitation to the park and the Estes Valley and on changes in hunter activity. Changes in expenditures for the agencies would vary according to the specifics of each management alternative and are based on the professional judgments of agency managers.

Potential changes in hunting activity are based on estimates made by the Colorado Division of Wildlife. Economic impacts are calculated based on the change in hunter days from current conditions and the estimated spending of hunters near the east and west sides of the park.

Information Sources

Impacts on each category are based on a variety of information sources, including surveys, interviews, case studies, public scoping results, and professional judgment. Specific methodologies are discussed within category subsections.

Surveys

Rocky Mountain National Park visitors, Colorado residents, and the general public have been surveyed by various groups to determine their perceptions regarding the park, the number of elk in the area, elk management strategies, and wolf release. Survey studies cited in this socioeconomic impact analysis include a survey of Colorado-resident and nonresident park visitors and the general public completed in 2004 by Stewart, Fix, and Manfredo; a survey of Colorado-resident and nonresident park visitors completed in 1995 by Valdez; a survey of Colorado-resident and nonresident park visitors completed in 2000 by Cordova; and a survey of Estes Valley residents completed in 1985 by Berris. These surveys explored perceptions of specific management strategies, including wolf release (Manfredo 1994).

Surveys indicate that over 90% of visitors rate natural scenery, undeveloped vistas, and wildlife as important park features (NPS 1995, Cordova 2000b). Many visitors come to the park to view scenery and take pictures and generally enjoy the feel of a pristine environment. Visitors value the wildness of the park and the feel of the park as a natural environment.

One survey (Stewart et al. 2004) indicated that park visitors would be willing to accept a decrease in the number of elk in the park if natural conditions dictated, even if it meant decreased viewing opportunities. Respondents also agreed that it would be acceptable to reduce the size of the elk population to ensure aspen and willow regeneration. A moderate reduction in elk combined with intensive management of aspen and willow was rated acceptable by 70% to 80% of respondents. Respondents were mixed as to the acceptability of specific management strategies.

Surveys also highlighted the strong feelings that Estes Park and area residents have about elk and elk management (Berris 1987). Survey respondents stated that elk were an asset to the quality of life in the area due to their visual appeal, their reminder of nature, and the freedom inspired by the elk. Respondents also acknowledged some drawbacks to elk in populated areas, such as landscape and property damage and traffic congestion.

Stakeholder Interviews

Interviews were conducted with 29 stakeholders in 2003 and 2004, including 24 in Estes Park and five in Grand Lake. Stakeholders are individuals who represent broader groups affected by elk in general and by elk management in the park, and these interviews allowed an in-depth exploration of a range of issues. Stakeholders interviewed included NPS professionals, Estes Park managers, area residents, business owners and a rancher.

Stakeholders generally exhibited the belief that tourism is the driving economic force in the Estes Valley and that elk are an important part of the tourist draw. Visitors were ranked as the number one driver of the local employment base. Stakeholders indicated that elk are a positive draw for visitors and one of the top five draws to the area; however, they also believe there are too many elk in the impact area and wish to see a reduction in the elk population. They are worried about the loss of the uniqueness of the elk experience in the Estes Valley as pressure on elk to move to other areas increases due to excess numbers.

Stakeholders believe that the elk are an important part of local quality of life but perceive both beneficial and adverse effects from elk. More commonly cited negative aspects of the elk were traffic delays and accidents; increasing negative interactions between elk and residents and visitors; and landscaping, golf course, and other property damage.

The need for elk management was apparent to the stakeholders, but they were less certain about which management options would have beneficial impacts on the area. Activities such as fencing, lethal reduction, fertility control, and predator release received mixed reactions from stakeholders about the impacts on the community.

Due to the minimal impact of agriculture in the area and the small percentage of the economy related to agriculture, the analysis of agricultural impacts related to elk is based on an interview with Eric Adams of the MacGregor Ranch, and Mike Beck of the Switzer-Land Alpaca Farm.

Case Studies, Scientific Papers, and Professional Reports

Case studies and scientific papers were incorporated into the socioeconomic analysis. These studies focused on the effects of wolf release and other specific wildlife management strategies and on the effects of management on public perceptions. Specifically, the effects were examined of wolf release, hunting, lethal reduction, fertility treatments, and fencing at Yellowstone National Park (Wyoming and Montana) and Banff National Park in Canada. The effects of these activities on elk numbers, distribution, and behavior; on park visitation and recreational activities; and on area towns and local residents were examined.

Scientific studies incorporated into impact analysis included Kloppers, St. Clair and Hurd (2005) on the effects of redistribution techniques on elk; Loomis (2004) on the impact of elk on park visitation; Loomis and Caughlan (2004) on linking national park visitation to regional economic models; Wagner and Seal (1992) on the methodologies of managing overabundant wildlife populations; and Lubow et al. (2002) on the dynamics of elk within and adjacent to the park.

Also taken into account were reports and data from the U.S. Fish and Wildlife Service, the National Park Service, the Colorado Division of Wildlife, the Colorado Department of Transportation, and the Colorado Department of Local Affairs.

Professional Judgment

The professional judgments of the National Park Service, the Colorado Division of Wildlife, and Town of Estes Park managers were taken into account. These professionals were contacted and interviewed on numerous occasions to obtain relevant information. Discussions with these professionals were taken into account in the professional judgments of the EIS team.

Impact Threshold Definitions

Intensity of Impact

Negligible: Economic and socioeconomic conditions would not be affected, or effects would not be measurable.

Minor*:* The effect on economic and socioeconomic conditions would be small but measurable and would affect a small portion of the population. Few effects could be discerned outside the Estes Valley area.

Moderate*:* The effect on economic and socioeconomic conditions would be readily apparent and widespread in the vicinity of the Estes Valley, with effects being evident at the county level.

Major: The effect on economic and socioeconomic conditions would be readily apparent and would substantially change the economy or social services within the county area.

Type and Duration of Impact

Beneficial impact would be a positive contribution to the financial condition of a business, government entity, or private individual.

Adverse impact would be a negative contribution to the financial condition of a business, government entity, or private individual.

Duration: Short-term effects would end within three to five years after the implementation of the management action. Long-term effects would persist beyond the 20-year analysis period of this study.

Alternative 1

Elk Tourism and Recreation Draw

Tourism and recreation activities related to elk in the park focus on viewing and photographing elk in their natural environment, particularly in September and October during the elk mating season. Visitors travel to the park from other parts of Colorado and from outside the state to see elk in their natural habitat. The primary reason many visitors come to the park during the fall is to see the elk rut and to listen to elk bugling. Other activities that focus on elk are wildlife photography and educational and interpretive programs related to elk in the park.

Tourists that visit the park to experience the elk may also participate in other activities in the area, either in the park or in the Estes Valley. They may spend money on food, lodging, or other entertainment and recreational activities, and so the park and the Estes Valley benefit from the revenues generated from those tourists who come to see the elk. Changes in the way the elk are managed within the park could have an impact on those tourists and their activities in the area.

Under current management, no changes are expected in the number of elk as compared with current conditions. The elk population would fluctuate between 2,200 and 3,100 elk. No changes are expected in distribution or behavior of elk as compared with current conditions. An estimated 2.8 million people visited the park in 2004. In this alternative, elk would continue to account for an estimated 15% of total draw to the park and the Estes Valley (NPS 2005k). Elk-related visitation currently contributes an estimated $30 million in sales of goods and services, $10 million in personal income, and 750 jobs to the area (NPS 2005e).

Under current management, the vegetation in the park would continue to be threatened by elk herbivory. Although the park visitors feel that the current population level of elk combined with vegetation loss is unacceptable (Stewart et al. 2004), no change in visitation attributable to the elk would be expected, resulting in continued moderate-to-major, long-term, beneficial impacts on the region.

Hunting Activity and Experience

Hunting is an important recreational activity that occurs in the vicinity of the park. Elk hunting occurs on both the east and west sides of the park, with a greater number of hunters near the west side. The number of hunters in the Estes Park area has risen during recent years, making the Estes Valley an increasingly popular place to participate in the elk hunting experience. The increasing number of hunters in the area has not had a substantial impact on the number of elk harvested. The number of hunters near the west side has remained steady in recent years.

In addition to having cultural and social value, hunting has a notable economic impact on the area. Hunters spend money on permits, food, lodging, hunting gear, and equipment. Changes in the way the elk are managed within the park could have an impact on the hunting experience and on the number of hunters in areas adjacent to the park, such as Estes Park and Grand Lake.

There would be no change in number, distribution, or behavior of elk compared to current conditions. A steady 200 to 700 elk would be taken near the east side by approximately 2,000 hunters. About the same number of elk would be taken near the west side by approximately 5,000 hunters (CDOW 2005). Direct economic contribution from elk hunting would total about $0.8 million and $1.7 million per year for the east and west sides, respectively (BBC 2004).

Alternative 1 would continue to contribute a long-term, moderate, beneficial impact on hunting.

Fiscal Conditions of Governmental Entities

Government entities in the Estes Valley are impacted by elk and vegetation management in the park, as management affects the number of elk outside the park in Estes Valley. The presence of elk in these areas is a benefit to many of the agencies, but the agencies also incur costs related to elk activity. Many of these entities rely on elk-related visitation and activity (tourists and hunters) to bring in revenue but also realize expenses due to elk management and elk-related damage. Changes in the way the elk are managed within the park could have an impact on the revenues and expenditures of these government entities.

With no change in the number or distribution of elk in the park and the Estes Valley, there would be no change in public sector expenditures or revenues compared to current conditions. Fiscal conditions for the National Park Service, the Town of Estes Park, the Estes Valley Recreation and Park District, and the Colorado Division of Wildlife would be unchanged.

No change in visitation to the park is expected due to this alternative; therefore, NPS revenue directly related to elk would be similar to current conditions. The National Park Service collected about $6.5 million in revenue from entrance fees and the sale of long-term passes from 2004 to 2005. Elk make up 15% of visitor draw to the park each year; therefore, 15% of the NPS entrance fee revenue, or approximately $1 million, is due to elk. A small portion of the park budget (less than 1%, or less than $200,000) is currently related to elk and vegetation management, and this would continue under Alternative 1. Revenues related to elk would continue to be a moderate, long-term benefit to the park, and elk-related costs would be long term, minor, and adverse.

The Town of Estes Park collects most of its revenues from sales and use taxes. Revenues for the town were about $11 million in 2002. Expenditures in 2002 were about $7.5 million (Colorado Department of Local Affairs 2002). Elk account for an estimated 15% of Estes Park tax revenue, or about $1 million. The Town of Estes Park estimates that it spends a minimal amount each year to manage elk and repair elk-related damage to town property (Feagans 2005). This would continue to result in long-term, moderate, benefits from revenues and negligible, adverse effects from elk-related costs.

The Estes Valley Recreation and Park District derives most of its revenue from user fees at its recreational facilities and devotes nearly its entire budget to maintenance and operations. Over half of district revenue is generated from the 18-hole Estes Park golf course. Revenue for the district in 2004 was greater than $2.5 million, and expenditures were greater than $2.3 million. Elk account for a minimal portion of district revenues and expenditures. The Estes Valley Recreation and Park District spends about $13,000 per year on managing elk and repairing any damage they cause to district property (Gengler 2005). The district was not able to estimate what portion of their revenue was a direct result of elk. This would continue to result in negligible benefits and long-term, moderate, adverse impacts.

The Colorado Division of Wildlife generates most of its revenues through hunting and fishing licensing fees. Elk hunting licenses alone account for about 40% of the CDOW annual budget. A nonresident elk hunting license costs about $500, and a Colorado-resident elk hunting license costs $30 (CDOW n.d.). In 2003, total license revenue for Colorado was greater than $60 million. Most CDOW expenses revolve around wildlife habitat management, recreation and education. In 2003, CDOW expenditures on these activities were greater than $60 million. A large portion of CDOW costs in the game management units near the east and west sides of the park would be related to elk due to the number of elk and the amount of hunting in the area. Only a small portion of statewide costs are due to elk; however, the Colorado Division of Wildlife does pay some damage reimbursement to farmers and ranchers affected by wildlife, though damage reimbursement is not a significant factor for the division in this area due to lack of agricultural activity. The overall impacts on the Colorado Division of Wildlife would continue to be negligible to minor and adverse.

There would be a net, negligible, long-term, beneficial impact on fiscal conditions compared to current fiscal conditions as a result of Alternative 1.

Landscaping and Property Impacts

Costs associated with elk damage to public property have been covered in the "Fiscal Conditions of Government Entities" section. This category focuses on elk-related impacts on private property, including costs realized by private landowners and benefits realized by local landscaping companies. The analysis of costs and benefits related to landscaping and property impacts is based on interviews with local homeowners and landscaping companies. Many individuals noted damage to landscaping as a negative impact of elk.

Large numbers and high concentrations of elk in the park and the Estes Valley have an impact on vegetation outside of the park as well as inside. Elk browse on landscaping plants, grasses, and trees and can cause damage to property, such as fences, as they graze. Landscaping damage is not aesthetically pleasing to homeowners, and the costs of repairing damage are a negative side effect of having elk in the backyard. However, landscaping companies do benefit from the amount of work created as a result of elk damage to property.

The number and distribution of elk in the Estes Valley area would not change, and neither would the amount or distribution of landscaping or property damage, as compared with current conditions. Most landscaping impacts would continue to be felt by local homeowners. The costs incurred by homeowners as a result of elk damage would be approximately equal to the benefits seen by local landscaping companies. Landscaping companies supply new shrubs, plants, and flowers to homeowners, supply or install fences, and supply other landscaping needs. The current impact of elk on landscaping costs to private homeowners in Estes Park is estimated at $350,000 annually (Dudzinski 2003, Harvey Economics 2005). The net long-term impact of Alternative 1 would be a continued long-term, minor-to-moderate, adverse impact on landscaping and private property.

Agriculture

Agriculture accounts for a minimal portion of the economy in the Estes Valley. There is only one operating cattle ranch in the geographic area of analysis.

The number of elk and the distribution of elk would be unlikely to change; therefore, no change would be expected in agricultural impacts as compared to current conditions. The one ranch owner in the region experiences between $90,000 and $180,000 in lost revenue annually due to elk grazing. The ranch grazing plan accounts for 100 to 200 elk on the property, equaling 500 to 1,000 annual unit months of hay consumed by the elk. In addition to lost revenue due to elk grazing, the ranch incurs minimal costs due to elk damage, mostly related to damaged fencing (Adams 2003). There would continue to be a moderate, long-term, adverse impact for the ranch and on the agricultural environment.

Traffic Accidents and Congestion

Roadways in Estes Park are crowded with visitors driving to the park or to the Town of Estes Park. In 2004, the Colorado Department of Transportation counted six million vehicles at the intersection of two major highways in Estes Park (CDOT 2005). Elk often congregate in large groups near roadways within the park and in areas around and within the Town of Estes Park, especially during the fall mating season. Elk graze on grassy areas and wander across roads and, at times, walk along road shoulders. Elk on the roads can cause congestion or traffic jams, especially during the fall mating season, as drivers stop to watch elk or wait for them to cross the road. The combination of elk and cars on roadways can also cause minor or severe traffic accidents. Accidents can result from hitting an unseen elk on roadways, from hitting an elk that has darted into the road, from a driver trying to avoid an elk, or from a driver watching elk and not paying attention to the road. Elk-automobile accidents and other elk-related accidents occur in the park and in other areas in the Estes Valley. Stakeholders indicated that elk-related traffic congestion and traffic accidents were a concern.

The Colorado Department of Transportation tracks traffic accidents in Estes Park and the Estes Valley and has information on the number of accidents involving wild animals in general but does not separate out accidents that involve elk specifically. In general, traffic accidents involving wild animals have been on the rise, both in absolute number and in proportion of the total number of accidents in town.

The number of elk and distribution in the park and in the Estes Valley would be unlikely to change. Visitation to the park is not expected to change as a result of current elk management. Therefore, any change in traffic congestion or numbers of traffic accidents involving wild animals would not likely be the result of elk-related accidents. Elk would continue to make a minor-to-moderate, adverse, seasonal (fall mating season) contribution to congestion and traffic accidents in the park and Estes Park.

Currently, up to an estimated 30 to 35 accidents per year involve elk and are repaired by body shops in the area (CDOT 2004, Thoms 2004). These accidents cost drivers an estimated $75,000 annually but benefit auto body shops in the area by approximately the same amount (Rocky Mountain Insurance Information Association 2005, Thoms 2004). There are three auto body shops in Estes Park that share the work from elk-related damage. Tourists generate most auto repair work and a small portion of body work for auto body shops in Estes Park (Thoms 2004).

This alternative would have a minor-to-moderate, beneficial, long-term effect on body shops, as they would continue to repair damages from elk-related accidents, and a minor, long-term, adverse impact on visitors compared to current conditions.

Property Values

Elk have direct and indirect impacts on property values in the Estes Valley. As mentioned above, elk have a beneficial impact on the quality of life in the area, which has an impact on property values. The benefits residents receive as a result of elk depend, in part, on the number of elk in the area. If there are too few elk, residents would not readily know they are there; if there are too many elk, there would be landscaping damage, traffic issues, and the possibility of negative elk-human interactions.

More important to property values than the addition to quality of life is the impact that elk have on visitor draw to the area. Tourism and recreation account for more than 40% of the economy in the Estes Valley, and elk are a large part of the draw to the area. Stakeholders indicated that visitors are vitally important to the local economy. A strong economy would affect the desire of people to move into the area and would have a positive impact on property values. Any change in tourist visitation to the area that has a significant impact on the local economy may have an impact on property values.

Current property values are relatively high in the Estes Valley and have risen rapidly since 1990. Since distribution and numbers of elk would be unlikely to change, and no change is expected in visitation to the area, no change in property values as a result of elk would be expected from current conditions. Elk would continue to contribute a net minor-to-moderate benefit to the quality of life of Estes Valley residents and would continue to contribute to the local economy through attraction of visitors. Property values would likely experience a negligible, long-term impact compared to current conditions.

Cumulative Impacts

The Estes Valley area is a growing community that is sustained in large part by its attractive mountain setting and its proximity to Rocky Mountain National Park. Population grew rapidly from the 1960s through the 2000, growing faster than the state. In the 1990s alone, the Estes Valley grew 47.1% compared to the state, which grew at 24.4%. The Estes Valley population is forecast to grow 29.4% by 2010. Tourism accounts for much of this growth; however, the socioeconomic environment is also changing as more retirees move to the community (Larimer County Planning Division 2005).

Tourism and visits to Rocky Mountain National Park are a substantial contributor to the Estes Valley economy. Since 1984, when visitor counting procedures improved, the number of visitors has grown fairly steadily from 2.2 million to 3.2 million. Although, elk contribute to the draw of the park, visitors come to the park for a variety of other reasons. Visitors also have many reasons for visiting the Town of Estes Park and other areas in the Estes Valley, including culture and entertainment, shopping, recreation, and dining.

The summer season is the peak for visitation to the park and to the Estes Valley. However, over the past 20 years, there has been an increased importance of the non-summer tourist season. This is evidenced by the declining percentage of visitors coming from June through September. In 1982 and 1983 , visits during this time period were over 78%, but fell fairly steadily to approximately 70% in 2000 through 2004 (NPS 2005f). Numerous special events outside the national park provide a sustained attraction to the area and contribute to both summer and non-summer visitation. These include activities such as the Wool Market (mid-June, 10,000 attendees), the Rooftop Rodeo (mid-July, 10,000 attendees), the Scottish Festival (early September, 65,000 attendees), the Elk Festival (end of September, 5,000 attendees), and the Christmas Parade (late November, 22,000 attendees). The attractions of the park and the Estes Valley cumulatively have a major, long-term, beneficial effect on the Estes Valley.

Sales tax revenues have grown steadily and are expected to grow at a rate of 4% to 5% per year for the next several years (RRC 2005). However, with rapid population growth and an increasing number of retirees, tourism has declined slightly in its relative importance to the economic base of Estes Park. To continue long-term stabilization and diversification of the Estes Valley economy, revitalization of the Estes Park Urban Renewal District has taken place and shopping and retail opportunities have been broadened. The Estes Valley Comprehensive plan intends to continue to broaden the job base through increasing industrial jobs (Larimer County Planning Division 2005). These actions and growth from sectors other than tourism are expected to contribute to long-term, moderate-to-major, cumulative benefits.

Growth in the Estes Valley would be expected to increase problems associated with more people and the relatively confined geography of the valley. Increases would be expected in encroachments of development on open spaces, adverse interactions with wildlife, and traffic congestion and accidents. Long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

Alternative 1 would continue to provide benefits because the distribution and numbers of elk would not be likely to change, and no change would result in the net positive contribution of elk to the socioeconomic environment. Elk would continue to attract a substantial number of visitors and hunters to the area who would spend money both inside and outside the park. Elk-related revenue and expenditures for government entities would be similar to current conditions. The beneficial effects of Alternative 1 would continue to contribute to the long-term, moderate-to-major, cumulative benefits within the socioeconomic environment.

Under Alternative 1, elk would continue to damage landscaping and property in the Estes Valley, adversely impact agricultural revenue in the area, and cause traffic congestion and accidents in the park and in town. Potential for negative elk-human interaction would continue, and elk would continue to have direct and indirect impacts on property values. The adverse impacts of Alternative 1 would continue to contribute to but not increase the long-term, minor-to-moderate, cumulative, adverse impacts that exist within the socioeconomic environment.

Conclusion

Under current management practices, the vegetation in the park would continue to be threatened by elk herbivory. Although park visitors feel that the current population level of elk combined with vegetation loss is unacceptable (Stewart et al. 2004), no change in visitation attributable to the elk would be expected, resulting in continued moderate-to-major, long-term, beneficial impact in the region.

Alternative 1 would continue to contribute a long-term, moderate, beneficial impact from its contribution to hunting. Revenues related to elk would continue to be a moderate, long-term benefit to Rocky Mountain National Park, and elk-related costs would be long-term, minor, and adverse. The Town of Estes Park would continue to receive long-term, moderate benefits from elk-related revenues and negligible, adverse effects from costs. The Estes Valley Recreation and Park District would receive negligible benefits from elk-related revenues, but would continue to experience long-term, moderate, adverse effects from costs. The overall impacts on the Colorado Division of Wildlife would continue to be negligible to minor and adverse. There would be a continued long-term, minor-to-moderate, adverse impact on landscaping and private property. There would continue to be a moderate, long-term, adverse impact on the ranching and agricultural community. Elk would continue to make a minor-to-moderate, seasonal (fall mating season) contribution to congestion and traffic accidents in the park and Estes Park. This alternative would have a minor to moderate beneficial, long-term effect on body shops, as they would continue to repair damages from elk-related accidents. Elk would continue to contribute a net minor-to-moderate benefit to the quality of life of Estes Valley residents. Property values would likely experience a negligible, long-term impact.

The beneficial effects of Alternative 1 would continue to contribute to the long-term moderate to major cumulative benefits within the socioeconomic environment. The adverse impacts of Alternative 1 would continue to contribute to, but not increase the long-term, minor to moderate cumulative adverse impacts that exist within the socioeconomic environment.

Alternative 2

Elk Tourism and Recreation Draw

Under this alternative, the target elk population would be at the low end of the natural range of variation, fluctuating between 1,200 and 1,700 animals. Elk distribution would be similar to that under current conditions, but there would be more elk outside the park near the west side during hunting season as a result of lethal reduction and redistribution techniques. Elk behavior would be similar to that under current conditions, but elk could be slightly more skittish or have a "wilder" feel to them as a result of lethal reduction and redistribution techniques. Visitors' likelihood of experiencing elk would be reduced slightly with a smaller number of elk, but visitor draw would not be affected , as bugling and rutting in the fall would occur in the same places as they currently do. Most visitors would be willing to accept a decrease in the number of elk if natural conditions dictated a decrease was necessary, even if it meant decreased viewing opportunities (Stewart et al. 2004).

Public perception would be a concern in the initial phase of this alternative. The most intensive lethal reduction would occur during the first four years of the program, during which 200 to 700 elk would be lethally removed per year. After that, lethal reduction would occur at a reduced rate of 25 to 150 elk per year for the next 16 years. Using government employees to lethally remove elk was rated as acceptable to approximately half of survey respondents (Stewart et al. 2004). However, there is concern that negative perception of lethal reduction efforts may affect visitation in the short term due to media coverage of the activity. Lethal removal of elk in the park could be a controversial issue for some groups of people. One of the major reasons for discontinuing the bison lethal reduction program at Yellowstone in 1968 was the public outcry after media coverage by the national news (Smith and White 2005). In addition to concerns related to the perception of lethal reduction, redistribution techniques, such as herding and aversive conditioning, are not highly acceptable to the public (Stewart et al. 2004, Kloppers et al. 2005).

Concerns about negative public perception could be addressed with public education of the program details. A lethal reduction program may be more acceptable to the public if they understand the impacts of the current number of elk, the reasons for reducing elk numbers, and program details such as the short-term timeline of intensive lethal reduction and the humane treatment of the elk. There would be a minor-to-moderate, adverse, short-term effect on visitation as a result of lethal reduction efforts. Decreased visitation would have a minor-to-moderate, adverse, short-term effect on area sales and local income.

It is estimated that there would be a 5% decrease in visitation during the first four years of the lethal reduction program due to negative public perception of lethal reduction activities. The 5% reduction in visitors would result in a $1.5 million loss in sales, $0.5 million loss in personal income to employees, and a loss of about 35 jobs. These losses are based on a 5% decrease in current condition sales, income, and number of jobs directly related to elk. Impacts would be felt within Rocky Mountain National Park as well as in Estes Park and other areas surrounding the park.

A small amount of fencing would be installed around 160 acres of aspen stands on the primary winter and summer ranges as part of this alternative. Fences would be temporary, and would be designed to allow access to other species and with gates to allow visitor access to enclosed areas. Efforts would be made to minimize the visual impact of fences through design and selection of materials. Vegetation would improve as a result of the reduction in the number of elk and the fencing. Survey respondents and stakeholders indicated that a balance between elk and vegetation was an important goal and that at least some aspen and willow management was needed. Vegetation alone is not a large draw to the park, and vegetation improvement in some areas would not be likely to have a substantial impact on visitation. Vegetation improvement and fencing would have a negligible-to-minor, long-term benefit on visitation.

Research activities to evaluate procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent during the first three years of plan implementation may cause some concern due to public perception of fertility control in a free ranging wildlife. Short- and long-term contraception were acceptable to approximately half of survey respondents (Stewart et al. 2004) and some portion of the public would support research on a non-lethal population control method. The number of female elk that would receive the fertility control treatment as part of the study would be small, as not more than 120 female elk would be subject to study and at least half would be treated with a fertility control agent. In addition, the public in general would support efforts to enhance the ability to test for chronic wasting disease in live elk as opposed to current methods of testing heads in deceased elk. Overall, there would be no effect on visitation to the area or park as a result of research activities.

Alternative 2 would be expected to create a net short-term, minor-to-moderate, adverse effects on tourism and recreation draw as a result of public perception of lethal reduction and redistribution techniques, but a negligible, long-term, adverse effect on tourism and recreation would be expected.

Hunting Activity and Experience

Elk distribution would be similar to that under current conditions, but there would be more elk outside of the west side of the park during hunting season as a result of lethal reduction and redistribution techniques inside the park. Elk hunting near the west side of the park would increase in the short-term due to the number of elk driven out of the park during hunting season. Redistribution techniques would push elk out of the park, but the increase in the number of elk near the west side would only occur in the short-term, since elk numbers would be greatly reduced after the initial phase of lethal reduction. Currently there is a limit on hunting licenses sold in GMUs on the west of the park, however license numbers generally are kept high in order to manage elk within the objectives established by CDOW. With increases in elk outside of the park, there likely would be a short term increase in hunter interest in areas immediately west of the park including a short term increase in licenses sold. (Leslie 2005). It is estimated that there is potential for a 5% increase in hunter days near the west side of the park. This increase would result in an additional $85,750 of direct contribution to the local economy from hunters near the west side of the park, based on a 5% increase in west side hunter-based revenue. There would therefore be a moderate, short-term, beneficial impact on hunters near the west side of the park and the Grand Lake community.

Decreased numbers of elk on the east side of the park would result in a short- and long-term decrease in the number of hunting licenses available (Leslie 2005). This would result in a slight decline in elk harvest in the east side of the park in the short and long terms, which would have a minor net adverse effect on the east side. It is estimated that there would be potential for a 2% to 3% decrease in the number of hunter days near the east side, which would mean a loss of between $16,000 and $24,000 of direct economic contribution to the local economy due to decreased elk hunting near the east side. These numbers are based on a decrease of 2% to 3% of hunter-based revenue near the east side. There would be a minor, long-term, adverse impact on hunters and the Estes Park community near the east side of the park.

In the short term, hunting near the east side of the park would be adversely affected from a reduction of elk and more skittish elk, and hunting near the west side would be positively affected as elk would be pushed out of the park from redistribution. Short term, there would be a net negligible-to-minor impact on hunting activity as a result of this alternative. In the long-term, hunting activity near the east side would continue at a decreased level and hunting near the west side would probably continue at original levels, since there would be fewer elk in the area. There would be a net negligible-to-minor, adverse, long-term impact on hunting.

Elk that are subject to the fertility control agent and to immobilization drugs to test for chronic wasting disease as part of the three-year research study may cross the park boundary and be subject to hunting. Treated elk would receive long-term mark that warns individuals not to consume the meat if the elk was killed before the required withdrawal period had passed for a regulatory approved fertility control agent or immobilization drug. Since capture of animals would happen in the winter, this would only potentially affect late-season hunters in January and February of the initial year of study. Because of the small number of female elk to be treated, the short timeframe of the study, and the limited exposure of hunters to study elk, there would be no effect on hunting activity in the area.

Fiscal Conditions of Governmental Entities

The National Park Service is expected to see a minor-to-moderate, short-term drop of approximately $50,000 in annual elk-related entrance fee revenue due to an estimated 5% decrease in visitation with Alternative 2. The National Park Service would also experience reduced revenue from its concessionaire contracts, as a reduced number of visitors would also spend less on concessions. In addition, the National Park Service would experience a moderate, short-term increase in costs and a minor, long-term increase in costs due to the activities of lethal reduction, redistribution, and fencing.

The Town of Estes Park would experience a minor-to-moderate, short-term adverse impact on revenue due to the decrease in park visitors. The decrease in visitors to the Estes Valley would result in a loss of about $50,000 in tax revenue for the town, a 5% decrease in current elk-related taxes. Beneficial impacts due to reduced costs related to elk management and damage would be negligible and long-term.

The Estes Valley Recreation and Park District would see a minor, beneficial impact from decreases in costs in the short- and long-terms due to the reduced number of elk. Costs to the district as a result of elk related management and damage repair would decrease by about $3,000, based on the assumption that elk-related costs would decrease by half the percentage decrease of elk. The Estes Valley Recreation and Park District would also experience a negligible, adverse impact from decreases in revenue in the short term due to decreased visitation to the area.

The Colorado Division of Wildlife would see costs and revenues similar to those under current conditions. The decrease in hunting activity near the east side of the park would be offset by increased hunting activity near the west side of the park, so total costs and revenues would not be significantly affected. Long-term, beneficial and adverse impacts from changes in fiscal conditions for the Colorado Division of Wildlife would be negligible.

Changes in long-term visitation to Rocky Mountain National Park and the Estes Valley would be negligible; therefore, long-term fiscal impacts would be negligible for all jurisdictions.

Landscaping and Property

With a decrease in the number of elk inside and outside the park, local landowners would see minor-to-moderate, short- and long-term decreases in landscaping and property damage costs. In the short-term, the number of elk in Estes Park would be reduced by about 30%; in the long-term the elk population would be reduced by about 45%. Fewer elk in the Estes Valley would mean less elk browsing and grazing, which would result in a decrease in the amount of elk-related damage. Conditions for homeowners' landscaping and property would improve, but some elk-related damage would still occur, since elk would still be present. Landscaping costs would decrease by half the percentage decrease of elk, resulting in about $80,000 in decreased annual damage costs in the short-term and long-term for homeowners.

Landscaping businesses would experience minor-to-moderate, short- and long-term decreases in revenue due to a decrease in elk related damage, with decreased annual revenue of up to $80,000. The amount of fencing installed to stop elk herbivory would decrease, as would the portion of plant sales due to elk browse. The loss of revenue would be slightly offset by homeowners buying more annuals, which they do not buy now due to the high numbers of elk browsing in town.

Agriculture

There would be fewer elk in the Estes Valley area as compared to current conditions, due to lethal reduction activity. With fewer elk on the property, the rancher would be able to graze more cattle on the ranch. Management activities are assumed to affect elk in direct proportion to their current distribution. It is assumed that the percentage decrease of elk in the Estes Valley would be equal to the percentage decrease of elk on the ranch property. This alternative would result in a decrease of between 46 to 92 elk on the ranch property and the possibility of increasing cattle by 23 to 46 animals. The increased cattle would increase ranch revenue by $41,000 to $82,000. With fewer elk in the Estes Valley and on the ranch property, the rancher would likely see a minor decrease in costs related to elk damage. Hunting is offered on the ranch, and fewer elk may reduce revenues received from hunters. This would off-set decreases in elk damage costs somewhat.

There may be a reduction in elk use on agricultural lands in the Kawuneeche Valley with a reduction of the elk population in the park. While damage claims on the west side are minimal there are many practices in place to reduce elk impacts on adjacent agricultural lands on the west side.

The rancher would likely experience minor-to-moderate, short- and long-term benefits from a reduced number of elk grazing on his property.

Traffic Accidents and Congestion

A decrease in the number of elk in the park and in the Estes Park area would mean a decreased number of elk in roadways and on road shoulders and would lessen the possibility of elk-related traffic congestion and traffic accidents. In the short-term, the number of elk in Estes Park would be reduced by about 30%; in the long-term, the elk population would be reduced by about 45%. In addition to fewer elk, there would also be 5% fewer visitors, in the short-term, to the park and to the surrounding areas to view the elk, resulting in a decrease of accidents and congestion. The reduction in the number of elk and in the number of visitors to the area would have a minor, short- and long-term benefit to traffic congestion.

The number of traffic accidents in the area would be reduced as a result of the smaller number of elk in the area. The reduction of elk as a result of lethal reduction in this alternative would lead to approximately $17,000 in decreased revenues for Estes Park auto body shops, based on the assumption that body shop revenue would drop by half the percentage decrease in the number of elk. There would be a minor, short- and long-term adverse impact on Estes Park body shops. The net effect of a reduced number of elk in the Estes Valley on elk-related traffic accidents would be negligible to minor and beneficial in the short and long term.

Property Values

There would be a decreased number of elk in the Estes Valley as a result of lethal reduction activity, but the presence of elk would probably be sufficient to maintain their contribution to the quality of life in the Estes Valley. With fewer elk in the area, there would be a lower amount of landscape damage, fewer elk-related traffic accidents and fewer possibilities for negative elk-human interactions, each of which would not likely impact property values but affects the overall quality of life. Visitation to the area would be decreased, but only in the short term. This short-term decrease would not have enough impact on the local economy to affect property values. These alternatives would result in minor, short- and long-term benefits to property values.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

Alternative 2 would reduce the number of elk as a result of lethal reduction activity; the intrinsic value of the elk experience would likely remain unchanged. In the short term, visitation would decrease, but long-term visitation would not be affected and adverse impacts would be negligible. Hunting activity would decrease near the east side of the park, but would increase near the west side. The National Park Service, Estes Park, and the Estes Valley Recreation and Park District would experience a short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities.

In the short and long-term, there would be a minor-to-moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor-to-moderate, short- and long-term benefits from the reduced number of elk. Traffic congestion would decrease in the short-term, but there would be negligible long-term impacts.

Elk-related traffic accidents would decrease in the short and long term. There would be minor, short- and long-term benefits to property values.

The short-term, minor-to-moderate and long-term, negligible, adverse effects on tourism and recreation draw resulting from Alternative 2 would likely be slightly measurable within the long-term, moderate-to-major cumulative benefits to the Estes Valley economy. The moderate-to-major, cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 2.

The beneficial effects on the Estes Valley through a reduction in landscape damage, agricultural impacts, and traffic congestion and accidents resulting from Alternative 2 would be slightly measurable in long-term, cumulative, adverse effects from future 29% population growth. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 2.

Conclusion

The number of elk in the park and in the Estes Valley would be reduced as a result of lethal reduction activity, but elk distribution and behavior would be similar to that of current conditions. The intrinsic value of the elk experience would likely remain unchanged. The visitor experience of elk viewing in the park would be reduced slightly as a result of fewer, more skittish elk. There would be no effect on visitation to the park or region as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease live testing. Alternative 2 would be expected to create a net short-term, minor-to-moderate, adverse effect on tourism and recreation draw as a result of public perception of lethal reduction and redistribution techniques, but a negligible, long-term effect on visitation would be expected.

In the short-term, visitation would decrease, but long-term visitation would not be affected. Hunting activity would decrease near the east side of the park but increase near the west side. There would be no effect on hunting activity as a result of research activities due to the short study timeframe, limited number of female elk treated, and limited exposure to hunters due to the time of year the study would be conducted. There would be a net negligible-to-minor, adverse, long-term impact on hunting. Rocky Mountain National Park, Estes Park, and the Estes Valley Recreation and Park District would experience short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities. In the short and long term, there would be a minor-to-moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor-to-moderate, short- and long-term benefits from the reduced number of elk. Traffic congestion would decrease in the short-term, but there would be minor, long-term, beneficial impacts. Elk-related traffic accidents would decrease in the short and long term, and beneficial impacts would be negligible to minor. There would be a minor, short- and long-term adverse impact on Estes Park body shops. There would be minor, short- and long-term benefits to property values. Overall, there would be a net negligible long-term impact compared to current conditions.

The moderate to major cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 2. The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 2.

Alternative 3

Elk Tourism and Recreation Draw

Up to 200 elk would be lethally taken each year for 20 years, making public perceptions of lethal reduction less of an issue than in Alternative 2. Fencing around aspen (160 acres) and willow stands (440 acres) would be located in areas popular with visitors. Many park visitors come to the park for the scenery and undeveloped vistas, and fencing would have an adverse impact on their experience. This alternative would implement mitigation measures to reduce the impact of fences on visitors through design and selection of materials as described in Alternative 2.

Even with these differences, however, the impacts on elk tourism and recreation draw would be similar to those under Alternative 2.

A three-year reseach study to evaluate procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent would have the same effects as described in Alternative 2; overall, there would be no effect on visitation to the area or park as a result of research activities.

Hunting Activity and Experience

Impacts on hunting activity and experience would be the same as under Alternative 2.

Fiscal Conditions of Governmental Entities

The impacts on fiscal conditions of government entities would be the same as under Alternative 2.

Landscaping and Property

With a decrease in the number of elk inside and outside the park to the higher end of the range of natural variation, local landowners would see minor, long-term decreases in landscaping and property damage costs. In the long-term, the elk population would be reduced by about 30%. Fewer elk in the Estes Valley would mean less elk browse and grazing, which would decrease the amount of elk-related damage. Conditions for homeowners' landscaping and property would improve, but elk-related damage would still occur, since elk would still be present. Landscaping costs would decrease by half of the percentage decrease of elk, resulting in about $50,000 in decreased annual damage costs for homeowners. In the short-term, decreases in landscaping costs would be minor due to the small amount of annual elk reduction.

Landscaping businesses would experience minor, long-term decreases in revenue due to a decrease in elk-related damage. Landscaping companies would see decreased annual revenue of up to $50,000 as the amount of elk fencing installed would decline, as would the portion of plant sales due to elk browse. In the short-term, decreases in landscaping revenue would be minor due to the small amount of annual elk reduction.

In the short term, net impacts would be negligible, as homeowner costs and company revenue would not change significantly compared to current conditions. The net long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible compared to current conditions.

Agriculture

There would be fewer elk in the Estes Valley area compared to current conditions due to lethal reduction activity. With fewer elk on the property, the rancher would be able to graze more cattle. Management activities are assumed to affect elk in direct proportion to their current distribution. It is assumed that the percentage decrease of elk in the Estes Valley would be equal to the percentage decrease of elk on the ranch property. These alternatives would result in a decrease of between 30 to 60 elk on the ranch property and the possibility of increasing cattle by 15 to 30 animals. The increased number of cattle would increase ranch revenue by $27,000 to $54,000. Hunting is offered on the ranch, and fewer elk may reduce revenues received from hunters. This would off-set decreases in elk damage costs somewhat. With fewer elk in the Estes Valley and on the ranch property, the rancher would likely see a minor decrease in costs related to elk damage.

The rancher would likely experience minor to moderate, short and long term benefits from a reduced number of elk grazing on his property.

Traffic Accidents and Congestion

A decrease in the number elk in the park and in the Estes Park area would mean a decreased number of elk in roadways and on road shoulders, reducing the possibility of elk-related traffic congestion and traffic accidents. In the long term, the number of elk in Estes Park would be reduced by about 30%. In addition to fewer elk, there would also be 5% fewer visitors to the park and to the surrounding areas to view the elk, resulting in a decrease of accidents and congestion. The reduction in the number of elk in the area and in the number of visitors to the area would have a minor, short- and long-term benefit to traffic congestion.

The number of traffic accidents in the area would be reduced as a result of the smaller number of elk. It is estimated that the reduction of elk as a result of lethal reduction in this alternative would lead to approximately $11,000 in decreased in revenues for Estes Park auto body shops, based on the assumption that body shop revenue would drop by half the percentage decrease in the number of elk. There would be a minor, short- and long-term, adverse impact on Estes Park body shops and a minor, short- and long-term, beneficial impact on visitors.

Visitation would decrease in the short-term only, so the short-term net effect on congestion would be negligible to minor. There would be no long-term effect on congestion compared to current conditions. The net effect of a reduced number of elk in the Estes Valley on elk-related traffic accidents would be negligible to minor and beneficial in the short and long term.

Property Values

The impacts on property values would be the same as under Alternative 2.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

The cumulative socioeconomic environment and the cumulative effects of Alternative 3 would be the same as Alternative 2.

Conclusion

Alternative 3 would be expected to create a net short-term, minor to moderate, adverse effect on tourism and recreation draw as a result of public perception of lethal reduction, herding and aversion techniques, but a negligible long-term effect on visitation would be expected. There would be no effect on visitation to the park or the region as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease testing.

In the short-term, visitation would decrease, but long-term visitation would not be affected. The National Park Service, Estes Park and the Estes Valley Recreation and Park District would experience a short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities. In the short and long-term, there would be a minor to moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor to moderate short and long-term benefits from the reduced number of elk. Traffic congestion would decrease in the short-term, but there would be minor, long-term beneficial impacts. Elk-related traffic accidents would decrease in the short and long-term, and beneficial impacts would be negligible to minor. There would be a minor short and long-term adverse impact on Estes Park body shops. Overall, there would be a net negligible long-term impact compared to current conditions.

Impacts on hunting activity and experience would be the same as under Alternative 2: net negligible to minor adverse and long-term.

The impacts on property values would be the same as under Alternative 2: minor short and long-term benefits. The moderate to major cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 3. The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 3.

Alternative 4

Elk Tourism and Recreation Draw

Under this alternative, the target elk population would be at the high end of the natural range of variation, fluctuating between 1,600 and 2,100 animals. Elk distribution would be similar to that under current conditions, but there would be more elk outside the park near the west side during hunting season as a result of lethal reduction and redistribution techniques. Elk behavior would be similar to that under current conditions, but elk could be slightly more skittish or have a “wilder” feel to them as a result of lethal reduction and redistribution techniques.

Public perception would be a concern due to the fertility treatments, the lethal reduction activity, and the amount of fencing (up to 420 acres of habitat fenced). Between 80 and 150 elk would be lethally removed each year over the life of the plan, making lethal reduction less of an issue than fertility control treatments. Fertility control of female elk, including those that would be subject to research of control agents, could be a controversial issue for some people. Some members of the public could have a negative perception of the fertility program, since the elk would no longer feel wild to them. Short- and long-term contraception were acceptable to approximately half of survey respondents (Stewart et al. 2004); however, the combined activities of large-scale fertility control of a high number of elk for population management, lethal reduction, and fencing around vegetation would bring a cumulative risk of making the park less attractive to the public. Large-scale fertility control, fencing, and redistribution techniques would diminish the perception of the park as a wild place. In addition, large-scale fertility control would diminish the overall reputation of the park, which would reduce visitation.

Visitation would probably diminish in the short and long-term as a result of the combined actions of fertility control for population management, lethal reduction, and fencing. There is potential for a 10% drop in visitation in both the short and long terms, which would result in a $3 million loss in sales, a $1 million loss in personal income to employees, and the loss of 75 jobs. These losses are based on a 10% decrease in current condition sales, income, and number of jobs directly related to elk. Impacts would be felt within the national park as well as in the towns and areas surrounding the park. These factors would have a moderate, adverse impact in the long term.

A three-year reseach study to evaluate procedures for testing live elk for chronic wasting disease would have the same effects as described in Alternative 2; overall, there would be no effect on visitation to the park or region as a result of research activities testing for chronic-wasting disease.

Vegetation would be improved as a result of the reduction in the number of elk and the fencing that would be installed around aspen and willow stands on the primary winter range. Survey respondents and stakeholders indicated that a balance between elk and vegetation was an important goal and that at least some aspen and willow management was needed. Vegetation improvement would have a negligible-to-minor, long-term benefit on visitation.

A net moderate, short- and long-term, adverse impact on visitation would be likely as a result of negative public perception of fertility control, lethal reduction, and fencing activities, balanced by a negligible-to-minor, long-term benefit on visitation from improved vegetation.

Hunting Activity and Experience

Elk distribution would be similar to that under current conditions, but there would be more elk outside the park during hunting season, especially near the west side, as a result of lethal reduction and redistribution techniques.

Elk treated as a result of management actions could be identified to hunters through permanent or temporary markings, based on Food and Drug Administration drug approval for consumption. Markings could include paint marks, collars, or other “do not eat” markings, and might reduce hunting interest and activity in the areas around the park. Due to the large number of elk being treated under this alternative to manage the elk population, fertility treated elk would likely move outside of the park on the west side. Currently the three-year average for elk harvest in GMU 18 is 58% cows and 42% bulls. Hunter concerns about potential problems associated with consuming a fertility treated elk would likely reduce hunter harvest, success, and pressure.

Hunter activity would likely drop by 5% as a result of the fertility control program. The drop in hunter activity would result in a loss of about $127,000 in direct economic contribution from hunters near the east and west sides of the park, based on a 5% drop in total revenue from elk hunters.

Subjecting elk to a multi-year fertility control agent and to immobilization drugs as part of a three-year research study would not result in detectable effects on hunting activity to the area compared to the large-scale control of the population with fertility control agents.

Overall, there would be a minor-to-moderate, adverse, short- and long-term impact on hunter activity and experience as a result of Alternative 4.

Fiscal Conditions of Governmental Entities

The park is expected to see a moderate to major short and long-term drop in annual elk-related entrance fee revenue due to an estimated 10% decrease in visitation, with an annual loss of revenue of approximately $100,000. The park would also see reduced revenue from its concessionaire contracts, as a reduced number of visitors would also spend less on concessions. In addition, the park would experience a moderate, short- and long-term increase in costs due to the activities of lethal reduction, redistribution, fencing, and fertility control.

The Town of Estes Park would feel a moderate to major, short- and long-term decrease in revenue due to the decrease of visitors to the area, resulting in a loss of about $100,000 in tax revenue for the town, calculated as a 10% decrease in current elk-related taxes. Decreases in costs related to elk management and damage would be negligible.

The Estes Valley Recreation and Park District would feel a minor decrease in costs in the short and long terms. Costs to the district as a result of elk-related management and damage repair would decrease by about $2,000, based on the assumption that elk-related costs would decrease by half of the percentage decrease of elk. The Estes Valley Recreation and Park District would also experience a slight decrease in revenues in the short and long terms due to decreased visitation to the area. Overall, there would be negligible net effect on the Estes Valley Recreation and Park District.

The Colorado Division of Wildlife would likely experience a minor-to-moderate increase in costs as a result of an increase in questions and concerns from residents, visitors, and hunters related to the fertility program (Leslie 2005). The Colorado Division of Wildlife would also see a minor decline in local revenue as a result of decreased hunting. A decrease of 5% in hunting activity would mean a decrease of 350 hunters in the area. Assuming 85% are Colorado residents and 15% are nonresidents (Spowart 2004), revenue loss for the Colorado Division of Wildlife would be about $35,000, based on the cost of elk-hunting licenses.

Net impacts on the public sector would be minor to moderate and adverse in the long term due to the decrease in visitors to the area.

Landscaping and Property Impacts

The impacts on landscaping and property would be the same as under Alternative 3.

Agriculture

The impacts on agriculture would be the same as under Alternative 3

Traffic Accidents and Congestion

The impacts on traffic accidents and congestion would be the same as under Alternative 3.

Property Values

There would be a decreased number of elk in the Estes Valley as a result of lethal reduction and fertility control, but the presence of elk would probably be sufficient to maintain their contribution to the quality of life in the Estes Valley. However, there would be less of a sense of the area being a wild environment, which would detract from the quality of life. With fewer elk in the area, there would be less landscape damage, fewer elk-related traffic accidents, and fewer possibilities for negative elk-human interactions, each of which would not likely impact property values but would affect the overall quality of life. Visitation to the area would be decreased in the short and long term, but this decrease would probably not have enough impact on the local economy to affect property values. This alternative would result in a net negligible, long-term, adverse impact on property values.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

Visitation would probably diminish in the short and long term as a result of the actions in Alternative 4, with a moderate, adverse impact in the long-term from the loss of $3 million in sales and of 75 jobs. Hunting activity would drop by 5% (2% of the Estes Valley total sales and employment). These effects would be measurable within the long-term, moderate-to-major cumulative benefits on the Estes Valley economy, but would not be large enough to substantially reduce the county-wide effects of a strong economy. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.

Impacts on landscaping and property, agriculture, traffic, and property values would be similar to Alternative 2. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.

Conclusion

Visitation would probably diminish in the short and long term as a result of the combined actions of large-scale fertility control for population management and research activities, lethal reduction, and fencing. Public perception would be a concern in both the short and long terms, with a potential 10% drop in visitation in the short and long terms. This would amount to a $3 million loss in sales, $1 million in personal income, and 75 jobs. These factors would have a moderate, adverse, impact in the long term. There would be no effect on visitation as a result of short-term research on chronic wasting disease live testing.

Hunter activity would likely drop by 5% overall as a result of the fertility control program for population management. The drop in hunter activity would result in a loss of about $127,000 in direct economic contribution from hunters near the east and west sides of the park, based on a 5% drop in total revenue from elk hunters. Overall, there would be a minor-to-moderate, adverse, short- and long-term, impact on hunter activity and experience. The effects to hunting as a result of research activities involving immobilization drugs and fertility control agents would not be distinguishable from the effects of the large-scale treatment of the population.

Net impacts on the public sector would be minor to moderate and adverse in the long term due to the decrease in visitors to the area.

In the short and long-term, there would be a minor to moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage.

Traffic congestion would decrease in the short-term, but there would be minor, long-term beneficial impacts. Elk-related traffic accidents would decrease in the short and long-term, and beneficial impacts would be negligible to minor. There would be a minor short and long-term adverse impact on Estes Park body shops.

This alternative would result in a net negligible, long-term, adverse impact on property values.

The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.

Alternative 5

Elk Tourism and Recreation Draw

Under this alternative, the target population range for the elk would fluctuate between 1,200 and 2,100 animals. Elk behavior would change slightly as the elk would be more skittish due to the presence of wolves, but bugling and mating behavior would remain unchanged. Elk would likely continue to congregate in open spaces, but they would be more skittish, making viewing opportunities unpredictable. The elk would be more dispersed outside the park into the Estes Valley and Grand Lake due to the presence of wolves. However, targeted elk reductions under this would result in a large enough reduction outside of the park than even with this dispersal, there would be fewer elk outside the park than under current conditions.

The public generally supports the idea of wolf release (Manfredo et al. 1994, Cordova 2000, Stewart et al. 2004, Duffield and Neher 2004) and believes that release of wolves would result in a balance of deer and elk population and a return of the natural environment to the way it once was (Manfredo et al. 1994). Wolves would become an important, long-term attraction for visitors to the park. Wolves attract visitors to Yellowstone National Park, in part due to the visibility of the wolves in the park and in part due to the idea of Yellowstone as "wolf territory" (Smith and White 2005)

Wolves would follow the elk for most of the year and would probably be most visible at the park in the winter, when elk congregate in open areas on the primary winter range. Wolves would be less visible in the park when the elk move to the primary summer range, but the possibility of seeing wolves and the knowledge that wolves are a part of the ecosystem would bring additional visitors to the park year round. Even in areas where the probability of seeing a wolf is low, such as Isle Royale National Park in Michigan, visitors come to experience "wolf territory" and to possibly see tracks and hear howling. The existence of wolves in the area would also lead to perceptions of the park as a wilder, more natural environment (Manfredo et al. 1994). The presence of wolves would result in a moderate-to-major, short -and long-term increase in visitor draw. There is potential for a 10% gain in visitors, which would result in an additional $3 million in sales, $1 million in personal income, and 75 new jobs within the National Park Service and the surrounding area.

Lethal reduction would take place to reduce the number of elk in the short-term. The most intensive lethal reduction would occur during the first four years of the program, during which time about 50 to 500 elk would be lethally removed per year. After that, lethal reduction would occur at a reduced rate of zero to 100 elk per year for the next 16 years. Lethal reduction could be a controversial issue for some park visitors and the general public. Public perception of lethal reduction efforts could impact visitation in the short term. Effects from research activities to evaluate procedures for testing live elk for chronic wasting disease and evaluating a fertility control agent would be the same as Alternative 2.

There would be a net short-term, moderate, beneficial impact on tourist draw and recreation as a result of wolf release, outweighing the adverse impact on tourist draw of lethal reduction. Some visitors would be more likely to come to the park because of knowledge of a wolf program, while others would be less likely as a result of lethal reduction activity. In the short- and long-term, there would be a net moderate beneficial impact on park visitation and tourism in the Estes Valley as a result of the adverse effects of lethal reduction activities and the benefits of wolves drawing people to the area.

Hunting Activity and Experience

Elk would be more heavily dispersed outside the park in the Estes Valley and Grand Lake area due to the presence of wolves. There would be fewer elk outside the park near the east side as a result of lethal reduction, but there would be more elk dispersed outside the park near the west side as a result of redistribution and the presence of wolves, in the short-term.

Decreased numbers of elk near the east side of the park would result in a short- and long-term decrease in the number of hunting licenses available (Leslie 2005). This would result in a slight decline in elk harvest in the east side of the park, which would have a minor net adverse effect near the east side. There would be potential for a 2% to 3% decrease in the number of hunter days near the east side, which would mean a loss of between $16,000 and $24,000 of direct economic contribution due to decreased elk hunting near the east side, based on a decrease of 2% to 3% of hunter-based revenue. There would be a negligible-to-minor, adverse impact on hunters and the Estes Park community near the east side of the park.

The increase in the number of elk near the west side of the park could result in a short-term increase in hunter activity in the area. The proximity of wolves would lead to perceptions of the park and the areas adjacent to the park as being a wilder, more natural environment (Manfredo et al. 1994), which could also lead to an increased interest in hunting in the area, but the release of wolves as a predator of elk in other areas has met with resistance from hunters (Smith and White 2005). Hunters could have a negative view on wolf release, since wolves would prey on elk and further reduce the elk population.

It is estimated that there is potential for a 2% to 3% short-term increase in hunter days near the west side of the park, due to the short-term increase in elk numbers outside the park as a result of redistribution techniques. Increased hunting activity near the west side of the park would result in an increase of approximately $34,000 to $51,000 of direct economic contribution due to elk hunting, calculated as a 2% to 3% increase in west side hunter-related revenue. In the long-run, elk numbers would decrease overall, and there would be fewer elk near the west side of the park, so hunting activity would return to current levels or decrease.

In the short-term, hunting near the east side of the park would be adversely affected by a reduction of elk and more skittish elk, and hunting near the west side would be positively affected as elk would be pushed out of the park by redistribution activities and wolves. Short-term, there would be a net negligible-to-minor impact on hunting activity as a result of this alternative. In the long-term, hunting activity near the east side would continue at a decreased level, and hunting near the west side would probably continue at original levels, since there would be fewer elk in the area as a result of lethal reduction and wolf activity, and elk would be more likely to seek refuge in town. There would be a net negligible-to-minor, adverse, long-term impact.

As described in Alternative 2, research activities involving immobilization drugs and a multi-year fertility control agent on a small number of female elk over a three-year period of the plan would have no effect on hunting activity in the area.

Fiscal Conditions of Governmental Entities

Wolves would become an attraction for visitors, and the park is expected to see a moderate-to-major, long-term increase in annual elk-related NPS entrance fee revenue, due to an estimated 10% increase in visitation related to the presence of wolves. The increase in revenue would be approximately $100,000, and the park would also see increased revenue from its concessionaire contracts, as a larger number of visitors would spend more on concessions. In addition, the park would experience a moderate, short- and long-term increase in costs due to the activities of wolf management, lethal reduction, herding, and fencing.

The Town of Estes Park would experience a moderate-to-major, long-term increase in revenue due to the estimated 10% increase in park visitors. The increase in visitors to the Estes Valley would result in an increase of about $100,000 in tax revenue for the town, calculated as a 10% increase in current elk-related taxes. Decreases in costs related to elk management and damage would be negligible.

The Estes Valley Recreation and Park District would experience a minor decrease in costs in the short and long terms due to decreased elk near the east side of the park. Costs to the district as a result of elk related management and damage repair would decrease by about $2,500, based on the assumption that elk-related costs would decrease by half of the percentage decrease of elk. The Estes Valley Recreation and Park District would also experience an increase in revenue in the short and long terms due to an increase of visitors to the area to experience wolves. Overall, there would be negligible-to-minor net effects on the Estes Valley Recreation and Park District.

Wolves would have a moderate-to-major, adverse impact on Colorado Division of Wildlife costs. Increased costs would result from an increase in questions and concerns from residents, visitors, and hunters related to the release of wolves (Leslie 2005). The Colorado Division of Wildlife would have to put additional time and money towards investigating complaints and answering questions. The division would see hunting-related costs and revenue similar to those under current conditions, since the decrease in hunting activity near the east side of the park would be offset by increased hunting activity near the west side. Long-term changes in fiscal conditions for the Colorado Division of Wildlife would be moderate to major.

Changes in long-term visitation to the park and the Estes Valley would be moderate to major; therefore, net long-term fiscal impacts would be moderate for all jurisdictions.

Landscaping and Property

The presence of wolves in the park would create greater dispersion of elk into areas outside the park, especially in the winter. Even though the existence of wolves in the park would cause elk to disperse out of the park, there would still be fewer elk in the Estes Valley than under current conditions. In the short term, the elk population would be reduced by about 10%; in the long-term by about 37%. It is estimated that local homeowners would see a minor, long-term decrease in landscaping costs due to the fewer number of elk in the Estes Valley. Homeowners would see a minor, short-term decrease in landscaping costs due to the reduced number of elk in town as a result of lethal reduction activity in the park. The extent of elk dispersion due to wolves is uncertain, so the change in landscaping costs is also uncertain, but annual landscaping costs could decrease by up to $68,000. It is assumed that landscaping costs would decrease by half of the percentage decrease of elk.

Landscaping businesses would experience minor, short- and long-term decreases in revenue of up to $68,000 due to a decrease in elk-related damage. The amount of fencing installed for elk would decline, as would the portion of plant sales due to elk browse.

There would be a small likelihood of wolves predating on pets and other domestic animals. If this were to occur, it would result in a short- and long-term, minor, adverse impact at a community level, although, individual pet owners may be substantially affected.

The net short- and long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible compared to current conditions.

Agriculture

The presence of wolves in the park would create greater dispersion of elk into areas outside the park, especially in the winter. Even with increased dispersal out of the park, there would still be fewer elk in the Estes Valley than under current conditions due to lethal reduction activity and a number of elk being killed by wolves. It is assumed that the percentage decrease of elk in the Estes Valley would be equal to the percentage decrease of elk on the ranch property. This alternative would result in a decrease of between 39 to 78 elk on the ranch property and the possibility of increasing cattle by 20 to 39 animals, increasing ranch revenue by $36,000 to $70,000. With fewer elk in the Estes Valley and on the ranch property, the rancher would likely see a minor decrease in costs related to elk damage. Hunting is offered on the ranch, and fewer elk may reduce revenues received from hunters. This would offset decreases in elk damage costs somewhat.

The rancher would likely experience some anxiety and concern regarding livestock losses due to wolf kills. It is highly unlikely that any livestock would be affected by the release of wolves, since the park has included a substantial monitoring program to keep track of and manage the wolves to stay inside the park boundary, which should prevent cattle loss. If wolves do attack livestock or cause any livestock deaths, they would be lethally removed.

There would be a net minor-to-moderate, short- and long-term benefit to agriculture from decreased numbers of elk grazing on the ranch property compared to current conditions.

Traffic Accidents and Congestion

The presence of wolves in the park would create greater dispersion of elk into areas outside the park, especially in the winter; however, there would still be fewer elk in the Estes Valley than under current conditions due to lethal reduction activity and a number of elk being killed by wolves. There would be fewer elk grazing in areas outside the park and fewer elk on or near roadways outside the park. In the short term, the number of elk in Estes Park would be reduced by about 10%; in the long-term, the elk population would be reduced by about 37%. On the other hand, the wolves are expected to be a strong attraction in the long-term, increasing net visitation by 10% and therefore also increasing the number of vehicles in the area and congestion.

The number of elk-related traffic accidents in the area would be reduced as a result of the smaller number of elk in the area. The change in costs to drivers and in the revenue of body shops is uncertain due to the unknown extent of elk dispersal outside the park. It is estimated that if elk are reduced in proportion to their current distribution (no dispersion on top of lethal reduction), there would be approximately $14,000 of cost savings for drivers and revenue decrease for Estes Park body shops, based on the assumption that body shop revenue would drop half the percentage decrease in the number of elk. If elk are dispersed into town, drivers would not realize as much savings, and body shops would not see as much revenue loss. There would be a minor, short- and long-term, adverse impact on Estes Park body shops and a minor, short- and long-term, beneficial impact on visitors compared to current conditions.

Property Values

There would be a decreased number of elk in the Estes Valley as a result of lethal reduction and wolf activity, but the presence of elk would probably be sufficient to maintain their contribution to the quality of life in the Estes Valley. In addition, there would be more of a sense of the area being a wild environment, which would add to the quality of life. With fewer elk in the area, there would be a lower amount of landscape damage, fewer elk-related traffic accidents, and fewer possibilities for negative elk-human interactions, each of which would not likely impact property values but would affect the overall quality of life. Visitation to the area would increase in the long term due to the attraction of the wolves, which would provide an economic stimulus to the local area. This long-term increase might have enough impact on the local economy to affect property values. This alternative would result in a net minor, long-term, beneficial impact on property values.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

The release of wolves would increase visitor draw and would result in an additional $3 million in sales and 75 new jobs (2% the Estes Valley total sales and employment). Hunting would decline near the east side in the short-term, but would be negligibly affected in the long term. Government entities would receive revenue benefits that would range from minor to major. The effects of these would be measurable within the long-term, moderate-to-major cumulative benefits on the Estes Valley economy and would contribute to the continuation of this level of cumulative effect on the socioeconomic environment.

Impacts on landscaping and property, agriculture, traffic, and property values would be similar to Alternative 2. The minor-to-moderate, adverse cumulative, effects within the Estes Valley socioeconomic environment would continue under Alternative 5.

Conclusion

The presence of wolves would result in a moderate-to-major, short- and long-term increase in visitor draw. There is potential for a 10% gain in visitors, which would result in an additional $3 million in sales, $1 million in personal income, and 75 new jobs within the park and the surrounding area. In the long-term, there would be a net moderate beneficial impact on park visitation and tourism in the Estes Valley as a result of the adverse effects of lethal reduction activities and the benefits of wolves drawing people to the area. There would be no effect on visitation to the park or the region as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease testing.

In the short-term, hunting near the east side of the park would be adversely affected by a reduction of elk and more skittish elk, and hunting near the west side would be positively affected as elk would be pushed out of the park by redistribution techniques and wolves. Short term, there would be a net negligible to minor impact on hunting activity as a result of this alternative. In the long term, hunting activity near the east side would continue at a decreased level, and hunting near the west side would probably continue at original levels, since there would be fewer elk in the area as a result of lethal reduction and wolf activity, and elk would be more likely to seek refuge in town. There would be no effect on hunting activity as a result of research activities due to the short study timeframe, limited number of female elk treated, and limited exposure to hunters due to the time of year the study would be conducted.

There would be a net negligible-to-minor, adverse, long-term impact.

Wolves would become an attraction for visitors, and the park would probably see a moderate-to-major, long-term increase in annual elk-related entrance fee revenue and a moderate, short- and long-term increase in costs, due to the activities of wolf management, lethal reduction, herding and fencing.

The Town of Estes Park would experience a moderate-to-major, long-term increase in revenue, due to the estimated 10% increase in park visitors. The Estes Valley Recreation and Park District would experience a negligible to minor net effect due to decreased elk near the east side of the park and increased visitors. Wolves would have a moderate-to-major negative impact on CDOW costs.

Local homeowners would likely see a minor, short- and long-term decrease in landscaping costs due to the fewer number of elk in the Estes Valley. The net short- and long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible compared to current conditions. There would be short- and long-term, minor, adverse impact as a result of potential wolf depredation on pets

There would be a net minor to moderate short and long-term benefit to agriculture from decreased numbers of elk grazing on the ranch property compared to current conditions.

There would be a minor short and long-term adverse impact on Estes Park body shops and a minor short and long-term beneficial impact from reduced accidents.

There would be a net minor long-term beneficial impact on property values.

The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 5.

PUBLIC HEALTH AND SAFETY

Rocky Mountain National Park is responsible for maintaining safe conditions that protect the health and safety of employees and the public.

Summary of Regulations and Policies

Management Policies (2006b) requires that

> Parks provide a safe and healthful environment for visitors and employees.
>
> Management actions strive to protect human life and provide injury-free visits to the extent that they will not impair park resources and values.
>
> Management actions reduce or remove known hazards and apply other appropriate measures, including closures, guarding, signing, or other forms of education
>
> Parks ensure compliance with applicable federal, state, and local public health laws, regulations, and ordinances.

Management Policies recognizes that when addressing safety and health issues, park managers must work within funding and staffing limits.

Director's Order #50B: Occupational Safety and Health Program addresses the policy, requirements, and responsibilities for managing an effective occupational safety and health program for NPS employees. It requires parks to integrate safety and health into every operation and activity. Parks must meet or exceed all applicable statutory, regulatory, and policy requirements relating to safety, health, and the environment, applying the more stringent requirement when conflicts exist between standards, or developing standards if none exist. Employees must adhere to established occupational safety and health procedures. Employees will receive specialized training when appropriate to safely perform assigned tasks and to respond effectively to recognized potential emergencies. Authorized agents of the National Park Service as described in Appendix H will comply with all applicable safety and health provisions and requirements (NPS 1999b).

Director's Order #50C: Public Risk Management Program implements a process to minimize the occurrence of visitor injury or illness and achieve maximum effectiveness in communicating risk to the public, without negative impacts on park resources. The service will strive to protect human life and provide an injury-free visit within the constraints of the 1916 Organic Act and available resources. Park visitors assume a substantial degree of risk and responsibility for their own safety when visiting areas that are managed and maintained as natural, cultural, or recreational environments. To minimize the number and severity of visitor incidents, parks will use risk assessment to develop appropriate mitigation strategies (NPS 2001d).

Director's Order #77-4: Use of Pharmaceuticals for Wildlife requires that all personnel performing remote delivery of pharmaceutical to wildlife must qualify, at a minimum, semi-annually with the type(s) of firearm(s) used, including safety, marksmanship, maintenance, storage, performance, limitations of weapons, accountability and control, and security. Such personnel must follow all Drug Enforcement Agency regulations when handling or using anesthetics or controlled substances, and must obtain certification to administer anesthetics or controlled substances to wildlife. Projects involving such substances must develop protocols for the use of anesthetics or controlled substances for wildlife (NPS 2002a).

Director's Order #83G: Vector-borne and Zoonotic Diseases calls for monitoring and dissemination of data about vector-borne diseases and the agents that spread them. Parks must ensure that educational materials are available for park staff and visitors, and conduct or coordinate preventive education and training sessions (NPS 2003a).

Methodologies and Assumptions for Analyzing Impacts

Safety concerns for this plan fall into two broad categories: risks posed by the elk and risks posed by management of elk and over-browsed vegetation. Detailed discussion of these risks can be found in Chapter 1, "Purpose of and Need for Action." Chapter 2, "Alternatives," discusses current and proposed management activities, including mitigation of risks associated with those activities.

Geographic Area Evaluated for Impacts

This discussion analyzes the impacts on public health and safety in the park where management activities take place.

Management actions within the park may affect the behavior of elk that move outside the park. Human-elk interactions are analyzed both in the park and within the Estes Valley.

Issues

Public health and safety issues identified during internal and public scoping related to elk and to management activities for elk and vegetation include the following:

Human proximity to wildlife in Rocky Mountain National Park involves risk during traffic encounters or when people approach elk during elk viewing.

Traffic congestion when elk congregate in meadows visible from the roads may cause vehicle-vehicle or vehicle-pedestrian collisions.

Pharmaceuticals used in some lethal control or fertility control operations involve inherent risks.

Equipment used in lethal control operations involves inherent risks.

NPS staff or authorized agents of the National Park Service may receive injuries when handling wildlife.

Carcass handling and disposal may put NPS staff or their authorized agents at risk of disease or injury.

People who consume meat from elk treated with fertility control drugs or from elk infected with chronic wasting disease may incur health risks.

Fence construction and maintenance may result in injuries to park staff and contractors.

Prescribed burning involves risks such as smoke inhalation and burn injuries.

High elk abundance and density may contribute to increased prevalence of chronic wasting disease (CDOW 2004c). Concern, perceived or real, has been raised regarding human health and safety in the presence of the disease.

Impacts on park management and operations were evaluated using the process described in the "General Methodology for Establishing Impact Thresholds and Measuring Effects by Resource" section near the beginning of this chapter. Information used in the analysis was obtained from meetings attended by park representatives and other interested governmental agencies, interviews with experts, literature searches, visitor surveys in the park, and input from members of the public.

Impact Threshold Definitions

Intensity of Impact

Negligible: Employee or visitor health and safety would not be affected, or effects would not be appreciable or measurable.

Minor: Effects on employee or visitor health and safety would be detectable but would not produce an appreciable change.

Moderate: The effects would be readily apparent, and would result in noticeable changes in employee or visitor health and safety. Changes in rates or severity of injury could be measured.

Major: The effects would be readily apparent, would result in substantial changes in employee or visitor health and safety, and could lead to employee or visitor mortality.

Type and Duration of Impact

Beneficial impacts would improve human health and safety or would reduce risks to human health and safety.

Adverse impacts would increase risks to human health and safety.

Duration: With short-term impacts, effects on human health and safety would persist for less than one year. With long-term impacts, effects on human health and safety would persist for one year or more.

Impacts Common to All Alternatives

Because removal of elk exhibiting chronic wasting disease symptoms would be an element of any alternative, safety considerations include those associated with sedating elk and handling sedated elk as well as risks for users and bystanders associated with firearms use (lethal and non-lethal rounds). NPS-required safety measures, such as *Director's Order #50B: Occupational Safety and Health Program* (NPS 1999b), reduce such risks to negligible-to-minor levels.

Monitoring elk and vegetation would be a component of any alternative implemented by the park. The Resources Management Division conducts and would continue to conduct elk monitoring along several routes on a regular schedule, supplemented by occasional aerial monitoring. The types of risks would be similar across alternatives, although intensities would vary with different frequencies of monitoring. Following standard NPS mitigation measures reduces the risks and adverse impacts to a negligible level.

Alternative 1

Elk Management

Park visitors' efforts to view or photograph elk or recreate in areas that elk congregate incur risks such as such as charging, trampling, and goring. Other hazards include traffic congestion, cars stopping on roads, car doors left open, pedestrians on roads, and resultant accidents. Such encounters are most likely during the spring calving season and fall rut, when elk are more aggressive than during the rest of the year (Elverum n.d.). To date, elk aggressiveness toward humans in Rocky Mountain National Park is still unusual. Within the past five years, bull elk twice charged hikers during the fall rut (once each on Hollowell Trail and Cub Trail), and a mother charged visitors in the spring to protect her newborn calf. No injuries resulted during these incidents (Langdon 2005f). These incidents represent only what has been reported during times that volunteers are present. Actual numbers may be higher. Currently, impacts on visitors over the long term are negligible and adverse.

As elk-human interactions increase in Rocky Mountain National Park and within the Estes Valley, whether due to high elk population, reduced elk mobility, or increasing visitation, the risk of aggressive elk behavior and human injuries may increase. This could increase the intensity of long-term, adverse risks from negligible to minor.

Mitigation of these risks could involve education (signs, pamphlets, notices in local papers, and broadcast media coverage) and area closings during calving and rutting seasons. In addition, aggressive elk could be marked, as in Canada's Banff National Park, where repeat offenders are aversively conditioned; they could be removed from the park or Estes Valley, or as a last resort, they could be destroyed (Elverum n.d.). Park staff and volunteers try to keep visitors at a safe distance at popular elk viewing areas in Rocky Mountain National Park, but ultimately, visitors are responsible for their own safety.

Park staff and volunteers face risk from elk as they perform their duties. Crowd control places them between visitors and elk. Euthanizing injured elk or those showing clinical signs of chronic wasting disease involves the possibility of injury from the animal, wildlife drugs, or from firearms. Handling carcasses can result in lifting injuries. Aversive conditioning of elk exposes staff to possible goring or trampling. The park has created various protocols, procedures, and plans to mitigate these risks (NPS 2001g, 2001e, 2001f, 2002c, 2002e, 2002f, 2004e, 2005d, 2005e). As a result, Natural Resource staff have conducted lethal control of injured or chronic wasting disease-positive elk and deer since 1981 with no injuries (Watry 2005f). The impact of elk control activities is long term, negligible to minor, and adverse.

Chronic wasting disease is a transmissible spongiform encephalopathy disease that attacks the brains of infected deer and elk. Like similar diseases such as scrapie in sheep and bovine spongiform encephalopathy in cows, it appears to be spread by prions, infectious protein particles similar to viruses but lacking nucleic acid (Belay et al. 2004). As the disease progresses, infected animals become emaciated, display abnormal behavior, lose bodily functions, and die (CDOW 2003a). The transmissibility of chronic wasting disease from infected elk carcasses to humans may be possible but appears to be unlikely, although many people perceive it as a real risk (Belay et al. 2004; CDOW 2003a).

Colorado Division of Wildlife precautions for hunters and others taking elk or deer in infected areas include not shooting, handling, or consuming animals that appear sick; wearing rubber gloves when field dressing or processing animals, minimizing handling of brain, spinal cord, eyes, spleen, tonsils, pancreas and lymph nodes; and washing hands and disinfecting instruments thoroughly after processing animal (CDOW 2003a). Current belief is that lower density could decrease chronic wasting disease prevalence and therefore any associated risk of transmission to members of the public (CDOW 2004c).

Because chronic wasting disease is expected to persist in the elk population near the park, and the elk population would remain unnaturally dense under current management practices, the possibility of chronic wasting disease transmission to humans under Alternative 1 would remain long term, negligible, and adverse.

The park first euthanized a chronic wasting disease suspect elk in 1981. Additional suspect elk were lethally removed in 1998 and in 2001. Since 2002 several elk are removed each year. No injuries have been sustained in these operations (Watry 2005f). To minimize risks, the park has developed an interim action plan for personnel treating and handling elk and deer (2001g), and all personnel must complete a firearms safety course and demonstrate proficiency by a firearms qualification test before using dart rifles or other firearms in field operations (Watry 2005f). Training must include safety, marksmanship, maintenance, storage, performance, limitations of weapons, accountability and control, and security (NPS 2002a). These risk-reduction measures would result in long-term, negligible-to-minor, adverse impacts for staff. This would also apply to contractors if their contracts specified that similar training was required.

Vegetation Management

Vegetation management under Alternative 1 consists primarily of using fencing to keep elk away from vulnerable plants in developed areas and out of 26 research plots covering 12 acres. Fence repairs involve little risk to staff, as does freeing elk or other animals that get trapped within exclosures. Because aspen and willow communities would not recover sufficiently under current management to allow prescribed burns, there would be no risks associated with such actions. The long-term, adverse impacts on public health and safety of vegetation management under Alternative 1 are negligible.

Cumulative Impacts

Public and employ health and safety are affected throughout the park by the interactions of people with the natural environment, with other people, and with park operations activities. Past, present, and future actions of the National Park Service are directed towards meeting statutory and regulatory health and safety requirements and managing risks to the public and employee. The 2002 snowmobile management plan and environmental assessment would reduce emission and provide negligible benefits for public health (NPS 2002b). Reduced opportunities for collisions and accident, including those with nonmotorized visitors, would result in negligible-to-minor benefits. The planned headquarters area emergency operations center would include a six-bay fire station and would improve emergency response capability to provide a moderate, beneficial impact. The transportation management plan (to be developed) and the reconstruction of the Bear Lake Road would reduce congestion and improve traffic and transportation safety, resulting in minor-to-moderate, beneficial effects. The ongoing mule deer testing and monitoring program for chronic wasting disease would improve determinations of the prevalence of chronic wasting disease in mule deer and removal of infected animals, resulting in long-term, negligible benefits to public health and safety. Wildland and structural fire fighting presents risks to staff through exposure to fire, helicopter flights, and operation of equipment and tools and create short-term, moderate adverse impacts on staff health and safety. Regular traffic management activities, such as directing cars at busy parking areas and intersections, during times of peak visitation results in current and future, short-term, minor adverse impacts. The past, present, and future actions to improve public health and safety would offset the current and future adverse effect, and would result in long-term, minor-to-moderate, cumulative impacts on public health and safety.

Alternative 1 would continue the adverse effects of park visitors' efforts to view or photograph elk, and the risks that park staff encounter when managing visitors viewing elk. Park staff would continue to encounter risks when monitoring for chronic wasting disease and the condition of vegetation. The effects of Alternative 1 on public health and safety would be slightly detectable when combined with the minor-to-moderate, cumulative, beneficial impacts from past, present, and future action, and would result in a continuation of cumulative impacts at that level.

Conclusion

Park visitors' efforts to view or photograph elk incur risks such as such as charging, trampling, and goring. Impacts on visitors over the long term are negligible and adverse. This could increase the intensity of long-term, adverse risks from negligible to minor with increased visitation. Park staff and volunteers face risk from elk as they perform their duties. The impact of elk control activities is long term, negligible to minor, and adverse.

The possibility of chronic wasting disease transmission to humans from handling elk under Alternative 1 would remain long term, negligible, and adverse. The use of firearms and dart rifles for lethal control of elk infected with chronic wasting disease results in long-term, negligible-to-minor, adverse impacts for staff or contractors. The long-term, adverse impacts on public health and safety of vegetation management, including fencing, under Alternative 1 are negligible.

The effects of Alternative 1 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 2

Elk Management

During the first four years of the plan, NPS staff and their authorized agents would participate in lethal control activities and NPS staff would conduct a three-year research study to evaluate procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent. Due to the high level of activity and management of elk during this period, chances for staff injury would increase. As lethal control activities would decline after the first four years, related risk to staff would decrease due to decreased elk-related duties. Training of personnel and application of existing safety procedures would mitigate this risk, as well as risk of injury to visitors. Mitigation could also include use of subsonic ammunition, which has a shorter range than conventional rounds, and shooting from elevated stands to reduce the distance bullets could travel. Temporary area closures where operations occur, conducting operations at low-use times such as night and early morning, and public education would also reduce risks to visitors. Together, these measures would keep the short- and long-term, adverse impacts at a negligible-to-minor intensity.

Darts may also be used to immobilize elk before euthanizing or for research purposes, which involves risks of accidental injection as well as injury from darts. Precautions for accidental exposure such as keeping the gun unloaded and unpressurized with the safety on until just before use, never pointing the muzzle at others, and securing areas before operations begin can prevent accidental administration to humans of the sedative. Other precautions include never working alone, wearing gloves and eye protection when loading or handling darts to minimize risk of absorbing agent through the skin or eyes, and having specialized first aid training and kits. Short- and long-term, adverse impacts on health and safety associated with dart gun use and with handling drugged animals would be mitigated by adherence to *Director's Order #77-4: Use of Pharmaceuticals for Wildlife* (NPS 2002a), job hazard analysis policies, and capture protocols, keeping these impacts at a negligible-to-minor level.

Reduced elk numbers, concentrations, and habituation in the park would reduce elk-human interactions. Animals rapidly dispersing during lethal control activities using unsuppressed firearms would slightly increase the risk of elk encounters with humans and vehicles; suppressed-noise weapons would virtually eliminate this risk, resulting in a short-term, negligible, adverse impact. Overall, encounters would decrease to the lowest level among the alternatives as elk numbers decrease, a long-term, negligible-to-minor, beneficial impact on health and safety.

Redistribution activities that would be used to drive elk away from sensitive vegetation would also serve to reduce habituation to humans. This would contribute to the long-term, minor benefits on human health and safety.

As elk numbers dropped after the first few years, hunting would also decrease. As hunting opportunities decreased, fewer hunters would inadvertently cross into the park from surrounding lands, reducing the risk to staff and visitors in the park.

A capture facility could be used for lethal reduction actions. Assembling, disassembling, and transporting mobile facilities involve risk of abrasion and crushing. Elk entering or within the facility could become agitated, especially by the sight of humans, increasing risk to handlers. Placing a cardboard lining along the entry chute can reduce agitation, and elk could be moved in small groups rather than in large groups (Grandin 1999). Adverse impacts on health and safety would be short term and negligible to minor.

Herding or bait lines would be needed to get elk to the facility. Horse or dog use, or helicopters as an adaptive tool would each involve risks, which would be mitigated by following standard practices and NPS procedures. Precautions include using techniques to avoid agitating the animals, remaining alert for warning signs of aggression, and proper defensive measures (Grandin 1999; Kloppers et al. 2004). Mitigation also includes separating the public and herding activities to reduce the risk of injuries resulting from goring and trampling (Kloppers et al. 2004). These mitigation measures would result in long-term, negligible-to-minor, adverse impacts from activities associated with elk capture and lethal taking.

Current knowledge suggests that chronic wasting disease is not transmissible from animals to humans (CDOW 2003a). Therefore, most risks associated with chronic wasting disease would result from handling carcasses for chronic wasting disease testing and with carcass disposal, such as cuts from knives and saws or strains from moving heavy animals, or from use of sharp implements to obtain biopsies from live elk as part of the research study, which would last for three years. A reduced elk population would result in handling fewer carcasses and, combined with required training, would reduce short- and long-term, adverse impacts on health and safety from these activities to a negligible level. In the short-term, the substantial increase in carcass handling within a compressed time frame could increase risk. This could be mitigated by adequate staffing, equipment, and training.

Vegetation Management

Elk population reduction would change vegetation management in the park, which would in turn affect public health and safety. Fencing aspen clones would involve slightly elevated risks for staff or contractors who erect, maintain, and take down fences. Effects on public health and safety from activities associated with fencing would be short term, negligible, and adverse.

As vegetation was protected from over-browsing, prescribed burning or mechanical thinning may be used to approximate natural processes that stimulate plant growth. Risks associated with mechanical thinning would be mitigated by following standard safety precautions when working with power tools and heavy machinery and by closing work areas to the public. The park's fire management plan includes mitigation for the risks, such as smoke inhalation or accidental injuries, associated with prescribed burns (NPS 2004a). In addition, fire personnel at the park must meet training and qualifications requirements (NWCG 2000) and follow all safety policies, standards, and guidelines (NWCG 2004a, 2004b, and 2004c; NIFC 2002, 2005). Road and area closures to visitor use would improve safety of visitors and fire personnel. Effects on public health and safety from thinning or prescribed burns would be short term (for individual operations) or long term (the life of the plan), minor, and adverse.

Smoke from fire may degrade air quality, a risk to public health. Fire management techniques, as used by the National Park Service and found in the park's fire management plan, minimize the amount of smoke produced by prescribed burns and reduce how much of that smoke drifts into smoke-sensitive areas such as population centers and roads. Mitigation measures also include encouraging workers and volunteers to stay upwind of fire and using signage to alert visitors to planned burns so that they may avoid exposure to the smoke and burning when environmental conditions would carry smoke away from population centers. As a result, adverse impacts on public health and safety due to smoke would be short term and negligible.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 2 would result in increased risks to health and safety through lethal control operations and the installation of fences. Reduced numbers, concentrations, and habituation of elk would decrease risks to visitor health and safety. The effects of Alternative 2 on public health and safety would be slightly detectable when combined with the minor-to-moderate, cumulative, beneficial impacts from past, present, and future action, and would result in a continuation of cumulative impacts at that level.

Conclusion

Lethal control activities and research activities would result in short- and long-term, adverse impacts on employee health and safety at a negligible-to-minor intensity. Use of darts and handling of drugged animals for lethal reduction or research activities would have short- and long-term, adverse impacts on health and safety that would be mitigated by adherence to NPS policies, guidance, and protocols to a negligible to minor level.

Reduced elk numbers, concentrations, and habituation in combination with redistribution activities would reduce encounters to the lowest level among the alternatives and result in a long-term, negligible-to-minor, beneficial impact on health and safety. Capture facilities for lethal reduction and research activities would have adverse impacts on health and safety that would be short-term and negligible to minor. Herding or bait lines would be needed to get elk to the facility and would result in long-term, negligible-to-minor, adverse impacts. Reduced elk population would result in handling fewer carcasses and would result in long-term, negligible, adverse impacts.

Effects on public health and safety from activities associated with fencing would be short-term, negligible, and adverse. Effects on public health and safety from thinning or prescribed burns would be short-term (for individual operations) or long-term (the life of the plan), minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible.

The effects of Alternative 2 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 3

Elk Management

Because population reduction would be more gradual and on a smaller scale than for Alternative 2, long-term changes to effects on public health and safety posed by the elk population and activities to manage it would be similar, somewhat less intense, and would remain constant through the 20 years of plan implementation. Darting and handling of elk for lethal reduction or research activities would be the same as Alternative 2. Safety measures implemented during lethal reduction activities and research activities would keep the associated short- and long-term, adverse impacts at a negligible-to-minor intensity. The gradually decreasing elk population under this option would have impacts on human-elk interactions similar to that of Alternative 2.

Because this option would involve taking fewer elk than under Alternative 2, chronic wasting disease risks compared to Alternative 2 would probably be slightly less for staff and contractors testing and removing carcasses. Impacts as a result of the research study to test biopsy procedures on live elk for chronic wasting disease would be the same as Alternative 2. Required training would reduce short- and long-term, adverse impacts on health and safety from handling carcasses of elk suspected to be infected with chronic wasting disease to a negligible level.

Because the target population would be larger than under Alternative 2 and the reduction would be more gradual, a greater number of habituated elk would require redistribution activities, especially during the early years. More frequent conditioning sessions would expose conditioners and bystanders to a slightly greater probability of conflict with elk. Staff training and limited area closures would keep associated short-term, adverse impacts on health and safety at a negligible-to-minor level.

Outside the park, the gradual reduction of the elk population would reduce elk numbers, so impacts of human-elk interactions outside the park on public health and safety would be long term, negligible, and beneficial.

Vegetation Management

The more extensive fencing compared to Alternative 2 would increase risks of lacerations, bruises, and crush injuries associated with installation and maintenance. Mitigation would include standard industry safety measures. Freeing wildlife that find a way into the exclosures could put staff at some risk, especially if the animals panic. Mitigation would include precautions similar to those used when herding or conditioning animals under Alternative 2, and staff would work in pairs in case one person got injured. Effects on public health and safety from activities associated with fencing would still be short-term, negligible, and adverse.

Because fencing would allow protection of aspen and willow communities from elk herbivory, prescribed burning and mechanical thinning would become available as management tools. Risks and mitigation would be the same as under Alternative 2.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 3 would result in increased risks to employee safety from the increased amount fence that would be installed. However, when combined with the cumulative impacts of past, present, and future actions, the cumulative impacts of Alternative 3 would be the same as Alternative 2.

Conclusion

The gradually decreasing elk population under this alternative would reduce elk numbers, concentrations, and habituation to humans in combination with aversive conditioning activities and would reduce encounters to the lowest level among the alternatives. This would result in a long-term, negligible to minor, beneficial impact on health and safety. Use of darts and handling of drugged animals during lethal reduction or research activities would have short- and long-term, adverse impacts on health and safety that would be mitigated by adherence to NPS policies, guidance, and protocols to a negligible to minor level. Adverse impacts on health and safety from handling elk carcasses and live elk to be tested for chronic wasting disease would be at a negligible level.

Staff training and limited area closures during more frequent redistribution actions would keep associated short-term, adverse impacts on health and safety to a negligible-to-minor level. Outside the park, the gradual reduction of the elk population would reduce elk numbers, so impacts of human-elk interactions outside the park on public health and safety would be long term, negligible, and beneficial.

The more extensive fencing compared to Alternative 2 would increase risks, and the effects on public health and safety from activities associated with fencing would still be short-term, negligible, and adverse. The effects of prescribed burning and mechanical thinning would be the same as under Alternative 2 (short-term or long-term, minor, and adverse and short term, negligible, and adverse from smoke).

The effects of Alternative 3 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 4

Elk Management

Because the target population range and the rate of population reduction would be similar to that of Alternative 3, the risk posed by the elk population and its management would be similar. Effects on health and safety as a result of research activities would be the same as described in Alternative 2.

One new source of risk for staff would be handling elk targeted for fertility control treatment and research purposes. Current technology requires capturing and handling elk because remote delivery of such agents has not been fully developed. Moreover, treated elk may need to receive a long-term mark warning against human consumption of meat if withdrawal time of agent or immobilization drug has not passed or if the fertility control agent isn't regulatory approved. At the least, treated elk would receive a short-term mark to prevent multiple treatments and to identify elk that were subject to the research study.

Use of darts to immobilize elk before fertility control, lethal control, and/or research activities involve risks of accidental injection as well as injury from darts. Precautions for accidental exposure such as keeping the gun unloaded and unpressurized with the safety on until just before use, never pointing the muzzle at others, and securing areas before operations begin can prevent accidental administration to humans of the sedative. Other precautions include never working alone, wearing gloves when loading or handling darts to minimize risk of absorbing agent through the skin or eyes, and having specialized first aid training and kits. Short- and long-term, adverse impacts on health and safety associated with dart gun use and with handling drugged animals would be mitigated by adherence to *Director's Order #77-4: Use of Pharmaceuticals for Wildlife* (NPS 2002a), keeping these impacts at a negligible-to-minor level.

Care would also be important when injecting sedated elk. GonaCon™ would cause sterility in humans for the length of the drug's efficacy (Eismann 2005). Leuprolide, used in humans to treat prostate cancer or endometriosis, can cause side effects such as hot flashes, impotence, temporary infertility, atrophic genitalia, potentially fatal cardiac effects, and serious central nervous system disturbances, and may cause fetal harm when given to pregnant women (Chemical Safety Associates 2000). Standard NPS safety procedures would reduce long-term, adverse impacts on health and safety associated with injecting sedated elk to a negligible-to-minor level.

Risk to hunters consuming meat from treated elk would differ depending on the agent. All elk treated with fertility control not suitable for human consumption would be permanently marked to reduce any risk. These precautions would result in long-term, negligible, adverse impacts on health and safety.

Vegetation Management

The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 4 would result in increased risks to employee safety from the increased amount fence that would be installed and from the handling of elk during fertility control operations. However, when combined with the cumulative impacts of past, present, and future actions, the cumulative impacts of Alternative 4 would be the same as Alternative 2.

Conclusion

The target population range and the rate of population reduction would be similar to that of Alternative 3, and the risk posed by the elk population and management and reduction activities would be similar. Use of darts and handling of drugged animals during fertility control, lethal reduction, or research activities would have short- and long-term, adverse impacts on health and safety would be mitigated by adherence to *Director's Order #77-4: Use of Pharmaceuticals for Wildlife* (NPS 2002a) to a negligible level. With observing standard precautions, risks of consuming meat from treated elk would be reduced, the long-term, adverse impacts on health and safety to a negligible-to-minor level.

The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3: short-term (for individual operations) or long-term (the life of the plan), minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible.

The effects of Alternative 4 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 5

Because the effectiveness of wolves as an elk management tool would increase gradually under the phased approach, lethal elk reduction by NPS staff or their authorized agents would augment wolf activities. To approximate conditions in a complete ecosystem, elk populations would be allowed to vary between 1,200 and 2,100 individuals. The use of lethal reduction in the first four years to supplement the activities of wolves would result in impacts similar to those under Alternative 2.

Risks during wolf release activities would be associated with constructing holding pens and handling areas, handling wolves during captivity, and monitoring and tracking wolves after release. Safety procedures would be developed from those at other areas that have released wolves. For example, attached holding areas could allow separating individual wolves, as for veterinary treatment, reducing risks to handlers while minimizing potential for habituation. In addition, the holding area could be closed to the public and marked to prevent unauthorized entry.

Park staff would monitor wolves' behavior, removing individuals that showed signs of habituation toward humans. The probability of such behavior is remote: no human deaths have been attributed to wild, healthy wolves in the 20th century, and attacks or bluff charges are rare enough to be reported in scientific journals (McNay 2002). A person is more likely to die from a lightning strike, bee sting, or car collision with a deer than to be injured by a wolf (International Wolf Center 2002). There have been 21 attacks on humans by healthy wolves in North America in the 20th century (International Wolf Center 2003), eight of them between 1982 and 2001 (Linnell et al. 2002). Eighteen of these attacks were by habituated wolves, and in the other three, humans were protecting their domestic dogs that they had taken into wolf territory (International Wolf Center 2003).

Proper wolf management can greatly reduce any threat that wolves present to humans. Banff and Jasper in Alberta, Canada, are among towns where wolves and humans peacefully coexist (Parsons 2004). Because habituation is the most common factor in wolf attacks on humans, Wyoming's wolf management plan emphasizes educating the public about the importance of not feeding wolves (Wyoming Game and Fish Department 2003). The International Wolf Center offers the following precautions for individuals who view wolves in the wild (2002):

Do not feed wolves.

Do not entice wolves to come closer.

Do not allow a wolf to approach closer than 300 feet.

Do not approach wolves.

Leave room for a wolf to escape.

With wolf management and public education, long-term, adverse impacts on health and safety would be negligible.

Elk Management

NPS staff or their authorized agents would use lethal elk removal to augment the effects of wolf predation on the population; the impacts on public health and safety as a result of elk management actions and research activities would be similar to those under Alternative 2.

As elk seek refuge from wolf predation, they often approach or enter areas frequented by humans because wolves generally avoid such areas. In the park, these would include campgrounds, visitor centers, and other areas with high concentrations of people. Experience in Banff National Park suggests that elk would also use nearby towns, such as Estes Park, as a refuge. Elk would be fewer in number, but the potential would be greater for movement to areas outside the park such as into the Town of Estes Park. Even so, the total number of elk in town could decrease because of a lowered overall elk population, even if elk move out of the park in response to wolves. Some elk may become conditioned by the presence of wolves and exhibit greater wariness and wildness, thus possibly presenting more erratic behavior around humans. The impact of human-elk interactions outside of the park would be negligible. Indirectly the presence of wolves to manage the elk population may cause an increase in mountain lion occurrence in areas outside of the park. Adverse impacts on health and safety in Rocky Mountain National Park would be negligible-to-minor in the long term (the life of the plan) and the short term (individual conditioning sessions).

Vegetation Management

The effects on human health and safety from prescribed burning and mechanical thinning would be the same as under Alternative 2.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 5 would result in increased risks associated with the wolf release activities including constructing holding pens and handling areas, handling wolves during captivity, and monitoring and tracking wolves after release as well as increased risk to visitors who attempt to approach wild animals. However, when combined with the cumulative impacts of past, present, and future actions, the cumulative impacts of Alternative 5 would be the same as those of Alternative 2.

Conclusion

Lethal control activities and research activities would result in short- and long-term, adverse impacts on employee health and safety at a negligible to minor intensity. Reduced elk numbers, concentrations, and habituation in combination with aversive conditioning activities would reduce encounters to the lowest level among the alternatives and result in a long-term, negligible to minor, beneficial impact on health and safety. The use of a capture facility for lethal reduction and research activities would result in adverse impacts on health and safety that would be short-term and negligible to minor. Herding or bait lines would be needed to get elk to the facility and would result in long-term, negligible-to-minor, adverse impacts.

Risks during wolf release activities would be associated with constructing holding pens and handling areas, handling wolves during captivity, and monitoring and tracking wolves after release; adverse impacts would be minor in intensity. With wolf management and public education, long-term, adverse impacts on health and safety would be negligible.

As elk seek refuge from wolf predation, they often approach or enter areas frequented by humans. Long- and short-term adverse impacts on health and safety would be negligible-to-minor in campgrounds, visitor centers, and other areas with high concentrations of people. There would be fewer elk, but the potential would be greater for movement to areas outside the park, such as into the Town of Estes Park. The number of elk in town may decrease because of overall smaller elk population, even if elk move out of the park in response to wolves. The impact of human-elk interactions outside of the park would be negligible.

The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3: short-term (for individual operations) or long-term (the life of the plan), minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible.

The effects of Alternative 5 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

VISITOR USE AND EXPERIENCE

Summary of Regulations and Policies

Management Policies (NPS 2006b) section 8.2 states that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all park units and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the national parks. Because many forms of recreation can take place outside of a national park setting, the National Park Service therefore seeks to:

> Provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular park unit.
>
> Defer to others to meet the broader spectrum of recreational needs and demands that do not depend on a national park setting. Those others can include local, state, and other federal agencies; private industry; and nongovernmental organizations.

Part of the purpose of the national parks is to provide for public outdoor recreation use and enjoyment. Goals for visitor experience provided in the NPS *Strategic Plan* for 2000 through 2005 (NPS 2001h) include:

> NPS Mission Goal IIa**:** Visitors safely enjoy and are satisfied with availability, accessibility, diversity, and quality of park facilities, services, and appropriate recreational opportunities.
>
> NPS Mission Goal IIb: Park visitors and the general public understand and appreciate the preservation of parks and their resources for this and future generations.

Implementation of this policy must meet the Organic Act's requirement that the park service conserve the scenery, natural and historic objects, and wildlife to leave them unimpaired for the enjoyment of future generations.

Management Policies also specifies that visitor activities appropriate to the park environment will be encouraged, whereas those that would impair park resources or are contrary to the purposes for which the park was established will not be permitted.

Section 8.4 of NPS *Management Policies* mandates that all necessary steps be taken to avoid or mitigate adverse effects from aircraft overflights to reduce adverse effects on resources and visitor enjoyment.

Any closures or restrictions, other than those imposed by law, must be consistent with applicable laws, regulations, and policies, and (except in emergency situations) require a written determination by the superintendent that such measures are needed for any of the following reasons:

> Protect public health and safety,
>
> Prevent unacceptable impacts on park resources or values,
>
> Carry out scientific research,
>
> Minimize visitor use conflicts, or
>
> Otherwise implement management responsibilities.

Methodologies and Assumptions for Analyzing Impacts

This impact analysis examines whether the management of elk and vegetation under each management alternative would be compatible with desired visitor experience goals and the purpose of the park as identified in the enabling legislation and in other laws and policies affecting visitor use.

To determine the effects of the alternatives on visitor experience, each issue was evaluated using the procedures described in the "General Methodologies" section near the beginning of this chapter. This impact analysis evaluates several aspects of visitor experience, including visitor perceptions of elk in and near the park, perception of vegetation in the park (including during the autumn "leaf season"), access to park resources, and understanding and appreciating park values. Professional judgment based on visitor surveys and informal interactions between visitors and park staff was used to reach reasonable conclusions as to the intensity and duration of potential impacts.

Area Evaluated

The geographic area evaluated for impacts includes Rocky Mountain National Park and nearby areas where park visitors go, including the town of Estes Park and U.S. Forest Service land.

Issues

Issues identified during internal and public scoping that relate to how alternative management approaches may affect visitor use and experience include:

Elk viewing is a popular activity within the park and is an important reason why many visitors come to the park, especially during the rutting season.

The natural and unaltered landscape of the park is an important component of visitors' experience. Structures and physical intrusions, such as fences, can detract from the viewshed and adversely affect the quality of the park experience.

Easy access to areas where elk congregate is provided by park roads and within park developed areas and enhances opportunities to view elk.

Visitor congestion and noise can be high in popular elk viewing areas and detract from the national park experience.

Noise associated with lethal control activities can intrude on visitors' experience and disrupt feelings of quiet and solitude.

The use of weapons for lethal reduction activities, dart guns for fertility control and research activities, and redistribution devices may be perceived as threats to visitor safety.

Many members of the public feel that lethal methods to reduce wildlife populations are unethical.

Prescribed burning can generate, noise, smoke, and odors, and can require closure of burn areas to visitors' use, which can detract from the park experience.

Impact Threshold Definitions

Intensity of Impacts

The following threshold definitions were applied to determine elk and vegetation management effects on visitor use and experience.

Negligible: Visitors would not be affected, or changes in visitor experience or understanding would be below or at the level of detection. Visitors would not likely be aware of the effects associated with the alternative.

Minor: Changes in visitor experience or understanding would be detectable, although the changes would be slight. Visitors could be aware of effects associated with the alternative, but only slightly.

Moderate: Changes in visitor experience or understanding would be readily apparent. Visitors would be aware of the effects associated with the alternative and would likely be able to express an opinion about the changes.

Major: Changes in visitor experience or understanding would be readily apparent and would have important consequences. Visitors would be aware of the effects associated with the alternative and would likely express a strong opinion about the changes.

Type and Duration of Impact

Beneficial impacts would improve visitor enjoyment and recreational or educational opportunities.

Adverse impacts would diminish visitor enjoyment and recreational or educational opportunities.

Duration: With short-term impacts, effects on visitor enjoyment and recreational or educational opportunities would persist for less than one year. With long-term impacts, effects on visitor enjoyment and recreational or educational opportunities would persist for one year or more.

Alternative 1

Elk and Wildlife Viewing and Natural Park Experience

Because elk in and around the park would remain plentiful and habituated, visitors would continue to have abundant opportunities to view elk, often from the convenience of their cars. This condition would continue to provide a moderate-to-major benefit over the long term, particularly for those who visit the park during rutting season to observe bugling, challenges, and other mating rituals from the bulls.

However, roads through large meadows where elk congregate would continue to attract large numbers of visitors, many of whom park along the roadside to watch. High visitor concentrations require traffic control and crowd management by park staff and volunteers, somewhat diminishing the enjoyment for all visitors viewing elk. In addition, the numerous parked or slow cars interfere with traffic flow, inconveniencing drivers who are trying to get through. Some visitors complain that the mood in September and October is more that of a tailgate party than a natural experience, with picnics and viewing platforms all too common. These effects would continue to cause moderate-to-major, adverse impacts over the long term on individual visitors who prefer a lower human density during their park experiences.

Visitors who prefer to view the park's wildlife under more natural conditions would instead be more likely to observe animals that have become habituated to the presence of large numbers of humans. Viewing opportunities for species that depend on habitat over-foraged by elk – such as deer, beaver, riparian songbirds, and some butterflies – decline with the unnaturally high elk population, resulting in a negligible-to-moderate, long-term, adverse impact on park visitors interested in viewing wildlife.

Visitors are also increasingly aware of the effects on aspen and willow of over-browsing by elk, particularly in Moraine Park, Horseshoe Park, and Upper Beaver Meadows on the east side of the park and Kawuneeche Valley on the west side (Ronca 2005d). Among some visitors, this causes concern that elk may starve. The over-browsing also slightly degrades fall foliage viewing in the park. As impacts on aspen and willows from elk over-browsing continue, those visitors who are aware of the condition of vegetation on the primary winter range or wish to view the fullest display of fall foliage would experience minor-to-major, long-term, adverse effects. For the overall visitor population, the effect would be minor and adverse.

Fencing

Experimental fencing to protect selected aspen communities has led to questions from visitors about the purpose of fences in otherwise natural-appearing areas. Cordova's survey found visitors to be fairly evenly divided in their opinions on the acceptability of such fencing for vegetation management (2000b). Fix and Stewart three years later found similar attitudes, with support for fencing ranging from 40% to more than 60% (2003). Fences would continue to be limited to several small research exclosures in scattered locations within the park. The studies suggest that continuation of current and foreseeable future levels of fencing would result in a negligible, long-term, adverse impact on visitors' experiences.

Aerial Activity

The use of helicopters for park resource monitoring would continue and occur for a probable total of four to six hours annually. Experiencing the short-duration noise and presence of aerial operations would continue to result, depending on the distance from the helicopter, in negligible-to-major, short-term, adverse impacts on visitors' experience, including visitors to the backcountry may experience short-term, moderate-to-major, adverse impacts.

Cumulative Impacts

Rocky Mountain National Park is one of the most popular parks in the national park system. Since 1984, when visitor counting procedures improved, visitation to Rocky Mountain National Park has grown fairly steadily from 2.2 million to 3.2 million where it has remained stable.

Visitors are positively affected by a wide range of opportunities and facilities within the park. Visitors engage in popular activities include viewing wildlife and scenery, hiking, backpacking, and horseback riding on nearly 360 miles of trails; fly fishing, bird watching, and photography. Campers have nearly 600 sites accessible by car, while backcountry visitors have another 208 sites available. In 2004, car-accessible campgrounds hosted 153,855 visitors, and backcountry campgrounds hosted 26,522 (NPS 2005f). Other popular park facilities include the park's five visitor centers and museums; the Kawuneeche Visitor Center, the Alpine Visitor Center, the Beaver Meadows Visitor Center, the Moraine Park Museum, and the Lilly Lake Visitor Center.

Conditions also exist in the park that result in adverse impacts on visitor experience. High levels of visitation to national parks results in crowding, dissatisfaction, and displacement of visitors to other parks or recreation opportunities (Gramann 2002). In Rocky Mountain National Park conditions exist that indicate a portion of park visitors are dissatisfied with the levels of use experienced in the park (NPS 2002d). Other activities have the potential for adversely affecting visitor experience including overflights by commercial aircraft from Denver International Airport, park search and rescue and resource management aircraft use, and snowmobile use on the west side of the park. These conditions can have long-term, minor-to-moderate, adverse impacts on visitor experience.

The park manages the impacts of these conditions through the development of management plans and implementation of subsequent actions to improve the experience of visitors. Past and future management plans that affect visitor use and experience include the snowmobile management plan (NPS 2002b), the commercial services plan (NPS 1999c), the commercial horse use plan (NPS 1994), and the backcountry and wilderness management plan including the use of minimum tool analysis (NPS 2001a), the second phase of the reconstruction of the Bear Lake Road, and the Highway 7 corridor management plan slated to start in 2006. These plans and actions have altered or will alter conditions, with adverse effects on visitor experience, and have long-term beneficial effects on visitor experience that range from minor to moderate in intensity.

The overall satisfaction of visitors was measured in 2002 with the Visitor Survey Card survey for the 12 national parks in the Rocky Mountain Cluster, including Rocky Mountain National Park (NPS 2002d). Ninety-five percent of park visitors are satisfied overall with appropriate facilities, services, and recreational opportunities. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 1 would continue to provide benefits because the distribution and numbers of elk would not be likely to change, and the positive contribution of elk to the visitor experience would not change. Elk would continue to be a draw for a substantial number of visitors. Localized crowding in elk viewing areas would continue. Vegetation within the primary winter and summer ranges would continue to be degraded. Existing small areas of fencing and monitoring activities would continue. The continuation of current management and the beneficial and adverse effects of Alternative 1 would contribute to the long-term, moderate, cumulative benefits to visitor use and experience.

Conclusion

Opportunities to view elk would continue to provide a moderate-to-major benefit over the long term. High concentrations of visitors viewing elk would cause moderate-to-major, adverse impacts over the long term for visitor preferring less crowding; minor-to-moderate for others. Visitors who prefer to view the park’s wildlife under more natural conditions would experience negligible-to-moderate, long-term, adverse impacts. Impacts on aspen and willows from elk over-browsing would continue to cause minor-to-major, long-term, adverse effects on visitors who are aware of the conditions. For the overall visitor population, the effect would be minor and adverse. Experimental fencing to protect selected aspen communities would result in a negligible, long-term, adverse impact on visitors’ experiences. The use of helicopters for park resource monitoring would result in negligible-to-major, short-term, adverse impacts, depending on the distance from the helicopter. The continuation of current management and the beneficial and adverse effects of Alternative 1 would contribute to the long-term, moderate, cumulative benefits to visitor use and experience.

Alternative 2

Elk and Wildlife Viewing and Natural Park Experience

Fewer elk that are more wary of humans would somewhat reduce viewing opportunities in the park, including at the large meadows bisected by the main roads. Despite this reduction, visitors would continue to have many opportunities to view elk, including during the fall rutting season. The numbers of elk visible at any given time would probably be less than under current management, but elk would continue to be seen congregating in open meadows. The park would monitor visitation patterns and visitor responses to changes in elk numbers and distribution, particularly during the fall rut, and could modify treatment as appropriate. The adverse impacts on visitors who visit the park with an interest in viewing elk would be negligible to minor over the long term.

Visitors' likelihood of experiencing elk would be reduced slightly, but should not affect visitor draw because bugling and rutting in the fall would occur in the same locations as under Alternative 1. Crowds viewing elk from park roadsides would not be substantially reduced. Impacts on visitor experience from crowding would be negligible, long-term, and beneficial.

With improved willow and aspen communities, visitors would have the opportunity to see elk in a setting closer to natural conditions, and visitors would also have more opportunity to see other wildlife, such as deer, beaver, riparian songbirds, and some butterflies, that depend on the forage and habitat currently over-browsed by elk. The net effect for those who prefer to view elk and other wildlife in a relatively natural setting would be minor, long term, and beneficial. For most visitors the beneficial impact would be negligible to minor.

The return of plant communities would result in a minor, long-term benefit, including improved fall colors for visitors who are aware of the improvements.

Reduction Activities

NPS staff and their authorized agents would use lethal methods to reduce the elk population to a target range that would allow restoration of over-browsed vegetation, especially aspen, willow, and upland shrub communities. Firearms use can disturb the natural soundscape that many visitors expect in the park (as discussed in the "Soundscape" section) and may cause visitors to be concerned for their personal safety (as discussed in the "Public Health and Safety" section).

Lethal reduction actions would be conducted in a manner that would minimize impacts on visitor use and experience. Mitigations would include varying the type of weapon or the times of day when actions occur. Adverse impacts on visitors' experience would be short term and moderate during the first four years of the plan reduced to minor in the last 16 years as the frequency of lethal reduction activities decreases. Education through displays and brochures and interpretation by park staff could prevent unrealistically high visitor perception of risk. When firearms with noise suppression and subsonic ammunition are used the impacts could further be reduced to a negligible level; anyone more than 50 yards away would be unlikely to notice anything.

Some visitors may have ethical concerns about the use of lethal control on elk. For those individuals, the knowledge and awareness of the National Park Service's actions would have an adverse effect ranging from minor to major, depending on the individual's sensitivity and ethical perspective. Some members of the public could have a negative perception of lethal reduction activities that could result in choosing not to visit the park, with up to a 5% decrease in visitation during the first four years of the plan. There would be negligible, adverse, long-term effect on visitation with improved education and interpretation.

A capture facility could be used inside the park if remote firearms use proved inadequate to reach population reduction targets, particularly during the first four years of high-intensity operation. Seeing the facility could have a minor adverse effect on some visitors by diminishing the sense of wildness or by associations with death. Individual visitors who may inadvertently witness capture facility and lethal reduction activities could have adverse, short-term, effects from moderate to major. Closing the area to visitors would minimize such effects, but would inconvenience those visitors who planned to pass through or use the area. Therefore, areas not frequented by the public, such as Little Horseshoe Park, could provide the preferred locations for a capture facility, if needed.

Area closures for lethal elk reduction would prevent access during operations, creating short-term inconveniences for visitors who planned to use those areas for recreation activities such as hiking, horseback riding, or photography. Performing operations at night or in low-use seasons would minimize such effects. The potential for closures would be greater in the first four years of the plan when operations to reduce the elk population would be more intense. As a result, there would be minor short-term adverse effects on visitor use and experience as a result of inconveniences caused by area closures. During the remaining 16 years of the plan when lethal reduction activities would be less frequent, the short-term adverse effects would be reduced to negligible to minor. By providing adequate information to visitors about closed areas and the reasons for closures, visitors would be able plan alternate trip destinations and understand the reasons for doing so.

Aerial activity associated with monitoring would occur throughout the 20-year plan. In addition, this alternative could involve the adaptive use of helicopters for elk management activities. A helicopter could be used for herding and carcass removal if necessary for disease management concerns. This would be more likely to occur during the first four years of the plan and the use of helicopters for elk population management would decrease in the remaining 16 years of the plan as the number of elk to be removed would be much less. Noise resulting from aerial activity would have negligible-to-major, short-term, adverse impacts on visitor experience from the intrusion of noise, vibration, and visibility of helicopters in a national park setting. The intensity of the impact would depend on the distance from the helicopter, and would occur periodically throughout the life of the plan.

Fencing

Fencing to protect up to 160 acres of aspen stands could be installed. Therefore, adverse impacts associated with fence installation and maintenance under this alternative would be minor to moderate over the long term, particularly in areas where fences can not be screened by landscape features such as hills or vegetation. Individual visitors would experience a localized, moderate-to-major adverse impact, but this would vary depending on the ability of visitors to see the fence or if hiking were to be interrupted by a fence and gate. Where helicopters are used to transport fence material to off-road areas, visitors would experience short-term, negligible-to-major adverse impacts, as described above.

Prescribed Fire

The use of prescribed burns to stimulate growth of aspen and willows could alarm or bother visitors who observe smoke or flames. Noise associated with machinery used for burn control or other mechanical treatment of vegetation could detract from the experience of visitors expecting a near-natural soundscape. Mitigation could include education programs explaining such activities, including what the treatments accomplish and, when possible, advance warning to help visitors plan. As a result, associated short-term adverse effects would be negligible to minor.

Research Activities

A research study evaluating procedures for a live test for chronic wasting disease in elk would be conducted in coordination with elk management activities in the first three years of the plan. Effects on visitor use and experience from the capture or darting, anesthetizing, and handling of elk would be the same as those described above for reductions activities involving the management of elk with firearms and access restrictions.

The three-year research study could affect visitor use and experience as a result of elk being marked or tagged and fitted with radio-collars. Some park visitors may feel that seeing wildlife with human-made marks or collars diminishes the viewing experience, and the sense of viewing wild animals would experience minor, adverse effects over the short term.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 2 would reduce the number of elk as a result of lethal reduction activity; the intrinsic value of the elk experience would likely remain unchanged. In the short term, visitation would decrease due to the adverse impacts of lethal reduction activities and ethical concerns of some people, but long-term visitation would not be affected, and adverse impacts would be negligible. The condition of affected plant communities would improve, including improved fall colors. The presence of fences to protect up to 160 acres of aspen would adversely affect visitor experience. The adverse effects of other actions within Alternative 2 would be negligible to minor.

Over the total visitor population and over all seasons, the beneficial and adverse effects of Alternative 2 would probably be slightly measurable as expressed by the Visitor Survey Card survey. The adverse effects of elk reduction activities and fencing would be most measurable, and the adverse effects on the cumulative visitor experience in the park would be minor and long-term. The beneficial effects from vegetation improvements would have a negligible, long-term effect. There would be little or no change in the park's cumulative impacts on visitor use and experience, and impacts would continue to be moderate, long term, and beneficial.

Conclusion

Fewer elk that are more wary of humans would somewhat reduce viewing opportunities in the park, but visitors would continue to have many opportunities to view elk, and the adverse impacts on visitors who visit the park with an interest in viewing elk would be negligible to minor over the long term. Impacts on visitor experience from crowding would be negligible, long term and beneficial. The net effect for those who prefer to view elk and other wildlife in a relatively natural setting would be minor, long term, and beneficial. For most visitors the beneficial impact would be negligible to minor. The return of plant communities would result in a minor, long-term benefit, including improved fall colors for visitors who are aware of the improvements.

Lethal control would result in adverse impacts on visitors' experience that would be short term moderate in the first four years of the plan and reduced to minor in the last 16 years. A capture facility could be used inside the park. Seeing the facility could have minor adverse effect on some visitors. Some visitors may have ethical concerns; for them, actions involving a capture facility and lethal control would have an adverse effect ranging from minor to major, depending on the individual's sensitivity and ethical perspective.

The adverse impacts on visitors as a result of closures during lethal elk reduction activities would be short-term and minor in the first four years of the plan reduced to negligible to minor in the remaining 16 years. Aerial activity associated with monitoring, management of elk, or fence installation would produce negligible-to-major, short-term, adverse impacts on visitors' experience. Use of fences to protect up to 160 acres of aspen would cause a long-term, local, minor-to-major, adverse impact, which would vary depending on the ability of visitors to see the fence. The use of prescribed burns to stimulate growth of aspen and willows would cause negligible to minor, short-term, adverse impacts.

The effects of firearms use to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk for research purposes would have short-term, minor, adverse effects.

Overall there would be little or no change in the park's cumulative impacts on visitor use and experience and impacts would continue to be moderate, long-term, and beneficial.

Alternative 3

Elk and Wildlife Viewing and Natural Park Experience

Effects on visitors due to management of the elk population would be similar to those of Alternative 2. However, this approach would achieve target numbers more gradually, and the overall reduction would be less than Alternative 2. Visitors would therefore be less likely to notice elk management activities or effects. By the end of the plan, visitors would experience a similar environment in both alternatives, and the adverse impacts on visitors' experience would be negligible.

Crowds viewing elk from park roadsides would not be substantially reduced. Impacts on visitor experience from crowding would be similar to Alternative 2.

Viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting would be similar to opportunities under Alternative 2.

The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2.

Reduction Activities

The effects of lethal reduction activities on visitors' experience would be similar to those during the maintenance phase (or last 16 years) of Alternative 2. The impacts would be short-term and minor to moderate.

A capture facility could be used adaptively if other methods of lethal reduction are not effective. The effects would be the same as in Alternative 2.

The effects of area closures would be similar to the the last 16 years of Alternative 2. Adverse impacts would be short-term and negligible to minor.

Aerial activity associated with monitoring or management of elk would be similar to Alternative 2.

Fencing

The effects of aspen fencing would be similar to those under Alternative 2.

Willow fence would be more visible than aspen fence, and the likelihood of seeing fences and the number of people that could see a fence would increase. Fencing would detract from the natural appearance and intrude on features, such as streams and trails, important to many visitors, diminishing the park's reputation. Fencing to protect willow habitat would be pervasive in areas of the primary summer and winter ranges, with up to 440 acres fenced. Much of this area would coincide with areas of high visitor use, including Moraine Park, Horseshoe Park, and the Kawuneeche Valley. Willow fencing would be more visible than aspen fencing. Efforts would be employed to minimize to the extent possible visual impacts through the design of the fence and selection of materials. In addition fences would be designed to allow for public access to enclosed areas via gates. Individual visitors would experience a localized, major adverse impact, but this would vary depending on the ability of visitors to see the fence or if hiking or use of an area were to be interrupted by a fence and gate.

The large amount of fencing to be installed may require more helicopter trips into off-road areas to haul heavy materials. If the maximum amount of fencing is installed, it would result in negligible-to-major, short-term, adverse impacts on visitor experience, as described in Alternative 2, but would occur more frequently throughout the life of the plan.

Prescribed Fire

The effects of prescribed fire would be the same as under Alternative 2, however, they would be realized more quickly in the plan implementation because increased fences would enable prescribed fire to be used sooner.

Research Activities

The capture or darting, anesthetizing, and handling of elk during research activities conducted in coordination with elk reduction activities would have similar effects on visitor use and experience as those described above for reduction activities involving the management of elk with firearms and access restrictions.

The three-year research study could affect visitor use and experience as a result of elk being marked or tagged and fitted with radio-collars and as a result of some animals being treated with a fertility control agent to evaluate drug effectiveness. Some park visitors may feel that seeing wildlife with human-made marks or collars diminishes the viewing experience, and the sense of viewing wild animals would experience short-term, minor, adverse effects over the short term. Elk behavior of those subject to the fertility control study would not be altered by fertility treatments; therefore, this would have no observable effect on visitor use and experience.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 3 would have similar cumulative effects as those in Alternative 2, including lethal reduction activities, elk viewing, vegetation condition, and monitoring. Up to 600 acres of habitat fenced would result in major adverse impacts, and would affect visitor experience in all seasons. The effects would be localized to the primary winter and summer ranges of elk, and most the park would not be affected. The effect on overall visitor satisfaction would be expected to be only slightly measurable by the Visitor Survey Card survey. Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long term, and beneficial.

Conclusion

Lethal control activities would have adverse impacts on visitors' experience that would be short-term and of minor intensity. Effects on visitors due to management of the elk population would be similar to those of Alternative 2, including impacts on visitor experience from crowding, viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting, and the return of plant communities.

A capture facility could be adaptively for lethal control of elk Seeing the facility could have minor adverse effect on some visitors. Some visitors may have ethical concerns; for them, actions involving a capture facility and lethal control would have an adverse effect ranging from minor to major, depending on the individual's sensitivity and ethical perspective.

The effects of area closures would be similar to those described under Alternative 2 for the last 16 years of the plan. The adverse impacts would be negligible to minor. Aerial activity associated with monitoring or management of elk as an adaptive tool would be similar to Alternative 2. If the maximum amount of fencing is installed, aerial activity would have similar impacts as Alternative 2, but they would occur more frequently throughout the life of the plan.

Fencing up to 600 acres of habitat to protect aspen and montane riparian willow would result in major adverse impacts. The effects of prescribed fire would be the same as under Alternative 2: short-term, negligible to minor, and adverse.

The effects of use of firearms to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects on visitor experience.

Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Alternative 4

Elk and Wildlife Viewing and Natural Park Experience

Visitor opportunities to view elk and the impact on visitors' experience, including crowding, and viewing opportunities for other wildlife would be the same as under Alternative 3.

The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2.

Reduction Activities

Both lethal reduction and fertility control methods would be used under this alternative. The intensity and type of reactions to the two management tools would vary across individuals. A poll in California found that 35% of respondents supported lethal control of ungulates, while 65% supported contraception, suggesting that the experience of more visitors could be adversely affected by lethal control than by fertility control (NPS 2004c). In a 1999 survey in Rocky Mountain National Park, fertility control as an elk management tool received support among 22.2% of visitors surveyed, roughly equivalent to the 21.3% who supported lethal control (Cordova 2000b).

Elk treated with a fertility control agent would receive a short-term mark, such as from a paintball, to prevent multiple treatments. Treated elk may also need to receive a long-term mark readily recognizable by hunters (perhaps ear tags or freeze brands with the warning, "Do Not Consume") to prevent human consumption of meat if the drug is not regulatory-approved agent or the withdrawal time of the agent has not passed. Those hunters outside the park could experience minor, adverse impacts over the long term from such warnings. Some park visitors may feel that seeing wildlife with human-made marks or collars diminishes the viewing experience and the sense of viewing wild animals would experience minor, adverse effects over the long term. If fertility control methods need to be substantially augmented with lethal control activities to meet population targets, the effects would be similar to Alternative 3. The adverse visual effects of fertility control markings or collars could reduce their attractiveness of elk to visitors during the rutting season. This could result in some people choosing not to visit the park and up to a 10% decrease in visitation during the first four years of the plan. There would be reduced long-term adverse effect on visitation with improved education and interpretation.

A capture facility could be used to treat elk with fertility control and mark as necessary. Impacts would be the same as under Alternative 2.

The effects of area closures would be similar to those described for Alternative 3; short-term, adverse, and negligible to minor.

Aerial activity associated with monitoring or management of elk would be the same as Alternative 2.

Fencing

Adverse impacts associated with fence installation and maintenance would be the same as under Alternative 3.

Prescribed Fire

The effects of prescribed fire would be the same as under Alternative 2.

Research Activities

The capture or darting, anesthetizing, and handling of elk during research activities conducted in coordination with elk reduction activities would have similar effects on visitor use and experience as those described above for reductions activities involving the management of elk with firearms and access restrictions.

Tagging or marking elk and the use of fertility control agent for research purposes would have the same effect on visitors experience of the park and viewing wildlife as described above in this alternative.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 4 would have similar cumulative effects as in Alternative 3 for lethal reduction activities, elk viewing, vegetation conditions, fencing, and monitoring. Fertility control activities would have adverse effects on visitor experience; however, given the level of acceptability of fertility control as identified in research cited above, the effect on the cumulative visitor experience would be negligible. Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Conclusion

Lethal control activities would have short-term, minor, adverse effects on visitors' experience. Visitor opportunities to view elk and the impact on visitors' experience, including crowding, would be the same as under Alternative 3: negligible to minor over the long-term. Viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting would be similar to opportunities under Alternative 2: negligible to minor, long term, and beneficial. The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2: negligible-to-minor, long-term, and beneficial.

Elk treated with a fertility control agent for population management and research activities would receive a short-term mark, such as from a paintball, to prevent multiple treatments, and possible long-term markings to warn hunters against consumption. Hunters could experience minor, adverse impacts over the long term from such warnings. Human-made marks or collars would diminish the viewing experience, and visitors would experience minor, adverse effects over the long term.

Adverse impacts associated with fences would be the same as under Alternative 3: long-term, major, and adverse. The effects of prescribed fire would be the same as under Alternative 2: short term, negligible to minor, and adverse.

The effects of use of firearms and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects.

Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Alternative 5

In a 1999 survey of park visitors, release of natural predators received the most support as a tool for managing elk, with approval by 67.9% of those surveyed (Cordova 2000b). The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation (Parsons 2003; International Wolf Center 1999). Park programs could enhance the experience with programs that interpret wolves and their behavior through a variety of media and activities.

Elk and Wildlife Viewing and Natural Park Experience

Visitor opportunities to view elk would be the same as under Alternative 3 in the early years of the plan and somewhat greater in the later years. Dispersal of elk would be greater, but viewing opportunities in large meadows would be expected to continue as in Yellowstone (Fortin et al. 2005). The beneficial impacts on visitors who visit the park with an interest in viewing elk would be minor over the long term.

Visitors would have the opportunity to see elk and other wildlife in a more natural setting similar to Alternative 2. However, wolves would restructure wildlife populations, and there would be changes in abundance and behavior of other species, such as deer and coyotes, that may make them more difficult to view. There would be an overall negligible-to-minor, long-term, beneficial impact due to improved natural settings, but a negligible-to-minor, adverse impact on the ability of visitors to view certain species affected by wolves.

The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation. The park would provide interpretive and educational programs that could enhance the experience for visitors by increasing their awareness of and appreciation for conditions in the park. While wolf management techniques, such as collars, could somewhat reduce the perception of wildness, for the visitors who value wolves or a more complete ecosystem, the opportunity to see or hear wolves would provide a long-term, minor-to-moderate benefit. For visitors who fear wolves and would choose not to hike or backpack as a result of wolf presence would experience a long-term, minor to moderate adverse impact.

The presence of wolves in the park and the opportunity to see wolves and their interactions with other wildlife would provide a substantial, long term attraction for visitors, and would result in a potential 10% increase in visitation. Increased visitation and increased probability for crowding, such as at wolf sightings, would result in long-term, minor, adverse impacts on visitor experience.

The return of plant communities and the benefits to visitor experience would be similar to Alternative 2.

Reduction Activities

If emphasis must be placed on lethal reduction over the actions of wolves, the effects on visitor experience would be as similar to those under Alternative 2.

If wolves are effective in reducing elk numbers, there would be minor-to-moderate, long-term, positive impacts on those who perceive wolves to be an ethical and natural method for reducing elk populations.

The impacts associated with an elk capture facility plus holding pens that would be used for the release of wolves would produce impacts similar to Alternative 2.

If there is a greater need for lethal reduction activities, area closures would be more intense in the first four years, and impacts would be similar to Alternative 2.

Aerial activity associated with monitoring or managing elk as an adaptive tool would be similar to Alternative 2; however, the activities associated with monitoring wolf behavior and movement require more helicopter use. This would be mitigated through the use of satellite monitoring rather than overflights.

Fencing

The effects of aspen fencing would be similar to those under Alternative 2.

Prescribed Fire

The effects of prescribed fire in vegetation communities that have been protected from excess grazing would be the same as under Alternative 2.

Research Activities

The capture or darting, anesthetizing, and handling of elk during research activities conducted in coordination with elk reduction activities would have similar effects on visitor use and experience as those described above for reductions activities involving the management of elk with firearms, use of a capture facility, and access restrictions.

Tagging or marking elk for research purposes would have the same effect on visitor use and experience as described in Alternative 2.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 5 would have similar cumulative effects as Alternative 2, including lethal reduction activities (if needed to the maximum extent), elk viewing, and vegetation condition. The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation and having beneficial effects on cumulative visitor experience. Increased visitation and increased opportunities for crowding, such as at wolf sightings, would have adverse effects but would not likely be measurable in overall park visitor satisfaction. The effects of Alternative 5 would be expected to be measurable by the Visitor Survey Card survey as a contributor to high levels of visitor satisfaction. Overall, however, the cumulative impacts on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Conclusion

Visitor opportunities to view elk would be the same as under Alternative 3 in the early years of the plan and somewhat greater in the later years. Dispersal of elk by wolves would be greater and viewing opportunities in large meadows would increase. The beneficial impacts on visitors who visit the park with an interest in viewing elk would be minor over the long term. Visitors would have the opportunity to see elk and other wildlife in a more natural setting similar to Alternative 2. There would be an overall negligible-to-minor, long-term, beneficial impact due to improved natural settings from wolves' overall impacts on other wildlife, but a negligible to minor, adverse impact on the ability of visitors to view certain species affected by wolves.

The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation. For the visitors who value wolves or a more complete ecosystem, the opportunity to see or hear wolves would provide a long-term, minor-to-moderate benefit. For visitors who fear wolves and would choose not to hike or backpack as a result of wolf presence would experience a long-term, minor to moderate adverse impact. Increased visitation and increased opportunities for crowding, such as at wolf sightings, would result in long-term, minor, adverse impacts on visitor experience. The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2: long-term and negligible to minor.

If emphasis must be placed on lethal reduction over the actions of wolves, the effects on visitor experience would be as similar to those under Alternative 2: short-term, minor, and adverse. If wolves are effective in reducing elk numbers and redistributing elk, there would be minor to moderate, long-term, positive impacts on those who perceive wolves to be an ethical and natural method for reducing elk populations and affecting elk movements. The impacts associated with an elk capture facility plus holding pens that would be used for the release of wolves would produce impacts similar to Alternative 2: minor and adverse. If there is a greater need for lethal reduction activities, area closures would be more intense in the first four years, and impacts would be similar to Alternative 2: short-term, adverse, and minor in the first four years of the plan reduce to negligible to minor in the remaining 16 years. Aerial activity associated with monitoring, management of elk as an adaptive tool, or fence installation would be similar to Alternative 2: short-term, negligible to minor, and adverse; however, the activities associated with monitoring wolf behavior and movement would require more helicopter use.

The effects of aspen fencing would be similar to those under Alternative 2: long-term, local, minor to major, and adverse. The effects of prescribed fire would be the same as under Alternative 2: short-term, negligible to minor, and adverse.

The effects of use of firearms and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects.

The cumulative impacts on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

PARK OPERATIONS

Guiding Regulations and Policies

Management Policies (NPS 2006b) gives guidance for the management of natural resources in the parks and how National Park Service staff should accomplish resource management goals through the use of various tools and approaches. It requires that park operations achieve the following conditions:

Park facilities and operations demonstrate the National Park Service's environmental leadership by incorporating sustainable practices to the maximum extent practicable in planning, design, siting, construction, and maintenance, including preventive and rehabilitative maintenance programs.

In regard to the park interpretive staff, Section 7.5.3 of *Management Policies* requires that "parks should, in balanced and appropriate ways, thoroughly integrate resource issues…into their interpretive and educational programs. Resource issue interpretation should be integrated into both on- and off- site programs, as well as into printed and electronic media whenever appropriate" (NPS 2006b). Augmenting the park's interpretive and educational programs to include information about resource management actions can build understanding of, and support for, the National Park Service's resource management decisions and the NPS mission in general. The park interpretive staff must be educated about the reasoning used in the decision-making process and be able to present a balanced view of the rationale.

The Rocky Mountain National Park Habituated Wildlife Standard Operating Procedures direct the actions to be taken in identifying habituated wildlife and in conducting both preventive and reactive resource management activities (NPS 2002e). During any park operations involving redistribution techniques, the administration of pharmaceuticals, destruction of animals, area closures, or marking of treated animals, these standards must be met.

Methodology and Assumptions

Geographic Area Evaluated for Impacts.

The elk population move within their primary winter and summer ranges within Rocky Mountain National Park. Park staff are responsible for their management throughout this area. Vegetation considered in this analysis include aspen and willow in primary winter and summer ranges, including montane riparian willow habitat on the east side of the park. The geographic area of effect of physical activities being evaluated for impacts on park operations are the primary winter and summer elk range within the park. Staff involved in the management of elk- and vegetation-related issues often have park-wide responsibilities that may be affected by elk and vegetation management. For this reason, the area of analysis is park-wide.

Issues

Park staff members from nearly all divisions at Rocky Mountain National Park are affected by the issues created by the interaction of park resources, visitors, and elk. One park operations issue related to elk and vegetation management was identified during internal and public scoping:

Funding and budget constraints continue to reduce the amount of park staff available for elk and vegetation management activities, crowd management (especially related to the elk rut season), and interpretation.

Assumptions

Operations such as lethal reduction, herding, or hazing may decrease densities, but population concentrations in present locations would continue. Meadow area closures and patrols would still be needed, especially during the elk rut season.

Good public education would be needed to inform and educate the public to help reduce negative public perceptions based on misinformation of the management action that is selected.

Visitation increases in the fall due to the elk rut.

Wolves would attract additional visitors.

Implementation of any of the action alternatives would require additional NPS staff and authorized agents of the National Park Service for lethal reduction (culling) activities as defined in Appendix H to accomplish the work.

Fences installed in the first year of the plan would remain in place until vegetation is recovered.

Some fence material would be transported to locations where fences would be constructed using helicopter support, following minimum tool analysis for sites in wilderness. Phased willow fencing coinciding with elk reductions would mitigate the potential for elk to move to town in a single migration in response to loss of habitat.

Phased fence installation could allow fences to be placed in select areas to mitigate impact on visitors.

Assessment Methods

Potential impacts on park operations, including staffing and funding needs, are assessed in relationship to the degree to which elk and vegetation management would change compared to existing management of these resources. Impacts on park operations were evaluated using the process described in the "General Methodology for Establishing Impacts Thresholds and Measuring Effects by Resource" section of this chapter. Information regarding park operations and staffing projections, as well as records used in this analysis, were obtained from the staff at Rocky Mountain National Park. The primary activities for which impacts were anticipated include elk and vegetation management activities, crowd management, and education/interpretation. The steps for assessing impacts included 1) identifying existing responsibilities and routine tasks of the park staff divisions that may be affected by elk and vegetation management actions, 2) determining the potential changes in staff duties or the need for additional staff and funding that would be caused by actions under each alternative, and 3) identifying the impacts of potential constraints in staffing.

Impact Threshold Definitions

Intensity of Impacts

The following thresholds were used to determine the magnitude of effects on park operations:

Negligible: Park operations would not be affected, or the effect would not be noticeable or measurable outside normal variability.

Minor: The effect on park operations would be measurable and might be noticed by park staff, but probably would not be noted by visitors.

Moderate: The effects on park operations would result in a substantial change in park operations and would be noticeable to park staff, but would probably not be noted by visitors.

Major: The effects on park operations would result in a substantial change in park operations and would be noticeable to both park staff and visitors. Staff and visitors would recognize the change as being quite different from existing operations.

Type and Duration of Impacts

Adverse effects would create additional disruptions to park operations or would increase the duties associated with elk and vegetation management.

Beneficial effects would reduce disruptions to park operations, or maintain (or potentially reduce) the duties related to elk and vegetation management.

Duration: Short-term effects on park operations would not extend beyond the first four years of the plan or would be intermittent and directly associated with the management activity being undertaken. Long-term effects on park operations would be continuous over the life of the plan, following the end of the management activity.

Alternative 1

Reduction Activities

Elk would continue to be lethally removed if they exhibit aggressive behavior or show clinical signs of chronic wasting disease. Carcasses would be tested for the presence of chronic wasting disease. The level of staff effort to address chronic wasting disease would continue at a rate similar to current conditions. No specialized funding would be available for chronic wasting disease in the fiscal years which this plan would be implemented.

Visitor Management

Park staff (primarily law enforcement rangers) would continue to address elk-human conflicts as the distribution of the elk population changes and affects different geographic areas. This staff would continue to manage visitors and control traffic. The law enforcement and interpretive rangers would continue to control the flow of traffic and disperse elk from areas where they congregate, with help from the Elk Bugle Corps volunteers. In the summer season, the park employs approximately 35 law enforcement rangers (Ronca 2005a). The activity of visitors watching wildlife would not measurably change, nor would the likelihood of elk-human conflicts (other than what would be attributed to visitation growth).

Fencing

Fencing inside the park is maintained only for vegetation restoration research purposes. Research exclosures cover approximately 12 acres (Ronca 2004). As long as these exclosures are needed they would be maintained

Willows and aspen in core winter range would not be further protected and would continue to become degraded. No measures would be employed to restore over-browsed vegetative areas. The ban on burning in upland shrub, aspen, and willow would continue. Staff would continue to use small amounts of fencing in some localized, developed areas when needed. This use of fencing would not exceed the regular duties of park staff.

Monitoring

Monitoring for elk population and distribution, chronic wasting disease, and surveillance would continue. Monitoring of the elk population and distribution would continue to be conducted both inside and outside the park. No changes would be expected of the methodology used, team size required, or frequency of this activity. Monitoring for animals infected with chronic wasting disease within the park would continue to occur year round. Fiscal year 2007 would be the last year of specialized funding for chronic wasting disease management. This would be a reduction of approximately $150,000 annually (approximately $10,000 used for chronic wasting disease management in elk) over funding from 2003-2007. It is expected that existing staff would absorb chronic wasting disease response activities at reduced levels.

The ongoing elk and vegetation management and monitoring activities would continue to create long-term, negligible, adverse effects on park operations.

Herding

The occasional herding of elk from the park's campgrounds or from areas where they create traffic problems would occur to disperse crowds of visitors watching them. This typically occurs when many elk congregate in a meadow or other easily visible area, causing onlookers to block traffic in the roadway. This activity would continue to be more frequent during the elk rut, when many visitors come to the park for the express reason of viewing the rut. This increase in traffic and crowd management would not exceed the typical amount for park staff.

Education and Interpretation

The interpretive staff would continue to create publications with information on the elk and their habitat, while interpretive programs would continue to address the elk and vegetation issues at the park to a limited degree. Interpretive programs would focus solely on elk only during the rut season in the program "Elk Echoes" and in some printed media. Degradation would continue in vegetation in areas where high numbers of elk congregate. The updating of interpretive documents would continue to occur as needed to reflect the condition of the elk population and vegetative habitat. This would be within the scope of typical daily and seasonal duties. Natural resource staff would continue to conduct outreach programs for various local groups and would incorporate this information in their presentations as well. The Lyceum series would continue to offer presentations on the elk population and habitat conditions, as they change.

Interpretive Division staff would continue to manage the Elk Bugle Corps, a volunteer group assisting the park rangers who provide interpretation to visitors during the elk rut. Under Alternative 1, these volunteers would continue to patrol the areas where elk congregate, control traffic, manage crowds, and educate the public about the natural history of the elk population. This volunteer contribution eases the burden on park staff to manage the events. No change would be expected in the number of volunteers needed, duties performed, or the amount of hours volunteered. The updating of educational material and management of the Elk Bugle Corps would not measurably differ from this staff's regular duties, and therefore would result in long-term, negligible, adverse effects on park operations.

Cumulative Impacts

Park staff from all divisions would implement existing and future plans and actions throughout the park while operating the park and protecting its resources. Park staff would continue to implement any plan or project within the park. These plans and actions, if successful, would result in better-managed resources and improved effectiveness of park staff over the long-term. However, the requirements on park staff for implementing resource management plans, infrastructure and construction projects, and administrative duties to manage contractors currently exceed the park's available staff level. This parkwide condition would continue to result in long-term, minor to moderate, adverse effects on park operations.

The Resource Management and Research Division staff organizes and conducts the monitoring and management actions such as exotic plant management, prescribed burns, and population and chronic wasting disease monitoring of wildlife. Fire management and fuels reduction activities throughout the park and dissemination of information to the public about the role of fire and the use of safe prescribed burning require a substantial commitment of staff and resources. Population monitoring of other wildlife and vegetation (such as mule deer and boreal toads) is conducted annually. The live testing and removal of mule deer infected with chronic wasting disease is conducted throughout the year by the same staff that remove elk suspected of being infected with chronic wasting disease. This program is scheduled to end prior to or in the initial years in which this plan is implemented. The public would not likely notice any changes in park staff duties, but park staff would be aware of any fluctuations in duties related to these projects and actions. Therefore, the ongoing staff and resource commitment for these resource management efforts represents a long-term, minor, adverse effect on park operations.

Park staff are also increasingly needed for additional visitor and traffic management in popular corridors of the park. A transportation management plan is currently investigating alternative means of managing visitor use, potentially including expanded shuttle bus service to reduce traffic congestion. The reduced traffic control duties for park staff would alleviate the strain on the already overextended Resource Protection Division staff and would result in a long-term, minor, beneficial effect.

Implementation of these past, ongoing, and future plans and actions all represent increased duties for the park staff. These tasks combine to have long-term, minor-to-moderate, adverse effects on park operations. Alternative 1 would contribute long-term, negligible, adverse effects on park operations due to continued monitoring and resource management tasks and updating of park interpretive media. Cumulatively, Alternative 1 with the other projects and actions would have long-term, minor-to-moderate, adverse effects on park operations.

Conclusion

Under Alternative 1, reduction activities would continue to occur only when elk are suspected of having contracted chronic wasting disease. Visitation would have no measurable change and cause no increase in the traffic or crowd control required. Vegetation exclosures in the park are no longer actively researched, and their maintenance would have no effect on park operations. The ongoing monitoring and management activities throughout the park would create long-term, negligible, adverse effects. Park staff would continue to update media regularly with the condition of the elk population and its habitat, and no measurable change would occur in the management of volunteers, resulting in long-term, negligible, adverse effects on park operations.

Cumulatively, Alternative 1, with the other projects and actions, would have long-term, minor-to-moderate, adverse effects on park operations.

Alternative 2

Reduction Activities

Under this alternative, NPS staff and their authorized agents would use high-intensity lethal reduction to achieve population targets. This would involve the reduction of 200 to 700 elk per year for first four years, followed by 25 to 150 per year over the next 16 years. Lethal reduction activities would be primarily conducted by contractors in the first four years of the plan, when lethal reduction efforts would be the most intense. In years 5 through 16, NPS staff and their authorized agents would have to be certified in firearms training, specially trained in wildlife culling, and be required to pass a proficiency test in order to qualify to participate in lethal reduction (culling) activities. If NPS staff would conduct lethal reduction, this would include NPS range qualification at the intensity and frequency required for law enforcement rangers. The removal of carcasses would be done by NPS staff and their authorized agents on foot or with a horse, all-terrain vehicle, truck, or helicopter in remote locations if necessary due disease management concerns , following a minimum tool analysis for areas in recommended or designated wilderness.

If necessary, a temporary capture facility, where the park staff and their authorized agents would administer the lethal measures, would be constructed to rapidly meet population objectives. The added tasks related to construction and teardown of the capture facility would be accomplished by new NPS staff or contractors and result in short-term, negligible-to-minor, adverse impacts on park operations.

The logistical and operational changes involved in the lethal reduction by new staff or authorized agents would result in short-term, minor-to-moderate, adverse impacts for the first four years, declining to short term and minor for the remainder of the plan.

Visitor Management

Park staff would continue to mitigate elk-human conflicts, manage traffic, and redistribute the elk from areas where they congregate. The tasks related to elk management and crowd control would be much the same as current conditions, as the presence and location of elk would continue to be a visitor attraction in the fall. Following the initial heavy reduction, there would be fewer elk, but they would still be expected to use highly visible areas. The need for elk management and crowd control would be somewhat less than present in the early part of the plan, but would return to levels equivalent to present in the later years of the plan. Some elk-human conflicts would continue to occur and therefore the need for occasional redistribution would remain, although the elk would be less habituated in general. The resulting beneficial effects would be short term and long term and of minor intensity. During lethal reduction activities, the increased need for visitor control would result in a short-term, negligible-to-minor, adverse impact on park operations. This may include management of individuals or groups who would choose to protest the lethal reduction activities.

Fencing

Under this alternative, the park staff would manage a contractor who would install fencing around aspen (up to 160 acres) on the primary winter and summer elk range. Park staff would be responsible for the maintenance of this fencing. Existing fencing surrounding the research exclosures would continue to be maintained. The added tasks related to fencing would be accomplished by existing park staff supplemented by new staff or by contractors and would result in short- and long-term, minor, adverse impacts on park operations.

Monitoring

Resource management staff would conduct monitoring at an increased level of intensity for elk population, demographics, and distribution, chronic wasting disease prevalence, and conditions of willow, aspen, herbaceous vegetation, and beaver. Monitoring the overall visitor experience would be altered in content and increased in intensity to assess the visitor response to elk and vegetation management activities. Monitoring chronic wasting disease would greatly increase because there would be many carcasses available during a short period of time due to the heavy lethal reduction. This would occur primarily in winter. The increased monitoring activities would be conducted by existing park staff supplemented by new staff or by contractors. The tasks and allocation of resources related to monitoring activities would create long-term, minor to moderate, adverse effects on park.

Redistribution Techniques

During lethal reduction activities, unsuppressed weapons could also be used to distribute the elk. Redistribution techniques would be conducted throughout the year, as needed, to disperse elk from sensitive areas in the park or to move aggressive elk.

Trained herding dogs, riders on horseback, staff members using noisemakers or visual devices, or helicopters as an adaptive tool would be used to herd elk from the primary winter range to the primary summer range or, if needed, into a capture facility. Redistribution activities would be conducted by existing park staff supplemented by new staff or by contractors. Redistribution activities may be needed more frequently in the last 16 years because less lethal reduction would be occurring. Redistribution techniques would have a long-term, minor-to-moderate, adverse effect on park operations.

Prescribed Fire

Fuels control and prescribed burn vegetation management for willow and aspen would be conducted by park staff to help restore the condition of these vegetative communities, if needed. Since no restoration of these species is currently undertaken, these efforts would result in an increase in regular staff duties. Effects on park operations due to the increased tasks for prescribed burning would be short term, minor, and adverse.

Education and Interpretation

Under Alternative 2, park staff would develop and disseminate information and educational materials regarding elk and vegetation management activities. This would include interpretation, literature and brochures, a plan-specific Website, and outreach programs intended to increase public understanding of the management actions taking place, safety risks, and the role of the elk in the environment. Initial development of new interpretive and educational media would result in a short-term, minor-to-moderate, adverse effect on park operations in the early period of plan implementation.

The Interpretation Division manages the Elk Bugle Corps. Under this alternative, the Elk Bugle Corps would still operate in the same manner as they have in the past because elk would still be readily visible in open areas. However, there would be fewer elk that are less habituated and less concentrated, but high numbers of visitors would still be expected to observe fall rut.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. As this study would be not be conducted by park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Effects on park operations from the ongoing condition of increasing duties for understaffed divisions, as well as the implementation of other plans and actions, would be the same as described under Alternative 1: long term, minor to moderate, and adverse. Alternative 2 would involve a large effort by park staff in the early years of the plan for establishing the lethal reduction and vegetation restoration program, constructing fencing and a capture facility, if needed, managing visitors during lethal reduction, developing new park media, and managing and performing the initial high-intensity lethal reduction activities. Over time, these effects of lethal reduction would diminish, but redistribution, monitoring, education, and fence maintenance would continue, resulting in long-term, negligible-to-moderate, adverse effects, as less lethal reduction would be necessary and the demands on park staff would return to more normal levels, resulting in long-term, negligible-to-moderate, adverse effects. The high-intensity reduction of elk would also create long-term, negligible-to-minor, beneficial effects from reducing the number of and habituation of elk congregating in the park and requiring management by park staff. Overall, cumulative effects of other plans and actions combined with Alternative 2 would be long-term, minor to moderate, and adverse.

Conclusion

The logistical and operational changes involved in the lethal reduction would result in short-term, minor-to-moderate, adverse impacts for the first four years, declining to short-term and minor for the remainder of the plan. The added tasks related to the capture facility would result in short-term, negligible-to-minor, adverse impacts on park operations. The decreased need for managing elk/human conflicts would result in short- and long-term, minor, beneficial effects. During lethal reduction activities, the increased need for visitor control would result in short-term, negligible-to-minor, adverse effects. The added tasks related to fence installation would result in short- and long-term, minor, adverse effects on park operations. The tasks and allocation of resources related to continued monitoring activities would create long-term, minor to moderate, adverse. Redistribution techniques would have a long-term, minor-to-moderate, adverse effect. Increased prescribed burning would have short-term, minor, adverse effects. The initial development of new interpretive and educational media would result in a short-term, minor-to-moderate, adverse effect on park operations in the early period of plan implementation. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures in a free-ranging population in concert with elk management activities would result in a negligible adverse effect.

Cumulative effects of other plans and actions combined with Alternative 2 would be long-term, minor to moderate, and adverse.

Alternative 3

Reduction Activities

Under this alternative, park staff and their authorized agents would conduct low-intensity lethal reduction of elk to achieve moderate population reduction. The operational changes involved in achieving the lower levels of lethal reduction would be similar to those described for the last 16 years of the plan in Alternative 2. The adverse effect on park operations would be short-term and minor.

Visitor Management

The effects of managing visitors and traffic would be similar to those described in Alternative 2. Park staff would continue to mitigate elk-human conflicts, manage traffic, and redistribute the elk from areas where they congregate. Because of the higher elk population target under this alternative, the frequency of park actions to manage visitors would be higher than Alternative 2. Management actions to reduce and redistribute the elk population would result in elk being less habituated in general. The resulting beneficial effects would be short term and long term and of minor intensity. During lethal reduction activities, the increased need for visitor control would result in a short-term, negligible-to-minor, adverse impact on park operations, although it would occur less frequently than in Alternative 2. This may include management of individuals or groups who would choose to protest the lethal reduction activities.

Fencing

The National Park Service would manage a contractors who would install fencing around aspen and willow (up to 600 acres) on the primary winter and summer elk ranges. Park staff would be responsible for maintaining this fencing. The increased installation and maintenance of fences would be accomplished by existing park staff supplemented by new staff or by contractors and would result in short- and long-term, minor-to-moderate, adverse effects on park operations.

Monitoring

The park staff would conduct increased vegetation monitoring activities, which would be at a similar level of intensity as described in Alternative 2 and impacts would be the same as under Alternative 2: long-term, adverse, and minor to moderate.

Redistribution Techniques

Redistribution techniques and their effects would be the same as described in Alternative 2. Due to the less intense lethal reduction and less effective distribution of elk, redistribution techniques would be used to a greater extent in the early years of the plan to protect sensitive vegetative habitat. The higher numbers of elk would likely congregate in higher concentrations in unfenced areas and would therefore require more redistribution. If redistribution techniques were successful and conducted over the long-term, the activity by staff to continually displace elk would result in long-term, moderate, adverse effects on park operations.

Prescribed Fire

Since reduction of elk would be slower in this alternative, prescribed fire activities would occur sooner in fenced areas to stimulate growth of sensitive vegetation. The increased prescribed fire activities conducted by park staff would create short-term, negligible-to-minor, adverse effects on park operations.

Education and Interpretation

The tasks involved in the development of updated interpretive and educational information and the effects of these efforts on park staff would be the same as described in Alternative 2.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. As this study would not be conducted be park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative 1: long term, minor to moderate, and adverse. Alternative 3 would have effects related to the annual lethal reduction of up to 200 elk that remain consistent throughout the life of the plan. The program establishment and lethal reduction activities, vegetation restoration activities, visitor management during lethal reduction activities, and redistribution of elk would result in long-term, negligible-to-moderate, adverse effects. Beneficial effects of reducing the elk population and, consequently, the park operations related to their management, would be both short- and long-term and of minor intensity. However, fencing, redistribution techniques, and prescribed burning would be used extensively for vegetation protection in this alternative to compensate for the slower reduction of the elk population. Overall, the cumulative effects of other plans and actions combined with Alternative 3 would be long term, minor to moderate, and adverse.

Conclusion

The operational changes involved in the lethal reduction would result in short-term, minor-to-moderate, adverse effects over the life of the plan. The beneficial effects of reduced elk-human conflicts would be short- and long-term and of minor intensity, although these effects would occur incrementally over the life of the plan. During lethal reduction activities, the increased need for visitor control would result in short-term, negligible to minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, minor-to-moderate, adverse effects. The tasks and related monitoring activities would create long-term, minor to moderate, adverse effects. The use of redistribution techniques would result in long-term, moderate, adverse effects on park operations. The increased prescribed fire activities that would be conducted would create short-term, minor, adverse effects on park operations. Developing new interpretive and educational media would result in a short-term, minor to moderate, adverse effect on park operations in the early period of plan implementation. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures and fertility control drug effectiveness in a free-ranging population in concert with elk management activities would result in a negligible adverse effect.

The cumulative effects of other plans and actions combined with Alternative 3 would be long term, minor to moderate, and adverse.

Alternative 4

Reduction Activities

Alternative 4 would include a combination of fertility control and lethal reduction of 80 to 150 elk per year over the 20-year life of the plan. Park staff or contractors would administer a fertility control agent by remotely darting and marking the cow elk or by hand injection. Lethal reduction would supplement the use of fertility control agents. Use of lethal reduction would decrease in the later years of the plan as the fertility control agent becomes more effective and there is increased technology to managing the population. Ongoing lethal reduction, fertility control, carcass removal, and chronic wasting disease testing activities by the staff and contractors would represent additional tasks for the resource management staff, resulting in long-term, minor-to-moderate, adverse effects.

Hand injection would require capture and handling of elk, and one temporary capture facility would be constructed if this method were necessary. This would require the park staff to construct and tear down the facility. Administering the drug by hand at a temporary capture facility would considerably increase the workload for resource management staff. The labor involved in the construction, use, and tear-down of a temporary capture facility would result in a short-term, minor, adverse effect.

Visitor Management

The effects of managing visitors would be the same as described in Alternative 3.

Fencing

Fencing of aspen on the winter and summer elk range and montane riparian willow communities on the core winter range, and the effects of these actions on park operations, would be the same as described for Alternative 3.

Monitoring

The park staff would conduct increased vegetation monitoring activities, which would be at a similar level of intensity as described in Alternative 2 and impacts would be the same as under Alternative 2: long-term, adverse, and minor to moderate.

Redistribution Techniques

Redistribution techniques would be conducted in the same manner as described in Alternative 2. Due to the less intense lethal reduction and less effective distribution of elk, they would congregate in higher concentrations in unfenced areas.

Herding activities would be conducted in the same manner as described in Alternative 3. If a temporary capture facility were used, park staff would use herding techniques to move the elk into the facility. It is estimated that herding would require the labor of three full-time-equivalent employees annually. Effects on park operations resulting from redistribution techniques would be the same as described for Alternative 3.

Prescribed Fire

The increased prescribed fire activities that would be conducted as a result of the slower reduction of elk in this alternative would have the same effects on park operations as described for Alternative 3.

Education and Interpretation

The tasks involved in the development of updated interpretive and educational information and the effects of these efforts would be the same as described in Alternative 2. Special media would be prepared for hunters in the areas outside the national park (Game Management Units 18, 19, and 20, and other units as needed) to give detailed information on the safety of consuming the meat of elk that have been treated with fertility control agents.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. As this study would not be conducted be park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative 1: long-term, minor to moderate, and adverse. Alternative 4 would involve increasing staff duties for the administration of fertility control agents, as lethal reduction activities would decrease over the life of the plan to augment the fertility control. Additional duties for park staff would be higher if a capture facility was built and the fertility control agent was hand administered. The program establishment, fertility control and lethal reduction activities, vegetation restoration activities, visitor management during lethal reduction activities, and redistribution of elk would result in long-term, negligible-to-moderate, adverse effects.

Some short-term adverse effects would occur due to the labor involved in program implementation, but these would be offset with the higher number of lethally removed animals in the later years of the plan. Beneficial effects of reducing the elk population and, consequently, the park operations related to their management would be short- and long-term and minor. Overall, the cumulative effects of other plans and actions combined with Alternative 4 would be long term, minor to moderate, and adverse.

Conclusion

Lethal reduction and fertility control activities and the removal of carcasses would result in long-term, minor-to-moderate, adverse effects on park operations. The labor involved in the construction and teardown of a temporary capture facility would result in a short-term, minor, adverse effect. The decreased need for traffic and crowd control would result in long-term, minor, beneficial effects. During lethal reduction activities, the increased need for visitor control would result in short-term, minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, minor-to-moderate, adverse effects. The tasks and related monitoring activities would create long-term, minor-to-moderate, adverse effects. Redistribution techniques would result in long-term, moderate, adverse effects. The increased prescribed fire activities that would be conducted would create short-term, minor, adverse effects. Developing new interpretive and educational media would result in a short-term, minor to moderate, adverse effect on park operations in the first years of the plan. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures and fertility control drug effectiveness in a free-ranging population in concert with elk management activities would result in a negligible adverse effect.

The cumulative effects of other plans and actions combined with Alternative 4 would be long term, minor to moderate, and adverse.

Alternative 5

Reduction Activities

Under this alternative, reduction and distribution of the elk population would be accomplished in part by the release of wolves in the park. A contractor would likely be responsible for most tasks required for implementing the release and monitoring program, including the construction of facilities and obtaining wolves from another location. NPS staff would be responsible for administering the program and coordinating activities with the contractor. Some NPS staff would intermittently assist the contractor with tasks or activities, such as installing the wolf acclimation pen. This would result in short-term, negligible-to-minor, adverse effects on park operations.

The reduction of the elk population by wolves would be supplemented with lethal control activities. This would involve the same methods and short-term effects as described in Alternative 2, including a temporary capture facility if needed for lethal reduction. The use of lethal reduction would decrease over time if the activities of wolves were successful in distributing and reducing elk numbers. The overall impact intensity would be the same as in Alternative 2.

Visitor Management

Elk-human conflicts and the need for traffic and crowd control would gradually decline over the life of the plan. Effects on park operations would be similar to those under Alternative 2. Wolves and the potential to see wolves would be a substantial attraction for visitors. When wolves are sighted, visitors would be expected to stop and congregate on road sides. This would be similar to the effects of elk viewing. This would result in the need to manage visitors that gather when wolves are visible. This would result in a short-term, minor, adverse effect on park operations.

Fencing

The extent of fencing, labor, and effects of installing and maintaining it would be the same as described for Alternative 2.

Monitoring

Under this alternative, the monitoring of elk and vegetation management activities would be the same as described under Alternative 2. The monitoring of chronic wasting disease from lethal reduction activities would be less than Alternative 2 because the reduction of elk would not be as rapid. Monitoring the chronic wasting disease status of wolf prey items (elk, deer, moose) would increase monitoring intensity. Wolf activity would be monitored and monitoring of visitor experience would change to assess the impact of the presence of wolves and any problems or perceived benefits of this action. These activities would result in long-term, moderate, adverse effects on park operations.

Redistribution Techniques

Wolves would effectively distribute the elk throughout the park; therefore, no additional redistribution techniques would be used.

Herding, as described in Alternative 2, would be used as necessary by park staff to move elk into a capture facility for lethal reduction. The effects of herding on park operations would be the same as in Alternative 2.

Prescribed Fire

The actions and effects of prescribed fire would be the same as described for Alternative 2.

Education and Interpretation

Development of interpretive programs and information describing the elk and vegetation management activities would be the same as in Alternative 2. New interpretive information and programs would be developed to explain the role of wolves in the ecosystem and safety and wolves. The public and the local community, however, would require a substantial amount of information, education, and outreach to achieve acceptance of wolves. Eight to 20 hours of orientation and training would be required for staff members from all divisions and volunteers including the Elk Bugle Corps (Langdon 2004a). These activities would result in a moderate-to-major, adverse effect, which would be reduced to minor in the long term.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk would be conducted in coordination with elk management activities in the first three years of the plan. As this study would not be conducted be park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative 1: long-term, minor to moderate, and adverse. Alternative 5 would involve an increase in staff duties for the establishment and management of a wolf program, including intensive monitoring and interpretive duties that would remain fairly consistent over time. The wolf release program, lethal reduction activities, and vegetation restoration activities would result in long-term, negligible to moderate, adverse effects.

Some short-term, adverse effects would result from supplementing the effort with lethal reduction activities, the management of visitors viewing the wolves, and construction of a acclimation pen; however, these effects would be intermittent. The cumulative effects of other plans and actions combined with Alternative 5 would be long term, minor to moderate, and adverse.

Conclusion

The release and monitoring of wolves would result in short-term, negligible-to-minor, adverse effects on park operations. The lethal reduction activities would result in minor-to-moderate, adverse effects in the short-term, but decline to short-term and minor for the remainder of the plan if wolves were successful. The added tasks related to the capture facility would result in short-term, negligible-to-minor, adverse effects on park operations. Elk-human conflicts would decrease in the park, but the need for traffic and crowd control would slightly increase over time due to the viewing of wolves, resulting in short-term, minor, adverse effects. The added tasks related to fence installation would result in short- and long-term, negligible, adverse effects on park operations. The tasks and related monitoring activities including increased monitoring of wolf activity and visitor response to wolves would create long-term, moderate, adverse effects. Herding to a capture facility would have a long-term, minor, adverse effect. Prescribed fire would have short-term, negligible to minor, adverse effects. Information, education, and outreach activities associated with the wolf release program would result in a moderate to major, adverse effect, which would be reduced to minor in the long term. Initial integration of wolves and lethal reduction into interpretive materials would result in a short-term, moderate to major, adverse effect that would reduce to minor in the long-term. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures in a free-ranging population in concert with elk management activities would result in a negligible adverse effect on park operations as a result of the study.

The cumulative effects of other plans and actions, combined with Alternative 5, would be long-term, minor to moderate, and adverse.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

Unavoidable Adverse Impacts

Unavoidable adverse impacts are those environmental consequences of an action that cannot be avoided, either by changing the nature of the action or through mitigation if the action is taken. Therefore, they would remain throughout the duration of the action.

There would be unavoidable impacts under Alternative 1 from the elk population continuing to be of higher density, less migratory, and more habituated to people. Vegetation degradation in the primary winter and summer ranges would continue as a result of high levels of elk herbivory. Wildlife, including species of special concern, would continue to be adversely affected by high elk populations and degraded vegetation. Decreased species richness and diversity would continue, and beaver, small mammal, songbird, waterfowl, and butterfly populations would continue to be depressed and adversely affected. Unavoidable impacts would continue on hydrology as a result of reductions in the activities of beavers and reduced presence of beaver ponds. Reduced soil productivity and nutrient cycling would continue in areas of high elk concentration. Alternatives 2, 3, 4, and 5 would have unavoidable impacts from increased deer populations and adverse effects on upland shrub from increased browsing and increased competition with other wildlife species. Under Alternative 5, wolves would periodically and rapidly disperse elk, sheep, and deer, causing increased stress and energy expenditure by the animals. Coyote populations may decline as a result of competition with wolves.

Unavoidable impacts from Alternatives 2, 3, 4, and 5 would occur on wildlife from human activity in the environment during lethal reduction, redistribution, carcass removal, capture activities, and use of helicopters as an adaptive management tool. These activities would produce noise and visible activity that would have unavoidable adverse impacts on the natural soundscape in the park and on the experience of visitors. The action of reducing elk through lethal methods would have unavoidable adverse effects on people who have ethical concerns about such actions. Park operations would be unavoidably affected by all action alternatives through increased staff activity and logistics associated with all means of elk and vegetation management and monitoring.

Fences would potentially interfere with movement for wildlife species in all action alternatives, especially in Alternatives 3 and 4. The installation and presence of large amounts of fence would have unavoidable adverse effects on and detract from wilderness quality and visitors' experience.

Reduced numbers of elk under Alternatives 2, 3, and 4 would cause reductions in park visitation that would have unavoidable adverse impacts on the regional economy. This would be most evident in Alternative 4 with its use of fertility control methods.

Relationship between Local Short-term Uses of the Environment and the Maintenance and Enhancement of Long-term Productivity

This determination identifies whether the proposed action would trade-off the immediate use of the land or resources for any long-term management possibilities, adversely affecting the productivity of recreation area resources. This determination also discloses whether the proposed action or alternatives would be a sustainable action that could continue over the long term without environmental problems (NPS 2001c).

None of the alternatives suggest substantial loss or impairment of natural resources or ecosystems in the park as a consequence of their implementation. In the short-term, the action alternatives would trade off small areas of land used temporarily for a capture facility or for staging materials and equipment for the construction of fences with the long-term improvements to vegetation and other associated natural resources within elk primary winter and summer ranges.

Irreversible or Irretrievable Commitments of Resources

The intent of this determination is to identify whether the proposed action or alternative would result in effects or impacts that could not be changed over the long term or would be permanent. An effect on a resource would be irreversible if the resource could not be reclaimed, restored, or otherwise returned to conditions that existed before the disturbance. An irretrievable commitment of resources involves the effects on resources that, once gone, cannot be replaced or recovered (NPS 2001c).

All five alternatives would involve the irretrievable commitment of labor and fossil fuels to varying degrees. None of the alternatives would be expected to result in the irreversible or irretrievable commitment of park resources.

Consultation and Coordination

This page intentionally left blank

CONSULTATION AND COORDINATION

HISTORY OF PUBLIC INVOLVEMENT

The public involvement activities for this *Elk and Vegetation Management Plan / Environmental Impact Statement* (plan/EIS) fulfill the requirements of the *National Environmental Policy Act* (NEPA) and National Park Service (NPS) *Director's Order 12* (NPS 2001a).

THE SCOPING PROCESS

The National Park Service divides the scoping process into two parts: internal scoping and external (public) scoping. Internal scoping for this plan/EIS involved discussions among NPS personnel regarding issues, management alternatives, mitigation measures, appropriate level of documentation, lead and cooperating agency roles, available references and guidance, the purpose and need for the plan, and other related dialogue.

Public scoping is the early involvement of the interested and affected public in the environmental analysis process. The public scoping process helps ensure that people have been given an opportunity to comment and contribute early in the decision-making process. For this plan/EIS, project information was distributed to individuals, agencies, and organizations early in the scoping process, and people were given opportunities to express concerns or views and identify important issues or even other alternatives.

Taken together, internal and public scoping are essential elements of the NEPA planning process. The following sections describe the various ways the National Park Service conducted internal and public scoping for this plan/EIS.

Internal Scoping

An interagency planning team was assembled in August 2002 to discuss the scope of this plan/EIS and the level of participation of the agencies. The interagency planning team includes the National Park Service, Town of Estes Park, Estes Valley Recreation and Parks District, Colorado Division of Wildlife, Grand County, Larimer County, Town of Grand Lake, U.S. Bureau of Reclamation, and U.S. Forest Service.

Interagency team meetings were held in January and February 2003 to make final determinations on agency participation. In March 2003, a final project agreement between the agencies was established that identified the roles and responsibilities of the participating agencies in development of the plan/EIS into three levels of participation. The project agreement that was signed is attached to this document as Appendix A.

> The NPS is the **lead agency,** and is responsible for all aspects of developing the plan and environmental impact statement (EIS), including selection of a preferred alternative and preparing a record of decision.

> Cooperating agencies on the **core planning team** will participate in all aspects of developing the plan and EIS. Agencies on this team include the Town of Estes Park and the Estes Valley Recreation and Parks District.
>
> Cooperating agencies on the **extended planning team** have agreed to provide expertise and data on pertinent topics and to review appropriate portions of the plan and EIS. Agencies on this team include the Colorado Division of Wildlife, Grand County, Larimer County, Town of Grand Lake, U.S. Bureau of Reclamation, and U.S. Forest Service.

While deliberations on agency participation were being held, the interagency team met numerous times. Initial discussions to discuss the planning process timeline and begin the scoping process were conducted in September 2003. The interagency team worked collectively to confirm the purpose and need for action, identify issues and concerns, create objectives for taking action, and identify potential management tools. In January 2004, the interagency team held an alternative development workshop and collaborated through July 2004 to develop preliminary draft alternatives that were then presented to the public in August. With input from the public, the interagency team has collaborated with numerous experts and agencies involved in wildlife management (see description below in "Public Scoping") in the development of the range of alternatives that were considered and in the analysis of effects for this plan/EIS. In September 2005, the interagency team met to review and evaluate the final alternatives for the plan/EIS at a Choosing-by-Advantages workshop. Giving consideration to the results of this evaluation, the National Park Service determined the agencies preferred alternative, Alternative 2.

Public Scoping

The public scoping process began on May 29, 2003, with the publication of a notice of intent in the *Federal Register* (Federal Register, Volume 69, Number 14). A newsletter was distributed to the public in September 2003 and an internet website developed specific to this plan/EIS (www.nps.gov/romo/planning/elkvegetation) which introduced the public to the planning process, summarized the nature and extent of the elk and vegetation problem in the park, the purpose of and need for plan, the objectives for this plan/EIS, and proposed management tools for elk and vegetation management. The newsletter was mailed to over 10,000 individuals, organizations, or agencies on the park's mailing list and in the areas of Estes Park and Grand Lake, Colorado. During this first phase of scoping the public was asked to identify issues, concerns, and ideas related to the management of elk and vegetation and also to review potential management tools and suggest additional management actions, which were considered in the development of draft alternatives.

The National Park Service conducted five public scoping meetings between September 23 and September 30, 2003 in the Loveland, Grand Lake, Boulder, and Estes Park, Colorado. A total of 107 people attended these workshops. More than 1,100 written comments were received, in addition to those comments recorded at the public scoping meetings.

The interagency team used these comments in developing preliminary draft alternatives for managing elk and vegetation which were then presented to the public in July and August 2004. These alternatives were presented in the summer 2004 newsletter which was sent to over 1,600 individuals, organizations, and agencies. During this phase of scoping the public was asked to provide input on the preliminary draft alternatives and to suggest additional management approaches. The National Park Service held four public workshops on the draft alternatives between August 16 and August 23 in the same locations listed above where a total of 133 people were in attendance. Over 1,000 comments were received through letters, emails, and workshops during the public comment period which ended in September 2004. A report summarizing the comments on the preliminary draft alternatives was made available to the public on the Elk and Vegetation Management Plan/EIS website.

With this input on the preliminary draft alternatives, the park staff and the cooperating agencies developed the final range of alternatives to be considered for analysis. Park staff consulted with technical experts and conducted internal workshops to develop the technical and logistical details of alternatives involving lethal reduction, redistribution, fertility control, and wolves. These workshops involved the participation of experts from Animal Plant and Health Inspection Service Wildlife Services Division, Colorado Division of Wildlife, Parks Canada, U.S. Fish and Wildlife Service, U. S. Geological Survey, U.S. Public Health Service, scientists from various universities, and numerous NPS resource experts.

To keep the public informed of the planning process, the National Park Service distributed another newsletter to the interested public, organizations, and agencies in August 2005. This newsletter informed the public about the progress of the plan/EIS and provided information on the changes in the alternatives and plan/EIS schedule.

The National Park Service released the Draft Elk and Vegetation Management Plan/EIS in April 2006. The draft plan/EIS was distributed to individuals, organizations, and agencies that were on the plan mailing list and to those who had requested copies. It was also available as an electronic document on the NPS planning website. The draft plan/EIS was available for public review for 75 days following publication by the National Park Service of the Notice of Availability in the Federal Register on April 20, 2006 (71 FR 76). The U.S. Environmental Protection Agency (EPA) published the Notice of Availability in the Federal Register on May 5, 2006 (71 FR 87). The comment period on the draft plan/EIS closed on July 5, 2006.

Public meetings were held from May 22 through May 25, 2006 in Boulder, Loveland, Grand Lake, and Estes Park, Colorado. The National Park Service provided notification of the public meetings on the project website, on the NPS planning website, and through press releases. The National Park Service presented information on the draft plan/EIS through posters, a slide presentation, and with a questions and answer session. A total of 231 people attended the public meetings.

During the public comment period, over 2,600 responses were received that contained approximately 3,146 comments in the form of letters, emails, internet responses, comment forms, and petitions. The National Park Service and its contractor analyzed all comments that were received during the public comment period to identify and respond to substantive issues. The introduction to Volume 2, "Comments and Responses to the Draft Environmental Impact Statement," contains a description of the purpose in reviewing and responding to public comments, provides a brief summary of the comments received, and provides a consolidation of comments and the agency response.

AGENCY CONSULTATION

U. S. Fish and Wildlife Service

In accordance with section 7 of the Endangered Species Act (16 U.S.C 1531 et seq.), the National Park Service conducted informal consultation with the U.S. Fish and Wildlife Service. On October 3, 2005 the National Park Service corresponded with the U.S. Fish and Wildlife Service requesting concurrence on the revised Threatened and Endangered Unit Species List (revised December 2004). A letter received from the U. S. Fish and Wildlife Service dated October 18, 2005 concurred with the Threatened and Endangered Unit Species List for the park and with the list of species that may be affected by management actions in the park such as elk and vegetation management and would require further consultation (see Appendix D to view a copy of this letter). It should be noted that a recent decision on September 20, 2005 by the U. S. Fish and Wildlife Service has determined that the boreal toad is not warranted at this time for listing. Therefore, the boreal toad was withdrawn from Rocky Mountain National Park's list as a candidate species on October 3, 2005. In addition, National Park Service staff met informally with the U.S. Fish and Wildlife Service on July 26, 2005 to provide information on the plan and the draft alternatives, to evaluate issues regarding listed species in the park and region that may be affected by management actions directly or indirectly, and to determine the section 7 consultation pathway for this plan/EIS. As a result of these discussions, a biological assessment was prepared and submitted with the plan/EIS to the U.S. Fish and Wildlife Service in April 2006 for their review as part of the Section 7 consultation process. Their response can be found in Volume 2 of this final plan/EIS.

Estes Park and Estes Valley Recreation and Park District Board of Trustees

During preliminary draft alternative development, a request was made by representatives of the Estes Park and Estes Valley Recreation and Park District for a formal presentation to the Board of Trustees of both agencies to provide more information on the plan/EIS and the planning process. On June 17, 2004, the National Park Service met with the board members and presented information regarding the purpose and need, the objectives, and the preliminary draft alternatives. In addition, the board members were briefed on the results of public scoping that had occurred in the summer 2003. The National Park Service and Colorado Division of Wildlife staff that were present addressed questions. Concerns raised by the board members concerning agency involvement outside of the park, issues related to public safety and property as a result of a human-habituated elk population, and effects of elk management on tourism were recorded. The input provided by the board members from this and subsequent meetings was used to modify and further develop the alternatives that are presented in this plan/EIS.

AMERICAN INDIAN CONSULTATION

In October 2002 the Northern Arapaho Tribe and the Northern Ute Tribe were contacted by letter for government-to-government consultation regarding the elk and vegetation plan. Copies of this correspondence are provided in Appendix F. At that time, the tribes were invited to participate in the planning process. The tribes have been invited to attend interagency meetings and the alternative development workshops that occurred in January 2004. Although not cooperating agencies in development of this plan, the tribes have been sent all information that has been provided to the interagency team members. As part of the consultation process, the tribes were sent copies of the draft plan/EIS for their review and comment. To date, no responses were received from the aforementioned tribes on the draft plan/EIS.

LIST OF PREPARERS AND CONSULTANTS

TABLE 5.1: LIST OF PREPARERS AND CONSULTANTS

Name	Title	Education	Experience
National Park Service			
Therese Johnson	Management Biologist	B.S. Wildlife Biology and M.S. Rangeland Ecosystem Science. Project leader for IET; responsible for developing alternatives, analyzing impacts, writing natural resources Affected Environment sections, contributing to other sections in "The Ecological Role of Elk in Rocky Mountain National Park" (Monello et al. 2005), and conducting document review.	24 years
Carlie Ronca	Natural Resource Management Specialist	B.S. Education and M.S. Biology in Management of Environmental Resources. Member of the IET; responsible for developing alternatives, analyzing impacts, writing natural resources Affected Environment sections, and conducting document review.	8 years
Ryan Monello	Biologist	B.A. Biology and M.S. Wildlife Resources. Responsible for writing "The Ecological Role of Elk in Rocky Mountain National Park" (Monello et al. 2005), and conducting document review.	10 years
Parsons			
Timberley Belish	Environmental Scientist	B.S. Biology and M.S. Ecology and Evolution. Responsible for planning scope, alternative development, general document writing and preparation, and vegetation impact analysis.	15 years
Janice Biletnikoff	Environmental Planner	B.A. Psychology and M.C.R.P. Natural Resources and Environmental Planning. Responsible for public involvement, park operations impact assessment, and research for the socioeconomic assessment.	5 years

Name	Title	Education	Experience
John Hoesterey	Project Manager and Public Involvement Specialist	B.A. Zoology and M.S. Geography and Environmental Science. Responsible for EIS team facilitation, public involvement, project management and document review.	30 years
Michelle Johnson	Environmental Scientist	B.S. Biology and M.S. Natural Resource Planning. Responsible for analysis of soils and nutrient cycling, water resources, natural soundscapes, and wilderness impact analysis.	8 years
Don Kellett	Wildlife Biologist / Environmental Scientist	B.S. Wildlife Biology. Responsible for purpose and need, alternative development, and wildlife and natural resource impact assessments.	15 years
Scott Lowry	Technical Editor	B.S. Psychology; J.D.; M.A. and Ph.D. English. Responsible for editing and writing.	16 years
Bruce Snyder	Technical Director	B.S. Biology and M.S. Wildlife Biology. Responsible for technical direction for compliance with NEPA, NPS DO-12, and other NPS policies and guidelines for EIS content; project team support; addressing issues and analytical requirements.	36 years
Harvey Economics			
Andy Fritsch	Socioeconomic Analyst	B.A. Environmental Economics. Responsible for gathering and analyzing socioeconomic data.	4 years
Edward Harvey	Socioeconomic Component Lead	B.A. Economics and M.S.B.A. Economics. Responsible for planning scope and reviewing results of socioeconomic impacts analysis.	32 years
Susan Walker	Socioeconomic Analyst	B.A. Forestry and M.S. Forest Economics. Responsible for gathering and analyzing socioeconomic data.	1 year
TQ NEPA			
Heidi West	NEPA Specialist	B.S. Biology, M.A. Science	22 years

Name	Title	Education	Experience
		Communication, M.S. Biology, Ph.D. Environmental Science and Engineering. Responsible for EIS team facilitation, interagency workshop facilitation, internal scoping, and alternative development.	

LIST OF RECIPIENTS

A postcard was mailed to the agencies, organizations, and businesses listed below as well as individuals who were listed on the project mailing list. The plan/EIS was distributed only to those entities that requested a copy.

Public Agencies

Adams County Sheriff's Department
Alamosa County
Arapahoe County Court
Arapahoe National Recreation Area
Arapaho-Roosevelt National Forest
Arkansas Game and Fish Commission
Arvada Animal Control
Attorney General's Office
Baca County
Bandelier National Monument
Basalt Police Department
Bent County
Board of County Commissioners
Boulder County
Boulder Parks and Open Space
Broomfield City and County
California Fish and Game Commission
Chaco Culture National Historical Park
Cheyenne and Arapaho Tribes of Oklahoma
Cheyenne County Court
City of Black Hawk
City of Boulder
City of Craig
City of Evans
City of Fort Collins
City of Greeley
City of La Junta
City of Lakewood
City of Longmont
City of Loveland
City of Northglenn
City of Pueblo
Coal Creek Canyon Fire Protection District
Colorado Attorney General's Office
Colorado Department of Agriculture
Colorado Department of Natural Resources
Colorado Department of Transportation
Colorado Division of Water Resources
Colorado Division of Wildlife
Colorado Geological Survey
Colorado State Forest Service
Colorado State Parks
Colorado State Public Defender's Office
Colorado State University
Colorado Wildlife Commission
Conejos County Sheriff's Office
Costilla County Sheriff's Department
Custer County Combined Courts
Delta County
Denver Water
Department of Defense
Divide Canal and Reservoir
Division of Water Resources
Dolores County
Douglas County
Eagle County Sheriff's Office
Elbert County Court
Eleven Mile & Spinney State Parks
Estes Park Library District
Estes Park Sanitation District
Estes Park Urban Renewal Authority

Estes Park Volunteer Fire Department
Estes Valley Planning Commission
Fort Collins Soil Conservation District
Fremont County Court
Garfield County
Georgetown Library
Gilpin County
Glen Haven Area Volunteer Fire Department
Grand County
Grand Lake Metropolitan Recreation District
Grand Lake Recreation District
Grand Teton National Park
Great Sand Dunes National Park
Great Smoky Mountains National Park
Horse Mountain Ranch Metro District
Hot Sulphur Springs
Jackson County Government
Jasper National Park
Jefferson County
Jefferson County School District
Kansas Department of Wildlife and Parks
Kiowa County
Kiowa Tribe of Oklahoma
La Junta Police Department
La Plata County Animal Control
Lafayette Public Library
Lakewood Animal Control
Larimer County
Las Animas County Combined Court
Lincoln County
Logan County
Louisville Police Department
Loveland Public Library
Lower South Platte River Water Conservation District
Lyons Fire Protection District
Medicine Bow-Routt National Forests
Mesa County
Middle Park Water Conservancy District
Mineral County
Moffat County
Montana Fish, Wildlife, and Parks
Montezuma County
Montrose County Associated Court
Morrison Police Department
National Center for Atmospheric Research
National Elk Refuge
National Park Service, Colorado Plateau Cooperative Ecosystem Studies Unit
National Park Service, Intermountain Region
National Park Service, Rocky Mountains Cooperative Ecosystem Studies Unit
National Park Service/Biological Resource Management
Natural Resource Conservation Service
Nevada Division of Wildlife
Northern Arapaho Culture Commission
Northern Arapaho Economic Development Commission
Northern Arapaho Tribe Business Council
Northern Cheyenne Tribe
Northern Colorado Water Conservancy District
Northern Ute Tribe
Northwest Colorado Council of Governments
Oak Creek Police Department
Office of Solicitor/U.S. Department of the Interior
Oglala Sioux Tribe
Otero County
Ouray County Sheriff's Department
Park School District
Phillips County Sheriff's Office
Pike/San Isabel National Forests
Pinewood Springs Fire Protection District
Prowers County
Pueblo County
Rio Grande National Forest
Routt County
Saguache County
San Juan County
San Juan National Forest
San Miguel County
Sedgwick County
Shoshone Tribal Council
Sibb County
Southeast Colorado Water Conservation District
Southern Ute Indian Tribe

Southern Ute Indian Tribe/Division of Wildlife Resource Management
Standing Rock THPO
State Land Board
State of Colorado
Sugar Leaf Fire Protection District
Summit County
Sunshine Fire Protection District
Teller County
Town of Debeque
Town of Empire
Town of Estes Park
Town of Fraser
Town of Georgetown
Town of Grand Lake
Town of Gypsum
Town of Jamestown
Town of Silver Plume
Town of Ward
Town of Wellington
Town of Winter Park
Trinidad Police Department
U.S. Air Force
U.S. Air Force Academy
U.S. Army
U.S. Department of Agriculture
U.S. Department of Agriculture, Agricultural Service
U.S. Department of Agriculture, Natural Resources Conservation Service
U.S. Department of Agriculture: Forest Service
U.S. Department of the Interior, Bureau of Land Management
U.S. Department of the Interior, Bureau of Reclamation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Forest Service, Gunnison National Forest
U.S. Forest Service, Norwood Ranger District
U.S. Geological Survey
U.S. Park Police
Uintah & Ouray Tribal Business Committee
United States Senate
University of Arizona
University of Colorado
University of Colorado at Boulder
University of Denver
University of Nevada Reno
University of Northern Colorado
USDA: APHIS, Wildlife Services
Ute Mountain Tribe
Washington County Combined Court
Washington County Sheriff's Department
Water Quality Control Division
Weld County
Western Area Power Administration
White River National Forest
Wind Cave National Park
Wyoming Fish and Game
Yale School of Forestry
Yellowstone National Park
Yuma County Courts

Elected Officials

United States Senate

Honorable Wayne Allard
Honorable Ken Salazar

United States House of Representatives

Honorable Bob Beauprez, District 7
Honorable Diana DeGette, District 1
Honorable Joel Hefley, District 5
Honorable Marilyn Musgrave, District 4
Honorable John T. Salazar, District 3
Honorable Tom Tancredo, District 6
Honorable Mark Udall, District 2

Colorado State Governor

Honorable Bill Owens

Colorado State Senate

Honorable Norma Anderson, District 22
Honorable Bob Bacon, District 14
Honorable Greg R. Brophy, District 1
Honorable Jim Dyer, District 26
Honorable John Evans, District 30
Honorable Joan Fitz-Gerald, District 16
Honorable Peter C. Groff, District 33

Honorable Deanna Hanna, District 21
Honorable Jim Isgar, District 6
Honorable Steve Johnson, District 15
Honorable Maryanne Keller, District 20
Honorable Ken Kester, District 2
Honorable Dave Owen, District 13
Honorable Brandon Shaffer, District 17
Honorable Abel J. Tapia, District 3
Honorable Jack Taylor, District 832.
Honorable Ron Tupa, District 18
Honorable Sue Windels, District 19
Honorable Tom Wiens, District 4

Colorado House of Representatives

Honorable Betty Boyd, District 26
Honorable Michael Cerbo, District 2
Honorable Fran Coleman, District 1
Honorable Bill Crane, District 27
Honorable Jerry K. Frangas, District 4
Honorable Dale K. Hall, District 48
Honorable Cheri Jahn, District 24
Honorable Kevin Lundberg, District 49
Honorable Alice Madden, District 10
Honorable Bob McClusky, District 52
Honorable Anne McGihon, District 3
Honorable Angie Paccione, District 53
Honorable Tom Plant, District 13
Honorable John V. Pommer, District 11
Honorable Andrew Romanoff, District 6
Honorable Joe Stengel, District 38
Honorable Paul Weissmann, District 12
Honorable Al White, District 57
Honorable Robert E. Witwer, District 25

Colorado County and Local Elected Officials

Mayor, City of Estes Park
Mayor, City of Grand Lake
Boulder County Board of Commissioners
Boulder District Attorney
Grand County Board of Commissioners
Grand County District Attorney
Jackson County Commissioner
Larimer County Commissioner
Larimer County District Attorney

Schools, Organizations, and Businesses

4-Wheeling America LLC
A All Animal Control, Inc.
A-1 Animal Control Services
Academy District #20
Adams County Museum
Adventure Travel West
Airborne Express
Alpine World Ascents
American Lands Alliance
American West Taxidermy
Aqua Sierra
Aqua-Hab; Aquatic Systems Consulting
Aquatics Associates, Inc.
Arapaho Estates Property Owners Association
Arapaho Meadows Homeowners Association
Arkansas City High School
Arkansas River Habitat Partnership Program
Arrow Dynamics
Asbury Images
Aspen Brook Homeowners Association
Aspen Canyon Ranch
Aspen Center for Environmental Studies
Aspen Grove Cottages, Inc.
Aspen Leaf Condominium Association
Aspen Lodge at Estes Park
Astraddle A Saddle, Inc.
Audubon Society of Greater Denver
Aurora Animal Care Division
Avalanche Tours
B&B Bird Farm
Back Country Skiers Alliance
Bar H Outfitters
BAR LAZY J Guest Ranch
Bark Association
Bayou State Bowhunters Association
Beaver View Estates
Bennett's Tackle
Big Elk Meadows Assoc.
Big Thompson Watershed Forum
Bighorn Lumber Co., Inc.
Bill Law Guide Service Inc.
Biodiversity Conservation Alliance
Black Canyon Hills, Inc.
Black Ranch Ltd.

BLM, Kremmling Field Office
Blue Mountain Ranches
Blue Ribbon Coalition
Blue Spruce Village Homeowners Association
Boulder County Audubon Society
Boulder County Horseman's Association
Boulder County Nature Association
Boulder Mountain Fire Authority
Boulder Outdoor Center
BRD Central Regional Office
Brookside Subdivision Homeowners Association, Inc.
Bruce's Fish Farm
Bruton's Guide Service, Inc.
Bull Basin Outfitters
Bullseye Outfitter & Adventures
Bulwark Ridge Association
Burlington Resources
Business Appraisal Associates, Inc.
Cairns Ranch, LLC
Calais Resources Inc.
Cal-Wood Education Center
Camp Timberline
Campground Association
Canyon Courier
Canyon Creek Townhome Condominium Assoc.
Caribou Ranch
Carriage Hills Property Owners Association
Cathcart Photography
Cedar Park Road Maintenance Corporation
Cedar Ridge Condominium Association
Cedar Springs Improvement Association
Center for Biological Diversity
Center for Native Ecosystems
Center For Wildlife Law
Cerand Jackson TAC
Charles Heights Association, Inc.
Cheley Camp
Cheyenne & Arapaho Business Committee
Circle K Ranch
Clear Channel- Northern Colorado
Clear Creek County
Clear Creek Economic Development Corporation
Clear Creek Supply Co.
Club 20
Colorado Aquaculture Board
Colorado Archaeological Society Indian Peaks
Colorado Association of 4-Wheel Drive Clubs, Inc.
Colorado BASS Federation
Colorado Bicycling Adventures
Colorado Bowhunters Association
Colorado Boys Ranch
Colorado Cattlemen's Association
Colorado Chapter of the Wildlife Society
Colorado Coalition of Land Trusts
Colorado Counties, Inc.
Colorado Division - Izaak Walton League
Colorado Elk Breeders Association
Colorado Elk Information Network
Colorado Environmental Coalition
Colorado Farm Bureau
Colorado Fish Health Board
Colorado Forestry Association
Colorado Grizzly Project
Colorado Hawking Club
Colorado Herpetological Society
Colorado Historical Society
Colorado Horse Council
Colorado Mountain Club
Colorado Mountain School
Colorado Mule Deer Association
Colorado Natural Areas Program
Colorado Natural Heritage Program
Colorado Off Highway Vehicle Coalition
Colorado Off-Highway Vehicle Coalition
Colorado Open Lands
Colorado Outfitters Association
Colorado Outward Bound School
Colorado Pesticide Network
Colorado Resident Hunters Equality Task Force
Colorado Ski County USA
Colorado State Muzzleloaders Association
Colorado Trappers Association
Colorado Trout Unlimited
Colorado Water Resources Research Institute

Colorado Wild
Colorado Wilderness Sports
Colorado Wildlife Alliance
Colorado Wildlife Federation
Colorado Wildlife Heritage Fund
Colorado Wildlife Heritage Fund/Owl Mountain Partners
Colorado Wool Growers
Colorado Working Landscapes
Columbine/Narcissus Road Association
Comanche Wilderness Outfitters
Compton Traditional Bow Hunters
Continental Divide Trail Alliance (CDTA)
Continental Divide Trail Society
Coors Brewing Company
Cortez Chamber of Commerce
Covenant Heights Conference Center
Craig Sports
D and D Logging and Chipping
Daily Camera
Daily Times-Call
Darryl's Taxidermy
Dave Parri's O/G Service
Daybreak Condominium Association, Inc.
Defenders of Wildlife
Denver Bass Masters
Denver Botanic Gardens
Denver Gem and Mineral Council
Denver Post
Denver Post, Northern Bureau
Devils Thumb Ranch
Diamond Trail Ranch
Dolores Chamber of Commerce
Dorothy J. Menges Trust
DTD Outfitters
Duck Creek Sporting Goods
Ducks Unlimited
Dunraven Heights Road Maintenance Association, Inc.
Duranglers, Inc.
Eagle Pharmacy, Inc.
Eagle Spirit Outfitters, LLC
Eagle View Condominiums
Eagles Landing Homeowners Assoc.
Earth Resource Investigations, Inc.
Earthjustice
Educo School of Colorado
Eldora Civic Association
Eldora Mountain Park
Elk Ridge Condominium Association
Elkhorn Plaza Lodges
Enos Mills Cabin
Environment Law Society, University of Colorado
Environmental Defense Fund
Environmental Products International, Inc.
ERO Resources Corporation
Estes Angler
Estes Park Bird Club
Estes Park Chamber Resort Association
Estes Park Gun & Archery Club
Estes Park Medical Center
Estes Park Mountain Fairways, Inc.
Estes Park Shuttle & Mountain Tours
Estes Park Trail Gazette
Estes Valley Land Trust
Estes Valley Trails Committee
Fairway Club Owners Association
Fall River Condominium Association, Inc.
Fall River Estates Community NonProfit Corporation
Fall River Estates Condominiums East Association
Fawn Valley Chalets, Inc.
Ferris Commercial Park
Figure 4 Salers
Fisheries Technology Associates, Inc.
Fishing and Hunting News
Forest Guardians
Fort Collins Coloradoan
Fort Collins Science Center
Four Seasons Trout Farm
Fox Creek Store
Friends of Animals
Front Range Anglers
Ft. Carson Rod and Gun Club
Ft. Collins Coloradoan
Ft. Collins Forum
Fund for Animals
Gardenswartz Sporting Goods
Gene Taylor's Sportsmen Supply
Giant Track Road Maintenance Association
Girl Scouts of the USA
Glen Haven Association
Glenwood Springs Post Independent

GLSE LLC
Gold Hill Town
Good Time Adventures
Goodman's Department Store
Gore Livestock, Inc.
Gorgeous Gardens Deer Proofing, LLC
Granby Chamber of Commerce
Grand Adventures, LLC
Grand County Land Conservancy
Grand Junction Sentinel
Grand Lake Area Chamber of Commerce
Grand Lake Trail Grooming, Inc.
Great Western Fly Fishing
Greenback Recovery Program
Greystone
Gunnison HPP
Hall Realty, Inc.
Henderson Mine
Hermit Lakes Recreation, Inc.
Hi Country Stables
High Drive Property Owners Association
High Lonesome Lodge
Highlands Presbyterian Camp
Highlands Unlimited, Inc.
Hill Tom Farm
Hill, Edwards, Edwards & Kinney, LLC
Hillbillies 4x4 Club
Hillcrest Meadows Homeowner's Association
Hinsdale County Combined Court
Hollowpoint Sporting Goods
Homestead Condominiums, Inc.
Hondius Water
Honholz
Howard's Sporting Goods
Hubbard Creek Outfitters
Humane Society of the United States
Hunter Services
Huro Creek Ranch
Hydro Terra Inc.
Indian Peaks Hardware
Indian Peaks Wilderness Alliance
Indian Springs Resort
International Sport Show Producers Association
Iron Horse Resort
Izaak Walton League of America
J & U Livestock, Ltd.
J.G.E. Mining, Inc.
James Creed Watershed Initiatives
James Frank Photography
James T. Ayers, Jr. P.C.
Jews of the Earth
Jim Clark Leasing
John Timothy Stone Cliff Association
Kansas City Star
KCL Guides and Outfitters
Ken Caryl Ranch Master Association
Kim Wildlife Ranching Area
King Mountain Ranch
Kings Mark Roost B&B
Kinsley Outfitters
Kirk's Flyshop
Kodak, Colorado Bowhunters
Koral Heights Property Owners Association
KUNC-FM
L. Dean Gent Company, Inc.
Lake City Ranches
Lake Meadow Condominiums, Inc.
Lake Pines Home Owners Association
Lakeshore Mobile Home Park
Lammert Associates, Inc.
Land and Water Fund
Lane Guest Ranch
Larimer County 4-Wheel Drive Club
Larkspur-Bluebell Road Association
League of Women Voters
Legacy Land Trust
Leonard Causland, Inc
Little Big Horn Lodge
Little Valley Owners Association
Liver LLC
LOBO Outfitters
Loci Media
Lockheed Martin/CO Bowhunters Association
Lone Pine Vista Condo Association
Longacre Expeditions
Longmont Times-Call
Longs Peak Mountain Guides
Lost Solar Outfitters
Loveland Academy of Fine Arts
Loveland Daily Reporter Herald
Loveland Reporter-Herald
Loveland Wildlife Association
Lurline Underbrink-Curran
M&M Outfitters

M.Y. Ranch
Making Tracks with the Forest Service
Mamm Peaks Outfitters
Mancos Trout Farm
Many Bears
Marys Lake Lodge-Hotel Owners Association, Inc.
McGraw Ranch Road Association, Inc.
McGregor Ranch
Meadow Mountain Water Supply Co.
Meadowdale Hills Property Owners Association
Meeker Park Lodge
Meeker Sportsmen's Club
Michael Fuller Architects
Mile-Hi Jeep Club
Morgan Timber Products
Moses Street Photography
Mountain Creek Home Owners Association
Mountain Golf Villas Condominium Association
Mountain Home Nutrition
Mountain Island Ranch/2V Outfitters, Ltd.
Mountain Research Station, University of Colorado
Mountain States Historical
Mountaineer Mobile Park
Muskie Inc.
National Audubon Society
National Park Gateway Stables
National Parks Conservation Association
National Parks Conservation Association - Northern Rockies Office
National Trust for Historic Preservation
National Wild Turkey Federation
National Wildlife Federation
National Wildlife Federation, Rocky Mountain Field Office
Natural Resource Consultants
Natural Resource Ecology Lab
Natural Resource Lab
Nederland Pharmacy
New England Hiking Holidays
North American Hunting Club
North American Mortgage
North End Property Owners Association
North Forty News
North Lake Condo Association
North Park Chamber of Commerce
North Shore Resort
Northern Colorado Trail Ridge
Northridge Meadow Condominium Association
Novartis Pharmaceuticals
Old Glendevey Ranch
Olympian Lane Condominium Association
Operation Game Thief- President
Parberry Fish Farm
Park Condos Association
Park County Apex
Park Entrance Estates Property Owners, Inc.
Partners For Access to the Woods
Pawnee Cooperative Grazing Association
Peabody Coal Mine
Peaceful Valley Water Association
Peak Ranch
People for the Ethical Treatment of Animals
Photos by Sandi
Pikes Peak Bass Masters
Pine Meadows Condo Association
Pinewood Springs Property Owners Association
Pingree Park Campus
Pole Hill Rode Association
Poudre Heritage Alliance
Poudre River Trust
Poudre Springs Landowners Association
Powell's Antler Division
Prairie Partners
Predator Conservation Alliance
Premiere International Corporation
Preserve Unique Magnolia Association
Progressive
Prospect Mountain Townhomes Association
Pt. Outfitter/ Mountain Agra
PTOS Boulder County
Pueblo Chemical Depot
Pueblo West Sportsmen's Association
Quarter Circle Saloon
QUICK-HIT Fish'n Products
Quinney Library
R & S Custom Rods

Rabbit Creek Ranch
Ranch Meadow Condominium Association
Ravencrest Chalet
Rawah Guest Ranch
Razor Creek Outfitters
Red Cliff Ranch
Red Feather Bowmen
Redfeather Guides and Outfitters
Reliance Tech, Inc.
Renoux Enterprises Inc.
Resort Valley Ranch
Retreat Landowners Association, Inc.
Ridgewood Condominium Association
RiverRock Townhomes
RMI Capital Management
RMNA-RMNPA Board of Directors
Rock Acres, Inc.
Rockwood Estates Home Owners Association
Rocky Mountain Adventures
Rocky Mountain Animal Defense
Rocky Mountain Bighorn Society
Rocky Mountain Bird Observatory
Rocky Mountain Elk Foundation
Rocky Mountain Forest and Range Experiment Station
Rocky Mountain National Park Associates
Rocky Mountain News
Rocky Mountain Outfitters
Rocky Mountain Park Company
Rocky Mountain Park Tours
Rocky Mountain School
Rocky Mountain Transit Management Inc.
Rocky Ridge Music Center
Rocky River Resort
Rohn Ranch
Rollin' High Sipal Ranch
Rollins Pass Restoration Association
Royal Gorge Anglers
Safari Club International
San Juan Basin HPP Committee
San Juan Outfitting, LLC
San Luis Valley Trout Unlimited
Scot's Sporting Goods
Scottsdale Ranches
Sheep Mountain Alliance
Shining Mountain Group, CMC
Shops at Riverwalk East Condominium Association
Shoreline Landing II Townhomes Association
Sierra Club
Silver Lane Stables
Silver Peaks Enterprises
Sinapu
Sky Hi News
Sky Ranch Lutheran Camp
Skyline Brittany Club
Skyline Hunting and Fishing
Slaven's True Value Hardware
Snake River Outfitters
Southeast Colorado Game & Fish Club
Southfork Riding Stables & Outfitters, Inc.
Space Imaging
Split Fire Sporting Goods
Stan Miller Inc.
Stanley Heights Home Owners Association, Inc.
Stanley Hills Subdivision
Summerset on Fall River
Summit Guides
Sundance Cottages Condominiums Association, Inc.
Sunnyside Farms
Sylvan Dale Ranch
T & D Outfitters
T.E.Y Edelweiss
Table Mountain Properties
Tahosa Valley Landowners Assoc.
Tamarack Camps and Fresh Air Society
The American Alpine Club
The Conservation Fund
The Crabtree Company
The Eye of the Beholder Photography Workshops
The Fishing Hole
The Idea Company
The Keystone Center
The Livery LLC
The Mountain Ear
The Nature Conservancy
The Perfect Portrait
The Ranch
The Reserve
The Road Less Traveled
The Trust for Public Land

The Uplands at Fish Creek, P.U.D.
The Wilderness Society
The Wilderness Society, Denver Office
The World Outdoors
Thorne Ecological Institute
Three Lakes Watershed
Thunder Mountain Homeowners Association
Thunder River Trading Post, Inc.
Timberline Archery
Timberline Group
Timberline Medical, P.C.
Timberline Sporting Goods
Trail Ridge Marina
Trailhead Wilderness School
TrenMart Cattle Company
Tribune
Tri-State G&T
Trophy Fish Ranch
Trout Trips
Trout Unlimited
Troutlodge Inc.
Turning Point of the Rockies
Two Park
URS
Ute Mountain Farm & Ranch Enterprise
Utterback Ranch
Valley Country Tackle
Venner Ranch Estates Property Owners Association
Waltonia Owners Association
Waltonia Road Association
Water Association of the Rockies
Water Supply and Storage Company
Weigel Construction Inc.
Weldon Lee's Rocky Mountain Photo Adventures
West Tahosa Park Property Owners Association
Western Land Exchange Project
Western Native Trout Company
Western Recreation Industries Inc.
Western Resource Advocates
Westview Homeowners Association
Wild Basin Lodge
Wild Basin Outfitters
Wild Turkey Federation
Wilderness Education Institute
Wilderness Watch
Wildlife 2000
Wildlife Expressions
Wildlife Management Institute
Wildlife Property Management, LLC
Williams Peak Ranch
Wind River Ranch
Windcliff Property Owners Association
Windhover Ranch
Winding River Resort
Winter Park Association
Winter Park Recreational Association
Winter Park/Fraser Valley Chamber of Commerce
Winter Wildlands Alliance
Winterhawk Outfitter
Wits End Guest Ranch
Women's Wilderness Institute
Working with Artists
Wright & Mcgill Co/ Eagle Claw
Yampa Valley Fly Fishers
YMCA of the Rockies
Young Life Wilderness Ranch

References

This page intentionally left blank

REFERENCES

Adams, E.

2003 Interview with Eric Adams, Executive Director, MacGregor Ranch, by Harvey Economics, November.

Alstad, K.P., J.M. Welker, S.A. Williams, and M.J. Trlica.

1999 Carbon and water relations of *Salix monticola* in response to winter browsing and changes in surface water hydrology: an isotopic study using $\delta^{13}C$ and $\delta^{18}O$. *Oecologia* 120:375-385.

Altmann, M.

1956 Patterns of herd behavior in free-ranging elk of Wyoming, *Cervus canadensis nelsoni*. *Zoologica* 41:116-143.

American Veterinary Medical Association (AVMA)

2001 Report of the AVMA panel on euthanasia. *Journal of the American Veterinary Association* 218: 669-696.

Andrew, R., and R. Righter

1992 *Colorado Birds: A Reference to Their Distribution and Habitat*. Denver, CO: Denver Museum of Natural History.

Animal Plant and Health Inspection Service (APHIS)

2005 GonaCon – birth control for deer: questions and answers. September 2005. Wildlife Services Division. Accessed on the Internet at http://www.aphis.usda.gov/lpa/pubs/fsheet_faq_notice/faq_wsgonacondeer.html.

Apt, A.

2001 *Snowshoe Routes: Colorado's Front Range*. Mountaineer Books.

Armstrong, D.

1987 *Rocky Mountain Mammals: A Handbook of Mammals of Rocky Mountain National Park and Vicinity*. Colorado Associated University Press, in cooperation with Rocky Mountain Nature Association.

Augustine, D.J., and S.J. McNaughton

1998 Ungulate effects on the functional species composition of plant communities: herbivore selectivity and plant tolerance. *Journal of Wildlife Management* 62: 1165-1183.

Bagdonis, C.R.

1971 *Differentiation of Western Wood Frogs*. Ph.D. diss., Colorado State University, Fort Collins.

Baker, B.W.

2005 Personal communication between B.W. Baker, U.S. Geological Survey, and Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park.

Baker, B.W., and B.S. Cade
1995 Predicting biomass of beaver food from willow stem diameters. *Journal of Range Management* 48:322-326.

Baker, B.W., D. Cooper, C. Westbrook, K. Czarnowski, T. Johnson, and R. Monello
2005 *Declining Beaver Populations in Rocky Mountain National Park*. Final report to the National Park Service. NRPP 99-04 (ROMO).

Baker, B.W., H.C. Ducharme, D.C.S. Mitchell, T.R. Stanley, and H.R. Peinetti
2003 Interaction of beaver and elk herbivory reduces standing crop of willow. *Ecological Applications* 15: 110-118.

Baker, B.W., D.L. Hawksworth, and J.G. Graham
1992 Wildlife habitat response to riparian restoration on the Douglas Creek watershed. *Proceedings of the Annual Conference of the Colorado Riparian Association* 4:62-80.

Baker, B.W., and E.P. Hill
2003 Beaver (*Castor canadensis*). In *Wild Mammals of North America: Biology, Management, and Conservation*, edited by G.A. Feldhamer, B.C. Thompson, and J.A. Chapman, 288-310. Baltimore, MD: the Johns Hopkins University Press.

Baker, D.L.
2004 Personal communication between Dan Baker, Colorado Division of Wildlife, and Carlie Ronca, Rocky Mountain National Park, National Park Service, July.

Baker, D.L., M.A. Wild, M.M. Conner, H.B. Ravivarapu, R.L. Dunn, and T.M. Nett
2002 Effects of GnRH agonist (Leuprolide) on reproduction and behavior in female wapiti (*Cervus elaphus nelsoni*). *Reproduction Supplement* 60:155-167.

Baker, W.L., J.A. Munroe, and A.E. Hessel
1997 The effects of elk on aspen in the winter range of Rocky Mountain National Park. *Ecography* 20:155-165.

Ballard, W.B., J.S. Whitman, and C.L. Gardner
1987 Ecology of an exploited wolf population in south-central Alaska. *Wildlife Monographs* 98.

Baron, J.S., D.S. Ojima, E.A. Holland, and W.J. Parton
1994 Analysis of nitrogen saturation potential in Rocky Mountain tundra and forest: implications for aquatic systems. *Biogeochemistry* 27: 61-82.

Baron, J.S., H.M. Rueth, A.N. Wolfe, K.R. Nydick, E.J. Allstott, J.T. Minear, and B. Moraska
2000 Ecosystem responses to nitrogen deposition in the Colorado Front Range. *Ecosystems* 3: 352-368.

Barrett, N.B.
1998 Sandhill crane. In *Colorado breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife,* edited by H. E. Kingery. Denver, CO.

Bartos, D.L.
2001 Landscape dynamics of aspen and conifer forests. In *Sustaining Aspen in Western Landscapes: Symposium Proceedings*, edited by W.D. Shepperd, D. Binkley, D.L. Bartos, T.J. Stohlgren, and L.G. Eskew, 5-14. RMRS-P-18. Fort Collins, CO: Rocky Mountain Research Station.

BBC Research and Consulting

2004 *The Economic Impacts of Hunting, Fishing, and Wildlife Watching in Colorado*.

Bear, G.D.

1989 Seasonal distribution and population characteristics of elk in Estes Valley, Colorado. *Colorado Division of Wildlife Special Report No. 65*.

Beck, Michael

2006 Personal communication between Michael Beck, farm manager, and Harvey Economics staff, March 22.

Becker, S.E. and L.S. Katz

1993 Gonadotropin-releasing hormone (GnRH) analogs of active immunization against GnRH to control fertility in wildlife. Paper presented at the Contraception in Wildlife Management Symposium, October 26-28, Denver, Colorado. Accessed on the Internet at http://www.aphis.usda.gov/ws/nwrc/symposia/contraception/index.html.

Beidleman, L.H., R. Beidleman, and B. Willard

2000 *Plants of Rocky Mountain National Park*. Rocky Mountain Nature Association and Falcon Publishing, Inc.

Belay, E.D., R.A. Maddox, E.S. Williams, M.W. Miller, P. Gambetti, and L.B. Schonberger

2004 Chronic wasting disease and potential transmission to humans. Centers for Disease Control and Prevention, Department of Health and Human Services. Accessed on the Internet at http://www.cdc.gov/ncidod/EID/vol10no6/03-1082.htm.

Bender, L.C., and J.G. Cook

2002 *Condition and Health of Elk (Cervus elaphus nelsonii) in Rocky Mountain National Park with Reference to Elk-Carrying Capacity Relations*. Final report for Rocky Mountain National Park prepared by USGS, New Mexico Cooperative Fish and Wildlife Research Unit.

Benedict, J.B.

1996 *The Game Drives of Rocky Mountain National Park*. Center for Mountain Archeology Research Report No. 7.

Bergerud, A.T., W. Wyett, and J.B. Snider

1983 The role of wolf predation in limiting a moose population. *Journal of Wildlife Management* 47:977-988.

Berris, C.R.

1987 Interactions of elk and residential development: planning, design and attitudinal considerations. *Landscape Journal* 6:31-41.

Betkowski, B.

2004 No penalty for high-sticking elk in Banff. University of Alberta Faculty of Science. Accessed on the Internet at http://www.science.ualberta.ca/nav02.cfm?nav02=32594&nav01=11471.

Bilbrough, C.J., and J.H. Richards

1993 Growth of sagebrush and bitterbrush following simulated winter browsing: mechanisms of tolerance. *Ecology* 74:481-492.

Binkley, D., F. Singer, M. Kaye, and R. Rochelle
2003 Influence of elk grazing on soil properties in Rocky Mountain National Park. *Forest Ecology and Management* 185:239-247.

Blaisdell, J.P., and W.F. Mueggler
1956 Sprouting of bitterbrush (*Purshia tridentata*) following burning or top removal. *Ecology* 37:365-377.

Blett, T. and K. Morris
2004 *Nitrogen Deposition: Issues and Effects in Rocky Mountain National Park.* Technical Background Document. Accessed on the Internet at http://www.cdphe.state.co.us/ap/rmnp/noxtech.pdf.

Boutin, S.
1992 Predation and moose population dynamics: a critique. *Journal of Wildlife Management*. 56:116-127.

Bowles, A.E.
1995 Responses of wildlife to noise. In *Wildlife and Recreation: Coexistence Through Management and Research,* edited by R. L. Knight and K. J. Gutzwiller. Washington D.C.: Island Press.

Boyce, M.S.
1993 Predicting the consequences of wolf recovery to ungulates in Yellowstone National Park. In *Ecological Issues on Reintroducing Wolves into Yellowstone National Park*, edited by R.S. Cook, 234-269. National Park Service Scientific Monographs 92/22.

Bradford, J., and Hobbs, N.T
2006 Analysis of options for elk population management in Rocky Mountain National Park – results of additional scenarios. Report to the National Park Service. On file at Rocky Mountain National Park, Estes Park, CO.

Brand, C.J., L.B. Keith, and C.A. Fischer
1976 Lynx responses to changing snowshoe hare densities in central Alberta. *Journal of Wildlife Management*. 40:416-428.

Braun, C.E., D.R. Stevens, K.M. Giesen, and C.P. Melcher
1991 Elk, white-tailed ptarmigan, and willow relationships: a management dilemma in Rocky Mountain National Park. *Transactions of the North American Wildlife Conference.* 56:74-85.

Bray, R.
2004 Personal communication among Rich Bray and Therese Johnson and Carlie Ronca, Rocky Mountain National Park.

Bryant, J.P., F.S. Chapin, III, and D.R. Klein
1983 Carbon/nutrient balance of boreal plants in relation to vertebrate herbivory. *Oikos* 40:357-368.

Buchholtz, C.W.
1983 *Rocky Mountain National Park: a History*. Boulder, CO: Colorado Associated University Press.

Bulkley, R.V.
1959 *Report on 1958 Fishery Studies in Rocky Mountain National Park*. Logan, UT: Bureau of Sport Fisheries and Wildlife.

Bunting, S.C., L.F. Neuenschwander, and G.E. Gruell
1985 Fire ecology of antelope bitterbrush in the northern Rocky Mountains. In *Fire's Effects on Wildlife Habitat: Symposium Proceedings*, edited by J.E. Lotan and J.K. Brown, 48-57. USDA Forest Service General Technical Report INT-186. Ogden, UT: Intermountain Research Station.

Burns, D.A.
2003 Atmospheric nitrogen deposition in the Rocky Mountains of Colorado and Southern Wyoming - A review and new analysis of past study results. *Atmospheric Environment* 37: 921-932.

Butler, W.
2003 Personal communication between William Butler, Rocky Mountain National Park, and Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, August 8.
2005 Personal communication via telephone between William Butler, Rocky Mountain National Park, and Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, August 8.

Buttery, R.
1955 *Range Conditions and Trends Resulting from Winter Concentrations of Elk in Rocky Mountain National Park, Colorado*. M.S. thesis, Colorado State University, Fort Collins.

Capp, J.C.
1967 *Competition among Bighorn Sheep, Elk and Deer in Rocky Mountain National Park, Colorado*. M.S. thesis, Colorado State University, Fort Collins.
1968 *Bighorn Sheep, Elk, and Mule Deer Range Relationships: A Review of the Literature*. Report to the Rocky Mountain Nature Association.

Carroll, C., R F. Noss, and P.C. Paquet
1999 *Carnivores as Focal Species for Conservation Planning in the Rocky Mountain Region*. Phase 1 report in the Carnivore Conservation in the Rocky Mountains project. World Wildlife Fund Canada. Accessed on the Internet at http://www.wwf.ca/NewsAndFacts/Supplemental/focalspeciesreport-textonly.pdf.

Carroll, C., M.K. Phillips, N.H. Schumaker, and D.W. Smith
2003 Impacts on landscape change on wolf restoration success: planning a reintroduction program based on static and dynamic spatial models. *Conservation Biology* 17:536-548.

Chemical Safety Associates, Inc.
2000 Leuprolide acetate injection material safety data sheet. Prepared for GensiaSicor Pharmaceuticals. Accessed on the Internet at http://www.sicor.com/products/fdp/msds/leup-msd.pdf.

Clarke, J.A., C.E. Olmsted, and K. Larkins
1994 *Patterns of Habitat Use, Movement, and Distribution of Elk Adjacent to the Eastern Boundary of Rocky Mountain National Park*. Report to the National Park Service.

Clements, F.E.
1910 *The Life History of Lodgepole Burn Forests*. USDA Forest Service Bulletin 79. Washington, DC: Government Printing Office.

Clements, C.D., and J.A. Young
1996 Influence of rodent predation on antelope bitterbrush seedlings. *Journal of Range Management* 49:31-34.

Cole, G.F.
1971 An ecological rationale for the natural or artificial regulation of native ungulates in parks. *Transactions of the North American Wildlife Conference.* 36:417-425.

Colorado Department of Labor and Employment
2004 Colorado ES202 wage and employment tables.

Colorado Department of Local Affairs
2002 Municipal budgets, 2002. Accessed on the Internet at http://www,dola.state.co.us/LGS/TA/compendium.htm.

2005 Population and housing estimates for 2003. Accessed on the Internet at http://www.dola.state.co.us, July 2005.

Colorado Department of Natural Resources (CDNR)

2005 Hunter harvested moose tests positive for CWD. Press release. Accessed on the Internet at http://dnr.state.co.us/news/press.asp?pressid=3645

Colorado Department of Transportation (CDOT)

2004 Traffic accidents in Estes Park, Colorado, 1993 through 2002.

2005 Annual average daily traffic (AADT) volumes for Highway 036B in 2004. Accessed on the Internet at http://www.dot.state.co.us/App_DTD_DataAccess/Traffic/index.cfm?fuseaction=TrafficMain&MenuType=Traffic, July 2005.

Colorado Division of Public Health and the Environment (CDPHE)

2005 Rocky Mountain National Park air quality initiatives, regulatory and non-regulatory. Accessed on the Internet at http://www.cdphe.state.co.us/ap/rmnp/policyoptions.pdf.

Colorado Division of Water Resources (CDWR)
n.d. Water rights terminology. Accessed on the Internet at http://water.state.co.us/wateradmin/terms.asp

Colorado Division of Wildlife (CDOW)
n.d Total licensing. Accessed on the Internet at http://wildlife.state.co.us/ShopDOW/AppsAndLicenses/.

1999 Declining mule deer populations in Colorado: reasons and responses. A report to the Colorado Legislature.

2003a Chronic wasting disease. Accessed on the Internet at http://wildlife.state.co.us/CWD/index.asp.

2003b Guidelines for response to gray wolf reports in Colorado. May 2003. Accessed on the Internet at http://www2.merid.org/graywolf/docs/graywolfguidelines.pdf

2003c Prevalence and distribution of chronic wasting disease in Colorado, 2002-2003. Accessed on the Internet at http://wildlife.state.co.us/CWD/pdf/PrevalenceSummary8-031.pdf

2004 Prevalence and distribution of chronic wasting disease in Colorado, 2003-2004. Accessed on the Internet at http://wildlife.state.co.us/CWD/pdf/PrevalenceSummary_9-14-04.pdf.

2005a 2004 elk harvest, hunters, and recreation days for all manners of take. Accessed on the Internet at http://wildlife.state.co.us/huntrecap/04harveststatistics/Elk.pdf.

2005b Big game hunting recap summaries and harvest survey statistics. Accessed on the Internet at http://wildlife.state.co.us/huntrecap/

Colorado State Forest Service

n.d. Prescribed fire in Colorado. Accessed on the Internet at http://lamar.colostate.edu/~montrose/rxfire.htm.

Colorado Wolf Management Working Group (CWMWG)

2002 *Findings and Recommendations for Managing Wolves that Migrate into Colorado*. Report commissioned by the Colorado Division of Wildlife. Accessed on the Internet at http://wildlife.state.co.us/species%5Fcons/GrayWolf/workinggroup/recomendations.pdf

2004 *Findings and Recommendations for Managing Wolves that Migrate into Colorado*. December 28, 2004. Accessed on the Internet at http://www2.merid.org/graywolf/comments.php.

Condon, D.D.

1943 *Recommendations and an outline for the management of the elk and deer population in Rocky Mountain National Park*. National Park Service Report.

Connor, J.

1993 *Neotropical Migrant Bird Survey for Rocky Mountain National Park*. Rocky Mountain National Park Resource Management Series #17.

2005 Personal communication between Jeff Connor, NPS biologist and Rocky Mountain National Park staff and Parsons staff during the Preferred Alternative Workshop, September 21-23.

Cooper, D.J.

2001 Email to Ryan Monello, Biologist, Rocky Mountain National Park from D.J. Cooper.

2003 Personal communication between D.J. Cooper and Ryan Monello,

Cooper, D.J., J. Dickens, and E. Gage

2003 *Constraints on, and Opportunities for, Riparian Willow Establishment, Rocky Mountain National Park, Colorado*. Report to the National Park Service.

Cooper, D.J., and C. Westbrook

2005 Personal communication among D.J. Cooper, C. Westbrook, and Rocky Mountain National Park staff, November 30.

Cooper, D.J., S.W. Woods, R.A. Chimner, and L.H. MacDonald

2000 *Effects of the Grand Ditch on wetlands of the Kawuneeche Valley, Rocky Mountain National Park, Colorado*. Report to the National Park Service.

Copeland, J.P.

1996 *Biology of the Wolverine in Central Idaho*. M.S. Thesis. University of Idaho, Moscow, ID.

Cordova, K.P.

2000a *Park Visitors' Beliefs, Attitudes and Preferences for Elk Management at Rocky Mountain National Park, Colorado*. Fort Collins, CO: Colorado State University.

2000b *Preliminary Results of Park Visitor Survey Regarding Elk Management in Rocky Mountain National Park, Colorado: Park Visitor's Attitudes and Preferences for Elk Management at Rocky Mountain National Park*. Fort Collins, CO: Colorado State University.

Corn, P. S., Jennings, M. L., and E. L. Muths

1997 Survey and assessment of amphibian populations in Rocky Mountain National Park. *Northwest Naturalist* 78:34-55.

Cottrell, T.R.

1993 *The Comparative Ecology of* Salix planifolia *and* Salix monticola *in Rocky Mountain National Park*. Ph.D., diss., Colorado State University, Fort Collins.

1995 Willow colonization of Rocky Mountain mires. *Canadian Journal of Forest Research* 25:215-222.

Coughenour, M.B.

1991 Biomass and nitrogen responses to grazing of upland steppe on Yellowstone's northern winter range. *Journal of Applied Ecology*. 28:71-82.

2002 *Elk in the Rocky Mountain National Park Ecosystem – A Model-based Assessment*. Final report to USGS Biological Resources Division and U.S. National Park Service. August 2002.

Coughenour, M.B., D. M. Swift, K.A. Galvin, and J.E. Ellis

2002 *Savanna – Landscape and Regional Ecosystem Model*. General Model Information. Accessed on the Internet at: http://eco.wiz.uni-kassel.de/model_db/mdb/savanna.html.

Council on Environmental Quality (CEQ)

1978 Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act. Code of Federal Regulations Title 40, Parts 1500–1508. Washington, D.C.

Crabtree, R.L., and J.W. Sheldon

1999 Coyotes and canid coexistence in Yellowstone. In *Carnivores in Ecosystems: the Yellowstone Experience*, edited by T.W. Clark, A.P. Curlee, S.C. Minta, and P.M. Kareiva, 127-164. Yale University Press, New Haven.

Creel, S., J.E. Fox, A. Hardy, J. Sands, B. Garrott, and R.O. Peterson

2002 Snowmobile activity and glucocorticoid stress responses in wolves and elk. *Conservation Biology* 16:809-814.

Creel, S., and J. Winnie

2005 Responses of elk herd size to fine-scale spatial and temporal variation in the risk of predation by wolves. *Animal Behaviour* 69:1181-1189. Accessed on the Internet at http://www.montana.edu/wwwbi/staff/creel/creel.html.

Daubenmire, R.F.

1943 Vegetational zonation in the Rocky Mountains. *Botanical Review* 9:325-393.

Daubenmire, R.F., and J.B. Daubenmire

1968 *Forest Vegetation of Eastern Washington and Northern Idaho.* Technical Bulletin 60. Pullman, WA: Washington State University Agricultural Experiment Station.

DeGregorio, M.
2005 Personal communication between Mark DeGregorio, Education Program Specialist, Rocky Mountain National Park and Janice Biletnikoff, Parsons, Denver, February 11.

Dekker, D.G.
1997 *Wolves of the Rocky Mountains from Jasper to Yellowstone*. Blaine: Hancock House.

Denney, R.N., R.J. Boyd, E. Bucknall, W. Schuett, P.F. Gilbert, J. Cooney, L.D. Hibbs, G.D. Bear, and R.B. Gill
1967 *Research Project Segment: Elk Seasonal Movements, Rocky Mountain National Park*. Job Completion Report (State of Colorado).

DeSimone, R., J. Vore, and T. Carlsen
1993 Older bulls — who needs them? In *Proceedings, 1993 Western States and Provinces Elk Workshop*, edited by J.D. Cada, J.G. Petersen, and T.N. Lonner, 29–34. Helena: Montana Department of Fish, Wildlife and Parks.

Dixon, J.S.
1939 *Special Report on the Elk Problem at Rocky Mountain National Park*. Report to the National Park Service.

Dobkin, D.S., F.J. Singer, and W.S. Platts
2002 *Ecological Condition and Avian Response in Willow, Aspen, and Cottonwood Communities of the National Elk Refuge, Jackson, Wyoming*. Final report by High Desert Ecological Research Institute.

Doerr, M.L., J.B. McAninch, and E.P. Wiggers
2001 Comparison of four methods to reduce white-tailed deer abundance in an urban community. Wildlife Society Bulletin. 29:1105-1113.

Duberstein, J.N.
2001 *The Effects of Elk on Nest Site Selection in Cavity-nesting Birds in Rocky Mountain National Park*. Report to the National Park Service.

Dudzinski, M.
2003 Interview of Mike Dudzinski, owner of Home and Garden Center, Estes Park, with Andrew Fritsch, Harvey Economics, December.

Duffield, J.W., and Neher, C.J.
2004 *Economics of Wolf Recovery in Yellowstone National Park*.

Dungan, J.
2005 Electronic mail message from Jason Dungan to Ryan Monello, December 2005.

Ehle, D.S.
2001 *Spatial and Temporal Patterns of Disturbance and Ponderosa Pine Forest Structure in Rocky Mountain National Park*. M.S. thesis, University of Wyoming, Laramie.

Eismann, J.
2005 Personal communication between John Eismann, Animal and Plant and Health Inspection Service and Timberley Belish, Parsons, Denver, February 5.

Elliott, K.J., and J.M. Vose
2005 Initial effects of prescribed fire on quality of soil solution and streamwater in the southern Appalachian mountains. *Southern Journal of Applied Forestry* 29: 5-15.

Elverum, C.

n.d. Elk/human conflicts in Banff National Park. Parks Canada, Alberta Regional Office. Calgary, Canada. Accessed on the Internet at http://www.rr2.ualberta.ca/Wildlife_Impacts/banff/elkpeo.htm.

Environmental Protection Agency (EPA)

1996 Draft Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. Washington, D.C.: U.S. Environmental Protection Agency.

Ernst, C.P.

n.d. How do you stop a charging elk? Banff National Park. Accessed on the Internet at http://www.pc.gc.ca/canada/pn-tfn/itm2-/2004/2004-05-10_E.asp.

Estes, M.

1939 The memoirs of Estes Park. Reprint of article in *Colorado Magazine* from 1939.

Feagans, T.

2005 Interview with Tracy Feagans, Administrative Assistant to Assistant Town Administrator, Town of Estes Park, by Harvey Economics, July.

Federal Aviation Administration (FAA)

2005 Special federal aviation regulation. Accessed on the Internet at http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgFAR.nsf/0/A3FB83C004F5EA2C86256C7900621394?OpenDocument.

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong

1994 *Mammals of Colorado*. Boulder, CO: Denver Museum of Natural History/University Press of Colorado.

Fix, P.J., S.C. Stewart, and M.J. Manfredo

2004 *Preferences for Elk and Vegetation Management in RMNP: Summary of Key Results*. Colorado State University, Human Dimensions in Natural Resources Unit.

Fleischner, T.L.

1994 Ecological costs of livestock grazing in western North America. C*onservation Biology* 8:629-644.

Forchhammer, M.C., N.C. Stenseth, E. Post, and R. Langvatn

1998 Population dynamics of Norwegian red deer: density-dependence and climatic variation. *Proceedings of the Royal Society of London* 265:341-350.

Forsyth, D.M., and G.J. Hickling

1998 Increasing Himalayan tahr and decreasing chamois densities in the eastern Southern Alps, New Zealand: evidence for interspecific competition. *Oecologia* 113:377-382.

Fortin, D., L.B. Hawthorne, M.S. Boyce, D.W. Smith, T. Duchesne, and J.S. Mao.

2005 Wolves influence elk movements: Behavior shapes a trophic cascade in Yellowstone National Park. *Ecology* 86:1320-1330.

Frank, D.A., and S.J. McNaughton

1993 Evidence for the promotion of aboveground grassland production by large herbivores in Yellowstone National Park. *Oecologia* 96:157-161.

Free Hearing Test
n.d. Gunfire sound levels. Accessed on the Internet at http://www.freehearingtest.com/hia_gunfirenoise.shtml

Frost, H.C., G.L. Storm, M.J. Batcheller, and M.J. Lovallo
1997 White-tailed deer management at Gettysburg National Military Park and Eisenhower National Historic Site. *Wildlife Society Bulletin* 25:462–469.

Gage, G. and Cooper, D.J.
2003 Chapter 5: Survival of rooted and unrooted willow stem cuttings, moraine and horseshoe parks, Rocky Mountain National Park, Colorado. In *Constraints on, and Opportunities for, Riparian Willow Establishment, Rocky Mountain National Park*, edited by Cooper, D.J., J. Dickens, and E. Gage. Report to the National Park Service.

Garton, E.O., R.L. Crabtree, B.B. Ackerman, and G. Wright
1990 The potential impact of a reintroduced wolf population on the northern Yellowstone elk population. In *Wolves for Yellowstone? A Report to the United States Congress, Vol. 2, Research and Analysis*, edited by J.D. Varley and W.G. Brewster, 3-59 – 3-91. National Park Service: Yellowstone National Park.

Gasaway, W.C., Boertje, R.D., Grangaard, D.V., Kellyhouse, D.G.,Stephenson, R.O. & Larsen, D.G.
1992 The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. *Wildlife Monograph* 120,:1-59.

Gehring, C.A., and T.G. Whitman
2002 Mycorrhizae-herbivore interactions: population and community consequences. In *Ecological Studies, Volume 157: Mycorrhizal Ecology*, edited by M.G.A. van der Heijden and I. Sanders. Berlin: Springer-Verlag.

Geist, V.
1978 Behavior. In *Big Game of North America, Ecology and Management*, edited by J.L. Schmidt and D.L. Gilbert. Harrisburg, PA.: Stackpole Books.

1982 Adaptive behavioral strategies. In *Elk of North America: Ecology and Management*, edited by Jack Ward Thomas and D.E. Toweill, 219-278. Harrisburg: Stackpole Books.

2002 Adaptive behavioral strategies. In *North American Elk: Ecology and Management*, compiled and edited by D.E. Toweill and J.W. Thomas, 389-433. Washington DC: Smithsonian Institution Press.

Gengler, S.
2005 Interview with Stan Gengler, EVRPD manager, by Andy Fritsch of Harvey Associates, 2005.

George, J.
2003 Personal communication between Janet George, and Therese Johnson, Rocky Mountain National Park, Denver, Colorado.

Gese, E.M., and S. Grothe
1995 Analysis of coyote predation on deer and elk during winter in Yellowstone National Park, Wyoming. *American Midland Naturalist.* 133:36-43.

Gill, K.
2004 Keep your distance from elk this time of year. *The Jasper Booster*. September 15.

Goodson, N.J.
1978 *Status of Bighorn Sheep in Rocky Mountain National Park.* M.S. thesis, Colorado State University, Fort Collins.

Gramann, J.H.
2002 *The Role of Crowding in Visitor Displacement at Mount Rainier and Olympic National Parks*. Washington, DC: National Park Service.

Grandin, T.
1999 Safe handling of large animals (cattle and horses). *Occupational Medicine*: *State of the Art Reviews* 14. Accessed on the Internet at http://www.grandin.com/references/safe.html.

Grater, R.K.
1945 *Report on the Elk-deer Reduction Program of 1944-1945 at Rocky Mountain National Park*. National Park Service Report.

Gray, J.A.
1943 Rodent populations in the sagebrush desert of the Yakima Valley, Washington. *Journal of Mammalogy*. 24:191-193.

Griggs, R.F.
1956 Competition and succession on a Rocky Mountain fellfield. *Ecology* 37:8-20.

Gross, J.E., and M.W. Miller
2001 Chronic wasting disease in mule deer: a model of disease dynamics, control options, and population consequences. *Journal of Wildlife Management*. 65:205-215.

Gude, J., and B. Garrot
2003 *Lower Madison Valley Wolf-Ungulate Research Project*. 2002-2003 Annual Report. Bozeman, MT: Montana State University.

Gurnell, A.M.
1998 The hydrogeomorphological effects of beaver dam-building activity. *Progress in Physical Geography* 22: 167-198.

Guse, N.G., Jr.
1966 *Administrative History of an Elk Herd*. M.S. thesis, Colorado State University, Fort Collins.

Gysel, L.W.
1960 An ecological study of the winter range of elk and mule deer in the Rocky Mountain National Park. *Journal of Forestry* 58:696-703.

Haight, R.G., and L.D. Mech
1997 Evaluating vasectomy as a means of wolf control. *Journal of Wildlife Management* 61:1023-1031

Hammerson, G.A.
1999 *Amphibians and Reptiles in Colorado*. Niwot, CO: University Press of Colorado.

Hannon, J.
2005 Interview with John Hannon, Supervisory Management Specialist, Business Program, NPS, by Harvey Associates, July.

Hansen, L., and J. Beringer
1997 Managed hunts to control white-tailed deer populations on urban public areas in Missouri. *Wildlife Society Bulletin* 25: 448–447.

Harrington, F.A.
1978 *Ecological Segregation of Ungulates in Alpine and Subalpine Communities*. Ph.D. diss., Colorado State University, Fort Collins.

Harris, Miller, Miller, and Hanson, Inc.
1998 *Results of Phase I, Task Order Number One, Sound Monitoring Results – September 1998 Field Work*. Report to Rocky Mountain National Park.

2001 Status on the I-Ince initiative on recreational noise and progress on quantifying noise intrusions in parks. *Noise Conference 2001*. October 29-31. Portland, Maine. Accessed on the Internet at http://www.hmmh.com/presentations/nc01-061.pdf.

Harvey Economics
2005 *Summary: Elk and Vegetation Management EIS, Stakeholder Interview Results*, working paper, July.

Hebblewhite, M.
2000 *Wolf and Elk Predator-Prey Dynamics in Banff National Park*. M.S. thesis, University of Montana, Missoula. On file at Rocky Mountain National Park, Estes Park, CO.

Hebbelwhite, M., D.H. Pletscher, and P.C. Paquet
2002 Elk population dynamics following wolf recolonization of the bow valley of Banff National Park. *Research Links* 11: 10-12.

Hebblewhite, M., C.A. White, C.G. Nietvelt, J.A. McKenzie, T.E. Hurd, J.M. Fryxell, S.E. Bayley, and P.C. Paquet
2005 Human activity mediates a trophic cascade caused by wolves. *Ecology* 86:2135-2144.

Herreman, J., and M. Ben-David
2001 Population survey for river otters in Rocky Mountain National Park. Accessed on the Internet at http://www.otternet.com/ROA/rockymtnsurvey.htm.

Hess, K., Jr.
1991 *Description and Evaluation of Cover Types in the Rocky Mountain National Park*. Unpublished report to the National Park Service.
1993 *Rocky Times in Rocky Mountain National Park*. University Press of Colorado, Niwot.

Hinds, T.E.
1985 Diseases. In *Aspen: Ecology and Management in the Western United States*, edited by N.V. DeByle and R.P. Winokur, 87-106. USDA Forest Service General Technical Report RM-119. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Hobbs, N.T.
2005 Personal communication between N Hobbs and Therese Johnson, Rocky Mountain National Park, December.

Hobbs, N.T., D.L. Baker, G.D. Bear, and D.C. Bowden

1996a Ungulate grazing in sagebrush grassland: mechanisms of resource competition. *Ecological Applications* 6:200-217

1996b Ungulate grazing in sagebrush grassland: effects of resource competition on secondary production. *Ecological Applications* 6:218-227.

Hobbs, N.T., D.L. Baker, J.E. Ellis, and D.M. Swift

1981 Composition and quality of elk winter diets in Colorado. *Journal of Wildlife Management* 45:156-171.

Hobbs, N.T., D.L. Baker, J.E. Ellis, D.M. Swift, and R.A. Green

1982 Energy- and nitrogen-based estimates of elk winter-range carrying capacity. *Journal of Wildlife Management* 46:12-21.

Hobbs, N.T., and Bradford, J.

2003 Analysis of options for elk population management in Rocky Mountain National Park. Final report to the National Park Service. On file at the park.

Holien, K.

2005a Email from Kris Holien, Communications Officer, Rocky Mountain National Park, to Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, April 8.

2005b Email from Kris Holien, Communications Officer, Rocky Mountain National Park, to Scott Lowry, Parsons, Denver, August 20.

2005c Email from Kris Holien, Communications Officer, Rocky Mountain National Park, to Scott Lowry, Parsons, Denver, August 31.

Hornocker, M.G.

1970 An analysis of mountain lion predation upon mule deer and elk in the Idaho primitive area. *Wildlife Monographs* No. 21.

Houston, D.B.

1982 *The Northern Yellowstone Elk*. New York: Macmillan Publishing Co.

Huff, D.E., and J.D. Varley

1999 Natural regulation in Yellowstone National Park's Northern Range. *Ecological Applications*. 9:17-29.

Hunter, D.O.

2005 Email from Don O. Hunter, Wildlife Biologist, USGS Fort Collins Science Center, to Don Kellett, Parsons, Denver, October 19.

International Wolf Center

1999 Survey shows Minnesotans' attitudes about wolves. Accessed on the Internet at http://www.wolf.org/wolves/learn/intermed/inter_human /survey_shows.asp.

2002 Living with wolves: tips for avoiding conflicts. *Wolves and Humans*. Accessed on the Internet at http://www.wolf.org/wolves/learn/basic/pdf/wh_avoiding%20_conflict.pdf.

2003 Too close for comfort: the problem of habituated wolves. *Wolves and Humans*. Accessed on the Internet at http://www.wolf.org/wolves/learn/basic/pdf/wh_close_for_comfort.pdf.

Irwin, L.L.
2002 Migration. In *North American Elk: Ecology and Management*, edited by D. E. Toweill and J. W. Thomas. Smithsonian Institution Press, Washington D.C.

Ives, R.L.
1942 The beaver meadow complex. *Journal of Geomorphology* 5:191-203.

Jarrett, R.D., and J.E. Costa
1993 Hydrology and geomorphology of the 1982 Lawn Lake dam failure, Colorado. In *Ecological effects of the Lawn Lake Flood of 1982, Rocky Mountain National Park*, edited by H. E. McCutchen, R. Herrmann, and D. R. Stevens, 1-17. Scientific Monograph NPS/NRROMO/NRSM-93/21.

Jehle, G., Kotliar, N.B., and Savidge, J.A.
In Review Avian response to prescribed fire in the upland shrub/ponderosa pine system of Rocky Mountain National Park, Colorado.

Jenkins, K.J., and R.G. Wright
1987 Dietary niche relationships among cervids relative to winter snowpack in northwestern Montana. *Canadian Journal of Zoology*. 65:1397-1401.

Johnsgard, P.A.
1986 *Birds of the Rocky Mountains*. Boulder: Colorado Associated University Press.

Johnson, T.
2005 Personal communication between Therese Johnson, Rocky Mountain National Park, and Ed Harvey, Harvey Associates, September.

2006 E-mail from Therese Johnson, Rocky Mountain National Park, to Parsons, Denver, March 7.

Johnson, T.L., and R.J. Monello
2001 An adaptive approach to elk management in Rocky Mountain National Park. In *Crossing Boundaries in Park Management: Proceedings of the 11th Conference on Research and Resource Management in Parks and on Public Lands,* edited by David Harmon. Hancock, Michigan: The George Wright Society.

Johnston, C.A., and R.J. Naiman
1990 Aquatic patch creation in relation to beaver population trends. *Ecology* 71:1617-21.

Jones, J.R., and G.A. Schier
1985 Growth. In *Aspen: Ecology and Management in the Western United States*, edited by N.V. DeByle and R.P. Winokur, 19-24. USDA Forest Service General Technical Report RM-119. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Kay, C.E.
1993 Aspen seedlings in recently burned areas of Grand Teton and Yellowstone National Parks. *Northwest Science* 67:94-104.
1997a Is aspen doomed? *Journal of Forestry* 95:4-11.
1997b The condition and trend of aspen, *Populus tremuloides,* in Kootenay and Yoho National Parks: implications for ecological integrity. *The Canadian Field-Naturalist* 111:607-606.

Kaye, J.P., and S.C. Hart
1998 Ecological restoration alters nitrogen transformations in a ponderosa pine-bunchgrass ecosystem. *Ecological Applications* 8: 1052-1060.

Kaye, M.W., D. Binkley, and T.J. Stohlgren
2005 Effects of conifers and elk browsing on quaking aspen forests in the central Rocky Mountains, USA. *Ecological Applications* 15: 1284–1295.

Kaye, M.W., T.J. Stohlgren, and D. Binkley
2003 Aspen structure and variability in Rocky Mountain National Park, Colorado, USA. *Landscape Ecology* 18:591-603.

Kaye, M.W., K. Suzuki, D. Binkley, and T.J. Stohlgren
2001 Landscape-scale dynamics of aspen in Rocky Mountain National Park, Colorado. USDA Forest Service Proceedings RMRS-P-18. Accessed on the Internet at http://www.fs.fed.us/rm/pubs/rmrs_p018/rmrs_p018_039_046.pdf.

Kershaw, L., A. MacKinnon, and J. Pojar
1998 *Plants of the Rocky Mountains*. Edmonton: Lone Pine Publishing.

Kiener, W.
1939 *Sociological Studies of the Alpine Vegetation on Longs Peak*. Ph.D. diss., University of Nebraska, Lincoln.

Kilpatrick, H.J., and W.D. Walter
1999 A controlled archery deer hunt in a residential community: cost, effectiveness and deer recovery rates. *Wildlife Society Bulletin* 27:115–123.

King, Z., and R. Brooks
2001 Montana study and results of the elk hunter preference survey. Helena: Montana Department of Fish, Wildlife and Parks.

Kingery, H.E., ed.
1998 *Colorado Breeding Bird Atlas*. Denver, CO: Colorado Bird Atlas Partnership and Colorado Division of Wildlife.

Kirkpatrick, J.F.
2004 Personal communication between Jay F. Kirkpatrick and Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, National Park Service, April 6.

Kloppers, E., J. Zehnder, G. Peers, R. Le Blanc, and C. St. Clair
2004 *Herding Techniques for Elk Aversive Conditioning*. Draft.

Kloppers, E.L., C.C. St. Clair, and T.E. Hurd,
2005 Predator-resembling aversive conditioning for managing habituated wildlife. *Ecology and Society* 10:31. Accessed on the Internet at http://www.ecologyandsociety.org/vol10/iss1/art31/

Knight, R.L., F.W. Smith, S.W. Buskirk, W.H. Romme, and W.L. Baker
1998 *Forest Fragmentation in the Rocky Mountains*. Boulder, CO: University of Colorado Press.

Knight, R.R., B.M. Blanchard, and P. Schullery
1999 Yellowstone bears. In *Carnivores in Ecosystems: the Yellowstone Experience*, edited by T.W. Clark, A.P. Curlee, S.C. Minta, and P.M. Kareiva, 51-76. New Haven, CT: Yale University Press.

Koehler, G.M., and K.B. Aubry

1994 Lynx. In *The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx, and Wolverine in the Western United States*, edited by Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski. General Technical Report RM-254. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Kufeld, R.C., O.C. Wallmo, and C. Feddema

1971 *Foods of the Rocky Mountain Mule Deer*. USDA Forest Service Research Paper RM-111. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Kunkel, K.E., and D.H. Pletscher

1999 Species-specific population dynamics of cervids in a multipredator ecosystem. *Journal of Wildlife Management* 63:1082-1093.

Kunkel, K.E., T.K. Ruth, D.H. Pletscher, and M.G. Hornocker

1999 Winter prey selection by wolves and cougars in and near Glacier National Park, Montana. *Journal of Wildlife Management* 63:901-910.

Kyttälä, I.

n.d. Suppressor project summary. Accessed on the Internet at http://guns.connect.fi/rs/summary.html.

Lane, J.R. and C. Montagne

1996 Comparison of soils inside and outside of grazing exclosures on Yellowstone National Park's northern winter range. In *Plants and Their Environments: Proceedings of the First Scientific Conference on the Greater Yellowstone Ecosystem*, edited by D. Despain, 329. Technical Report NPS/NRYELL/NRTR. Denver, CO: USDI, NPS.

Langdon, Sue

2004a. Personal communication between Sue Langdon, Park Ranger, Interpretation, Rocky Mountain National Park, and Janice Biletnikoff, Parsons, Denver, December 17.

2004b. Email from Sue Langdon, Park Ranger, Interpretation, Rocky Mountain National Park, to Janice Biletnikoff, Parsons, Denver, December 22.

2005a. Personal communication between Sue Langdon, Park Ranger, Interpretation, Rocky Mountain National Park, and Janice Biletnikoff, Parsons, Denver, February 13.

2005b. Personal communication between Sue Langdon, Park Ranger, Interpretation, Rocky Mountain National Park, and Janice Biletnikoff, Parsons, Denver, March 9.

2005c. Email from Sue Langdon, Park Ranger, Interpretation, Rocky Mountain National Park, to Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, April 5.

2005d. Email from Sue Langdon, Park Ranger, Interpretation, Rocky Mountain National Park, to Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, August 12. Forwarded to Scott Lowry, Parsons Denver, August 12.

Larimer County Planning Division

2005 *Estes Valley Plan*. Accessed on the Internet at http://www.co.larimer.co.us/planning/planning/estes_valley_plan/estes_valley_plan_toc.htm, January 2005.

Larkins, K.F.
1997 *Patterns of Elk Movement and Distribution in and adjacent to the Eastern Boundary of Rocky Mountain National Park*. M.S. thesis, University of Northern Colorado, Greeley.

Laundré, J.W., L. Hernández, and K.B. Altendorf
2001 Wolves, elk, and bison: reestablishing the "landscape of fear" in Yellowstone National Park, U.S.A. *Canadian Journal of Zoology* 79:1401-1409.

League for the Hard of Hearing (LHH)
2003 Recreational Noise Fact Sheet. Accessed on the Internet at http://www.lhh.org/noise/facts/recreation.htm.
2005 Noise levels in our environment fact sheet. Accessed on the Internet at http://www.lhh.org/noise/decibel.htm.

Leslie, M.
2005 Interview with Mark Leslie, Area Supervisor, Colorado Division of Wildlife by Ed Harvey, Harvey Associates, September.

Leukering, T., and M. Carter
1999 *Abundance and Nesting Success of Common Breeding Birds in Willow Riparian Areas in Rocky Mountain National Park.* Report to the National Park Service.

Lind, J., and W. Cresswell
2005 Determining the fitness consequences of antipredation behavior. *Behavioral Ecology* 16:945-956.

Linnell, J., D.C., R. Andersen, Z. Andersone, L. Balciauskas, J.C. Blanco, L. Boitani, S. Brainerd, U. Breitenmoser, I Kojola, O. Liberg, J. Løe, H. Okarma, H. Pedersen, C. Promberger, H. Sand, E. Solberg, H. Valdman, and P. Wabakken
2002 The fear of wolves: A review of wolf attacks on humans. *Oppdragsmelding* 731:1-65. Trondheim, Norway: Norsk Institutt for Natursforskning. Accessed on the Internet at http://www.timberwolfinformation.org/info/wolfattack.pdf.

Lloyd, J.
1997 The effect of elk herbivory on vegetation and songbirds of aspen communities in Rocky Mountain National Park. Report to the National Park Service.

Loeffler, C., ed.
1998 *Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad* (Bufo boreas boreas), Boreal Toad Recovery Team.

Loomis, J.
2004 How bison and elk populations impact park visitation: a comparison of results from a survey and a historic visitation regression model. *Society and Natural Resources* 17:1-9.

Loomis, J., and L. Caughlan
2004 Linking intended visitation to regional economic impact models of bison and elk management. *Human Dimensions of Wildlife Journal* 9:17-33.

Loomis, J., J. Cooper, and S. Allan
1988 *The Montana Elk Hunting Experience: A Contingent Valuation Assessment of Economic Benefits to Hunters*, September.

Lubow, B.C.
2005 Personal communication between Bruce Lubow, Colorado State University, and Therese Johnson, Rocky Mountain National Park, October 17.

Lubow, B.C., F.J. Singer, T.L. Johnson, D.C. Bowden
2002 Dynamics of interacting elk populations within and adjacent to Rocky Mountain National Park. *Journal of Wildlife Management* 66:757-775.

Leukering, T., and M. F. Carter
1999 Colorado birds monitored by 2001: Results of point-transects in three Colorado habitats with an appendix of results of special species monitoring. Colorado Bird Observatory. Unpublished report.

Mack, J.A., and F. J. Singer
1993 Using pop-II models to predict effects of wolf predation and hunter harvests on elk, mule deer, and moose on the northern range. In *Ecological Issues on Reintroducing Wolves into Yellowstone National Park*, edited by R.S. Cook, 49-74. National Park Service Scientific Monographs 92/22.

Manfredo, M.J., A.D. Bright, J. Pate, and G. Tischbein
1994 *Colorado Residents' Attitudes and Perceptions Toward Reintroduction of the Gray Wolf (Canis lupus) into Colorado*. Project Report No. 21. Project Report for the U.S. Fish and Wildlife Service. Fort Collins, CO: Colorado State University, Human Dimensions in Natural Resources Unit.

Martin, A.C., H.S. Zim, and A.L. Nelson
1951 *A Guide to Wildlife Food Habits*. Dover Publications, Inc., New York.

Mast, J.N., T.T. Veblen, and Y.B. Linhart
1988 Disturbance and climatic influences on age structure of ponderosa pine at the pine/grassland ecotone, Colorado Front Range. *Journal of Biogeography* 25:743-755.

May, T.A., and C.E. Braun
1972 Seasonal foods of adult white-tailed ptarmigan in Colorado. *Journal of Wildlife Management*. 36:1180-1186.

McClintock, B.T.
2004 *The Mark-Resight Method: An Application to Bighorn Sheep in Colorado and a Simulation Study Evaluating Estimators*. M.S. thesis, Colorado State University, Fort Collins. Accessed on the Internet at http://holly.colostate.edu/~btm119/thesis.pdf.

McCutchen, H.E.; R. Hermann, and D.R. Stevens
1993 *Ecological Effects of the Lawn Lake Flood of 1982.* Rocky Mountain National Park.

McDonough, W.T.
1985 Sexual reproduction, seeds, and seedlings. In *Aspen: Ecology and Management in the Western United States*, edited by N.V. DeByle and R. P. Winokur, 25-28. USDA Forest Service General Technical Report RM-119. No. 21. Project Report for the U.S. Fish and Wildlife Service. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

McLaughlin, J.S.
1931 *First Annual Spring Wildlife Report, Rocky Mountain National Park.* National Park Service Report.

McNaughton, S.J.
1983 Compensatory plant growth as a response to herbivory. *Oikos* 40:329-336.

McNaughton, S.J., F.F. Banyikwa, and M.M. McNaughton
1998 Root biomass and productivity in a grazing ecosystem: the Serengeti. *Ecology*. 79:587-592.

McNay, M.E.
2002 *A Case History of Wolf-Human Encounters in Alaska and Canada*. Alaska Department of Fish and Game Wildlife Technical Bulletin 13.

Mcsquared System Design Group
n.d. Decibels and Distance. Accessed on the Internet at http://www.mcsquared.com/dbframe.htm

Mech, L.D., T.J. Meier, J.W. Burch, and L.G. Adams
1995 Patterns of prey selection by wolves in Denali National Park, Alaska. In *Ecology and Conservation of Wolves in a Changing World, Proceedings of the Second North American Symposium on Wolves, Canadian Circumpolar Institute, Edmonton, Alberta, Occasional Publication 35*, edited by L.D. Carbyn, S.H. Fritts, and D.R. Seip, 231-244. Jamestown, ND: Northern Prairie Wildlife Research Center Online. Accessed on the Internet at http://www.npwrc.usgs.gov/resource/2000/denali/denali.htm

Mech, L.D., M.K. Phillips, D.W. Smith, and T.J. Kreeger
1996a Denning behavior of non-gravid wolves, *Canis lupus*. *Canadian Field-Naturalist* 110: 343-345.

Mech, L.D., S. H. Fritts, and M. E. Nelson
1996b Wolf management in the 21st century: from public input to sterilization. *Journal of Wildlife Research* 1: 195-198.

Mech, L.D., D.W. Smith, K.M. Murphy, and D.R. MacNulty
2001 Winter severity and wolf predation on a formerly wolf-free elk herd. *Journal of Wildlife Management* 65:998–1003.

Medin, D.E., and W.P. Clary
1989 *Small Mammal Populations in a Grazed and Ungrazed Riparian Habitat in Nevada.* USDA Forest Service Research Paper INT-413. Intermountain Research Station.
1990a *Bird and Small Mammal Populations in a Grazed and Ungrazed Riparian Habitat in Idaho.* USDA Forest Service Research Paper INT-425. Intermountain Research Station.
1990b *Bird Populations in and adjacent to a Beaver Pond Ecosystem in Idaho.* USDA Forest Service Research Paper INT-432. Intermountain Research Station.

Menezes, R.S.C., E.T. Elliot, D.W. Valentine, and S.A. Williams
2001 Carbon and nitrogen dynamics in elk winter ranges. *Journal of Range Management* 54:400-408.2001

Menezes, R.S.C., E.T. Elliot, and J.M. Welker
2002 Isotopic evidence of the effects of herbivory and landscape position on plant nitrogen sources in a riparian ecosystem. In *Ecological Evaluation of the Abundance and Effects of Elk in Rocky Mountain National Park, Colorado, 1994-1999*, edited by F.J. Singer. Report to the National Park Service.

Milchunas, D.G., O.E. Sala, and W.K. Lauenroth
1988 A generalized model of the effects of grazing by large herbivores on grassland community structure. *The American Naturalist* 132:87-106.

Miller, L.A.
1995 Immunocontraception as a tool for controlling reproduction in coyotes. In *Coyotes in the Southwest: A Compendium of Our Knowledge, Symposium Proceedings, December 1995, San Angelo TX*.

Miller, M.W.
2005 Chronic wasting disease in Colorado, 2002-2004. Colorado Division of Wildlife. Accessed on the Internet at http://wildlife.state.co.us/Hunting/BigGame/CWD.

Miller, M.W., M.A. Wild, and E.S. Williams
1998 Epidemiology of chronic wasting disease in Rocky Mountain elk. *Journal of Wildlife Diseases*. 34:532-538.

Miller, M.W., E.S. Williams, N.T. Hobbs, and L.L. Wolfe
2004 Environmental sources of prion transmission in mule deer. *Emerging Infectious Diseases* 10:1003-1006. Accessed on the Internet at http://www.cdc.gov/ncidod/EID/vol10no6/04-0010.htm.

Miller, M.W., E.S. Williams, C.W. McCarty, T.R. Spraker, T.J. Kreeger, and E.T. Thorne
2000 Epidemiology of chronic wasting disease in free-ranging cervids. *Journal of Wildlife Diseases* 36:676-690.

Minkkinen, K., H. Vasander, S. Jauhiainen, Karsisto, M. and J. Laine
1999 Post-drainage changes in vegetation composition and carbon balance in Lakkasuo mire, central Finland. *Plant and Soil* 207: 107-120.

Mitchell D., J. Tjornehoj, and B. W. Baker
1999 Beaver populations and possible limiting factors in Rocky Mountain National Park. USGS, Midcontinent Ecological Science Center, Ft. Collins, CO.

Monello, R. J., T.L. Johnson, and R.G. Wright
2005 *The Ecological Role of Elk in Rocky Mountain National Park*. Report to the National Park Service.

Mostaghimi S., K. Brannan, and T.A. Dillaha
2002 Fecal coliform TMDL development: case study and ramifications. *Water Resources Update, University Council on Water Resources* 122. Accessed on the Internet at http://www.ucowr.siu.edu/updates/122/index.html.

Mueggler, W.F.
1985 Vegetative associations. In *Aspen: Ecology and Management in the Western United States*, edited by N.V. DeByle and R. P. Winokur, 45-55. USDA Forest Service General Technical Report RM-119. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Muenchrath, Jean.
2006 Personal communication between Jean Muenchrath, Park Ranger, Rocky Mountain National Park, and Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park. March 16.

Murie, O.J.
1951 *The Elk of North America*, Harrisburg, PA: Stackpole Co.

Naiman, R J., C.A. Johnston, and J.C. Kelley
1988 Alteration of North American streams by beaver. *Bioscience* 387:753-762.

Naiman, R.J., and J.M. Melillo
1983 Nitrogen budget of a subarctic stream altered by beaver (*Castor canadensis*). *Oecologia* 62:150-155.

National Institute on Deafness and Other Communication Disorders (NIDCD)
n.d. Interactive sound ruler. Accessed on the Internet at http://www.nidcd.nih.gov/health/education/decibel/decibel_text.asp

National Interagency Fire Center (NIFC)
2002 *Interagency Helicopter Operations Guide*. Boise, ID. Accessed on the Internet at http://www.nifc.gov/ihog/.

2005 *Interagency Standards for Fire and Fire Aviation Operations*. Boise, ID. Accessed on the Internet at http://www.fire.blm.gov/Standards/redbook.htm.

National Park Service (NPS)
1994 *Commercial Horse Use Management Plan and Environmental Assessment.* Estes Park, CO: Rocky Mountain National Park.

1995 *Rocky Mountain National Park Visitor Use Survey: 1994-1995*. Denver, CO: Socio-Economic Studies Division.

1997 *Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem*. Accessed on the Internet at http://www.nps.gov/yell/nature/northernrange/ch5.htm.

1999a *Director's Order #41: Wilderness Preservation and Management*. Washington, DC: NPS Office of Policy. Accessed on the Internet at http://data2.itc.nps.gov/npspolicy/DOrders.cfm.

1999b *Director's Order #50B and Reference Manual 50B: Occupational Safety and Health Program*. Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://data2.itc.nps.gov/npspolicy/DOrders.cfm.

1999c *Rocky Mountain National Park Commercial Services Plan*.

2000 *Director's Order #47: Soundscape Preservation and Noise Management.* Washington DC: NPS Office of Policy. Accessed on the Internet at http://www.nps.gov/refdesk/DOrders/DOrder47.html.

2001a *Backcountry/Wilderness Management Plan and Environmental Assessment*. Estes Park, CO: Rocky Mountain National Park.

2001b *Baseline Water Quality Data Inventory and Analysis for Rocky Mountain National Park*. Water Resource Services. Accessed on the Internet at http://www.nature.nps.gov/water/.

2001c *Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making*. Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://data2.itc.nps.gov/npspolicy/DOrders.cfm.

2001d *Director's Order #50C: Public Risk Management Program*. Draft. Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://data2.itc.nps.gov/npspolicy/DOrders.cfm.

2001e *Firearms Qualification Course – Shotgun Specialty Shells*. Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://data2.itc.nps.gov/npspolicy/DOrders.cfm.

2001f *Resource Management Firearms Qualification Course - Dart Rifles/Pistols*. Estes Park, CO: Rocky Mountain National Park.

2001g *Rocky Mountain National Park: Interim Operating Plan for Handling Elk and Deer in Areas Where Chronic Wasting Disease Is Present*. Estes Park, CO: Rocky Mountain National Park.

2002a *Director's Order #77-4: Use of Pharmaceuticals for Wildlife.* Draft. Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://data2.itc.nps.gov/npspolicy/DOrders.cfm.

2002b *Environmental Assessment for the Management of Snowmobiles in Rocky Mountain National Park*. Estes Park, CO: Rocky Mountain National Park.

2002c *Paintball Gun Standard Operating Procedures*. Estes Park, CO: Rocky Mountain National Park.

2002d *Rocky Mountain Cluster 2002 Visitor Survey Card Data Report*. Prepared by University of Idaho Cooperative Park Studies Unit for the National Park Service. Accessed on the Internet at http://www.psu.uidaho.edu/files/vsc/cluster/RMCL/vsc.RMCL02.pdf.

2002e *Rocky Mountain National Park Habituated Wildlife Standard Operating Procedures*, August.

2002f *Rocky Mountain National Park Protocol for the Use of Specialty 12 Gauge Shotgun Shells in Wildlife Management*. Draft. Estes Park, CO: Rocky Mountain National Park.

2003a *Director's Order #83G: Vector-borne and Zoonotic Diseases*. Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://www.nps.gov/public_health/inter/info/rms/rm83g.pdf.

2003b *Wildland-Urban Interface Fuels Management Plan and Environmental Assessment*.

2003c *Rocky Mountain National Park: Invasive Exotic Plant Management Plan and Environmental Assessment*. August.

2004a *Fire Management Plan: Rocky Mountain National Park, Colorado*. U.S. Department of the Interior.

2004b *Nitrogen Deposition: Issues and Effects in Rocky Mountain National Park*, Technical Background Document. Fort Collins, CO: Air Resources Division.

2004c *Non-Native Deer Management Plan Draft Environmental Impact Statement: Point Reyes National Seashore*. Accessed on the Internet http://www.nps.gov/pore/home_mngmntdocs_exoticdeer_deis.htm.

2004d *Point Reyes National Seashore Contraception Program 2001*. Report prepared by Natalie B. Gates. Point Reyes National Seashore, Point Reyes, CA. http://www.nps.gov/pore/home_mngmntdocs_exoticdeer_deis.htm.

2004e *Protocol Field Anesthesia of Free-Ranging Elk by National Park Service Staff*. Rocky Mountain National Park, CO.

2004f *Rocky Mountain National Park Wilderness Planning and Use Website*. Accessed on the Internet at http://www.nps.gov/romo/resources/research/needs/wilderness.html.

2004g Statistical Abstract 2003. Denver, CO: NPS Public Use Statistics Office. Accessed on the Internet at http://www2.nature.nps.gov/stats/.

2005a Air quality. Accessed on the Internet at http://www.nps.gov/romo/resources/environment/airandwater.html

2005b *Greenback Cutthroat Trout Management Plan and Environmental Assessment: Background and Status of Draft Alternatives*. Presentation on the NPS Rocky Mountain National Park website. Accessed on the Internet at http://www.nps.gov/romo/downloads/planningpdfs/GBCT_1204.pdf.

2005c *Job Safety Analysis: Use of Firearms (shotguns, dart rifles, paintball guns) for Wildlife Management*. Estes Park, CO: Rocky Mountain National Park.

2005d *Job Safety Analysis: Use of Wildlife Pharmaceuticals with Dart Rifles*. Estes Park, CO: Rocky Mountain National Park.

2005e The money generation model. *Public Use Statistics Office Website*. Accessed on the Internet at http://www2.nature.nps.gov/stats/.

2005f *Monthly Public Use Report: Rocky Mountain National Park*. Denver, CO: NPS Public Use Statistics Office. Accessed on the Internet at http://www2.nature.nps.gov/mpur/Reports/reportlist.cfm.

2005g *Nitrogen Deposition: Issues and Effects in Rocky Mountain National Park.* Estes Park, CO: Rocky Mountain National Park.

2005h *Rocky Mountain National Park, Colorado*. Accessed on the Internet at http://www.nps.gov/romo/.

2005i *Statistical Abstract 2004*. Denver, CO: NPS Public Use Statistics Office. http://www2.nature.nps.gov/mpur/Reports/reportlist.cfm.

2005j *Strategic Plan for Rocky Mountain National Park, October 1, 2005 to September 30, 2008.* Estes Park, CO: Rocky Mountain National Park. On file at the park.

2005k *Visitation Statistics*. Denver, CO: NPS Public Use Statistics Office. Accessed on the Internet at http://www2.nature.nps.gov/stats/, July 2005.

2005l Volunteer website. Accessed on the Internet at http://data2.itc.nps.gov/vips/volunteer.cfm?id=romo, July 2005.

2006a Elk and Deer Meat from Areas Affected by Chronic Wasting Disease: A Guide to Human Consumption. NPS Office of Public Health. Visitor and Resource Protection Directorate. National Park Service Public Health Program – Intermountain Region.

2006b *Management Policies: The Guide to Managing the National Park System.* Washington, D.C.: NPS Office of Policy. Accessed on the Internet at http://www.nps.gov/policy/mp/policies.pdf.

National Wildfire Coordinating Group (NWCG)

2000 *Wildland and Prescribed Fire Qualification System Guide*. National Interagency Incident Management System.

2004a *Fireline Handbook*. National Interagency Incident Management System. Accessed on the Internet at http://www.nwcg.gov/pms/pubs/IIBMH2/iibmh.pdf.

2004b *Incident Response Pocket Guide*. National Interagency Incident Management System. Accessed on the Internet at http://www.nwcg.gov/pms/pubs/IRPG_Jan2004.pdf.

2004c *Interagency Incident Business Management Handbook*. National Interagency Incident Management System. Accessed on the Internet at http://www.nwcg.gov/pms/pubs/IIBMH2/iibmh.pdf.

National Wildlife Research Center (NWRC)

2004 *GnRH Deer Population Control*. National Wildlife Research Center, USDA, APHIS, Wildlife Services brochure. Accessed on the Internet at www.aphis.usda.gov/ws/nwrc.

Natural Resources Conservation Service (NRCS)

2000 *Soil Survey of Rocky Mountain National Park, Colorado,Parts of Boulder,Grand, and Larimer Counties*.

Nesvacil, K.

2003 *Plant, Herbivore, and Prescribed Fire Interactions in the Upland Bitterbrush (Purshia tridentata) Communities of Rocky Mountain National Park, Colorado*. Greeley: University of Northern Colorado.

Nesvacil, K., and C.E. Olmsted

2002 The effects of prescribed fire and ungulate herbivory 6 and 7 years post-burn in the upland bitterbrush (*Purshia tridentata*) communities of Rocky Mountain National Park, Colorado. *Proceedings - 2002 Fire Conference: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwest, December 2-5, 2002, San Diego, California*. USDA Forest Service General Technical Report, in press.

Nietvelt, C.G.

2001 Herbivory interactions between beaver (*Castor canadensis*) and elk (*Cervus elaphus*) on willow (*Salix spp.*) in Banff National Park, Alberta. M.S. thesis, University of Alberta, Edmonton.

Nowak, R.M.

1991 *Walker's Mammals of the World*. Baltimore, MD: Johns Hopkins University Press.

Oliff, T.K., K. Legg, and B. Kaeding, eds.

1999 *Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: a Literature Review and Assessment*. Report to the Greater Yellowstone Coordinating Committee. Yellowstone National Park

Oliver, K.

2005 Personal communication between Kurt Oliver, Supervisory Park Ranger, Rocky Mountain National Park, and Janice Biletnikoff, Parsons, Denver, March 9.

Olmsted, C.E.

1979 The ecology of aspen with reference to utilization by large herbivores in Rocky Mountain National Park. In *North American Elk: Ecology, Behavior and Management*, edited by M.S. Boyce and L.D. Hayden-Wing, 89-97. University of Wyoming Press, Laramie.

1997 *Twenty Years of Change in Rocky Mountain National Park Elk Winter Range Aspen*. Report to the National Park Service.

Oregon Department of Fish and Wildlife (ODFW)
2005 Oregon's beaver. Accessed on the Internet at http://www.dfw.state.or.us/Springfield/Beaver.html.

Orians, G., D.A. Cochran, J.W. Duffield, T.K. Fulla, R.J. Gutierrez, W.M. Hanemann, F.C. James, P. Karieva, S.R. Kellert, D. Klein, B.N. McLellan, P.D. Olson, and G. Yaska
1997 *Wolves, Bears and their Prey in Alaska*. National Academy of Press, Washington, D.C.

Packard, F.M.
1939 Notes on a conversation of Fred M. Packard with Mr.Abner Sprague at Estes Park Colorado on August 7, 1939, regarding the early history of the bighorn and other game animals in Rocky Mountain National Park. Unpublished report to the National Park Service.

1946 An ecological study of the bighorn sheep in Rocky Mountain National Park. *Journal of Mammalogy*. 27:3-28.

1947 A survey of the beaver population of Rocky Mountain National Park, Colorado. *Journal of Mammalogy*. 28:219-227.

Parsons, D.R.
2003 *Natural History Characteristics of Focal Species in the New Mexico Highlands Wildlands Network*. Presentation at the New Mexico Lyceum. Richmond, VT: The Wildlands Project. Accessed on the Internet at http://www.safepassagecoalition.org/resources/nmhwn_focal%20species.pdf.

2004 Personal communication between David Parsons, Wildlife Biologist, Parsons Biological Consulting and Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, March 17.

Peek, J.W., and A.L. Lovaas
1968 Differential distribution of elk by sex and age on the Gallatin Winter Range, Montana. *Journal of Wildlife Management* 32:553-557.

Peinetti. H.R.
2000 *Riparian Willow Dynamics and Their Interaction with Environmental and Biological Factors in the Elk Winter Range of Rocky Mountain National Park (Colorado) – a Multi-scale Analysis*. Ph.D. disseration, Colorado State University, Fort Collins.

Peinetti, H.R., M.A. Kalkhan, and M.B. Coughenour
2002 Long-term changes in willow spatial distribution on the elk winter range of Rocky Mountain National Park (USA). *Landscape Ecology* 17:341-354.

Peinetti, H.R., R.S. C. Menezes, and M.B. Coughenour
2001 Changes induced by elk browsing in the aboveground biomass production and distribution of willow (*Salix monticola* Bebb): their relationships with plant water, carbon, and nitrogen dynamics. *Oecologia* 127:334-342.

Pettibone, L.
2005 Email from Lani Pettibone, Ranger Division Administrative Assistant, Rocky Mountain National Park to Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, February 1, Forwarded to Timberley Belish, Parsons, Denver, 3 February.

Peterson, R.O.
1999 Wolf-moose interaction on Isle Royale: the end of natural regulation. *Ecological Applications* 9:10-16.

Picton, H.D.
1999 Energetic cost of displacement to wildlife by winter recreation. In *The Effects of Winter Recreation on Wildlife: a Literature Review and Assessment*, edited by S.T. Olliff and K.L. Legg. Yellowstone National Park.

Pidwirny, M.
2006 Introduction to the biosphere. In Fundamentals of Physical Geography website. Accessed on the Internet at http://www.physicalgeography.net/fundamentals/9s.html

Powell, R.A., J.W. Zimmerman, and D.E. Seaman
1997 *Ecology and Behaviour of North American Black Bears: Home Ranges, Habitat, and Organization*. New York: Chapman and Hall.

Quinn, R.D., and L. Wu.
2001 Quaking aspen reproduce by seed after wildfire in the mountains of southeastern Arizona. In *Sustaining Aspen in Western Landscapes: Symposium Proceedings*, edited by W. D. Shepperd, D. Binkley, D. L. Bartos, T. J. Stohlgren, and L. G. Eskew, 369-376. Proceedings RMRS-P-18. Fort Collins, CO: Rocky Mountain Research Station.

Raedeke, K.J., J.J. Millspaugh and P.E. Clark
2002 Population characteristics. In *North American Elk: Ecology and Management*, edited by D.E. Toweill and J.W. Thomas, 449-91. Washington DC: Wildlife Management Institute.

Ratcliff, H.M.
1941 Winter range conditions in Rocky Mountain National Park. *Transactions of the North American Wildlife Conference*. 6:132-139.

Ratzlaff, T.D., and J.E. Anderson
1995 Vegetal recovery following wildfire in seeded and unseeded sagebrush steppe. *Journal of Range Management* 48: 386-391.

Ream, R.R., L.L. Rogers, and J.M. Peek
1989 Managing natural populations of wildlife in wilderness. In *Managing America's Enduring Wilderness Resource*, edited by D. Lime, 357-362. Proceedings of the Conference, Minneapolis, Minnesota, September 11-17, 1989.

Redente, E.

2006 Vegetation Restoration Management Plan Version 2, Rocky Mountain National Park, Colorado State University. 113 pp.

Renkin, R., and D. Despain
1996 Preburn root bio- mass/basal area influences on the response of aspen to fire and herbivory. In *The Ecological Implications of fire in Greater Yellowstone: Proceedings of the Second Biennial Conference on the Greater Yellowstone Ecosystem*, edited by J. Greenlee, 95-106. International Association of Wildland Fire, Fairfield, Washington.

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Iñigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, T.C. Will.

2004 *Partners in Flight North American Landbird Conservation Plan*. Ithaca, NY: Cornell Lab of Ornithology.

Riordan, L.E.

1948 Sexing of deer and elk by airplane in Colorado. *Transcripts from the 13th North American Wildlife Conference*. Colorado Division of Wildlife. 409-430. Colorado W-038-R.

Ripple, W.J., and R.L. Beschta

2003 Wolf reintroduction, predation risk, and cottonwood recovery in Yellowstone National Park. *Forest Ecology and Management* 184:299-313.

2004a Wolves and the ecology of fear: Can predation risk structure ecosystems? *Bioscience* 54:755-766.

2004b Wolves, elk, willows, and trophic cascades in the upper Gallatin Range of Southwestern Montana, USA. *Forest Ecology and Management* 200: 161-181.

Ripple, W.J., and E.J. Larsen

2000 Historic aspen recruitment, elk, and wolves in northern Yellowstone National Park, USA. *Biological Conservation* 95:1-10.

Ripple, W.J., E.J. Larsen, R.A. Renkin, and D.W. Smith

2001 Trophic cascades among wolves, elk and aspen on Yellowstone National Park's northern range. *Biological Conservation* 102:227-234.

Ritchie, M.E., D. Tilman, and J.H.N. Knops

1998 Herbivore effects on plant and nitrogen dynamics in oak savanna. *Ecology* 79:165-177.

Rocky Mountain Insurance Information Association

2005 *Rocky Mountain Insurance Information Association website*. Accessed on the Internet at http://www.rmiia.org/.

Rogers, L.

1976 Effects of mast and berry crop failures on survival, growth, and reproductive success of black bears. *Transcripts of the. North American Wildlife and. Natural Resources Conference* 41:431-438.

Rolf, J.M.

2001 Aspen fencing in northern Arizona: a 15-year perspective. In *Sustaining Aspen in Western Landscapes: Symposium Proceedings*, edited by W. D. Shepperd, D. Binkley, D. L. Bartos, T. J. Stohlgren, and L. G. Eskew, 193-196. Proceedings RMRS-P-18. Fort Collins, CO: Rocky Mountain Research Station.

Romme, W.H., L.F. Hanna, D.D. Hanna, and E. Bartlett

2001 Aspen's ecological role in the west. In *Sustaining Aspen in Western Landscapes: Symposium Proceedings*, edited by W. D. Shepperd, D. Binkley, D. L. Bartos, T. J. Stohlgren, and L. G. Eskew, 243-259. Proceedings RMRS-P-18. Fort Collins, CO: Rocky Mountain Research Station.

Romme, W.H., M.G. Turner, L.L. Wallace, and J.S. Walker

1995 Aspen, elk, and fire in northern Yellowstone National Park.. *Ecology* 76: 2097-2106.

Ronca, C.

2004 Personal communication between Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, and Timberley Belish, Parsons, Denver, November 17.

2005a Personal communication between Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, and Janice Biletnikoff, Parsons, Denver, February 28.

2005b Personal communication between Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, and Janice Biletnikoff, Parsons, Denver, March 16.

2005c Email from Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, to Janice Biletnikoff, Parsons, Denver, April 4.

2005d Email from Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, to Scott Lowry, Parsons, Denver, April 5.

2006 Internal review comment from Carlie Ronca, Natural Resource Management Specialist, Rocky Mountain National Park, to Parsons, Denver, January.

Rossow, L.J., J.P. Bryant, and K. Kielland

1997 Effects of above-ground browsing by mammals on mycorrhizal infection in an early successional taiga ecosystem. *Oecologia* 110: 94-98.

Rowdabaugh, K.M.

1978 *The Role of Fire in the Ponderosa Pine-Mixed Conifer Ecosystem.* M.S. thesis, Colorado State University, Fort Collins.

RRC Associates

1999 *Summer 1999 Estes Park Housing Study*.

2005 *Town of Estes Park Economic Development Study*.

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski

1994 American martin, fisher, lynx, and wolverine in the Western United States. U.S. Forest Service. General Technical Report RM-254.

Rutledge, C.R., and T. McLendon

1996 *An Assessment of Exotic Plant Species of Rocky Mountain National Park*. Colorado State University, Fort Collins.

Salas, D., J. Stevens, and K. Schultz

2005 *Rocky Mountain National Park, Colorado, 2001-2005 Vegetation Classification and Mapping*. Final Report. US Bureau of Recreation Technical Memorandum 8260-05-02.

Schell, L.D., and T.J. Stohlgren

1997 *Effect of Elk Grazing on Native and Non-native Plant Species Diversity in Beaver Meadows*. Final report to the Rocky Mountain Elk Foundation.

Schier, G.A.

1975 *Deterioration of Aspen Clones in the Middle Rocky Mountains*. USDA Forest Service Research Paper INT-170. Ogden, UT: Intermountain Forest and Range Experiment Station.

1985 Vegetative regeneration. In *Aspen: Ecology and Management in the Western United States*, edited by N.V. DeByle and R.P. Winokur, 29-33. USDA Forest Service

General Technical Report RM-119. Fort Collins, CO: Rocky Mountain Forest and Range Experimental Station.

Schoenecker, K.A., F.J. Singer, R.S.C. Menzenes, L.C. Zeigenfuss, and D. Binkley
2001 Sustainability of vegetation communities grazed by elk in Rocky Mountain National Park. In *Ecological Evaluation of the Abundance and Effects of Elk Herbivory in Rocky Mountain National Park, Colorado, 1994-1999*, edited by F.J. Singer and L.C. Zeigenfuss, 187-204. Fort Collins CO: Colorado State University and U.S. Geological Survey.

Schoenecker, K.A., F.J. Singer, L.C. Zeigenfuss, D. Binkley, and R.S.C. Menenzes
2004 Effects of elk herbivory on vegetation and nitrogen processes. *Journal of Wildlife Management* 68: 835-847.

Schulz, T.T., and W.C. Leininger
1990 Differences in riparian vegetation structure between grazed areas and exclosures. *Journal of Range Management* 43:295-299.

Schuster, K.
2005 Email from Krista Schuster, Human Resources Specialist, Rocky Mountain National Park to Carlie Ronca, Natural Resources Management Specialist, Rocky Mountain National Park, March 16. Forwarded to Janice Biletnikoff, Parsons, Denver, March 16.

Seidel, J., B. Andree, S. Berlinger, K. Buell, G. Byrne, B. Gill, D. Kenvin, and D. Reed
1998 *Draft Strategy for the Conservation and Reestablishment of Lynx and Wolverine in the Southern Rocky Mountains*. Colorado Division of Wildlife, U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, New Mexico Game and Fish Department, Wyoming Game and Fish Department. Technical Report, RM-GTR-256. Fort Collins, CO: Rocky Mountain Forest and Range Experimental Station.

Shepperd, W.D.
1996 *Response of Aspen Root Suckers to Regeneration Methods and Postharvest Protection*. Research Paper RM-RP-324. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.
2001 *Manipulations to Regenerate Aspen Ecosystems*. USDA Forest Service Proceedings RMRS-P-18. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Shepperd, W.D., and O. Engelby
1983 *Rocky Mountain Aspen*. U.S. Forest Service Agricultural Handbook 445:77-79.

Simonson, S.E., P.A. Opler, T.J. Stohlgren, and G.W. Chong
2001 Rapid assessment of butterfly diversity in a montane landscape. *Biodiversity and Conservation* 10:1369-1386.

Singer, F.J.
1995 Effects of grazing by ungulates on upland bunchgrass communities of the northern winter range of Yellowstone National Park. *Northwest Science* 69: 191-203.

Singer, F.J., L.C. Mack, and R.C. Cates
1994 Ungulate herbivory of willows on Yellowstone's northern winter range. *Journal of Range Management*. 47: 435-443.

Singer, F.J., and J.E. Norland
1994 Niche relationships within a guild of ungulate species in Yellowstone National Park, Wyoming, following release from artificial controls. *Canadian Journal of Zoology* 72:1383-1394.

Singer, F.J. and K.A. Schoenecker
2003 Do ungulates accelerate or decelerate nitrogen cycling? *Forest Ecology and Management* 16: 189-204.

Singer, F.J., G. Wang, and N.T. Hobbs
2003 The role of ungulates and large predators on plant communities and ecosystem processes in national parks. In *Large Mammal Communities in U.S. Western Coniferous Forests*, edited by R. G. Anthony and C. Zabel. Cambridge: Cambridge University Press.

Singer, F.J., and L.C. Zeigenfuss, eds.
2002 *Ecological Evaluation of the Abundance and Effects of Elk Herbivory in Rocky Mountain National Park, Colorado, 1994-1999*. Fort Collins CO: Colorado State University and U.S. Geological Survey.

Singer, F.J., L.C. Zeigenfuss, R.G. Cates, and D.T. Barnett
1998 Elk, multiple factors, and persistence of willows in national parks. *Wildlife Society Bulletin* 26:419-428.

Singer, F.J., L.C. Zeigenfuss, B. Lubow, and M.J. Rock
2002 Ecological evaluation of the potential overabundance of ungulates in U.S. National Parks: a case study. In *Ecological Evaluation of the Abundance and Effects of Elk Herbivory in Rocky Mountain National Park, Colorado, 1994-1999*, edited by F.J. Singer and L.C. Zeigenfuss, 205-248. Fort Collins CO: Colorado State University and U.S. Geological Survey.

Smith, B.L., and S.H. Anderson
1996 Patterns of neonatal mortality of elk in northwest Wyoming. *Canadian Journal of Zoology* 747:1229-1237.

Smith, D.W.
2005 Ten years of Yellowstone wolves. *Yellowstone Science* 13: 7-33.

Smith, D.W., R.O. Peterson, and D.B. Houston
2003 Yellowstone after wolves. *Bioscience* 53: 330-340.

Smith, D., and P.J. White
2005 Interview of Doug Smith and P.J. White,Yellowstone National Park, with Ed Harvey and Susan Walker, Harvey Associates, October.

Songster-Alpin, M.S., and R.L. Klotz.
1995. A comparison of electron transport system activity in stream and beaver pond sediments. *Canadian Journal of Fisheries and Aquatic Science* 52: 1318–1326.

Spence, C.E., J.E. Kenyon, D.R. Smith, R.D. Hayes, and A.M. Baer
1999 Surgical sterilization of free-ranging wolves. *Canadian Veterinarian Journal* 40: 118-121.

Sprague, A.E.
1925 Game more plentiful now than 50 years ago in Estes Park region. *Estes Park Trail*. June 5, 1925.

Squibb, R.C.
1985 Mating success of yearling and older bull elk. *Journal of Wildlife Management*. 49:744–750.

Steidl, R.J., and R.G. Anthony
2000 Experimental effects of human activity on breeding bald eagles. *Ecological Applications* 10:258-268.

Stephens, S.L., T. Meixner, M. Poth, B. McGurk, and D. Payne
2004 Prescribed fire, soils, and stream water chemistry in a watershed in the Lake Tahoe Basin, California. *International Journal of Wildland Fire* 13:27-34.

Stevens, D.R.
1979a *Effects of Elk on Vegetation in Rocky Mountain National Park*: Report to Rocky Mountain National Park.

1979b Problems of revegetation of alpine tundra. *First Conference on Scientific Research in the National Parks* 1979:241-245.

1980a *The Deer and Elk of Rocky Mountain National Park: a 10-year Study*. National Park Service Report ROMO-N-13.

1980b Impact of elk on alpine tundra in Rocky Mountain National Park. *Proceedings of High Altitude Vegetation Workshop* 4:228-244.

Stewart, K.M., R.T. Bowyer, B.L. Dick, B.K. Johnson, and J.G. Kie
2005 Density-dependent effects on physical condition and reproduction in North American elk: an experimental test. *Oecologia* 143:85-93.

Stewart, S.C., P.J. Fix, and M.J. Manfredo
2004 *Public Perceptions of Elk and Vegetation Management in Rocky Mountain National Park, Colorado*. Project Report No. 56. Project Rep. for Rocky Mountain National Park. Fort Collins, CO: Colorado State University, Human Dimensions in Natural Resources Unit.

Stohlgren, T.J.
2001a Data acquisition for ecological assessments. In *Ecological Assessments*, edited by M. Jensen and P. Bougeron,. Springer-Verlag.

2001b *Rocky Mountain National Park Long-Term Monitoring Plan*. Report to Rocky Mountain National Park. 137 pp.

Stohlgren, T.J., L.D. Schell, and B.V. Heuvel
1999 How grazing and soil quality affect native and exotic plant diversity in Rocky Mountain grasslands. *Ecological Applications* 9:45-64.

Straight Shooters
n.d. Decibel ranking of airguns. Accessed on the Internet at http://www.straightshooters.com/docs/decibc.html

Suzuki, K., H. Suzuki, D. Binkley, and T.J. Stohlgren
1999 Aspen regeneration in the Colorado Front Range: differences at local and landscape scales. *Landscape Ecology* 14:231-237.

Sylvia, D.M.
2004 Overview of mycorrhizal symbioses. Accessed on the Internet at http://cropsoil.psu.edu/sylvia/mycorrhiza.htm#UPTAKE.

Taber, R.D., K. Raedeke, and D.A. McCaughran
1982 Population characteristics. In *Elk of North America: Ecology and Management*, edited by J.W. Thomas and D.E. Toweill, 279-299. Harrisburg, PA: Stackpole Books.

ter Braak, C.J.F., and J. Wiertz
1994 On the statistical analysis of vegetation change: a wetland affected by water extraction and soil acidification. *Journal of Vegetation Science* 5:361-72.

Terres, J.K.
1980 *The Audubon Society Encyclopedia of North American Birds*. Alfred A. Knopf, New York.

Thoms, S.
2004 Interview with Steve Thoms, Owner, Steve's Autobody, by Andy Fritsch, Harvey Economics, and Janice Biletnikoff, Parsons, Denver, March.

Town of Estes Park.
2004 Sales tax collection data obtained from the Finance Department for the year 2004.

2005a Estes Park, Colorado: Get into the real rockies. Accessed on the Internet at http://estesparkcvb.com.

2005b Welcome to Estes Park, Colorado. Accessed on the Internet at http://www.estesnet.com.

Town of Grand Lake
2005 *Comprehensive Land Use Plan*. Accessed on the Internet at http://www.townofgrandlake.com/documents/wa_gl_plan_screen.pdf.

Turbak, G.
2005 When carnivores clash. *National Wildlife Federation website*. Accessed on the Internet at http://www.nwf.org/nationalwildlife/article.cfm?issueID=18&articleID=143.

Turchi, G.M., P.L. Kennedy, D. Urban, and D. Hein
1994 Bird species richness in relation to isolation of aspen habitats. *Wilson Bulletin* 107:463-474.

U.S. Air Force and U.S. Fish and Wildlife Service (USAF and USFWS)
1988 *Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: a Literature Synthesis*. NERC 88/29. AFESC TR 88.14, June.

U.S. Bureau of Economic Analysis
2005 *Regional Economic Information System*, April.

U.S. Census Bureau
2005 Data from 1990 and 2000 censuses for Boulder, Grand, Jackson and Larimer Counties and for the state of Colorado. Accessed on the Internet at http://www.census.gov.

U.S. Fish and Wildlife Service (USFWS)
1994 *The reintroduction of gray wolves to Yellowstone National Park and central Idaho: Final Environmental Impact Statement*. Denver, CO: U. S. Fish and Wildlife Service.

1998 *Greenback Cutthroat Trout Recovery Plan*. Denver, CO: U.S. Fish and Wildlife Service.

2001 *Net Economic Values for Wildlife Related Recreation in 2001: Addendum to the 2001 National Survey of Fishing, Hunting and Wildlife Associated Recreation*, Report 2001-03, September 2001.

2003 *2001 National Survey of Fishing, Hunting and Wildlife Associated Recreation: Colorado*, March.

2005a Southern Rocky Mountain population of boreal toad no longer candidate for listing. Accessed on the Internet at http://mountain-prairie.fws.gov/pressrel/05-68.htm.

2005b Service will not appeal U.S. district court decisions of U.S. gray wolf delisting. Statement of Craig Manson, Assistant Secretary of the Interior for Fish, Wildlife and Parks. December 16, 2005. Accessed on the Internet at http://www.fws.gov/midwest/wolf/esa-status/manson_stm_dec05.htm.

U.S. Food and Drug Administration (USFDA)

2001 *Lupron Depot – 3 Month 22.5 mg (leuprolide acetate for depot suspension) 3-Month Formulation*. USFDA Center for Drug Evaluation and Research. Accessed on the Internet at http://www.fda.gov/cder/foi/label/2001/20517S10lbl.pdf.

Vasander, H., R. Laiho, and J. Laine

1997 Changes in species diversity in peatlands drained for forestry. In *Northern Forested Wetlands: Ecology and Management*, edited by C. Trettin, M. Jurgensen, D. Grigal, M. Gale, and J. Jeglum. CRC Press.

Veblen, T.T., T. Kitzberger, and J. Donnegan

2000 Climatic and human influences on fire regimes in ponderosa pine forests in the Colorado Front Range. *Ecological Applications* 10:1178-1195.

Veblen, T.T., and D.C. Lorenz

1991 *The Colorado Front Range: a Century of Ecological Change*. Salt Lake City, UT: University of Utah Press.

Vitousek, P.

1982 Nutrient cycling and nutrient use efficiency. *The American Naturalist* 119:553-572.

Wagner, F.H. and U.S. Seal

1992 Values, problems, and methodologies in managing overabundant wildlife populations: an overview. In *Wildlife 2001: Populations*, edited by D.R. McCullough and R.H. Barrett, 279-293. London: Elsevier.

Walker, T.

2003 Let Denali animals roam free. *Anchorage Daily News*, May 29.

Wall, R.

2004 Watching the river run, the science of sustainable flow. *The Academy of Natural Sciences*. Accessed on the Internet at http://www.acnatsci.org/research/kye/articles.html accessed February 2004.

Wambolt, C.L.

1998 Sagebrush and ungulate relationships on Yellowstone's northern range. *Wildlife Society Bulletin* 26:429-437.

Wambolt, C.L., K.S. Walhof, and M.R. Frisina
2001 Recovery of big sagebrush communities after burning in south-western Montana. *Journal of Environmental Management* 61:243-252.

Wang, G., N.T. Hobbs, H. Galbraith, K.M. Giesen
2002a Relationships between climate and population dynamics of white-tailed ptarmigan Lagopus leucurus in Rocky Mountain National Park, Colorado, USA. *Climate Research* 23:81-87.
2002b Signatures of largescale and local climates on the demography of white-tailed ptarmigan in Rocky Mountain National Park, Colorado, USA. International *Journal of Biometeorology* 46:197-201.

Warren, R.J.
1997 Deer population management through hunting and alternative means of control. *Proceedings of the Conference on Deer as Public Goods and Public Nuisance*, edited by B.L. Gardner, 81-88. College Park, MD: University of Maryland. Accessed on the Internet at: http://www.arec.umd.edu/Policycenter/Deer-Management-in-Maryland/warren.htm.

Watry, M.K.
2005a Personal communication from Mary Kay Watry, Biologist, Rocky Mountain National Park, to Janice Biletnikoff, Parsons, Denver, March 15.
2005b Personal communication from Mary Kay Watry, Biologist, Rocky Mountain National Park, to Michelle Johnson, Parsons, Denver, March 31.
2005c Email from Mary Kay Watery, Biologist, Rocky Mountain National Park, to Scott Lowry, Parsons, Denver, April 5.
2005d Email from Mary Kay Watry, Biologist, Rocky Mountain National Park, Estes Park, to Michelle Johnson, Parsons, Denver, July 18.
2005e Email from Mary Kay Watry, Biologist, Rocky Mountain National Park, to other Rocky Mountain National Park staff, August 11.
2005f Email from Mary Kay Watry, Biologist, Rocky Mountain National Park, to Scott Lowry, Parsons, Denver, August 20.
2005g Email from Mary Kay Watry, Biologist, Rocky Mountain National Park, to Timberley Belish, Parsons, Denver, August 21.
2006 Internal review documentation from Mary Kay Watry, Biologist, Rocky Mountain National Park, to EIS administrative record.

Weisberg, P.J., and M.B. Coughenour
2003 Model-based assessment of aspen responses to elk herbivory in Rocky Mountain National Park, U.S.A. *Journal of Environmental Management* 32: 152-169.

West, N.E.
1968 Rodent influenced establishment of ponderosa pine and bitterbrush seedlings in central Oregon. *Ecology* 49:1009-1011.

Westbrook, C.
2005 *Beaver as Hydrological and Ecological Drivers of Mountain Valley Functioning*. PhD dissertation, Colorado State University, Fort Collins.

Westbrook, C., D. J. Cooper, and B. W. Baker
2006 Beaver dams and overbank floods influence groundwater – surface water interactions of a Rocky Mountain riparian area. *Water Resources Research* 42, W06404.

White, C.
2005 Interview with Cliff White, Banff National Park, Canada, by Susan Walker, Harvey Associates, October.

White, C.A., C.E. Olmsted, and C.E. Kay
1998 Aspen, elk, and fire in the Rocky Mountain national parks of North America. *Wildlife Society Bulletin* 26:449-462.

White, M.
1999 The use of firearm sound suppressors for wildlife management. *Gunwriters*. Accessed on the Internet at http://guns.connect.fi/gow/wildlife.html.

Wild, M.
2005 Email from Margaret Wild, NPS veterinarian, to Don Kellett, Parsons, Denver, September 1.

Wildlife Forever
2005 Frequently asked questions on immunocontraception. Accessed on the Internet at http://www.pzpinfo.org/faq.html.

Willard, B.E.
1963 *Phytosociology of the Alpine Tundra of Trail Ridge, Rocky Mountain National Park, Colorado*. Ph.D. diss., University of Colorado, Boulder.

Wilmers, C.C., R.L Crabtree., D.W. Smith, K.M. Murphy, and W.M. Getz
2003 Trophic facilitation by introduced top predators: grey wolf subsidies to scavengers in Yellowstone National Park. *Journal of Animal Ecology* 72:909-916.

Wilson, M.A.
n.d. The human dimensions of wolf ecotourism in North America. *International Wolf Center*. Accessed at http://www.wolf.org/wolves/learn/intermed/inter_human/wilson_ecotour.asp.

Winternitz, B.L.
1998 Bald eagle. In *Colorado Breeding Bird Atlas*, edited by H. E. Kingery. Denver, CO: Colorado Bird Atlas Partnership and Colorado Division of Wildlife.

Wittenauer, C.
2005 Zoo reverses vasectomy on bush dog. Associated Press article in *Environmental News Network* April 28, 2005.

Wolff, J.O., and T. Van Horn
2003 Vigilance and foraging patterns of American elk during the rut in habitats with and without predators. *Canadian Journal of Zoology* 81:266-271.

Woods S.W.
2000 *Hydrologic Effects of the Grand Ditch on Streams and Wetlands in Rocky Mountain National Park, Colorado*. M.S. thesis, Colorado State University, Fort Collins.

Wright, G.M., J.S. Dixon, and B.H. Thompson
1933 *Fauna of the National Parks of the United States: a Preliminary Survey of Faunal Relations in National Parks*. U.S. Government Printing Office, Washington D.C.

Wright, R.G.
1992 *Wildlife Research and Management in the National Parks*. Chicago: University of Illinois Press.

Wyoming Game and Fish Department (WGFD)
2003 *Final Wyoming Gray Wolf Management Plan*. Accessed on the Internet at http://gf.state.wy.us/downloads/pdf/WolfPlanFinal8-6-03.pdf.

Yeary, M.
2005 Personal communication between Michael Yeary, Colorado Wildlife Services, Lakewood, and Michelle Johnson, Parsons, Denver, October 17.

Yellowstone National Park (YELL)
2004 Yellowstone visitor gored by elk. Yellowstone National Park news release, September 22. Accessed on the Internet at http://www.nps.gov/yell/press/04102.htm

Zaninelli, J., and T. Leukering.
1998 *Aspen: A Critical Component of Cavity-nesting Bird Habitat in Rocky Mountain National Park*. Report to the National Park Service.

Zeigenfuss, L.C.
2001 *Ecology of Black Bears in Rocky Mountain National Park; An Analysis of Population Dynamics, Diet, and Habitat Selection (1985-1991).* Report to Rocky Mountain National Park.
2005 Personal communication between Linda Zeigenfuss and Carlie Ronca, Rocky Mountain National Park.

Zeigenfuss, L.C., F.J. Singer, and D. Bowden
2002 Vegetation responses to natural regulation of elk in Rocky Mountain National Park. Biological Science Report USGS/BRD/BSR-1999-0003. Denver: U.S. Government Printing Office.

Zeigenfuss, L.C., F.J. Singer, S. Williams, and T. Johnson
2002 Influences of herbivory and water on willow in elk winter range. *Journal of Wildlife Management* 66:788-795.

This page intentionally left blank

Glossary of Terms

This page intentionally left blank

Glossary of Terms

Abiotic: Characterized by the absence of life or living organisms.

Adaptive management: A principle that incorporates monitoring and research into conservation actions. Specifically, it is the integration of planning, management, and monitoring to test assumptions in order to adapt and learn.

Biodiversity: The diversity of plant and animal species in an environment.

Biotic: Pertaining to life or living organisms.

Browsing: When used in reference to deer, describes the eating of shoots or twigs of shrubs and trees.

Carrying capacity (K): Sometimes called "biological carrying capacity," this is the maximum number of animals of a species that can live in a given environment. Carrying capacity is not a static number but an ever-changing target that will vary, short-term, with weather and range conditions, and long-term with gradual alterations in habitat and vegetation communities.

Cervid: A member of the deer family Cervidae, comprising deer, caribou, elk, and moose.

Clone: Aspen trees connected by their roots; they are a single organism.

Compaction: The compression of soil layers reducing the ability of plants to survive, reducing water infiltration capacity, and increasing water runoff.

Core winter range: Areas within the park in which some elk congregate from October through April, including the vicinity of Moraine Park / Beaver Meadows and Horseshoe Park.

Critical habitat: As defined in the Endangered Species Act (1973), pertains to: "(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of this Act, upon a determination by the Secreatary (of the U.S. Department of the Interior) that such areas are essential for the conservation of the species."

Density dependent: Having influence on individuals in a population that varies with the degree of crowding within the population.

Density independent: Having influence on individuals in a population that does not vary with the degree of crowding.

Depredation: A term used by state wildlife agencies to describe animals that cause economic damage to private landowners by destroying structures, consuming feed or preying on domestic animals.

Desired conditions: In this case, describes what the vegetation on the elk range should be like after implementation of the management actions contained in this plan/EIS. It summarizes the anticipated changes in vegetation that would result from carrying out planned management actions. It is an expression of resource goals that have been set for vegetation on the elk range and describes the vegetation as it would appear when the goals set for it have been achieved.

Ecosystem: A system formed by the interaction of a community of organisms with their environment.

Endangered: Defined by U.S. Fish and Wildlife Service and listed in the Federal Register as being in danger of extinction.

Exclosure: A fenced area designed to exclude one or more species.

Exotic: As described by NPS Management Policies (2001), describes a species that did not evolve in concert with the species native to an ecosystem, and occupies or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Sometimes called "non-native," "alien," or "invasive."

Extinction: Disappearance from the earth.

Extirpation: Disappearance from a specified geographic area.

Extra-label: Use of a non-approved product or use of an approved product in a way that differs from the package insert (dose, frequency, route) or for a condition not specified on the label.

Forbs: Non-woody, broad-leaf, flowering plants that are neither grasses nor grasslike.

Gregarious: Tending to form a group with others of the same species

Herbaceous: A plant with no persistent woody stem above ground; characteristics of that of an herb.

Hydrologic: Pertaining to the occurrence, circulation, distribution, and properties of the water.

Intraspecific: Between members of the same species.

Microclimate: The climate of a small area, such as a plant community or wooded area, which may be different from that in the general region.

Native: As described by NPS Management Policies (2001), pertains to a species that has occurred or now occurs as a result of natural processes on lands designated as units of the national park system.

Recruitment: Birth and survival of young to the age at which their survival rates approximate those of adults in the population.

Primary summer range: The areas used by most of the Rocky Mountain National Park / Estes Valley elk population during June, July, and August. It includes the Kawuneeche Valley and subalpine and alpine areas within the park as well as areas outside the park.

Primary winter range: From October through April, most elk use the primary winter range, which is on the eastern portion of the park and extends outside the park to the Estes Valley and eastward.

Range: The geographical extent of a species or subspecies. See also primary range and core winter range.

Riparian: Pertaining to, situated or dwelling on the bank of a river or other body of water.

Rut: The mating season for certain species, usually ungulates.

Scrub: A large area covered with low trees and shrubs.

Sedimentation: The deposition or accumulation of mineral or organic matter by water, air, or ice.

Steroid: Any of a large group of fat-soluble compounds, such as bile acids and sex hormones, most of which have specific physiological actions.

Subspecies: Sometimes called a "race", a genetically distinct geographical subunit of a species.

Threatened: Defined by U.S. Fish and Wildlife Service and listed in the Federal Register as likely to become endangered within the foreseeable future (see "endangered").

Ungulate: Belonging to the group of hoofed animals (the former order Ungulata), including the odd-toed perissodactyls (including horses and rhinoceros) and even-toed artiodactyls (including cows, deer, and pigs).

Watershed: The region or area drained by a river, stream, etc.

Withdrawal period: The number of days that must elapse between drug administration and slaughter so that meat from a treated animal is fit for human consumption.

Zona Pellucida: The proteinaceous layer surrounding the ovum of mammals.

This page intentionally left blank

Index

APPENDIXES

This page intentionally left blank

APPENDIX A: INTERAGENCY PROJECT AGREEMENT

This page intentionally left blank

PROJECT AGREEMENT
Elk and Vegetation Management Plan/Environmental Impact Statement
Rocky Mountain National Park and Vicinity
March 4, 2003

Approved by:

____

Vaughn L. Baker — Date
Superintendent, Rocky Mountain National Park

____

Russell George — Date
Director, Colorado Division of Wildlife

____

Honorable John Baudek — Date
Mayor, Town of Estes Park

____

Tony Paglia, President of the Board of Directors — Date
Estes Valley Recreation and Parks District

____

James S. Bedwell, Supervisor — Date
Arapaho and Roosevelt National Forests

____

Brian Person, Area Manager — Date
U.S. Bureau of Reclamation, Eastern Colorado Area Office

____

Honorable Gene Stover — Date
Mayor, Town of Grand Lake

Honorable Duane Dailey | Date
Commissioner, Grand County

Tom Bender, Chair of the Board of County Commissioners | Date
Larimer County

PROJECT AGREEMENT

Elk and Vegetation Management Plan/Environmental Impact Statement
Rocky Mountain National Park and Vicinity

PURPOSE

The purpose of this project agreement is to establish how an Elk and Vegetation Management Plan and Environmental Impact Statement (Plan/EIS) will be prepared for the Rocky Mountain National Park area using the planning process required by the National Environmental Policy Act of 1969 (as amended) (NEPA), laws applicable to the Park, and National Park Service (NPS) policy. This agreement will terminate on the issuance of the final Plan/EIS. This agreement identifies the products to be produced, a project schedule, and the roles and responsibilities of the following participating agencies:

- Rocky Mountain National Park
- Arapaho-Roosevelt National Forest
- U.S. Bureau of Reclamation
- Colorado Division of Wildlife
- Town of Estes Park, Colorado
- Estes Valley Recreation and Park District, Colorado
- Town of Grand Lake, Colorado
- Grand County, Colorado
- Larimer County, Colorado

PROJECT BACKGROUND

The appropriate population size and associated effects of elk in Rocky Mountain National Park (RMNP) and Estes Park have been intensely debated since the 1930s. Recent research results indicate that the elk population size, distribution, and migratory patterns are outside the range of variability that would be expected under natural conditions. This has resulted largely because the influence of any significant predation (including hunting) is missing from the system. All major, natural predators of elk (e.g., wolves) were gone from the area by the early 1900s; and hunting on adjacent U.S. Forest Service and private lands has become largely ineffective due to extensive land development in and around the Town of Estes Park and elk habituation to these residential areas.

The size and concentration of the elk population is resulting in a number of adverse effects in the area. Willow and aspen have declined on the core winter range in RMNP, and these species are not sustainable in some areas under the current level of herbivory. Property damage and human safety concerns in Estes Park have escalated as elk increasingly winter and summer within town limits.

Due to the migratory nature of the elk population, local land and wildlife management agencies consider a regional approach essential to develop a meaningful, long-term plan.

During winter, there are approximately 1000 elk in the lower elevations of RMNP and 2000 elk in the Town of Estes Park and adjacent U.S. Forest Service and private lands. The majority of all these animals migrate to higher elevations in RMNP during the summer. Throughout the course of a year, elk and the habitat they occupy are under the jurisdiction of different state and federal agencies, local governments, and private landowners.

As such, an interagency planning team has been assembled to prepare an Elk and Vegetation Management Plan/EIS. The Plan/EIS will evaluate a range of management alternatives and the potential impacts to natural and human environments resulting from each alternative.

PROJECT PURPOSE

The Plan/EIS will discuss the following:

1. Address size and distribution of the elk population.
    - Maintain a wild and free-ranging population
    - Restore the natural range of variability to the extent possible
    - Make specific commitments related to size, density, and distribution

2. Coordinate strategies and objectives of this Plan/EIS with those of the RMNP Chronic Wasting Disease EIS.

3. Recognize the need to coordinate the management of natural, social, and economic values of the affected agencies.

4. Reduce the risk from elk to public safety to the extent practicable.

5. Address the risk of damage to private property by elk.

6. Provide for recreational opportunities associated with elk, such as viewing or hunting.

7. Restore the natural range of variation in plant communities that would be expected under natural conditions in the park and at selected sites outside the park, to the extent possible.

    - Make specific commitments regarding levels of herbivory
    - Prevent loss of aspen clones on the core winter range until more information on historic significance is available
    - Maintain or increase existing willow cover

8. Recognize the economic significance of the elk herd.

PLANNING PROCESS

The purpose of the interagency planning team is to undertake a quality planning process to produce the Plan/EIS. The National Park Service will function as the lead agency. The U.S. Forest Service, U.S. Bureau of Reclamation, Colorado Division of Wildlife, Grand County, Larimer County, Town of Estes Park, Town of Grand Lake, and Estes Valley Recreation and Parks District will serve as cooperating agencies.

Each agency is represented on either the core planning team or an extended planning team. Throughout the planning process, all core planning team members will maintain consistent communication and coordination with each other and the extended team. Routine coordination will be accomplished through a variety of methods, including electronic mail, conference calls, meetings, memoranda, and progress reports. Core planning team members will be present at internal team meetings to determine issues and objectives, potential management techniques, develop specific alternatives, evaluate the potential impacts of each alternative, and identify the environmentally preferred alternative; attend public scoping meetings; and write or review appropriate portions of the Plan/EIS. The core planning team will periodically update the extended planning team. The extended planning team will stay informed on the progress of the planning process, participate in meetings as needed, provide information to the core planning team within their area of expertise or jurisdiction, and review appropriate portions of the Plan/EIS. The cooperating agencies agree not to share preliminary draft documents with the media prior to the lead agency's announcement of availability of those documents.

Total Quality NEPA, Inc., has been contracted to provide NEPA guidance and to facilitate internal team meetings. A private firm(s) will also be contracted to assist with public involvement and EIS preparation.

Appropriate coordination with the U.S. Fish and Wildlife Service, Army Corps of Engineers, and the State Historic Preservation Office will be conducted to ensure compliance with applicable laws, regulations and executive orders.

The planning process will follow the steps outlined on the attached project schedule. These include the following steps required by the NEPA process: public scoping, development of a draft Plan/EIS, public review and comment period on the draft Plan/EIS, preparation of a final Plan/EIS, preparation of a Record of Decision, and approval by the NPS Intermountain Regional Director.

PRODUCTS

The primary products that will be developed are:

- *Draft Elk and Vegetation Management Plan/Environmental Impact Statement*
- *Final Elk and Vegetation Management Plan/Environmental Impact Statement*
- *Record of Decision* (NPS only)

The draft Plan/EIS will include the following key components, as well as all pertinent supporting data: purpose and need, description of alternatives and proposed action, affected environment, environmental consequences, and consultation/coordination.

The final Plan/EIS will incorporate any necessary revisions, and will document comments to the draft Plan/EIS and associated responses.

A Record of Decision (ROD) will concisely explain, in accordance with Council on Environmental Quality guidelines, the decision made, when the decision will be implemented, the rationale for the decision, other alternatives considered, and applicable mitigation measures.

PUBLIC INVOLVEMENT

Extensive public involvement will be undertaken to provide information to and solicit input from all interested stakeholders. Stakeholders will be identified during the scoping process. Public involvement will be conducted as an iterative process, allowing stakeholders to participate at multiple stages of the Plan/EIS process.

Methods of Communication

- NOTICE OF INTENT - A Notice of Intent to prepare an Elk and Vegetation Management Plan/EIS will be published in the *Federal Register.*
- MAILING LIST - A comprehensive mailing list for the Plan/EIS will be developed. The team will compile an initial list of interested citizens and organizations. Individuals and organizations will be continually added to the mailing list at their request.
- NEWSLETTER – A series of newsletters will be prepared at the key stages to convey the planning process, inform stakeholders of progress, and invite response.
- WEB SITE – A web site will be developed and maintained on the NPS Park-Net planning site throughout the process (this site will be linked to the park's home page). The site will provide background information including research reports, notice of public involvement opportunities, newsletters, and draft and final plans.
- PUBLIC MEETINGS – public meetings will be held for scoping and review of the draft Plan/EIS, and at other times as needed throughout the process. A variety of methods (open houses, workshops, etc.) will be employed based on the desired objectives of each meeting. A contractor will be responsible for designing, facilitating and handling logistics of public meetings. Core planning team members will be present at each public meeting to answer questions. A variety of media materials (e.g., handouts, presentations, research reports, etc.) will be used to best enable the public to understand the issues and alternatives.
- NEWS RELEASES – At significant steps of the process, news releases will be used to inform the public of the nature and content of the plan, public meetings, and where to get more detailed information. All public meetings and comment periods will be preceded by press releases to newspapers, TV and radio stations.

- TRIBAL CONSULTATION – Consultation with the American Indian tribes will recognize the government-to-government relationship between the tribes and the federal government. The timing and methods of consultation with tribes who have religious or cultural associations with the lands of Rocky Mountain National Park will be determined with each interested tribe.

SCIENTIFIC INFORMATION

The planning team will prepare the Plan/EIS using the best available scientific and project area information. This will include data on local economics, tourism, hunter harvest, and social values. It will also include the final report of a National Park Service/United States Geological Survey research initiative that was recently completed, along with numerous other studies conducted in the area (e.g., aspen research), data from on-going monitoring (e.g., annual elk population surveys), and relevant research from other areas. Any applicable new data or research results that become available will be incorporated in the planning process.

PROJECT TEAM, ROLES AND RESPONSIBILITIES

Most tasks will require a combined effort by various planning team members and contractors. The following roles and responsibilities of each signatory of this agreement are listed below. Appendix 1 identifies agency representatives.

Core Team

Lead Agency:

Rocky Mountain National Park

- Contract private firm(s) (NEPA oversight, public involvement, EIS preparation) and provide the point of contact for the interagency team
- Identify stakeholders and maintain comprehensive mailing list
- Distribute federal register notices, meeting notices, scoping brochure, newsletters, and draft and final documents as appropriate
- Issue press releases
- Prepare and submit federal register notices
- Maintain an administrative record of the planning process
- Attend all team meetings
- Work with contractors to develop public involvement media
- Attend all public meetings
- Provide expertise and data on park resources, visitors, and operations
- Contribute to data analysis and write sections of the Plan/EIS
- Review entire Plan/EIS
- Keep extended team members informed
- Coordinate with NPS Intermountain Region and Washington Offices
- Select the preferred alternative

- Prepare a Record of Decision

Cooperating Agencies:

Town of Estes Park

- Identify stakeholders and provide mailing list
- Attend all team meetings
- Review press releases and public involvement media
- Attend public meetings
- Provide expertise and data on local economics, public safety, zoning and planning
- Review and comment on appropriate portions of the draft and final Plan/EIS

Estes Valley Parks and Recreation District

- Identify stakeholders and provide mailing list
- Attend all team meetings
- Review press releases and public involvement media
- Attend public meetings
- Provide expertise and data on conditions and management of recreational fields and golf courses
- Review and comment on appropriate portions of the draft and final Plan/EIS

<u>Extended Team</u>

Cooperating Agencies:

Colorado Division of Wildlife

- Attend team meetings as necessary
- Attend public meetings as necessary
- Provide expertise and data on wildlife related topics
- Review and comment on appropriate portions of the draft and final Plan/EIS

Arapaho-Roosevelt National Forest

- Attend team meetings as necessary
- Attend public meetings as necessary
- Provide expertise and data on habitat conditions and management on USFS lands
- Review and comment on appropriate portions of the draft and final Plan/EIS

Town of Grand Lake

- Attend team meetings as necessary

8

- Attend public meetings as necessary
- Provide expertise and data on local economics, public safety, zoning and planning as needed
- Review and comment on appropriate portions of the draft and final Plan/EIS

Grand County

- Attend team meetings as necessary
- Attend public meetings as necessary
- Provide expertise and data on county zoning and planning as needed
- Review and comment on appropriate portions of the draft and final Plan/EIS

U.S. Bureau of Reclamation

- Attend team meetings as necessary
- Attend public meetings as necessary
- Provide expertise and data on USBR property in the project area
- Review and comment on appropriate portions of the draft and final Plan/EIS

Larimer County

- Attend team meetings as necessary
- Attend public meetings as necessary
- Provide expertise and data on county zoning and planning as needed
- Review and comment on appropriate portions of the draft and final Plan/EIS

APPENDIX 1. Agency Representatives

Rocky Mountain National Park
- Vaughn Baker
- Ken Czarnowski
- Therese Johnson
- Ryan Monello

Colorado Division of Wildlife
- Rick Kahn
- Rick Spowart

Town of Estes Park
- Richard Widmer
- Bob Joseph
- Dave Shirk

Estes Valley Parks and Recreation District
- Stan Gengler

Arapaho-Roosevelt National Forest
- Hal Gibbs
- Vernon LaFontaine
- Dennis Lowry

Town of Grand Lake
- James Cervenka

Grand County
- Duane Dailey

Bureau of Reclamation
- Will Tully

Larimer County
- Frank Lancaster

APPENDIX B: ESTIMATED COSTS OF THE ACTION ALTERNATIVES

This page intentionally left blank

ESTIMATED COSTS OF THE ACTION ALTERNATIVES

The cost of each alternative was derived from multiple sources. Direct professional estimates were provided by staff from the National Park Service and the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, Wildlife Services Division for costs associated with lethal reduction, wolf reestablishment, chronic wasting disease testing, monitoring, education/interpretation, and aversion methods. Comparable costs were derived from literature sources and subject matter experts for fences, fertility control, and carcass disposal.

The costs for Alternative 1 are not presented in the following tables. Alternative 1 assumes continuation of the current staff levels described in Chapter 3, Affected Environment, Park Operations. It is assumed that funding would continue throughout the 20-year planning timeframe to support current levels of staffing.

Cost estimates are presented for the components of the alternatives and include both infrastructure and other costs that occur one time during the project and annual or recurring costs that are incurred throughout the life of the project. In all action alternatives, the cost of overall project oversight, visitor management including carrying out any temporary closures, and visitor education and interpretation about the program would be provided with existing personnel as a part of their other regular duties.

The base assumptions for each alternative are presented in the alternatives descriptions in Chapter 2 and the methodology sections in Chapter 4, and were used for determining amounts and frequencies of use for the various elements of the alternatives. Additionally, the following assumptions were used to develop cost estimate:

The expected amount of fencing for each alternative is as represented in Chapter 2 description of the alternatives. Although the timing for the installation of fences would be based on monitoring and the effect of elk herbivory on aspen and willow recovery, it is uncertain in what years fences would be installed. Fence costs were estimated at $30,000 per linear mile.

Linear miles of fence for willow were based on information from the fence design of the park's Fan Lake exclosure. A 20 acre exclosure with a typical number of turns and corners requires approximately 5,600 linear feet of fence. Total milage was calculated by dividing the total willow acreage fenced by 20 acre blocks and multiplying the number of blocks by 5,600 feet and converted to miles.

Linear miles for aspen were based on best professional judgement with an assumed average exclosure size of 2.5 acres. A 2.5 acre square would equal 0.25 miles of fence. A thirty-five percent increase was added to account for turns and bends in the fence to arrive at a total of 0.3375 mile per 2.5 acre block.

The use of helicopters to transport fence materials to remote locations varies based on the amount of fencing estimated for each alternative. The cost to use helicopters was based on $1,400 per hour. The number of hours needed per alternative was estimated as follows and was based on best professional judgement:

Alternative 2 = 50 hours
Alternative 3 = 500 hours
Alternative 4 = 350 hours
Alternative 5 = 25 hours

The cost of high intensity lethal reduction (culling more than 200 elk per year) in the first four years for Alternatives 2 and 5 are based on using contractors. The costs for this type of operation were estimated by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service. Assumptions used included:

> Lethal reduction activities would require a staff of 1.5 full-time equivalents (FTE) to administer the program;
>
> Field operations would require a seasonal staff of 10 at a GS-9 federal salary level working for 7 months each year.

The cost for lower intensity lethal reduction (culling less than 200 elk per year) during years 5-20 in Alternatives 2 and 5 and in years 1-20 in Alternatives 3 and 4 is based on using park staff labor. Work would be accomplished by two teams composed of one full time GS-9 staff position; and one GS-6 and two GS-5 staff positions for 13 weeks each year. The cost also includes pack stock to support the culling activities.

The cost of all lethal reduction activities, CWD testing, and disposal of carcasses that test positive for CWD was estimated using the median number within the range of elk to be culled for each alternative..

Labor to collect CWD samples is included in lethal reduction labor since it is assumed that these activities would take place concurrently by the same staff. The materials cost of the CWD test is $25 per test.

Carcass disposal is based on a five percent CWD rate in the median number of elk culled. Disposal of CWD positive carcasses would be accomplished with chemical digestion at a cost of $70 per carcass.

Ninetyfive percent of culled elk will not test positive for CWD and meat and/or carcasses would be donated to eligible recipients, with funding for a donation program covered by other entities such as non-governmental organizations.

The cost for elk redistribution in years 1-4 in Alternatives 2 is based on labor provided by one GS-6 and two GS-5 staff positions for 13 weeks each year.

The cost of elk redistribution in years 5-20 in Alternative 2 and years 1-20 in Alternatives 3 and 4 is based on labor provided by one GS-6 and two GS-5 staff positions for 13 weeks each year; and one GS-5 staff position for 26 weeks each year.

Fertility control operations in Alternative 4 would have similar operating characteristics as those of high intensity lethal reduction performed by contractors, but would require approximately 50% less labor.

The wolf release program in Alternative 5 would require an additional full-time biologist at a GS-11 federal salary level; aerial surveillance and tracking would take place with fixed-wing aircraft or helicopters, and an average of 12 surveillance and tracking outings would take place each year.

An adaptive management assessment would be conducted every five years to evaluate the effectiveness of the elk and vegetation management program and determine the need to adjust or change any component of the program. The cost of the adaptive management assessment is indicated annually as one-fifth of the estimated cost of additional monitoring and evaluation that would be needed every five years.

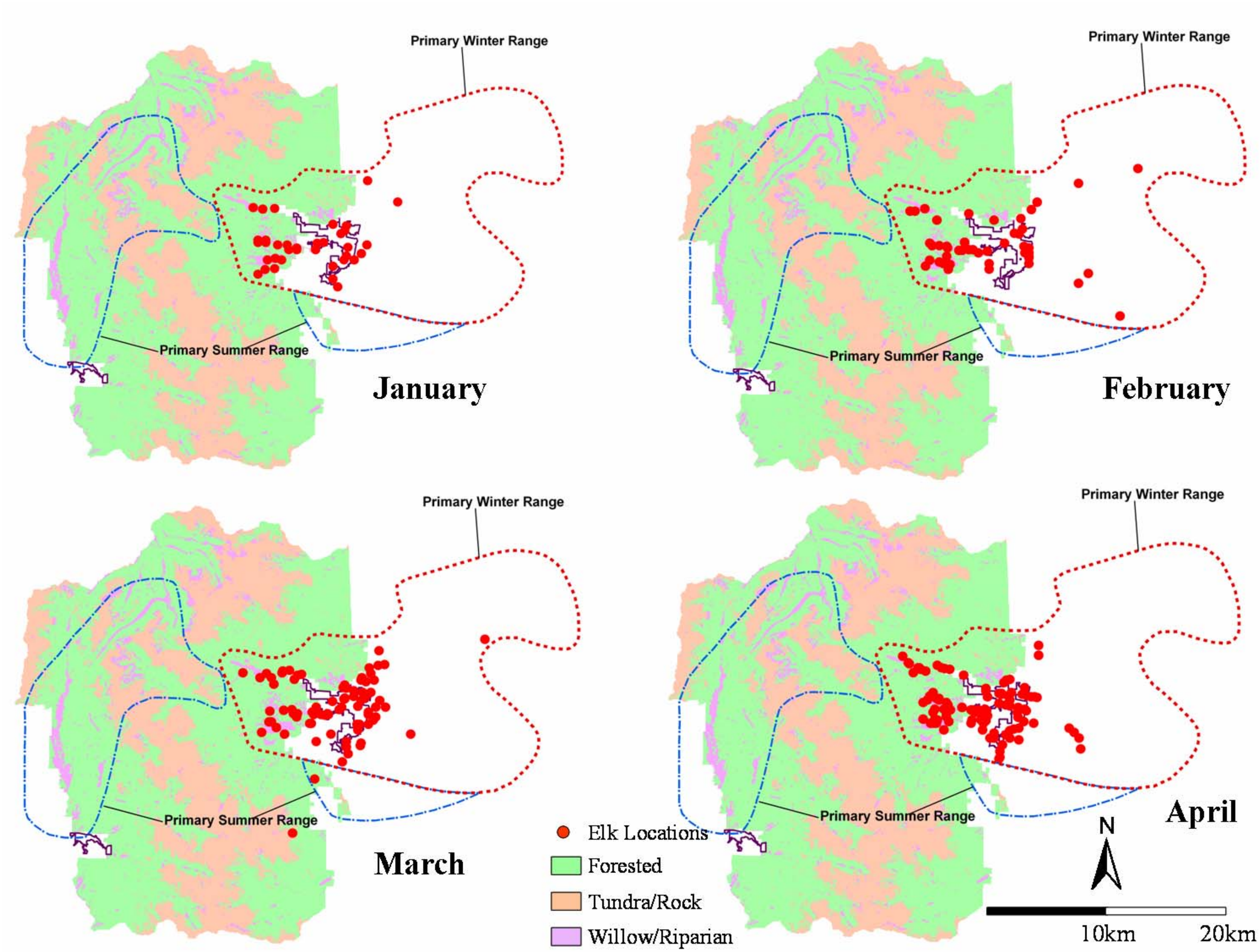
			Alternative 2
INFRASTRUCTURE AND ONE-TIME COSTS			**Estimated Cost**
A.	Fencing (aspen only)		$630,000.00
B.	Aviation (fence installation)		$70,000.00
C.	Initial equipment (reduction operations)		$172,000.00
D.	Refrigerated Truck		$75,000.00
E.	Capture Facility		$25,000.00
Total Infrastructure and One-Time Cost			**$972,000**
ANNUAL COSTS			
A.	Reduction - Lethal		
	Year 1-4	450 elk per year Labor, Travel, Pack Animals	$991,646.24
	Year 5-20	88 elk per year Labor, Pack Animals	$95,950.00
B.	Carcass Disposal		
	Year 1-4		$1,610.00
	Year 5-20		$350.00
C.	CWD Testing		
	Year 1-4		$11,250.00
	Year 5-20		$2,200.00
D.	Monitoring (elk and vegetation)		$42,075.00
E.	Redistribution (Yr.1-4)		$31,350.00
F.	Redistribution (Yr. 5-20)		$50,050.00
G.	Adaptive Management Assessment		$21,130.00
Total Annual Cost (Years 1-4)			**1,099,061**
Total Annual Cost (Years 5-20)			**211,755**

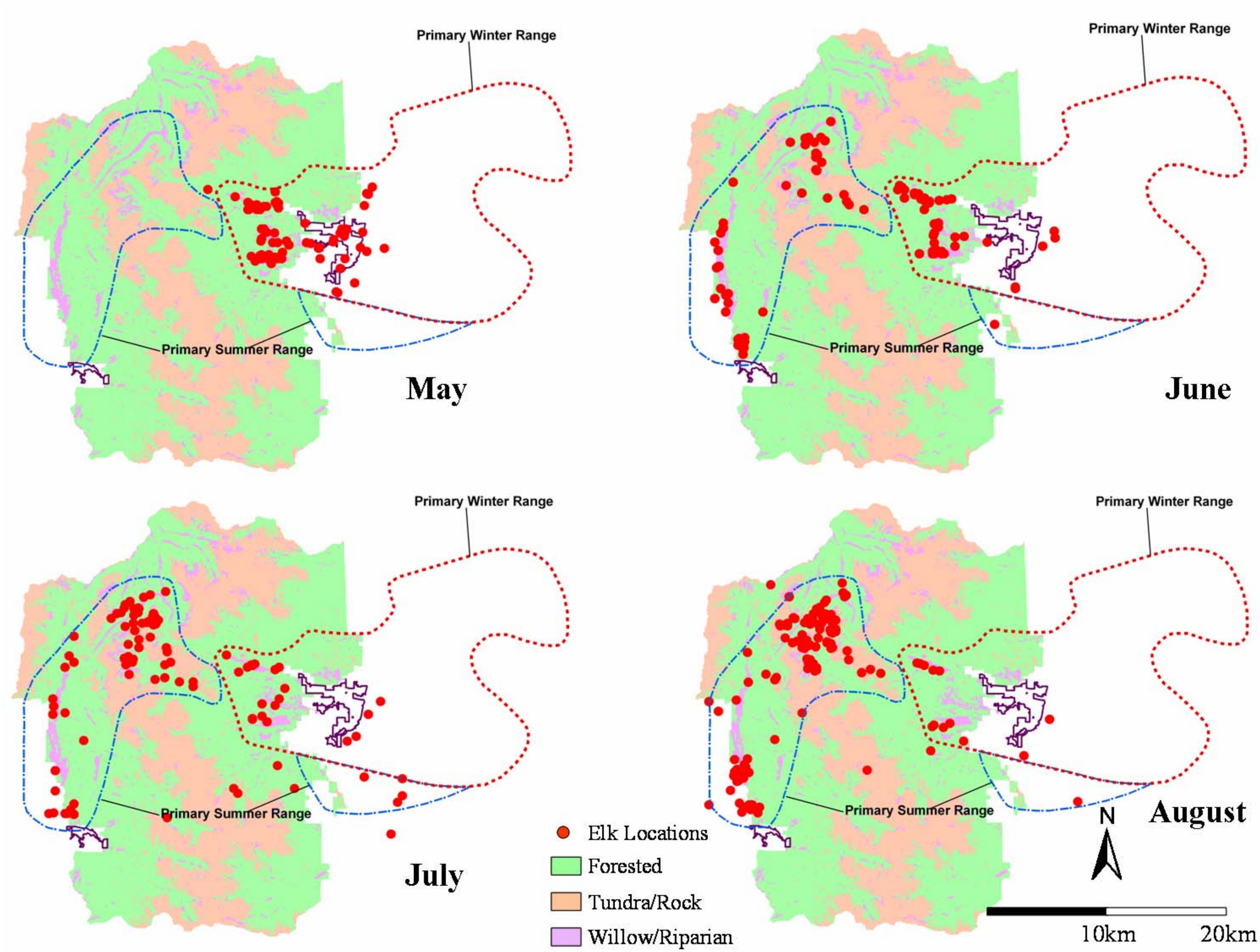
			Alternative 3
INFRASTRUCTURE AND ONE-TIME COSTS			**Estimated Cost**
A.	Fencing		$1,440,000.00
B.	Aviation (fence installation)		$700,000.00
C.	Initial equipment (reduction operations)		$34,100.00
Total Infrastructure and One-Time Cost			**2,174,100**
ANNUAL COSTS			
A.	Reduction - Lethal		
	Year 1-20	100 elk per year	
		Labor and pack animals	$95,950.00
B.	Carcass Disposal		
	Year 1-20		$350.00
C.	CWD Testing		
	Year 1-20		$2,500.00
D.	Monitoring (elk and vegetation)		$42,075.00
E.	Redistribution		$50,050.00
F.	Adaptive Management Assessment		$21,130.00
Total Annual Cost (Years 1-20)			**212,055**

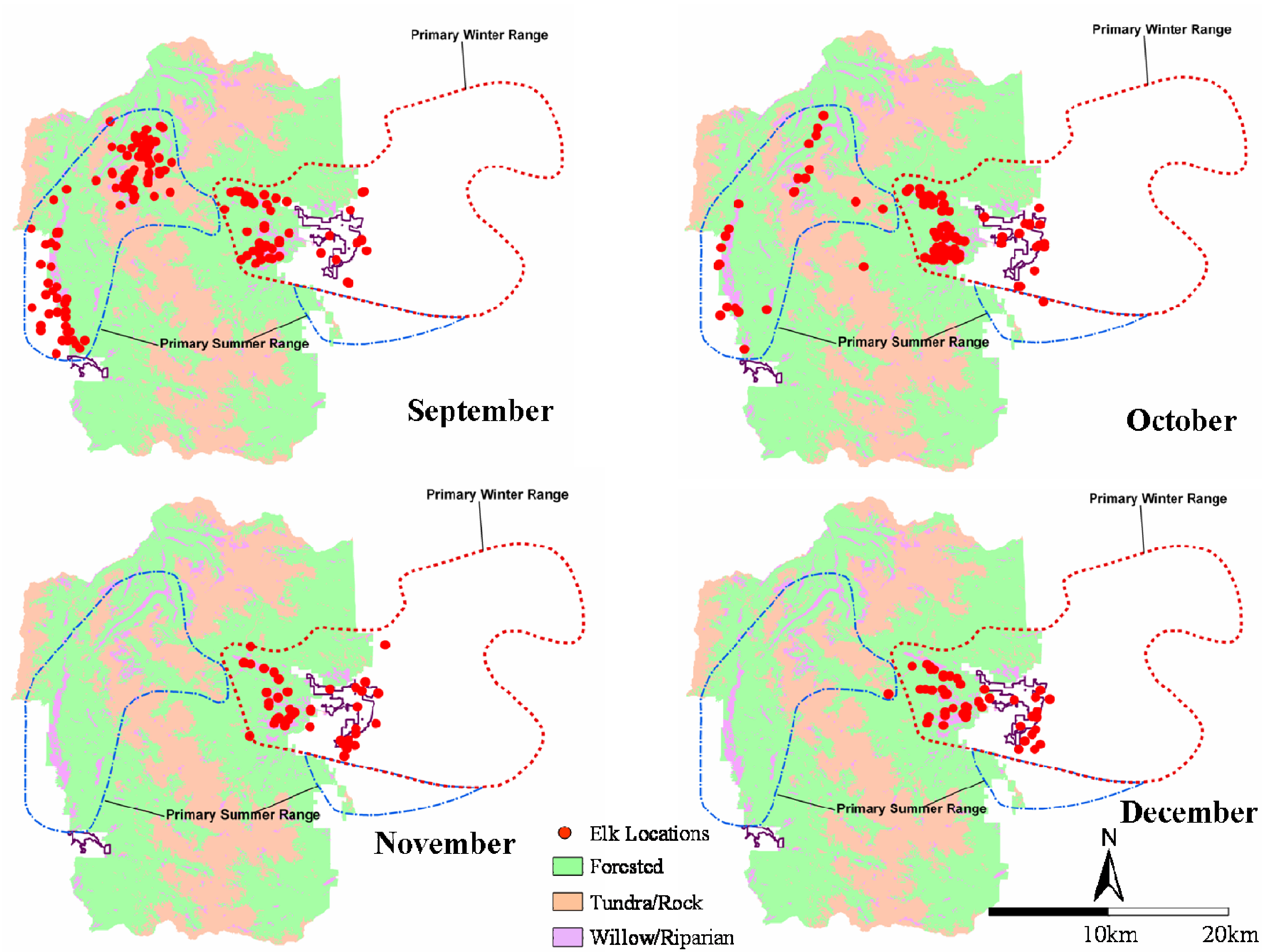
	Alternative 4
INFRASTRUCTURE AND ONE-TIME COSTS	**Estimated Cost**
A. Fencing	$1,020,000.00
B. Aviation (fence installation)	$490,000.00
C. Initial equipment (reduction operations)	$34,100.00
D. Capture Facility	$25,000.00
Total Infrastructure and One-Time Cost	**1,569,100**
ANNUAL COSTS	
A. Reduction - Fertility	
Year 1-4 — 400 elk per year	
Labor and fertility agent	$464,000.00
Year 5-20 — 200 elk per year	
Labor and fertility agent	$232,000.00
B. Reduction - Lethal	
Year 1-20 — 115 elk per year	
Labor and pack animals	$95,950.00
C. Carcass Disposal	
Year 1-20	$420.00
D. CWD Testing	
Year 1-20	$2,875.00
E. Monitoring (elk and vegetation)	$42,075.00
F. Redistribution	$50,050.00
Total Annual Cost (Years 1-4)	**655,370**
Total Annual Cost (Years 5-20)	**423,370**

	Alternative 5
INFRASTRUCTURE AND ONE-TIME COSTS	**Estimated Cost**
A. Fencing (aspen only)	$330,000.00
B. Aviation (fence installation)	$35,000.00
C. Initial equipment (reduction operations)	$172,000.00
D. Refrigerated Truck	$75,000.00
E. Initial equipment (wolf program)	$55,220.00
F. Capture/transport - Wolves	$28,412.00
G. Wolf Pen - for soft release	$42,618.00
H Capture Facility	$25,000.00
Total Infrastructure and One-Time Cost	**763,250**
ANNUAL COSTS	
A. Reduction - Wolves	
Labor	$114,608.00
Fixed Wing Aircraft	$18,652.80
Tranquilizer and net gun supplies	$1,160.00
Capture operations	$290,000.00
Education/enforcement (NPS)	$35,515.00
B. Reduction - Lethal	
Year 1-4 225 elk per year	
Labor, travel, pack animals	$724,278.00
Year 5-20 50 elk per year	
Labor, pack animals	$95,950.00
C. Carcass Disposal	
Year 1-4	$840.00
Year 5-20	$210.00
D. CWD Testing	
Year 1-4	$5,625.00
Year 5-20	$1,250.00
E. Monitoring (elk and vegetation)	$42,075.00
Total Annual Cost (Years 1-4)	**1,232,754**
Total Annual Cost (Years 5-20)	**599,421**

APPENDIX C: ELK USE OF RANGES BY SEASON


Primary Winter Range
Primary Summer Range
January
Primary Winter Range
Primary Summer Range
February
Primary Winter Range
Primary Summer Range
March
Primary Winter Range
Primary Summer Range
April
Elk Locations
Forested
Tundra/Rock
Willow/Riparian
N
10km
20km


Primary Winter Range
Primary Summer Range
May
June
July
August
Elk Locations
Forested
Tundra/Rock
Willow/Riparian
N
10km
20km


Primary Winter Range
Primary Summer Range
September
Primary Winter Range
Primary Summer Range
October
Primary Winter Range
Primary Summer Range
November
Primary Winter Range
Primary Summer Range
December
Elk Locations
Forested
Tundra/Rock
Willow/Riparian
N
10km
20km

This page intentionally left blank

APPENDIX D: SPECIAL STATUS SPECIES

This page intentionally left blank

THREATENED AND ENDANGERED UNIT SPECIES LIST
ENDANGERED SPECIES ACT (ESA)
ROCKY MOUNTAIN NATIONAL PARK

December 2004

The following table contains a list of species that are specific to Rocky Mountain National Park and are federally listed as endangered, threatened or candidates for listing, by the U.S. Fish and Wildlife Service under the provisions of the Endangered Species Act. The U.S. Fish and Wildlife Service has reviewed the list and provided a letter of concurrence dated April 12, 2005 (see attached).

The species that are included in the table must meet one of the following criteria:

1. The species is known to occur within the park.

2. The species does not occur within the park, but suitable habitat is available, the habitat is within the known elevation range for the species, and the species is known to exist in counties that the park occupies.

3. The species does not occur within the park, but actions within the park have the potential to affect the species.

In compliance with the Endangered Species Act, all management actions within the park are evaluated to determine if they will have any effect on endangered, threatened or candidate species on this list.

Federally Listed and Candidate Species & Their Status in Colorado	Known to Occur in RMNP	Known to Occur in Boulder County	Known to Occur in Larimer County	Known to Occur in Grand County
Amphibians				
Boreal toad, *Bufo boreas boreas*, Candidate for Listing	Yes	Yes	Yes	Yes
Birds				
Bald Eagle, *Haliaeetus leucocephalus,* Threatened	Yes	Yes	Yes	Yes
Least tern, *Sterna antillarum*, Endangered	No	▲	▲	No
Mexican spotted owl, *Strix occidentalis lucida*, Listed Threatened	No	Yes Historically	Yes Historically	No
Piping plover, *Charadrius melodus*, Threatened	No	▲	▲	No

Federally Listed and Candidate Species & Their Status in Colorado	Known to Occur in RMNP	Known to Occur in Boulder County	Known to Occur in Larimer County	Known to Occur in Grand County
Whooping crane, *Grus americana*, Endangered	No	▲	▲	No
Yellow-billed cuckoo, *Coccyzus americanus*, Candidate for Listing	Yes Historically	No	Yes	Yes
Fish				
Bonytail, *Gila elegans*, (presumed-historical) Endangered	No	No	No	*
Colorado pikeminnow, *Ptychocheilus lucius*, Endangered	No	No	No	*
Greenback cutthroat trout, *Oncorhynchus clarki stomias*, Threatened	Yes	Yes	Yes	No
Humpback chub, *Gila cypha*, Endangered	No	No	No	*
Pallid sturgeon, *Scaphirhunchus albus*, Threatened	No	▲	▲	No
Razorback sucker, *Xyrauchen texanus*, Endangered	No	No	No	*
Mammals				
Canada lynx, *Lynx canadensis*, Threatened	Yes	Yes	Yes	Yes
Preble's meadow jumping mouse, *Zapus hudsonius preblei*, Threatened	No	Yes	Yes	No
Plants				
Colorado butterfly plant, *Gaura neomexicana* spp. *Coloradensis*, Threatened	No	Yes	Yes	No
Utes ladies'-tresses, *Spiranthes diluvialis*, Threatened	No	Yes	Yes	No

Table Terminology
* Water depletions in the Upper Colorado River basin may affect these species
▲ Water depletions in the South Platte River basin may affect these species
Candidate - Means there is sufficient information indicating that formal listing under the ESA maybe appropriate
Endangered - Means the species could become extinct
Threatened - Means the species could become endangered

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Colorado Field Office
755 Parfet Street, Suite 361
Lakewood, Colorado 80215

IN REPLY REFER TO:
ES/CO: NLAA/RMNP
Mail Stop 65412

OCT 18 2005

Mr. Larry Gamble
Chief, Branch of Planning & Compliance
Rocky Mountain National Park
Estes Park, Colorado 80517

Dear Mr. Gamble:

The U.S. Fish and Wildlife Service has received your October 3, 2005, emailed correspondence requesting concurrence for your revised Threatened and Endangered Unit Species List (revised December 2004). The purpose of the "unit species list" is to streamline the section 7 consultation required of Federal agencies under the Endangered Species Act. This list would eliminate the Rocky Mountain National Park (RMNP) agencies from having to request a threatened and endangered species list each time they require consultation with the Service.

The Service concurs with your updating the status listed for the Boreal toad, *Bufo boreas boreas*. This species is no longer a candidate species and it is appropriate to remove it from your Threatened and Endangered Unit Species List. The Service also concurs that the following listed species may be affected by activities of the Rocky Mountain National Park and consultations will be needed. Although candidate species presently receive no protection under the Act, it is within the spirit of the Act to consider project impacts to potentially sensitive species. Please be aware that threatened and endangered species lists should be updated every 90 days by telephone or in writing. If the update requires a change in the list below, the change will be documented in writing. The following species are of potential concern for your projects.

Unit Species List for the Rocky Mountain National Park

Bald eagle	*Haliaeetus leucocephalus*
Bonytail	*Gila elegans*
Canada lynx	*Lynx canadensis*
Colorado butterfly plant	*Gaura neomexicana spp. Coloradensis*
Colorado pikeminnow	*Ptychocheilus lucius*
Greenback cutthroat trout	*Oncorhynchus clarki stomias*
Humpback chub	*Gila cypha*
Least Tern	*Sterna antillarum*
Mexican spotted owl	*Strix occidentalis lucida*

Pallid sturgeon	*Scaphirhunchus albus*
Piping plover	*Charadrius melodus*
Preble's meadow jumping mouse	*Zapus hudsonius preblei*
Razorback sucker	*Xyrauchen texanus*
Ute ladies'-tresses	*Spiranthes diluvialis*
Whooping crane	*Grus americana*
Yellow-billed cuckoo	*Coccyzus americanus*

If the Service can be of further assistance, contact Andrea Jackson of my staff at (303)275-2349.

Sincerely,

Susan C. Linner

Susan Linner
Colorado Field Supervisor

Reference: SpeciesList/ RMNP 10-2005

State Endangered, Threatened, and Rare Species

for

Rocky Mountain National Park

Last Revised February 2006

Rocky Mountain National Park (RMNP) uses the following table to identify state endangered and threatened species, species of concern and rare species that must be protected if found within a proposed project site. The RMNP list is updated annually. Federally threatened, endangered and candidate species are maintained in another list, separate from state listed species.

Agencies have a variety of ways of tracking and measuring the biological imperilment of species. The Colorado Wildlife Commission determines if a given specie needs protection under state laws. Three primary categories are applicable to Rocky Mountain National Park:

State Status Codes

E **State Endangered** – Listed as endangered by the Colorado Division of Wildlife. Those species or subspecies of native wildlife whose prospects for survival or recruitment within Colorado are in jeopardy, as determined by the Commission. State endangered species have legal protection under Colorado Revised Statues 33-2-105 Article 2.

T **State Threatened** – Listed as threatened by the Colorado Division of Wildlife. Those species or subspecies of native wildlife which, as determined by the Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct. State threatened species have legal protection under Colorado Revised Statues 33-2-105 Article 2.

SC **State Special Concern** – Those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

The Colorado Division of Wildlife maintains species list for T&E and SC species at http://wildlife.state.co.us/wildlifespecies/speciesofconcern/

Species of Continental Importance Code

Partners in Flight (PIF) developed a North American Landbird Conservation Plan in 2004 and an updated species assessment database and handbook in 2005. These documents provide a continental synthesis of priorities, objectives and rankings that will guide landbird conservation actions at national and international scales. Species of continental concern are identified in the column with CNHP global rank codes as CC. A list of all PIF landbird species of continental importance, watch listed species, and stewardship species can be found at http://www.rmbo.org/pif/pifdb.html . North American Avian Species of Continental Importance (RMNP is within the Intermountain West Avifaunal Biome Bird Conservation Region (BCR) 16)

CC Continental Concern Species. Species must meet all of the following criteria in order to rank as a species of concern within RMNP

Population size (PS-g) score greater than 3,

Breeding distribution (BD-g) score greater than 3,

Threats to breeding (TB-g) score greater than 3,

Population trend (PT-t) score greater than 2,

Percent of Population (Pct POP) in BCR-16 greater than 20%

Global and State Ranking Codes

The Colorado Natural Heritage Program (CNHP), based in Fort Collins manages a large database and ranking system for Colorado species. The database can be accessed through the Internet at www.cnhp.colostate.edu The CNHP ranking system has two primary components – a ranking for the global status of the specie (G), and a ranking for that part of the range found within the state (S). Numeric extensions are added to these on a scale of 1 (critically imperiled) to 5 (demonstrably secure). A reference that CNHP uses to identify global status of a species is an online encyclopedia of life maintained by NatureServe at http://www.natureserve.org/

Natural Heritage ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. National Park Service policies and guidelines require the preservation and protection of all native species.

Global Rank Codes

G1 Critically imperiled globally because of rarity (5 or fewer occurrences in the world; or 1,000 or fewer individuals), or because of some factor of its biology makes it especially vulnerable to extinction.

G2 Imperiled globally because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.

G3 Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).

G4 Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery, usually more than 100 occurrences and 10,000 individuals.

G5 Demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery.

G#T# Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.

GQ Indicates uncertainty about taxonomic status.

G#? Indicates uncertainty about an assigned global rank.

State Rank Codes

S1 Critically imperiled state because of rarity (5 or fewer occurrences in the world; or 1,000 or fewer individuals), or because of some factor of its biology makes it especially vulnerable to extinction.

S2 Imperiled state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.

S3 Vulnerable through its range within a state or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).

S4 Apparently secure within the state, though it might be quite rare in parts of its range, especially at the periphery, usually more than 100 occurrences and 10,000 individuals.

S5 Demonstrably secure within the state, although it may be quite rare in parts of its range, especially at the periphery.

S#B Refers to the breeding season imperilment of species that are not permanent residents.

S#N Refers to the non-breeding season imperilment of species that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used.

SH Historically known, but usually not verified for an extended period of time and could be extirpated from the park or the state.

SNR Not yet ranked in the state due to lack of information.

SX Presumed extirpated from within the state.

S#? Indicates uncertainty about an assigned state rank.

The RMNP list of state Endangered, Threatened, and Rare Species does not include State Rank Codes S4 and S5, unless it has been identified as a species of continental concern (CC), because these rankings indicate that the specie is apparently or demonstrably secure within the state. If a specie is listed as unconfirmed, it means it occurred historically and is presently not confirmed in the park; or has never been confirmed but the park has appropriate habitat, or it has been confirmed (historically or presently) in the counties the park occupies.

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Amphibians					
Bufo boreas pop1	Boreal toad (Southern Rocky Mountain Population)	All year	E	G4T1Q	S1
Rana sylvatica	Wood Frog	All year	SC	G5	S3
Birds					
Accipiter gentiles	Northern goshawk	All year		G5	S3B
Aegolius funereus	Boreal owl	All year		G5	S2
Otus flammeolus	Flammulated owl	Summer or migrant		CC, G4	S4
Amphispiza belli?	Sage sparrow	Summer or migrant		G5	S3B
Bucephala islandica	Barrow's goldeneye	Winter or migrant	SC	G5	S2B
Buteo regalis	Ferruginous hawk	Migrant	SC	G4	S3B, S4N
Calcarius mccownii	McCown's longspur	Migrant		G5	S2B
Catharus fuscescens	Veery	Summer or migrant		G5	S3B
Sialia mexicana	Western bluebird	Summer		CC , G5	S5B, S4N
Pipilo chlorurus	Green-tailed towhee	Summer		CC, G5	S5
Catoptrophorus semipalnatus	Willet	Migrant		G5	S1B
Melanerpes lewis	Lewis's woodpecker	Summer, migrant		CC, G4	S4

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Sphyrapicus thyroideus	Williamson's sapsucker	Summer		CC, G4	S4B
Coccyzus americanus occidentalis (unconfirmed)	Western Yellow-billed cuckoo	Accidental, two recorded occurrences, 1947 & 1980	SC	G5T2Q	SNA
Empidonax occidentalis	Cordilleran flycatcher	Summer		CC, G5	S5B
Cypseloides niger	Black swift	Summer		G4	S3B
Vermivora virginiae	Virginia's warbler	Summer		CC, G5	S5
Dendroica graciae	Grace's warbler	Accidental, one recorded occurrence, 1990		G5	S3B
Dolichonyx oryzivorus	Bobolink	Accidental, summer or migrant		G5	S3B
Egretta thula	Snowy Egret	Migrant or rare summer		G5	S2B
Falco peregrinus anatum	American peregrine falcon	Summer or migrant	SC	G4T3	S2B
Glaucidium gnoma	Northern pygmy owl	All year		G5	S3B
Grus canadensis tabida	Greater sandhill crane	Summer or migrant	SC	G5T4	S2B, S4N
Haliaeetus leucocephalus	Bald eagle	All year	T	G5	S1B, S3N
Leucosticte australis	Brown-capped rosy-finch	All year		CC, G4	S3B, S4N
Loxia leucoptera	White-winged crossbill	All year, Irregular visitor		G5	S1B

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Numenius americanus	Long-billed curlew	Migrant	SC	G5	S2B
Pelecanus erythrorhynchos	American white pelican	Migrant	SC	G3	S1B
Plegadis chihi	White-faced ibis	Migrant		G5	S2B
Seiurus aurocapillus	Ovenbird	Rare summer or rare migrant		G5	S2B
Sterna forsteri	Forster's tern	Migrant		G5	S2B, S4N
Strix occidentalis lucida (Unconfirmed)	Mexican spotted owl	* All Year	T	CC, G3T3,	S1B, SUN
Fish					
Oncorhynchus clarki pleuriticus	Colorado River cutthroat Trout	All year	SC	G4T3	S3
Oncorhynchus clarki stomias	Greenback cutthroat trout	All year	T	G4T2T3	S2
Mammals					
Canis lupis (historic/ presently unconfirmed)	Gray wolf		E	G4	SX
Lynx canadensis	Lynx	All year	E	G5	S1
Gulo gulo (unconfirmed)	Wolverine	All year	E	G4	S1
Lontra canadensis	River otter	All year	T	G5	
Sorex hoyi montanus	Pygmy shrew	All year		G5T2 T3	S2
Sorex nanus	Dwarf shrew	All year		G4	S2
Ursus arctos (historic/extirpated)	Grizzly or Brown bear		E	G4	SX

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Invertebrates (Insects)					
Alloperia pilosa	A stonefly	All year		G3	S2
Colorado luski	Lusk's pinemoth	Summer		G4	S1?
Hyles galli	Galium sphinx moth	Summer		G5	S3?
Paratrytone snowi	Snow's skipper	Summer		G5	S3
Perlomyia utahensis	A stonefly	All year		G3	S2
Pictetiella expansa	A stonefly	All year		G3	S2
Pyrgus ruralis	Two-banded skipper	Summer		G5	S3
Stinga morrisoni	Morrison's skipper	Summer		G4G5	S3S4
Mollusk					
Acroloxus coloradensis	Rocky mountain capshell	All year	SC	G3	S1
Lichens					
Brachythecium ferruginascens				G3G4	S1S3
Bryum alpinum				G4G5	S1S3
Mosses					
Andreaea heinemannii				G3G5	S1S3
Andreaea rupestris				G5	S1S3
Aulacomnium palustre var. imbricatum				G5TNR	S1S3
Campylopus schimperi				G3G4	S1S3
Grimmia mollis				G3G5	S1S3

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Grimmia teretinervis				G3G5	S1S3
Hylocmiastrum pyrenaicum				G4G5	S1S3
Hylocomium alaskanum				G5	S1S3
Leptopterigynandrum austro-alpinum				G3G5	S1S3
Mnium blyttii				G5	S1S3
Oreas martiana				G5?	S1S3
Plagiothecium cavifolium				G5	S1S3
Pleurozium schreberi	Feathermoss			G5	S1S3
Pohila tundrae				G2G3	S1S3
Rhytidium rugosum	Golden Glade-moss			G5	S1S3
Roellia roellii				G4	S1S3
Sphagnum contortum	Sphagnum			G5	S1S3
Liverworts					
Gymnomitrion corallioides				G4G5	S1S3
Nardia geoscyphus				G5	S1S3
Plants					
Aletes humilis (unconfirmed)	Larimer aletes			G2G3	S2S3
Aquilegia saximontana	Rocky Mountain columbine			G3	S3
Artemisia pattersonii	Patterson's wormwood			G3G4	S3

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Asplenium septentrionale	Grass-fern			G4G5	S3S4
Botrychium echo	Reflected moonwort			G3	S3
Botrychium hesperium	Western moonwort			G4	S2
Botrychium lanceolatum var lanceolatum	Lance-leaved moonwort			G5T4	S3
Botrychium lunaria	Common Moonwort			G5	S3
Botrychium minganense	Mingan's moonwort			G4	S1
Carex diandra	Lesser panicled sedge			G5	S1
Carex leptalea	Bristle-stalk sedge			G5	S1
Carex limosa	Mud sedge			G5	S2
Carex oreocharis	A sedge			G3	S1
Carex stenoptila	River bank sedge			G2	S2?
Castilleja puberula	Downy Indian-paintbrush			G2G3	SNR
Chionophila jamesii	Rocky mountain snowlover			G4?	S3S4
Cyripedium fasciculatum	Clustered lady’s-slipper			G4	S3
Cystopteris montana	Mountain bladder fern			G5	S1
Draba crassa	Thick-leaf whitlow-grass			G3	S3

Scientific Name	Common Name	Time of Occurrence in RMNP	State Status	CNHP, CC Rank	
				Global	State
Draba fladnizensis	Arctic Draba			G4	S2S3
Draba grayana	Gray's peak whitlow-grass			G2	S2
Draba porsildii	Porsild's Whitlow-grass			G3G4	S1
Draba streptobrachia	Colorado Divide whitlow-grass			G3	S3
Drymaria effuse var. depressa	Spreading drymaria			G4T4	SNR
Dryopteris expansa	Spreading wood fern			G5	S1
Erocallis triphylla	Dwarf Spring Beauty			G4?	S2
Hippochaete variegata	Variegated scouringrush			G5	S1
Isoetes tenella	Spiny-spored quillwort			G5?T5?	S2
Juncus tweedyi	Tweedy rush			G3Q	S1
Juncus vaseyi	Vasey bulrush			G5?	S1
Lewisia rediviva	Bitteroot			G5	S2
Liatris ligulistylis	Gay-feather			G5?	S1S2
Lilium philadelphicum	Wood lily			G5	S3S4
Listera borealis	Northern twayblade			G4	S2
Listera convallarioides	Broad-Leaved twayblade			G5	S2
Luzula subcapitata	Colorado wood-			G3?	S3?

Scientific Name	**Common Name**	**Time of Occurrence in RMNP**	**State Status**	**CNHP, CC Rank**	
				Global	**State**
	rush				
Mimulus gemmiparus	Weber monkey flower			G1	S1
Minuartica stricta	Rock sandwort			G5	S1
Mentzelia sinuata	Wavy-leaf stickleaf			G3	S2
Nuttallia speciosa	Jeweled blazingstar			G3?	S3?
Papaver radicatum spp. Kluanense	Alpine poppy			G5T3 T4	S3S4
Parnassia kotzebuei	Kotzebue grass-of-parnassus			G4	S2
Penstemon harbourii	Harbour beardtongue			G3	S3S4
Polypodium hesperium	Western polypody			G5	S1S2
Potentilla rupincola	Rocky mountain cinquefoil			G2	S2
Pyrola picta (unconfirmed)	Pictureleaf wintergreen			G4G5	S3S4
Salix serissima	Autumn willow			G4	S1
Silene kingii	King's campion			G2G4Q	NT
Sisyrinchium pallidum	Pale blue-eyed grass			G2G3	S2
Telesonix jamesii	James' telesonix			G2G3	S2
Tonestus lyallii	Lyall haplopappus			G5	S1?
Viola Selkirkii	Selkirk violet			G5?	S1

There is no record of the Mexican spotted owl occurring in the park, but RMNP with concurrence from the US Fish and Wildlife Service has identified potential habitat; and there are historic records of the owl occurring in Boulder and Larmier Counties in lower elevations.

List of Sources used by Rocky Mountain National Park to Identify Endangered, Threatened, Candidate and Rare Species,

Andrew R. and R. Righter. 1992. Colorado Birds, a Reference to Their Distribution and Habitat. Denver Museum of Natural History

Andrews, T. 1991. A Survey of Rocky Mountain National Park and Surrounding Areas of Arapaho and Roosevelt National Forests for Wolverine and Lynx, Winter 1990-1991.

Armstrong D. 1987. Rocky Mountain Mammals, A Handbook of Mammals of Rocky Mountain National Park and vicinity. Colorado Associated University Press in cooperation with Rocky Mountain Nature Association.

Linner S. 2005. Letter from the United States Fish and Wildlife Service, Ecological Services, Colorado Field Office, Federally Listed and Candidate Species & Their Status in Colorado, Effective October 18, 2005.

Colorado Division of Wildlife. 2006. Endangered, Threatened and Special Concern species. Available: http://wildlife.state.co.us/wildlifespecies/speciesofconcern/

Colorado Natural Heritage Program. 2006. Colorado's Natural Heritage: Rare and Imperiled Animals, Plants, and Natural Communities. Colorado Natural Heritage Program, Fort Collins, Colorado. Available: www.cnhp.colostate.edu.

Denver Botanic Gardens. 1999. ROMO Working Herbarium. 1998 Herbarium Collection Summary.

Denver Botanic Gardens. 2000. ROMO Rare Plant Survey, Final Report 2000 Rare Plant List Occurrence Records.

Kingery H. 1998. Colorado Breeding Bird Atlas. Colorado Bird Atlas Partnership and Colorado Division of Wildlife. Colorado Wildlife Heritage Foundation.

National Park Service. 2006. National Resource Information Division, I&M NPSpecies Database, Rocky Mountain National Park's Species Lists are currently certified or being prepared for certification.

NatureServe. 2006. An online encyclopedia of life [web application]. Version 1.4 Arlington, Virginia, USA. Association for Biodiversity Information. Available: http://www.natureserve.org/

Packard, F.M. 1945. The Birds of Rocky Mountain National Park, Colorado. Auk 62:271-294.

Reed, D.F., G. Byrne, J. Kindler. 1998. Snowshoe Hare Density/Distribution Estimates and Potential Release Sites for Reintroducing Lynx in Colorado. Colorado Division of Wildlife Report.

Rich, T. D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E. E. Inigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C. M. Rustay, J. S. Wendt, T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, NY.

Spackman S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program.

Species Assessment Database and Handbook. 2005. Available: http://www.rmbo.org/pif/pifdb.html

U.S. Bureau of Land Management. 2006. Bureau of Land Management Sensitive Species List for Colorado.

U.S. National Forest Service. 2006. Rocky Mountain Region Sensitive Species List.

U.S. Fish and Wildlife Service. 1995. Migratory Nongame Birds of Management Concern in the United States: The 1995 List.

U.S. Fish and Wildlife Service 1996. Candidates for Endangered Species Act Protection. 1996 Notice of Review, Questions and Answers.

U.S. Fish and Wildlife Service. 1997. Endangered and threatened wildlife and plants; review of plant and animal taxa that are candidates for listing as endangered or threatened species. 50 CFR 17.11 and 17.12. 52pp.

U.S. Fish and Wildlife Service. 2004. Endangered and Threatened Wildlife and Plants; Final Designation of Critical Habitat for the Mexican Spotted Owl; Final Rule. Federal Register, Part III 50 CFR Part 17.

U.S. National Park Service. 1994. Memorandum of Understanding with the U.S. Fish and Wildlife Service, Bureau of Land Management, and the National Marine Fisheries Service.

U.S. National Park Service. 1996. Automated National Catalog System (ANCS) for Rocky Mountain National Park.

U.S. National Park Service. 1996. Memorandum on Interim Category 2 Candidate Species Guidance.

U.S. National Park Service. 2005. Programmatic Biological Assessment for Fire and Fuels Management Activities, Rocky Mountain National Park.

APPENDIX E: ROCKY MOUNTAIN NATIONAL PARK WILDLIFE SPECIES LISTS

This page intentionally left blank

Mammal Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Masked shrew	*Sorex cinereus*
Water shrew	*Sorex palustris*
Townsend's big-eared bat	*Corynorhinus townsendii (Plecotus townsendii)*
Silver-haired bat	*Lasionycteris noctivagans*
Hoary bat	*Lasiurus cinereus*
Long-eared myotis	*Myotis evotis*
Little brown bat	*Myotis lucifugus*
Long-legged myotis	*Myotis volans*
American pika	*Ochotona princeps*
Snowshoe hare	*Lepus americanus*
White-tailed jackrabbit	*Lepus townsendii*
Mountain cottontail	*Sylvilagus nuttallii*
Yellow-bellied marmot	*Marmota flaviventris*
Abert's squirrel	*Sciurus aberti*
Eastern fox squirrel	*Sciurus niger*
Wyoming ground squirrel	*Spermophilus elegans*
Golden-mantled ground squirrel	*Spermophilus lateralis*
Rock squirrel	*Spermophilus variegatus*
Least chipmunk	*Tamias minimus*
Colorado chipmunk	*Tamias quadrivittatus*
Uinta chipmunk	*Tamias umbrinus*
Red squirrel	*Tamiasciurus hudsonicus*
Northern pocket gopher	*Thomomys talpoides*
American beaver	*Castor canadensis*
Southern red-backed vole	*Clethrionomys gapperi*
Long-tailed vole	*Microtus longicaudus*
Bushy-tailed woodrat	*Neotoma cinerea*
Mexican woodrat	*Neotoma mexicana*
Common muskrat	*Ondatra zibethicus*
Deer mouse	*Peromyscus maniculatus*
Western jumping mouse	*Zapus princeps*
Common porcupine	*Erethizon dorsatum*
Coyote	*Canis latrans*
Common gray fox	*Urocyon cinereoargenteus*
Red fox	*Vulpes vulpes (Vulpes fulva)*
Black bear	*Ursus americanus*
Common raccoon	*Procyon lotor*
Northern river otter	*Lutra canadensis (Lontra canadensis)*
American marten	*Martes americana*
Short-tailed weasel	*Mustela erminea*
Long-tailed weasel	*Mustela frenata*
Mink	*Mustela vison*
American badger	*Taxidea taxus*
Striped skunk	*Mephitis mephitis*
Western spotted skunk	*Spilogale gracilis*
Bobcat	*Lynx rufus (Felis rufus)*
Mountain lion	*Puma concolor (Felis concolor)*

Mammal Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Moose	*Alces alces*
Elk	*Cervus elaphus*
Mule deer	*Odocoileus hemionus*
Pronghorn	*Antilocapra americana*
Bighorn sheep	*Ovis canadensis*

Source:
http://www.enature.com/parks/localguide_park_display.asp?rgn=PK_32&showType=4&curGroupID=5&curFamilyID=0&showClass=

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Common loon	*Gavia immer*
Western grebe	*Aechmophorus occidentalis*
Horned grebe	*Podiceps auritus*
Red-necked grebe	*Podiceps grisegena*
Eared grebe	*Podiceps nigricollis*
Pied-billed grebe	*Podilymbus podiceps*
American white pelican	*Pelecanus erythrorhynchos*
Double-crested cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodias*
American bittern	*Botaurus lentiginosus*
Cattle egret	*Bubulcus ibis*
Green heron	*Butorides virescens*
Snowy egret	*Egretta thula*
Least bittern	*Ixobrychus exilis*
Black-crowned night-heron	*Nycticorax nycticorax*
White-faced ibis	*Plegadis chihi*
Turkey vulture	*Cathartes aura*
Wood duck	*Aix sponsa*
Northern pintail	*Anas acuta*
American wigeon	*Anas americana*
Northern shoveler	*Anas clypeata*
Green-winged teal	*Anas crecca*
Cinnamon teal	*Anas cyanoptera*
Blue-winged teal	*Anas discors*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Greater white-fronted goose	*Anser albifrons*
Lesser scaup	*Aythya affinis*
Redhead	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Canada goose	*Branta canadensis*
Bufflehead	*Bucephala albeola*
Common goldeneye	*Bucephala clangula*
Barrow's goldeneye	*Bucephala islandica*

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Snow goose	*Chen caerulescens*
Long-tailed duck	*Clangula hyemalis*
Tundra swan	*Cygnus columbianus*
Hooded merganser	*Lophodytes cucullatus (Mergus cucullatus)*
White-winged scoter	*Melanitta fusca*
Surf scoter	*Melanitta perspicillata*
Common merganser	*Mergus merganser*
Red-breasted merganser	*Mergus serrator*
Ruddy duck	*Oxyura jamaicensis*
Cooper's hawk	*Accipiter cooperii*
Northern goshawk	*Accipiter gentilis*
Sharp-shinned hawk	*Accipiter striatus*
Golden eagle	*Aquila chrysaetos*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Broad-winged hawk	*Buteo platypterus*
Ferruginous hawk	*Buteo regalis*
Swainson's hawk	*Buteo swainsoni*
Northern harrier	*Circus cyaneus*
Bald eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
Merlin	*Falco columbarius*
Prairie falcon	*Falco mexicanus*
Peregrine falcon	*Falco peregrinus*
American kestrel	*Falco sparverius*
Blue grouse	*Dendragapus obscurus*
White-tailed ptarmigan	*Lagopus leucurus*
Wild turkey	*Meleagris gallopavo*
American coot	*Fulica americana*
Common moorhen	*Gallinula chloropus*
Sora	*Porzana carolina*
Virginia rail	*Rallus limicola*
Sandhill crane	*Grus canadensis*
Killdeer	*Charadrius vociferus*
American avocet	*Recurvirostra americana*
Spotted sandpiper	*Actitis macularia*
Baird's sandpiper	*Calidris bairdii*
Western sandpiper	*Calidris mauri*
Least sandpiper	*Calidris minutilla*
Willet	*Catoptrophorus semipalmatus*
Wilson's snipe	*Gallinago delicata (Gallinago gallinago)*
Marbled godwit	*Limosa fedoa*
Long-billed curlew	*Numenius americanus*
Red-necked phalarope	*Phalaropus lobatus*
Wilson's phalarope	*Phalaropus tricolor*
Lesser yellowlegs	*Tringa flavipes*
Greater yellowlegs	*Tringa melanoleuca*

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Solitary sandpiper	*Tringa solitaria*
Black tern	*Chlidonias niger*
Herring gull	*Larus argentatus*
California gull	*Larus californicus*
Ring-billed gull	*Larus delawarensis*
Bonaparte's gull	*Larus philadelphia*
Franklin's gull	*Larus pipixcan*
Caspian tern	*Sterna caspia*
Forster's tern	*Sterna forsteri*
Sabine's gull	*Xema sabini*
Band-tailed pigeon	*Columba fasciata*
Rock pigeon	*Columba livia*
Mourning dove	*Zenaida macroura*
Northern saw-whet owl	*Aegolius acadicus*
Boreal owl	*Aegolius funereus*
Long-eared owl	*Asio otus*
Great horned owl	*Bubo virginianus*
Northern pygmy-owl	*Glaucidium gnoma*
Eastern screech-owl	*Otus asio*
Flammulated owl	*Otus flammeolus*
Western screech-owl	*Otus kennicottii*
Common nighthawk	*Chordeiles minor*
Common poorwill	*Phalaenoptilus nuttallii*
White-throated swift	*Aeronautes saxatalis*
Black swift	*Cypseloides niger*
Black-chinned hummingbird	*Archilochus alexandri*
Magnificent hummingbird	*Eugenes fulgens*
Broad-tailed hummingbird	*Selasphorus platycercus*
Rufous hummingbird	*Selasphorus rufus*
Calliope hummingbird	*Stellula calliope*
Belted kingfisher	*Ceryle alcyon*
Northern flicker	*Colaptes auratus*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Lewis's woodpecker	*Melanerpes lewis*
Downy woodpecker	*Picoides pubescens*
Three-toed woodpecker	*Picoides tridactylus*
Hairy woodpecker	*Picoides villosus*
Red-naped sapsucker	*Sphyrapicus nuchalis*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Olive-sided flycatcher	*Contopus cooperi (Contopus borealis)*
Western wood-pewee	*Contopus sordidulus*
Hammond's flycatcher	*Empidonax hammondii*
Least flycatcher	*Empidonax minimus*
Dusky flycatcher	*Empidonax oberholseri*
Cordilleran flycatcher	*Empidonax occidentalis*
Willow flycatcher	*Empidonax traillii*

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Ash-throated flycatcher	*Myiarchus cinerascens*
Say's phoebe	*Sayornis saya*
Eastern kingbird	*Tyrannus tyrannus*
Western kingbird	*Tyrannus verticalis*
Cassin's kingbird	*Tyrannus vociferans*
Northern shrike	*Lanius excubitor*
Loggerhead shrike	*Lanius ludovicianus*
Cassin's vireo	*Vireo cassinii*
Warbling vireo	*Vireo gilvus*
White-eyed vireo	*Vireo griseus*
Red-eyed vireo	*Vireo olivaceus*
Plumbeous vireo	*Vireo plumbeus*
Florida scrub-jay	*Aphelocoma coerulescens*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Blue jay	*Cyanocitta cristata*
Steller's jay	*Cyanocitta stelleri*
Pinyon jay	*Gymnorhinus cyanocephalus*
Clark's nutcracker	*Nucifraga columbiana*
Gray jay	*Perisoreus canadensis*
Black-billed magpie	*Pica hudsonia*
Horned lark	*Eremophila alpestris*
Barn swallow	*Hirundo rustica*
Cliff swallow	*Petrochelidon pyrrhonota (Hirundo pyrrhonota)*
Purple martin	*Progne subis*
Northern rough-winged swallow	*Stelgidopteryx serripennis*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*Tachycineta thalassina*
Juniper titmouse	*Baeolophus ridgwayi (Parus ridgway)*
Black-capped chickadee	*Poecile atricapilla*
Mountain chickadee	*Poecile gambeli*
Red-breasted nuthatch	*Sitta canadensis*
White-breasted nuthatch	*Sitta carolinensis*
Pygmy nuthatch	*Sitta pygmaea*
Brown creeper	*Certhia americana*
Canyon wren	*Catherpes mexicanus*
Marsh wren	*Cistothorus palustris*
Rock wren	*Salpinctes obsoletus*
Bewick's wren	*Thryomanes bewickii*
House wren	*Troglodytes aedon*
Winter wren	*Troglodytes troglodytes*
American dipper	*Cinclus mexicanus*
Ruby-crowned kinglet	*Regulus calendula*
Golden-crowned kinglet	*Regulus satrapa*
Blue-gray gnatcatcher	*Polioptila caerulea*
Veery	*Catharus fuscescens*
Hermit thrush	*Catharus guttatus*

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Swainson's thrush	*Catharus ustulatus*
Wood thrush	*Hylocichla mustelina*
Varied thrush	*Ixoreus naevius*
Townsend's solitaire	*Myadestes townsendi*
Mountain bluebird	*Sialia currucoides*
Western bluebird	*Sialia mexicana*
Eastern bluebird	*Sialia sialis*
American robin	*Turdus migratorius*
Gray catbird	*Dumetella carolinensis*
Northern mockingbird	*Mimus polyglottos*
Sage thrasher	*Oreoscoptes montanus*
Brown thrasher	*Toxostoma rufum*
European starling	*Sturnus vulgaris*
American pipit	*Anthus rubescens*
Cedar waxwing	*Bombycilla cedrorum*
Bohemian waxwing	*Bombycilla garrulus*
Black-throated blue warbler	*Dendroica caerulescens*
Bay-breasted warbler	*Dendroica castanea*
Yellow-rumped warbler	*Dendroica coronata*
Blackburnian warbler	*Dendroica fusca*
Grace's warbler	*Dendroica graciae*
Magnolia warbler	*Dendroica magnolia*
Black-throated gray warbler	*Dendroica nigrescens*
Palm warbler	*Dendroica palmarum*
Chestnut-sided warbler	*Dendroica pensylvanica*
Yellow warbler	*Dendroica petechia*
Cape may warbler	*Dendroica tigrina*
Townsend's warbler	*Dendroica townsendi*
Black-throated green warbler	*Dendroica virens*
Common yellowthroat	*Geothlypis trichas*
Worm-eating warbler	*Helmitheros vermivora*
Yellow-breasted chat	*Icteria virens*
Black-and-white warbler	*Mniotilta varia*
Connecticut warbler	*Oporornis agilis*
Macgillivray's warbler	*Oporornis tolmiei*
Northern parula	*Parula americana*
Ovenbird	*Seiurus aurocapillus*
Northern waterthrush	*Seiurus noveboracensis*
American redstart	*Setophaga ruticilla*
Orange-crowned warbler	*Vermivora celata*
Golden-winged warbler	*Vermivora chrysoptera*
Tennessee warbler	*Vermivora peregrina*
Blue-winged warbler	*Vermivora pinus*
Nashville warbler	*Vermivora ruficapilla*
Virginia's warbler	*Vermivora virginiae*
Hooded warbler	*Wilsonia citrina*
Wilson's warbler	*Wilsonia pusilla*

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Hepatic tanager	*Piranga flava*
Western tanager	*Piranga ludoviciana*
Scarlet tanager	*Piranga olivacea*
Sage sparrow	*Amphispiza belli*
Black-throated sparrow	*Amphispiza bilineata*
Lark bunting	*Calamospiza melanocorys*
Mccown's longspur	*Calcarius mccownii*
Lark sparrow	*Chondestes grammacus*
Dark-eyed junco	*Junco hyemalis*
Lincoln's sparrow	*Melospiza lincolnii*
Song sparrow	*Melospiza melodia*
Savannah sparrow	*Passerculus sandwichensis*
Fox sparrow	*Passerella iliaca*
Green-tailed towhee	*Pipilo chlorurus*
Eastern towhee	*Pipilo erythrophthalmus*
Canyon towhee	*Pipilo fuscus*
Spotted towhee	*Pipilo maculatus*
Vesper sparrow	*Pooecetes gramineus*
American tree sparrow	*Spizella arborea*
Brewer's sparrow	*Spizella breweri*
Clay-colored sparrow	*Spizella pallida*
Chipping sparrow	*Spizella passerina*
White-throated sparrow	*Zonotrichia albicollis*
Golden-crowned sparrow	*Zonotrichia atricapilla*
White-crowned sparrow	*Zonotrichia leucophrys*
Harris's sparrow	*Zonotrichia querula*
Lazuli bunting	*Passerina amoena*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Black-headed grosbeak	*Pheucticus melanocephalus*
Red-winged blackbird	*Agelaius phoeniceus*
Bobolink	*Dolichonyx oryzivorus*
Rusty blackbird	*Euphagus carolinus*
Brewer's blackbird	*Euphagus cyanocephalus*
Bullock's oriole	*Icterus bullockii*
Baltimore oriole	*Icterus galbula*
Brown-headed cowbird	*Molothrus ater*
Common grackle	*Quiscalus quiscula*
Western meadowlark	*Sturnella neglecta*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Common redpoll	*Carduelis flammea*
Pine siskin	*Carduelis pinus*
Lesser goldfinch	*Carduelis psaltria*
American goldfinch	*Carduelis tristis*
Cassin's finch	*Carpodacus cassinii*
House finch	*Carpodacus mexicanus*
Evening grosbeak	*Coccothraustes vespertinus*
Black rosy-finch	*Leucosticte atrata*

Bird Species Reported from Rocky Mountain National Park

Common Name	Scientific Name
Brown-capped rosy-finch	*Leucosticte australis*
Gray-crowned rosy-finch	*Leucosticte tephrocotis*
Red crossbill	*Loxia curvirostra*
White-winged crossbill	*Loxia leucoptera*
Pine grosbeak	*Pinicola enucleator*
House sparrow	*Passer domesticus*

Source: http://www.enature.com/parks/localguide_park_display.asp?rgn=PK_32&showType=4

Fish Species Reported for Rocky Mountain National Park

Common Name	Scientific Name
Greenback cutthroat trout	*Oncorhynchus clarki stomias*
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*
Colorado speckled dace	*Rhinichthys osculus*
Mottled sculpin	*Cottus bairdi punctulatus*
Mountain sucker	*Catostomus platyrhynchus*
Western longnose sucker	*Catostomus catostomus griseus*
Western white sucker	*Catostomus commersoni suckii*
Brown trout	*Salmo trutta*
Eastern brook trout	*Salvelinus fontinalis*
Rainbow trout	*Oncorhynchus gairdneri*
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*

Amphibian Species Reported for Rocky Mountain National Park

Common Name	Scientific Name
Boreal toad	*Bufo boreas*
Tiger salamander	*Ambystoma tigrinum*
Western chorus frog	*Pseudacris triseriata*
Wood frog	*Rana sylvatica*
Northern leopard frog	*Rana pipiens*

Reptile Species Reported for Rocky Mountain National Park

Common Name	Scientific Name
Western terrestrial garter snake	*Thamnophis elegans*

APPENDIX F: AMERICAN INDIAN CONSULTATION

This page intentionally left blank

AMERICAN INDIAN CONSULTATION

In October 2002 the Northern Arapaho Tribe and the Northern Ute Tribe were contacted by letter for government-to-government consultation regarding the elk and vegetation. These correspondences are provided in this section. Throughout the planning process, the tribes were invited to participate in the interagency planning meetings and review of internal draft and final documents as well as the Draft Elk and Vegetation Management Plan/Environmental Impact Statement (plan/EIS). Although not cooperating agencies in development of this plan, the tribes have been sent all information that has been provided to the interagency team members.

United States Department of the Interior

NATIONAL PARK SERVICE
Rocky Mountain National Park
Estes Park, Colorado 80517

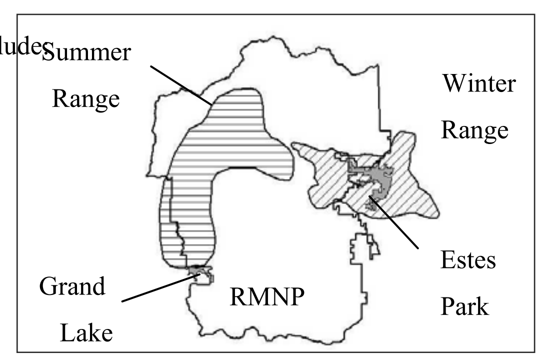
IN REPLY REFER TO:
L76

Mr. Pat Moss, Tribal Planner
Northern Arapaho Business Council
P.O. Box 396
Fort Washakie, WY 82514

Dear Mr. Addison:

The National Park Service recognizes the historic and current significance of the lands and wildlife in the Rocky Mountain National Park (RMNP) area to the Northern Arapaho tribal members. Currently, the park is in the initial stages of forming an interagency planning team that will formulate a regional Elk and Vegetation Management Plan/Environmental Impact Statement (EIS). At the suggestion of your Tribal Planner, Mr. Pat Moss, I would like to bring you up-to-date on our current research and management planning activities; and begin consultations with yourself, Alonzo Moss, Sr., and William C'Hair to determine the preferred level of involvement of the Northern Arapaho Tribe.

An intensive research initiative on the elk population and their ecological effects in the RMNP area was recently completed and is enclosed. The results provide detailed information on elk population size, trends, distribution, and ecological effects; and strongly reinforce the regional nature of elk management issues in the Estes Valley and Rocky Mountain National Park. Some of the significant findings include



- About 3,000 elk reside in the Estes Valley during winter (November to May). Approximately 1/3 of these winter in the park (park sub-population) and 2/3 winter in and around the Town of Estes Park (town sub-population). Over 90% of the elk from both areas migrate to higher elevations or the west side of RMNP during the summer.

- The park sub-population has been stable at approximately 1,000 elk for over 10 years. This portion of the population is at the carrying capacity of its winter range, meaning elk numbers are limited by food resources. The size of the town sub-population is about 2,000 elk. Separate carrying capacity estimates for the town winter range were inconsistent, making it unclear whether the population may currently be at or nearing carrying capacity, or whether the population may continue to grow to nearly 3,000 elk before stabilizing.
- Willow shrub cover has declined approximately 20% on the primary winter range since the late 1930s, and elk are suppressing the growth and reproduction of willow in these areas. Modeling results indicate that under natural conditions wolves limited the elk population size to at least 15-40% below the number of elk that could be supported by available food resources. Undisturbed conditions were also predicted to support up to twice the current amount of willow cover on primary winter range areas.
- Modeling results indicate that continuing current management would be expected to result in continued conversion of riparian willow and aspen communities to grasslands on the primary winter range. Restoring more natural conditions with vigorous willow communities would require a combination of long-term, intensive management interventions.

The results of this research initiative will be used to develop the Elk and Vegetation Management Plan/EIS. The park planning staff for this project is currently in the process of formulating an interagency planning team and project agreement among local, state, and federal agencies. The interagency team has also identified objectives for the Plan/EIS. As such, I would like to suggest that our planning staff and I visit the Wind River Reservation, so that we can meet with yourself, Alonzo Moss, Sr., William C'Hair, and fully brief you on our progress to date. In addition, this will allow us to begin formal consultations and determine what role the Northern Arapaho Tribe would like to play in the upcoming Elk and Vegetation Management Plan/EIS process. Please feel free to identify any other appropriate tribal or business council members that should be included in consultations. We will be in Ft. Duchense, Utah meeting with the Northern Ute Tribe on October 29th and would be available to come to Ethete to meet with you on October 30th. If that were not possible, we would be available on November 14 or 15 or any day during the week of November 18th. As such, I would appreciate your calling Ken Czarnowski of my staff at (970) 586-1263 to confirm if October 30th would be acceptable for a meeting or perhaps another time as indicated above.

Thank you for your time and interest in this very important topic.

Sincerely,

Vaughn L. Baker
Superintendent

cc: Mr. Pat Moss, Tribal Planner
RESMGT: KCzarnowski: SB 100902

United States Department of the Interior

NATIONAL PARK SERVICE
Rocky Mountain National Park
Estes Park, Colorado 80517

IN REPLY REFER TO:

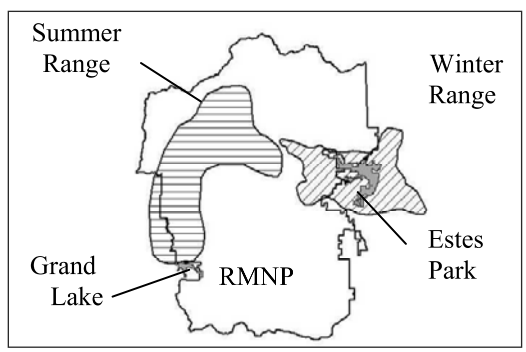
L76

Mr. Floyd Wopsock, Chairman
Northern Ute Tribe
P.O. Box 190
Fort Duchesne, UT 84602

Dear Mr. Wopsock:

The National Park Service recognizes the historic and current significance of the lands and wildlife in the Rocky Mountain National Park (RMNP) area to the Northern Ute tribal members. Currently, the park is in the initial stages of forming an interagency planning team that will formulate a regional Elk and Vegetation Management Plan/Environmental Impact Statement (EIS). At the suggestion of Mr. Roland McCook, I would like to bring you up-to-date on our current research and management planning activities and begin consultations with yourself, and the Tribal Council to determine the preferred level of involvement of the Northern Ute Tribe.

An intensive research initiative on the elk population and their ecological effects in the RMNP area was recently completed and is enclosed. The results provide detailed information on elk population size, trends, distribution, and ecological effects; and strongly reinforce the regional nature of elk management issues in the Estes Valley and Rocky Mountain National Park. Some of the significant findings include:



- About 3,000 elk reside in the Estes Valley during winter (November to May). Approximately 1/3 of these winter in the park (park sub-population) and 2/3 winter in and around the Town of Estes Park (town sub-population). Over 90% of the elk from both areas migrate to higher elevations or the west side of RMNP during the summer.
- The park sub-population has been stable at approximately 1,000 elk for over 10 years. This portion of the population is at the carrying capacity of its winter range, meaning elk numbers are limited by food resources. The size of the town sub-population is about 2,000 elk. Separate carrying capacity estimates for the town winter range were inconsistent, making it unclear whether the population may currently be at or nearing carrying capacity, or whether the population may continue to grow to nearly 3,000 elk before stabilizing.
- Willow shrub cover has declined approximately 20% on the primary winter range since the late 1930s, and elk are suppressing the growth and reproduction of willow in these areas.

Modeling results indicate that under natural conditions wolves limited the elk population size to at least 15-40% below the number of elk that could be supported by available food resources. Undisturbed conditions were also predicted to support up to twice the current amount of willow cover on primary winter range areas.

- Modeling results indicate that continuing current management would be expected to result in continued conversion of riparian willow and aspen communities to grasslands on the primary winter range. Restoring more natural conditions with vigorous willow communities would require a combination of long-term, intensive management interventions.

The results of this research initiative will be used to develop the Elk and Vegetation Management Plan/EIS. The park planning staff for this project is currently in the process of formulating an interagency planning team and project agreement among local, state, and federal agencies. The interagency team has also identified objectives for the Plan/EIS. As such, I would like to suggest that our planning staff and I visit with you at Ft. Duchesne and fully brief you on our progress to date. In addition, this will allow us to begin formal consultations and determine what role the Northern Ute Tribe would like to play in the upcoming Elk and Vegetation Management Plan/EIS process. As arranged with Ms. Dana West, we will be in Ft. Duchesne on October 29th to meet with you and the Tribal Council at 10:30 A.M.

Thank you for your time and interest in this very important topic. If you have any questions, please call Ken Czarnowski of my staff at (970) 586-1263.

Sincerely,

Vaughn L. Baker

Superintendent

cc: Roland McCook

This page intentionally left blank

APPENDIX G: WILDERNESS MINIMUM REQUIREMENTS DECISION GUIDE

This page intentionally left blank

Wilderness Minimum Requirement / Minimum Tool Analysis

This appendix contains a programmatic level minimum requirements analysis evaluating the elements associated with the Elk and Vegetation Management Plan/EIS action alternatives. Final determination of what methods would be used in wilderness areas on the primary elk range for site-specific actions to manage elk and vegetation will be further evaluated and determined when the National Park Service completes the minimum tool analysis prior to implementation of actions of this plan/EIS. The minimum tool analysis will be tiered from this programmatic analysis to evaluate a hierarchy of actions and least intrusive tools which could be used within wilderness on the primary elk range.

MINIMUM REQUIREMENTS DECISION GUIDE

Rocky Mountain National Park
Elk and Vegetation Management Plan/EIS

". . . except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

– the Wilderness Act, 1964

Please refer to the accompanying MRDG *Instructions* for filling out this guide. The spaces in the worksheets will expand as necessary as you enter your response.

Step 1: Determine if any administrative action is necessary.

Description: ***Briefly describe the situation that may prompt action.***

(A.)

Implementation of the elk and vegetation management plan/environmental impact statement (plan/EIS) would prompt action in wilderness in Rocky Mountain National Park. The plan/EIS considers a range of alternatives to manage the elk population and restore native vegetation within areas of the primary elk range, a large portion of which occurs in wilderness. The attached Figure 1 depicts wilderness within the park and the primary elk range. The following section describes briefly the purpose and need for the plan/EIS that may prompt actions in wilderness. Full description of the existing conditions that have prompted action is provided in the "Purpose and Need" and "Background" sections of the plan/EIS.

The National Park Service is obligated by law and policy to maintain and restore, to the extent possible, the natural conditions and processes in park units. The Rocky Mountain National Park / Estes Valley elk population is larger, less migratory, and more concentrated than it would be under natural conditions. Elk heavily use the habitats in aspen and montane riparian willow communities, which support high levels of biodiversity; as a result, these communities may be declining in areas on the elk range where elk concentrate. The high concentrations of elk and levels of herbivory have degraded the vegetation in communities that support large numbers of bird, butterfly, and plant species in comparison to other habitat types in the park and in the Rocky Mountains (Connor 1993, Mueggler 1985, Simonson et al. 2001, Turchi et al. 1994).

NPS management policies (NPS 2006b) direct managers to strive to maintain the components and processes of naturally evolving park ecosystems. These policies also recognize that if biological or physical processes were altered in the past by human activities, they may need to be actively managed to restore them to a natural condition or to maintain the closest possible approximation of the natural condition. Natural conditions are defined as the condition of resources that would occur in the absence of human dominance over the landscape. Natural conditions occur when the components and processes of the natural system are intact. Natural change is recognized as an integral part of the functioning of natural systems; that is, resource conditions are not static, but fluctuate in response to natural processes, such as weather conditions. Recognizing such fluctuations, the plan/EIS bases its descriptions and analysis on the natural range of variation in resource conditions. A key element in determining the need for action was the comparison between existing conditions and the estimates for the natural range of variation that would be expected under natural conditions.

Elk are a natural component of the Rocky Mountain National Park ecosystem and are expected to affect native vegetation communities that occur in the park. The natural range of variation for elk populations and associated vegetation conditions in the park were estimated based on research and ecosystem modeling specific to Rocky Mountain National Park, as well as related research and experiences in other locations.

Under natural conditions, the elk population size and distribution would be controlled by a number of factors, including predators such as wolves and grizzly bears, hunting by American Indians, and the presence of competitors such as bison. Ecosystem modeling predicted that the elk population under natural conditions, given the current amount of available habitat, would fluctuate between 1,200 and 2,100 elk (Coughenour 2002) with 200 to 800 in the sub-population that winters inside the park, and 1,000 to 1,300 in the sub-population that winters outside the park. These sub-populations are referred to as the park and town sub-populations respectively throughout the text. With an intact predator base, elk would be less sedentary and more wary, resulting in lower concentrations of elk on the elk range. With elk less concentrated and less sedentary, montane riparian willow and aspen would be more abundant with increased stand size and complexity; that is, stands would have a variety of age classes and stems of differing sizes. Under natural conditions with suitable levels of montane riparian willow habitat available, beaver would be more abundant on the elk range and as a result, water levels on the primary elk winter and summer ranges would be higher, further encouraging the establishment and growth of willows. These natural conditions represent the overall desired future condition for elk and vegetation on the elk range, as presented in detail in the "Alternatives" chapter, and are what the National Park Service strives to achieve.

The purpose of the plan/EIS is to guide management actions in Rocky Mountain National Park to achieve these desired natural conditions by reducing the impacts of elk on vegetation and by restoring, to the extent possible, the natural range of variability in the elk population and affected plant communities. A successful plan would realize these purposes while providing continued elk viewing opportunities for visitors.

To determine if administrative action is necessary, answer the questions listed in A - F.

A. Describe Valid Existing Rights or Special Provisions of Wilderness Legislation

Are there valid existing rights or is there a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that allows consideration of action involving Section 4(c) uses? Cite law and section.

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain: There are no special provisions in the Wilderness Act of 1964 or subsequent wilderness legislation that specifically allow consideration of the uses prohibited in Section 4(c) for management of wildlife and vegetation. There is a reference to fire related activities in Section 4(d)(1) which states "In addition, such measure may be taken as may be necessary in the control of fire, insects, and diseases, subject to such conditions as the Secretary deems desirable." This language allows for fire related actions to be considered but taken only if they are the minimum necessary.

B. Describe Requirements of Other Legislation

Do other laws require action?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: As an administrative unit of the National Park System, Rocky Mountain National Park is governed by the National Park Service Organic Act (39 Stat. 535, codified at 16 U.S.C. sections 1 through 4), which prohibits the National Park Service from allowing impairment of park resources and values. Thus the National Park Service would have the authority to remove or redistribute elk and to employ measures to protect vegetation if elk have the potential to impair park resources or values.

C. Describe Other Guidance

Does taking action conform to and implement relevant standards and guidelines and direction contained in agency policy, unit and wilderness management plans, species recovery plans, tribal government agreements, state and local government and interagency agreements?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: The reduction and redistribution of the elk population and restoration of native vegetative communities would conform to NPS Management Policies and NPS wilderness preservation and management policies.

Management Policies provide guidelines and direction for management of elk and vegetation within the park.

Section 4.4.1.1 requires that the National Park Service "adopt park resource preservation, development, and use management strategies that are intended to maintain the natural population fluctuation and processes that influence the dynamics of individual plant and animal populations, groups of plant and animal populations, and migratory animal populations in parks".

Section 4.1.5 also directs the National Park Service to reestablish natural functions and processes in human-disturbed components of natural systems in parks (unless otherwise directed by Congress). Impacts on natural systems resulting from human disturbances include the disruption of natural processes. The National Park Service will seek to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated. The National Park Service is to use the best available technology, within available resources, to restore the biological and physical components of these systems, accelerating both their recovery and the recovery of landscape and biological- community structure and function. This includes the restoration of native plants and animals, which Section 4.4.1.3 defines as "all species that have occurred or now occur as a result of natural processes on lands designated as units of the national park system".

NPS Management Policies recognize that due to human disruption of natural processes, more manipulative management of wildlife in units of the National Park system may be necessary. As such section 4.4.2 of the Management Policies allows for the manipulative management of wildlife when "a population occurs in an unnaturally high or low concentration as a result of human influences (such as loss of seasonal habitat, the extirpation of predators, the creation of highly productive habitat through agriculture or urban landscapes) and it is not possible to mitigate the effects of the human influences."

Section 6.3.7 of the NPS Reference Manual #41 – Wilderness Preservation and Management (RM-41) recognizes that wilderness is a composite resource with interrelated parts. "Without spectacular natural resources, especially indigenous and endemic species, a wilderness experience might not be possible. Natural resources are critical, defining elements of the wilderness resource, but need to be managed within the context of the whole. Natural resources management in wilderness will include and be guided by a coordinated program of scientific inventory, monitoring, and research."

The NPS RM-41 further states that "The principle of non-degradation will be applied to wilderness management, and each wilderness area's condition will be measured and assessed against its own unimpaired standard. Natural processes will be allowed, in so far as possible, to shape and control wilderness ecosystems. Management should seek to sustain natural distribution, numbers, population composition, and interaction of indigenous species. Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries. Management actions, including restoration of extirpated native species, altered natural fire regimes, controlling invasive alien species, endangered species management, and the protection of air and water quality, should be attempted only when the knowledge and tools exist to accomplish clearly articulated goals."

D. Describe Options Outside of Wilderness

Can this situation be resolved by an administrative activity outside of wilderness?

Yes: ☐ **No:** ☒

Explain: In Rocky Mountain National Park, 94% of the park is recommended wilderness and 1% is designated wilderness. The degradation of vegetation on the primary elk range occurs predominantly in wilderness. To prevent degradation of native plant communities and potential impairment, action would need to be taken in wilderness areas.

- **"Untrammeled" – Wilderness is ideally unhindered and free from modern human control or manipulation.**
- **"Undeveloped" – Wilderness has minimal evidence of modern human occupation or modification.**
- **"Natural" – Wilderness ecological and evolutionary systems are substantially free from the effects of modern civilization.**
- **"Outstanding opportunities for solitude or a primitive and unconfined type of recreation" – Wilderness provides opportunities for people to experience natural sights and sounds, solitude, freedom, risk, and the physical and emotional challenges of self-discovery and self reliance**

E. Wilderness Character

Does taking administrative action preserve or impair wilderness character, as described by the qualities listed below?

Untrammeled: **Preserve:** ☒ **Impair:** ☐

Explain: Reductions and redistribution of elk and actions to protect vegetation from elk herbivory would not leave the wilderness unhindered and free from human manipulation. However actions to reduce the elk population and to redistribute elk would be transient in nature. Over the long-term, reduction of the elk population and densities to within the natural range of variation would reestablish natural conditions and the untrammeled nature of the wilderness character by reducing evidence of human manipulation (e.g., elk population outside natural conditions and habituated to humans) on the primary elk range. The use of temporary fences to protect aspen and/or willow habitat on the primary elk range would result in a patchy recovery of vegetation across the landscape that would reflect human manipulation of the environment. As the elk population is reduced and vegetation recovers, fences would be removed and vegetation would return to more natural conditions reestablishing the untrammeled nature of the wilderness character on the primary elk range.

Undeveloped: **Preserve:** ☒ **Impair:** ☐

Explain: Fences would be installed to protect native vegetation from herbivory and potential loss of aspen and riparian willow on the elk range. Fences, although not permanent, would be evidence of human modification over the 20-year planning period. The long-term benefits however are the protection and preservation from elk herbivory that is leading toward loss of vegetation and impairment of the resource.

Natural: **Preserve:** ☒ **Impair:** ☐

Explain: Installation of non-permanent fences would adversely affect the natural quality of wilderness character while they were in place. Fences would be removed at the end of the planning period. Actions to reduce the elk population size and densities and protection and restoration of vegetative conditions would result in the substantial restoration of natural conditions within wilderness on the primary elk range.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation:

Preserve: ☒ **Impair:** ☐

Explain: Actions to reduce and redistribute elk and install fences such as unsuppressed weapons, motorized equipment use, helicopters, aversive conditioning tools, and presence of management crews would result in short-term transient disturbance of solitude in wilderness areas of the primary elk range. Management activities within wilderness on the elk range would be temporally and spatially dispersed, and opportunity to recreate in wilderness would not be substantially inhibited on the primary elk range. In addition, a large expanse of wilderness in the park outside of the primary elk range would continue to be available for primitive and unconfined recreation.

Other unique components that reflect the character of this wilderness:

Preserve: ☐ **Impair:** ☐ **Not Applicable:** ☒

Explain:

F. Describe Effects to the Public Purposes of Wilderness

Is taking administrative action consistent with the public purposes for wilderness (as stated in Section 4(b) of the Wilderness Act) of recreation, scenic, scientific, education, conservation, and historical use?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Restoration of the elk population size and densities and vegetation on the primary elk range to natural conditions would best protect the conservation, scenic, recreation, and educational uses of the wilderness within this portion of the park. The overall purpose of the action under all alternatives would be to restore natural conditions on the elk range in both the elk population and vegetative communities thereby fulfilling the NPS mandate to protect and conserve natural resources.

Reducing elk herbivory would prevent the potential loss of aspen and the conversion of montane riparian habitat to grasslands on the elk range. Aspen and riparian habitats provide habitat for a large number of birds, animals, and insects. Restoration of these habitats would result in an increase in diversity of the park's wildlife and plant species. Improving these habitats protects scenic and recreational opportunities which visitors come to the park to enjoy. All alternatives involve actions to further educate the public on the effects that an overabundant and highly concentrated elk population have on native ecological systems in the park and the effects that management actions would have on restoring native ecological components to wilderness areas.

Management actions would be taken to restore natural behaviors so that elk would be less sedentary and more wary. One of the management objectives of the plan is to decrease the level of habituation to humans that elk currently exhibit and to restore elk behaviors reflective of natural conditions. The ability to observe and study the natural behaviors of elk and the response of vegetation would be valuable to scientific uses as it progresses the understanding of the park's natural resources and ecosystem processes. In addition, there would be a benefit to the visitor experience of the park from the ability to view elk that exhibit more natural behaviors.

Step 1 Decision: **Is any administrative action necessary?**

Yes: ☒ **No:** ☐ **More information needed:** ☐

Explain: Impacts of overabundant and highly concentrated elk on vegetative communities on the primary elk range within the park are well documented and the National Park Service believes it is necessary to reduce elk population numbers and densities and protect vegetation. The plan/EIS concludes that if no action is taken and elk continue to over graze vegetation on the primary elk range. Over time there would be major adverse impacts to native vegetation leading to impairment due to the potential loss of aspen and montane riparian habitats that are limited to a large degree in the park to areas of the primary elk range. In addition, loss of these habitats would result in major adverse impacts on other wildlife species that depend upon the habitat and a likely reduction in biological diversity on the elk range.

If action is necessary, proceed to Step 2 to determine the minimum activity.

Step 2: Determine the minimum activity.

Description of Alternatives

For each alternative, describe what methods and techniques will be used, when the activity will take place, where the activity will take place, what mitigation measures are necessary, and the general effects to the wilderness resource and character.

The alternatives described below correspond to the action alternatives evaluated in the plan/EIS. The actions are described in detail in the "Alternatives" chapter of the plan/EIS and summarized below.

Actions common to all alternatives

Mitigations – Mitigations to reduce or eliminate the risk to public health and safety would include use of subsonic ammunition, which has a shorter range than conventional rounds, and shooting from elevated stands to establish shooting lanes and reduce the distance bullets could travel via backstops. Every action would involve the presence of agency spotters who would ensure that the area is clear of people and to prevent individuals from entering the area during lethal reduction activities. Temporary area closures would occur as needed for short-periods while management activities were occurring. Required safety procedures would be implemented and required personal protective equipment would be used during all management activities.

To mitigate impacts on visitor use of the park consideration would be given to the type of method used and the time of day actions to reduce the elk population would be taken.

To reduce the effects of fences on park visitors and resources the following mitigations would be implemented.

- Fences would be temporary and removed once monitoring indicates that vegetation has recovered.
- Fence design would allow access of other wildlife species to enclosed areas with the exception of large mammals such as moose.
- Fence material and design would be selected to minimize impacts on visitors and wilderness character.
- Fences would be designed to allow public access into enclose areas via gates to the extent possible.

Monitoring – Monitoring would be conducted in the short- and long-term on geographic scales ranging from site-specific to landscape. Elk population size, densities, demographics, and distribution would be monitored annually. Vegetation changes would be monitored as needed to determine progress toward restoration goals and could be done annually and/or at 5- or 10-year interval depending upon vegetation type and parameter measured. Monitoring of vegetation communities would provide the information necessary to determine how many acres of aspen and/or willow habitat on the primary elk range need to be protected. Similarly, monitoring data would provide the information necessary to determine when fences can be removed once communities are restored.

Adaptive management – The action alternatives would incorporate the principle of adaptive management using monitoring and evaluation to determine if management actions were achieving objectives or having unacceptable levels of adverse impact on resources including wilderness value and character and adjusting actions accordingly.

Information and education – Public education efforts would be enhanced to provide additional information about elk and their role in the Rocky Mountain ecosystem. Educational materials would be developed to inform and increase public understanding of the management actions taking place in the park and the effects these actions have on vegetation, other wildlife, and visitors.

Opportunistic research activities – In coordination with elk and vegetation management activities, up to 120 elk would be subject to a research study evaluating procedures for testing for chronic wasting disease in live elk and the effectiveness of a multi-year fertility control agent. The elk would be tagged and/or marked for identification. The study would be conducted over a 3-year period.

Alternative 2

Description:

The elk population would be reduced to the lower end of the natural range of variation. This alternative would involve the rapid reduction of elk in the first four years of the plan using noise suppressed and unsuppressed weapons, darting and euthanasia, and/or use of a temporary, non-permanent capture facility. In the first four years, approximately 200 to 700 elk would be removed annually. To maintain the target population range, 25 to 150 elk would be removed annually over the remaining 16 years of the plan. To allow management of both subpopulations of elk subject to the plan, lethal reduction actions could occur any time of year inside the park. However, to allow for the greatest opportunity to reduce the park subpopulation, most lethal reductions would likely take place between November and February.

Herding using trained dogs, riders on horseback, and/or people on foot with noisemakers or visual devices could encourage elk migration from the primary winter range to the primary summer range, to move elk from the Kawuneeche Valley to areas outside the park where they could be hunted, and to direct elk to a capture facility during the reduction phase to efficiently remove a high number of elk. If necessary, helicopters could be used adaptively during herding efforts if monitoring indicates that other methods are not effective.

Aversive conditioning as with visual devises, trained herding dogs, people on foot, riders on horseback, rubber bullets, cracker shot, or noisy weapons could be used as needed to prevent excessive concentrations of elk in unfenced areas. In wilderness areas, the use of non-mechanized tools would be implemented to the greatest extent possible. Given appropriate interagency cooperation, adaptive management could also include wolves as a redistribution tool. This would involve the installation of wolf pens which could require the use of horses, all-terrain vehicles (ATVs), or helicopters to transport materials. Using wolves as a management tool for elk would also require intensive monitoring to maintain wolves within the boundary of the park. This would involve use of helicopters and the need to radio-collar and permanently mark wolves for identification purposes. The pens would need to be located on the elk range in wilderness areas to inhibit easy accessibility by the public for the safety of the wolves and the visitor.

Aspen stands (up to 160 acres; 0.1% of total wilderness in the park) on the elk range would be fenced to exclude elk herbivory. These temporary fences would be installed adaptively, based on vegetation response to elk management actions as indicated through the monitoring program. Installation of fences in locations away from roadsides may involve helicopters or other motorized vehicles such as ATVs to transport materials. Fence options include the use of wooden and/or wire fence in a rail or page-wire fence design. The design would be most compatible with wilderness character to reduce intrusiveness on the wilderness landscape. Once an area is protected from herbivory, prescribed burning, mechanical vegetation thinning, and replanting of vegetation could occur. These activities could include use of hand held tools, chainsaws, trucks, portable pumps and generators.

Removal of carcasses from the field would be accomplished using techniques such as removal on foot; using a litter or sled over frozen ground; on a horse, all-terrain vehicle, or truck; or by winching and dragging behind a horse, all-terrain vehicle, or truck to facilitate removal from remote areas of the park. In general, helicopters would not be used to remove carcasses except from remote locations if determined necessary due to disease management concerns. Due to concerns in wilderness, preference would be given to non-motorized removal techniques to the extent possible; however, because of the high number of elk removed during the first four years of the plan, mechanized equipment would likely be required.

Monitoring of the elk population and vegetation recovery would involve ground surveys using crews on foot and annual aerial surveys using helicopter or fixed wing air craft.

Effects:

Wilderness character - Management activities would have a variety of short-term adverse effects to wilderness character in limited areas of wilderness. Under this alternative, the frequency at which these disruptions would occur is greater in the first four years of the plan due to the intensive management of elk to reach management objectives and would take place potentially over a greater area of the wilderness. As fences would not be used to protect riparian willow, redistribution activities would be frequent resulting in periodic disruptions of solitude in these areas of wilderness. The short-term transient adverse impacts that would affect opportunities for outstanding solitude include:

- Reduced opportunities for solitude in limited areas of the wilderness due to presence of crews, horses, and/or trained herding dogs;
- Periodic use of helicopters to transport materials and monitoring and the potential for adaptive use of helicopters for carcass removal and herding activities;
- Use of motorized equipment such as ATVs, trucks, chainsaws, portable pumps, and/or generators;
- Use of firearms, shotguns, and/or darting equipment to lethally remove elk; and
- Redistribution activities using noisy aversive conditioning techniques such as cracker shot and rubber bullets. Visual techniques would have a lesser degree of adverse effect on opportunity for solitude.

The presence of a temporary capture facility for lethal reduction and holding pens for wolves under the adaptive approach would have a short-term effect on the scenic quality and would reduce the untrammeled, undeveloped character of wilderness.

The tagging or marking of elk and disruption of natural biological processes for those treated with fertility control agent for research purposes would negatively affect the natural quality of wilderness to a minimal degree. The small number of elk marked for research purposes would have a minimal effect on wilderness recreational opportunities for wildlife viewing.

Carcasses that result from management actions would be removed from the field to the extent possible given logistical constraints. Some carcasses would be left in the field to approximate natural conditions so as not to negatively affect wilderness character or values.

There would be overall long-term benefits to wilderness character from management of the elk population. Under this alternative, natural conditions in the elk population would be restored as elk are less habituated and exhibit natural behaviors and the density and size of the population would be within the natural range of variation. Restoration of natural conditions would provide benefit to promoting science of natural ecosystems and visitors to the wilderness would benefit from the ability to view elk that exhibit more wild behaviors.

Long-term but temporary impacts would result from the presence of fences around aspen habitat in less than 0.1 percent of wilderness that would reduce the undeveloped, untrammeled nature of wilderness for the 20 year planning period. The National Park Service would minimize to the extent possible the obtrusiveness of the fences through selection of fencing materials and where possible the placement of fences on a site specific basis. Which fence designs are used would depend on the location and the potential effects on wilderness, the viewshed, visitor access, and movement of other wildlife species. Informal visitor surveys would assess the effects of fences on the visitor experience, and monitoring would assess the effects on other wildlife species. These factors would be used to evaluate the type of fence to be used given particular locations to minimize impacts on wilderness character and values. Long-term benefits however would result from preventing the potential loss of native plant communities within wilderness and restoring native ecological processes. Fire would also be restored as a natural process into wilderness areas that would result in a long-term benefit in treated areas. Restoration of native vegetative communities and potential benefits to other wildlife within wilderness would have a long-term benefit on the recreational use of wilderness by visitors and restoration of wilderness that does not reflect human influences.

If wolves are used adaptively to redistribute elk in the future, the presence within wilderness of this historic native predator would provide long-term benefit to the natural character of wilderness areas. Temporary structures would be constructed as holding pens and helicopters would be the only efficient means of monitoring and retrieving wolves to prevent crossing park boundaries. A small number of wolves would be released into the park in a phased approach and strictly managed to control their population size and behaviors. These tools and the intensive management of wolves however would detract from the natural wilderness character and reduce periodically the opportunity for solitude. It should be noted that release of wolves into the park would be considered experimental. It is uncertain whether wolves would establish within the park, whether they would remain within the park boundaries, whether they would redistribute elk on the primary winter range enough to allow vegetation to recover, and how they would react to frequent recapture and release, if needed.

Heritage and cultural resources – No effect

Maintaining contrast and unimpaired character – The use of mechanized equipment in wilderness would reduce the contrast between wilderness on the primary elk range and other areas for short periods of time in localized areas while activities were taking place. Fences in wilderness would result in a long-term contrast between wilderness and other lands, however this contrast would lessen as vegetation develops and fences are less visible.

This alternative would result in the prevention of loss of important vegetative communities within wilderness that provides habitat for a variety of wildlife and plant species. This alternative would promote wilderness character and values unimpaired for future generations. The restoration of vegetative communities and the natural condition and behavior of elk would promote contrast between developed areas particularly those outside of the park and wilderness areas.

Special provisions – None identified.

Safety of visitors, personnel, or contractors - With implementation of mitigation measures described in above in "Actions Common to All Alternatives", the risks to the public and management personnel are minimal from elk and vegetation management activities. There is risk to herders and personnel from working in rugged terrain. This risk may be lessened to some degree by use of helicopters to transport materials, to remove carcasses from remote locations (most likely to occur in years one through 4) and under limited circumstances for herding elk. . There is also a benefit to visitors to the park and region as management activities would reduce habituation of elk and increase their wariness of people. This would reduce the potential over the long-term for human-elk conflict.

Economic and time constraints - Under this alternative, the use of motorized equipment including helicopters would increase costs of implementation particularly in the first four years of the plan. Use of this equipment would reduce the time required by crews to transport materials and to remove carcasses. Implementation of activities strictly by hand tools and ground crews would not allow for management objectives and purpose of the plan to be met. If wolves are used adaptively to redistribute elk, wolf behaviors and movements could not be strictly managed within the framework of the alternative without the use of mechanized equipment in wilderness. Mechanized equipment is needed to effectively monitor wolves and to reach wolves in remote areas efficiently and effectively reducing the risk of wolves extending beyond park boundaries. Helicopters therefore are the minimum tool to manage wolves in the park.

Alternative 3

Description: This alternative would result in the gradual reduction of the elk population to the higher end of the natural range of variation. This alternative would use the same methods described above in Alternative 2 to reduce the elk population, redistribute elk, monitoring, and carcass removal. There are some exceptions. Because a smaller number of elk would be removed annually, it is less likely compared to Alternative 2 that helicopters would be necessary to remove carcasses from remote locations on the primary elk range due to the fewer number of elk removed annually under this alternative. Helicopters would be used adaptively to remove carcasses from remote locations only if necessary to due disease management concerns. Redistribution methods would be the same as described in Alternative 2. Because of the higher elk population target under this alternative, use of aversive conditioning and herding would likely be more frequent to reduce browsing pressure on vegetation. Although these activities would not occur over as large an area as Alternative 2 due the increased amount of fences to protect both aspen and riparian willow. .. Under Alternative 3 temporary fences would be used to protect up to 160 acres of aspen as described in Alternative 2. Fences would also be installed adaptively in wilderness areas on the primary elk summer and winter range to protect montane riparian willow habitat. This would require fences to protect up to 440 acres of willow on both the primary winter and summer ranges. This total amount of expected fencing would impact approximately 0.2% of the total park wilderness. Wolves could be used as an adaptive management tool in the future to facilitate elk redistribution as described above in Alternative 2 and fertility control agents could be implemented adaptively if logistically feasible to control the elk population in the future as described in Alternative 4 below.

Effects:

Wilderness character - The effects on wilderness character and value would be similar to Alternative 2. However, because of the lower annual reduction target the short-term effects would be less frequent and less intense as a result of fewer crews to conduct elk population management activities. Because of the fewer number of animals to be removed annually, this alternative may not require use of a capture facility. However based on the monitoring of the effectiveness of other removal methods, a capture facility may be required as an adaptive management tool resulting in impacts on the scenic, untrammeled quality of wilderness as described in Alternative 2. Due to the fewer number of elk removed annually, the frequency of carcass removals and the potential use of mechanized equipment in wilderness areas would less than other alternatives , having less adverse effects on the opportunity for solitude. As in Alternative 2, some carcasses would be left in the environment to reflect natural conditions to the greatest extent possible resulting in no negative effects on wilderness character or values.

The increased use of temporary fences to protect up to 600 acres of aspen habitat and suitable willow habitat would result in more frequent disturbance of solitude in wilderness due to the use of motorized equipment such as ATVs and helicopters to transport materials. Also, there would be increase presence of crews and noise during installation of fences. The use of fences to protect willow and aspen would result in a greater impact on wilderness character as the impact of human development would be more noticeable under this alternative. This effect would lessen over time as vegetation develops and the fences become less visible. The selection of fencing materials and where possible the placement of fences would be done on a site specific basis to minimize to the extent possible the obtrusiveness of fences in wilderness areas on the primary elk range while still allowing for achievement of vegetation restoration objectives. Which fence designs are used would depend on the location and the potential effects on wilderness, the viewshed, visitor access, and movement of other wildlife species. Informal visitor surveys would assess the effects of fences on the visitor experience, and monitoring would assess the effects on other wildlife species. These factors would be used to evaluate the type of fence to be used given site-specific conditions to minimize impacts to the greatest degree on wilderness character and values.

Over the long-term, the use of fences to protect vegetation fully ensures protection from elk herbivory and would result in recovery of vegetation to natural conditions more rapidly than with use of redistribution activities. This alternative would also allow fire to be restored more rapidly as a natural component of the ecosystem. With a more rapid recovery of vegetation, the potential for beaver recolonization of the primary elk range whether naturally or through reintroduction would also occur faster.

The tagging or marking of elk and disruption of natural biological processes for those treated with fertility control agent as part of the research study or as an adaptive tool to control the elk population would negatively affect the natural value of wilderness and opportunities for recreational wildlife viewing in wilderness.

If wolves are used adaptively to redistribute elk in the future, the presence within wilderness of this historic native predator would provide long-term benefit to the natural character of wilderness areas. Temporary structures would be constructed as holding pens and helicopters would be the only efficient means of monitoring and retrieving wolves to prevent crossing park boundaries. A small number of wolves would be released into the park in a phased approach and strictly managed to control their population size and behaviors. These tools and the intensive management of wolves however would detract from the natural wilderness character and reduce periodically the opportunity for solitude. It should be noted that release of wolves into the park would be considered experimental. It is uncertain whether wolves would establish within the park, whether they would remain within the park boundaries, whether they would redistribute elk on the primary winter range enough to allow vegetation to recover, and how they would react to frequent recapture and release, if needed.

Heritage and cultural resources – No effect

Maintaining contrast and unimpaired character – The use of mechanized equipment in wilderness would reduce the contrast between wilderness on the primary elk range and other areas for short periods of time in localized areas while activities were taking place. Due to the low number of elk to be removed under this alternative, it is unlikely that helicopters would be necessary to remove carcasses. Helicopters could be used adaptively to remove carcasses from remote locations if necessary due to disease management concerns. Some carcasses would be left in the field to approximate natural conditions so as not to negatively affect wilderness character or values. Because of the fewer number of animals removed over time, the reduction in contrast due to management actions to reduce the elk population size would occur less frequently than the other alternatives. Fences in wilderness would result in a reduced contrast between wilderness and other lands across a greater area of wilderness for a longer period of time; however the contrast between wilderness and other areas would become more evident over time as vegetation develops and fences are less visible.

This alternative would result in the prevention of loss of important vegetative communities within wilderness that provides habitat for a variety of wildlife and plant species. This alternative would promote wilderness character and values unimpaired for future generations. The restoration of vegetative communities and the natural condition and behavior of elk would promote contrast between wilderness on the primary elk range and developed areas particularly those outside of the park.

Special provisions – None identified.

Safety of visitors, personnel, or contractors – Under this alternative, due to the fewer number of elk removed annually, crews would be in the field less frequently which would reduce the risk of injury to management crews and there would be less risk to visitors as actions are occurring less frequently. If fertility control agents are used adaptively in the future, there are some increased risks with handling and treating elk. With implementation of mitigation measures described in above in "Actions Common to All Alternatives", the risks to the public and management personnel are minimal from elk and vegetation management activities. For those in the field there would continue to be a risk to herders and personnel from working in rugged terrain. This risk may be lessened to some degree by use of helicopters to transport fence materials and under limited circumstances to herd elk to the summer range if necessary. There is also a benefit to visitors to the park and region as management activities would reduce habituation of elk and increase their wariness of people. This would reduce the potential over the long-term for human-elk conflict.

Economic and time constraints - Under this alternative, the use of motorized equipment in particular helicopters for the transport of large amounts of fence material would increase costs of implementation. However, use of this equipment would reduce the amount of time that would be required by crews to transport materials using less intrusive or non-motorized means and it would reduce the amount of time wilderness character and values are disrupted. Transportation of fence material by ground crews across difficult terrain would require extraordinary amount of staff resources and time, limiting the ability of management objectives for vegetation restoration to be met.

If wolves are used adaptively to redistribute elk, wolf behaviors and movements could not be strictly managed within the framework of the alternative without the use of mechanized equipment in wilderness. Mechanized equipment is needed to effectively monitor wolves and to reach wolves in remote areas efficiently and effectively reducing the risk of wolves extending beyond park boundaries. Helicopters therefore are the minimum tool to manage wolves in the park.

Alternative 4

Description: This alternative would result in the gradual reduction of the elk population to the higher end of the natural range of variation emphasizing the use of fertility control agents to reduce and maintain the elk population. This alternative would use darting and anesthetizing or a capture facility to treat up to 400 female elk annually in the first four years of the plan, and 200 for each of the remaining 16 years. All elk treated would require marking or tags for identification purposes. In addition, if a short-term agent lasting only one year is used, 80 to 150 elk would be lethally removed using methods described in Alternative 2 to meet management objectives. Fences would be installed to protect up to 160 acres of aspen on the primary summer and winter ranges, and fences would be used to protect up to 260 acres of montane riparian willow on the primary winter range. In addition to the redistribution effects of fertility control activities, redistribution activities using methods described in Alternative 2 would be used to protect vegetation in unfenced areas.

Effects:

Wilderness character - The effects of lethal reduction activities, redistribution actions, carcass removal, installation and presence of fences would be as described in Alternative 3. Fences would not be used on the primary summer range to protect montane riparian vegetation and redistribution techniques would be employed to a greater degree in this area to protect vegetation from herbivory. The use of a temporary capture facility would be as described in Alternative 2. Under this alternative elk management activities would occur more frequently if a short-term fertility control agent is employed due to the high number of elk that would need to be treated and removed on an annual basis. These actions would reduce opportunities for solitude in wilderness frequently and the disturbance would occur in more areas of the wilderness. The marking of elk for identification purposes would adversely affect the scenic quality of wilderness and recreational opportunities by reducing the wildness of the treated animals. The treatment of elk with fertility control would disrupt natural processes of elk reproduction adversely affecting wilderness to a greater degree than other alternatives due the large number of elk to be treated.

Heritage and cultural resources – No effect

Maintaining contrast and unimpaired character – Intensive management activities early in the plan to treat and remove elk would result in reduced contrast between wilderness and other lands as the number of field personnel and noise producing activities would increase. The use of mechanized equipment in wilderness would reduce the contrast between wilderness on the primary elk range and other areas for short periods of time in localized areas while activities were taking place. Due to the lower number of elk to be removed annually, it is unlikely that helicopters would be necessary to remove carcasses. Helicopters could be used adaptively to remove carcasses from remote locations if necessary due to disease management concerns. Some carcasses would be left in the environment to reflect to natural conditions to the greatest extent possible resulting in no negative effects on wilderness character or values.

Fences in wilderness would result in reduced contrast between wilderness and other lands across a greater area of wilderness for a longer period of time; however this contrast would become more evident over time as vegetation develops and fences are less visible.

This alternative would result in the prevention of loss of important vegetative communities within wilderness that provides habitat for a variety of wildlife and plant species. This alternative would promote wilderness character and values unimpaired for future generations. The restoration of vegetative communities and the natural condition and behavior of elk would promote contrast between developed areas particularly those outside of the park and wilderness areas.

Special provisions – None identified.

Safety of visitors, personnel, or contractors – Under this alternative, due to the number of elk to be treated, handled, and removed annually; crews would be in the field frequently with an increased risk to personnel and/or contractors. With implementation of mitigation measures described above in "Actions Common to All Alternatives", the risks to the public and management personnel are minimal from elk and vegetation management activities. For those in the field there would continue to be a risk to herders and personnel from working in rugged terrain. This risk may be lessened to some degree by use of helicopters to transport fence materials and under limited circumstances to herd elk to the summer range if necessary. There is also a benefit to visitors to the park and region as management activities would reduce habituation of elk and increase their wariness of people. This would reduce the potential over the long-term for human-elk conflict.

Economic and time constraints - Under this alternative, the use of motorized equipment in particular helicopters for the transport of large amounts of fence material would increase costs of implementation. However, use of this equipment would reduce the amount of time that would be required by crews to transport materials using less intrusive or non-motorized means and it would reduce the amount of time wilderness character is disrupted. Transportation of fence material by ground crews across difficult terrain would require extraordinary amount of staff resources and time, limiting the ability of management objectives for vegetation restoration to be met.

Alternative 5

Description: This alternative would release a two pair of wolves in the park to be intensively managed and allowed to increase to a maximum of 14 in a phased approach. A highly managed wolf population would be used to facilitate redistribution of elk in combination with the use of lethal control activities such as described in Alternative 2 to reduce the elk population initially to the higher end of the natural range of variation. Wolves would be transported to the park and acclimated in holding pens. Temporary pens would need to be constructed in remote wilderness areas of the primary elk range to reduce access by the public. Wolf movement and activity would be continuously monitored and their activities restricted to within the boundaries of the park. This would be accomplished using GPS-collars and helicopters. Because of the remoteness of the park, helicopters would be necessary for monitoring activities and possibly transport of staff to retrieve wolves near the park boundary.

Lethal reduction would remove 50 to 500 elk per year in the first four years and in the remaining 16 years up to 100 elk would be lethally removed each year to maintain the population, if needed.

Fences would be installed to protect up to 160 acres of aspen on the primary summer and winter ranges. No other redistribution actions would be used under this alternative. Depending on the number of elk lethally removed each year in the first four years, carcass removal could be accomplished as described in Alternative 2.

Effects:

Wilderness character - The effects of lethal reduction activities, carcass removal, and installation and presence of fences on wilderness character would be as described in Alternative 2. The presence of temporary capture facilities for lethal reduction and temporary holding pens for wolves would have a short-term effect on the scenic quality and reduce the untrammeled character of wilderness. Compared to other alternatives, this alternative would not result in the disruption of opportunities for solitude due to the presence of field crews, mechanized equipment, horses and trained herding dogs to redistribute elk. Over time the number of elk carcasses needing to be removed would decrease as elk population management would rely more on wolves with less reliance on lethal reductions and the short-term impacts on wilderness character and values would diminish. As in Alternative 2, some carcasses would be left in the environment to reflect to natural conditions to the greatest extent possible resulting in no negative effects on wilderness character or values.

The presence of wolves, and historic native predator, within wilderness areas of the elk range would provide long-term benefit to the natural character of wilderness. Wolves would restore to wilderness the natural condition and behavior of elk by making them less sedentary and more wary. This would provide improved recreational viewing of natural elements and processes within wilderness. However, the presence of temporary holding pens, use of helicopters, and the intensive management of wolves would detract from the natural wilderness character and reduce the opportunity for solitude. Depending upon the movements of wolves, the use of helicopters and field crews to monitor and retrieve wolves could be frequent and would extend to wilderness areas outside of the primary elk range.

The tagging or marking of study elk and disruption of natural biological processes for those treated with fertility control agent would negatively affect the natural quality of wilderness to a minimal degree and the small number of elk marked for research purposes would have a minimal effect on wilderness recreational opportunities for wildlife viewing.

Heritage and cultural resources – No effect

Maintaining contrast and unimpaired character – The use of mechanized equipment in wilderness would reduce the contrast between wilderness on the primary elk range for short periods of time in localized areas while activities were taking place. The use of helicopters for monitoring and management of wolves however would reduce the contrast between wilderness and other lands over a wider area as wolves would be expected to use larger areas of habitat in the park. Although the reduction in contrast between wilderness and other lands due to wolf management activities would be for short periods, it may occur frequently depending upon the movements of wolves. Fences in wilderness would result in a long-term contrast between wilderness and other lands, however this contrast would lessen as vegetation develops and fences are less visible.

This alternative would result in the prevention of loss of important vegetative communities within wilderness that provides habitat for a variety of wildlife and plant species. This alternative would promote wilderness character and values unimpaired for future generations. The restoration of vegetative communities and the natural condition and behavior of elk as well as the presence of a historically native predator would promote to the greatest extent the contrast between developed areas particularly those outside of the park and wilderness areas.

Special provisions – None identified.

Safety of visitors, personnel, or contractors – Management personnel would be exposed to increased risk under this alternative due to the handling and intensive management of wolves in addition to lethal reduction activities. With implementation of mitigation measures described in above in actions common to all alternatives the risks to the public and management personnel are minimal from elk and vegetation management activities. For those in the field there would continue to be a risk to personnel from working in rugged terrain. This risk may be lessened to some degree by use of helicopters to transport fence materials. Safety concerns related to presence of wolves would be mitigated using public education efforts.

Economic and time constraints - Under this alternative, the use of motorized equipment in particular helicopters for the transport of fence material and to monitor and manage wolves would increase costs of implementation. However, use of this equipment would reduce the amount of time that would be required by crews to transport materials using less intrusive or non-motorized means and it would reduce the amount of time wilderness character is disrupted. Transportation of fence material by ground crews across difficult terrain would require extraordinary amount of staff resources and time, limiting the ability of management objectives for vegetation restoration to be met. Wolf behaviors and movements could not be managed without the use of mechanized equipment in wilderness. Mechanized equipment is needed to effectively monitor wolves and to reach wolves in remote areas efficiently and effectively reducing the risk of wolves extending beyond park boundaries. Helicopters therefore are the minimum tool to manage wolves in the park.

Step 2 Decision: What is the Minimum Activity?

The selected alternative is: **Alternative 3**

Gradual reduction of the elk population would occur using mechanical methods of noise suppressed and unsuppressed weapons to remove a low number of elk annually to achieve a population at the high end of the natural range. To minimize impacts in wilderness, noise suppressed weapons would be used to the greatest extent while allowing management objectives for vegetation restoration to be met. Redistribution activities would be conducted using the least intrusive methods in an adaptive approach. Non-mechanical means in wilderness would be employed first and results monitored. To the greatest extent possible, management activities to reduce the elk population would be conducted during periods of the day when visitation is low, would be done in areas not frequented by visitors, and would use noise suppressed weapons. Due to the fewer number of elk to be removed annually, it is less likely under this alternative that helicopters would be used to remove carcasses from the field. If necessary, helicopters would only be used adaptively to remove carcasses from remote locations due to disease management concerns Some carcasses would be left in the environment to approximate natural conditions so as not to negatively affect wilderness character or values. Fences would be installed using the least intrusive design for the site-specific conditions in wilderness areas on the primary elk range and to minimize impacts on visitors to wilderness. To reduce safety risks, improve efficiency, and limit the frequency of intrusion on wilderness character, helicopters and motorized equipment would be used to transport fence materials. Prescribed burning and mechanical removal to stimulate vegetation recovery would involve the use of hand tools to a large degree; however chain saws may be used to effectively and safely treat large pieces of woody material. Portable pumps and generators would be used during prescribed burns as needed to ensure the containment of fires and prevent risks to public health and safety. A small number of wolves and fertility control could be used adaptively in the future to control elk distributions and population size.

Describe the rationale for selecting this alternative:

This alternative allows the National Park Service to meet management objectives with the minimum use of motorized equipment. Due to the lower number of elk to be removed annually the frequency of management actions to control the population and to remove carcasses would be less compared to other alternatives. Overall, this alternative reduces to a greater degree impacts on opportunities for solitude and visitor recreation within wilderness. Although this alternative requires more fences in wilderness which would adversely impact the character of wilderness on the primary elk range over a longer period, fences would not be permanent and they would not prevent public access and use of wilderness areas or access to habitat by other wildlife. Increased use of fences would reduce the amount of unfenced areas in wilderness that redistribution activities would need to take place, thus reducing the extent of adverse impacts of these activities on wilderness character. The use of fences provides a higher level of certainty that native vegetative communities would be restored to natural conditions more rapidly than other alternatives. As a result, fire as a natural part of the ecosystem could be restored more quickly to a large expanse of wilderness on the primary elk range. The restoration of vegetation and protection from herbivory would increase the potential for natural recovery of beaver or the reintroduction of beaver back into the wilderness area. This alternative also provides for adaptive management of elk and vegetation using wolves or fertility controls. If management objectives are not being met, a highly managed wolf population could be used to more effectively redistribute elk which would reduce the need for fences in wilderness. If administration of a fertility control agent becomes logistically feasible in the future, the treatment of elk by darting would be less intrusive on wilderness character than lethal removal using firearms.

Describe any monitoring and reporting requirements:

Monitoring would be conducted in the short and long-term on geographic scales ranging from site-specific to landscape. Elk population size, densities, demographics, and distribution would be monitored annually. Vegetation changes would be monitored as needed to determine progress toward restoration goals and could be done annually and/or at 5- or 10-year interval depending upon vegetation type and parameter measured. Informal and formal visitor surveys would be conducted to monitor public reaction to management actions. Under the adaptive management approach which this alternative would be implemented, if impacts of management activities on wilderness resources are occurring at unacceptable levels, the National Park Service would apply additional mitigations or select a different tool to reduce or eliminate the effect.

Please check any Wilderness Act Section 4(c) uses approved in this alternative:

- ☒ mechanical transport
- ☒ motorized equipment
- ☒ motor vehicles
- ☐ motorboats
- ☒ landing of aircraft
- ☐ temporary road
- ☒ structure or installation

Be sure to record and report any authorizations of Wilderness Act Section 4(c) uses according to agency procedures.

APPROVAL

Recommended by:

Mark Magnuson, Chief Ranger   12/03/07

for Wilderness Specialist, Rocky Mountain National Park   Date

Approved by: Vaughn Baker   12/03/07

Superintendent, Rocky Mountain National Park   Date

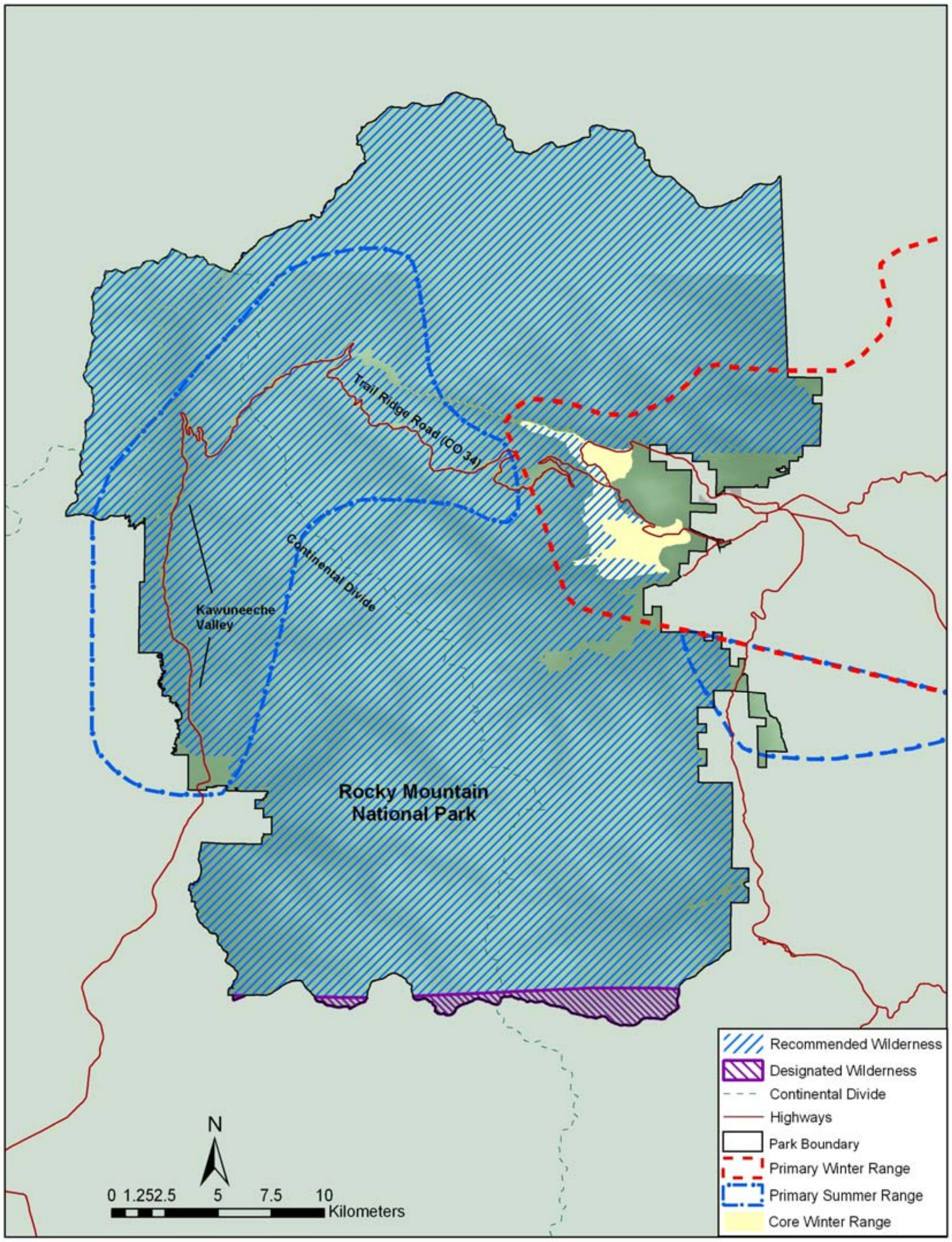


FIGURE 1: PRIMARY ELK RANGE AND WILDERNESS TYPES IN ROCKY MOUNTAIN NATIONAL PARK

APPENDIX H: DIFFERENCES BETWEEN CULLING AND HUNTING AND DESCRIPTION OF AUTHORIZED AGENTS

This page intentionally left blank

APPENDIX H –DIFFERENCES BETWEEN CULLING AND HUNTING AND DESCRIPTION OF AUTHORIZED AGENTS

Hunting is a recreational activity that includes the elements of fair chase and personal take of the meat, as well as being a conservation tool. Hunting is administered by the state fish and game agency, which licenses hunters. If areas of the park were to be opened to hunting those areas would need to be closed to visitor use while hunting was taking place. The NPS would need to absorb the costs of managing hunters, visitors and the media during a hunt.

Culling is used as a conservation tool to reduce populations that have exceeded the carrying capacity of their habitat. As opposed to hunting, culling is done under very controlled circumstances in order to minimize impacts on park operations, visitors, private inholdings and neighbors. Culling is also an efficient and humane way to reduce herds of animals that are habituated to the presence of humans. Culling is not recreational and does not incorporate the concept of fair chase. Culling would be administered by the NPS and carried out by NPS personnel and their authorized agents, and would not require licensing by the state. The personnel doing the shooting would be responsible for killing and processing several animals in any session. Carcasses from culling operations would be tested for chronic wasting disease and to the extent possible carcasses and/or meat would be donated through an organized program to eligible recipients, including members of tribes, based on informed consent and pursuant to applicable public health guidelines. Short-term road closures (a few hours most likely early in the morning) could be needed while culling activity is ongoing.

NPS management policies (2006) allow destruction of animal populations (culling) under certain circumstances:

4.4.2.1 NPS Actions That Remove Native Plants and Animals

… Where visitor use or other human activities cannot be modified or curtailed, the Service may directly reduce the animal population by using several animal population management techniques, either separately or together. These techniques include relocation, public hunting on lands outside a park or where legislatively authorized within a park, habitat management, predator restoration, reproductive intervention, and destruction of animals by NPS personnel or their authorized agents….

All of these techniques including culling have been evaluated in the Environmental Impact Statement on the Elk and Vegetation Management Plan for possible use at Rocky Mountain National Park.

For purposes of this plan, "authorized agents" could include: professional staff from other federal, state or local agencies or tribes; contractors; or qualified volunteers. National Park Service personnel would be responsible for culling operations. There may be circumstances when additional personnel are needed to achieve annual population goals. National Park Service personnel would be augmented by authorized agents who would be afforded the opportunity to assist in culling operations under the direct supervision of NPS personnel. Cost, efficiency and effectiveness would be the factors that determine when supplemental personnel are needed.

NPS personnel and their authorized agents would cull inside Rocky Mountain National Park removing mostly female elk for the purposes of population reduction. During the winter (October to May) elk are concentrated on the east side of the park and adjacent public and private land in and around the Town of Estes Park. Any action taken inside the park would affect adjoining lands and neighbors as would any action taken outside the park affect park lands. Cooperation among the park, local communities, Colorado Division of Wildlife, and U.S. Forest Service is thus essential in managing the herd. The National Park Service would continue to encourage the Colorado Division of Wildlife and neighboring communities to consider taking further actions outside of the park in addition to public hunting to manage the elk of the larger town subpopulation that spend most of their time outside of the park (e.g., Estes Park subpopulation).

The number of animals removed and the costs would vary each year based on annual population surveys and hunter success outside the park. The level of management action that would be taken to control the population size would be adjusted annually based on the current population size estimates. Based on adaptive management, management actions to control the population would not be taken if the population size was within the range specified within the final plan and vegetation objectives were being met.

Those responsible for population reduction would focus on removing female elk and would cull multiple animals in any one event. Cullers would not be allowed to keep the animal in part or in whole.

Cullers would be expected to assist in processing the animals in preparation for disbursement. These activities could include: gutting, skinning, quartering, boning, and packing animals (sometimes long distances) to holding facilities or locations. Cullers including NPS personnel and authorized agents would be certified in firearms training, specially trained in wildlife culling, and be required to pass a proficiency test in order to qualify to participate in culling activities. Cullers would be expected to work in teams under the supervision of a NPS team leader, cull and process multiple animals in any one culling event, and spend the time necessary to ensure humane dispatch and quality meat recovery.

As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS F-333 – (December 2007)

National Park Service
U.S. Department of the Interior

United States Department of the Interior
National Park Service
Rocky Mountain National Park, Colorado