Bison and Elk Management Plan

National Elk Refuge
Grand Teton National Park

April 2007

Prepared by the U.S. Fish and Wildlife Service and National Park Service

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SUMMARY

INTRODUCTION

Jackson Hole is home to one of the largest concentrations of elk and bison in North America, with an estimated 13,000 elk and over 1,000 bison. The elk migrate across several jurisdictional boundaries in northwestern Wyoming, including the National Elk Refuge, which is managed by the U.S. Fish and Wildlife Service (USFWS), and Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway, which are managed by the National Park Service (NPS). Ranges also extend into Yellowstone National Park, Bridger-Teton National Forest, Bureau of Land Management (BLM) resource areas, and state and private lands.

The bison range largely within Grand Teton National Park and the National Elk Refuge, with some crossing into Bridger-Teton National Forest and onto state and private lands in the Jackson Hole area.

Both species contribute significantly to the ecology of the southern greater Yellowstone ecosystem because of their large numbers, wide distribution, effects on vegetation, and their importance to the area's predators and scavengers.

The U.S. Fish and Wildlife Service and the National Park Service have selected a plan for managing bison and elk on the National Elk Refuge and in Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway for a 15-year period. The plan was developed in accordance with the National Environmental Policy Act and included extensive public input and close collaboration with several cooperative agencies and partners. These agencies include

- the Wyoming Game and Fish Department (WGFD), which manages resident wildlife species throughout most of the state
- the U.S. Forest Service, which administers Bridger-Teton National Forest
- the Bureau of Land Management, which administers BLM resource areas in Jackson Hole
- the U.S. Department of Agriculture's Animal and Plant Health Inspection Service, which is in part responsible for preventing the introduction and spread of significant livestock diseases

Extensive opportunities for input were also provided to local governmental agencies, tribal

Photo courtesy of Diana L. Stratton

Sleigh ride on the National Elk Refuge, with the Teton Range in Grand Teton National Park as a backdrop.

Bison and elk on the National Elk Refuge.

governments and organizations, nongovernmental organizations, and private citizens, as well as during review of the *Draft* and *Final Environmental Impact Statements*.

BACKGROUND

The Role of Elk

Elk figure prominently in Jackson Hole's history and culture. In the late 1800s, when elk populations all over North America were being extirpated, the residents of Jackson Hole protected elk from "tusk hunters" and from large-scale commercial hunting operations. At the same time changes in land use and development reduced access to significant parts of elk native winter range. Before Euro-American settlement, elk had wintered to some degree in the southern portion of Jackson Hole (the location of the National Elk Refuge and the town of Jackson), as well as the Green River, Wind River, and Snake River basins.

By the end of the 19th century the Jackson elk herd was largely confined to Jackson Hole and the immediately surrounding area, and it was at the mercy of severe winter weather when snow accumulation and subzero temperatures made foraging difficult. Substantial numbers of elk died during several severe winters in the late 1800s and early 1900s. This prompted local citizens and organizations in Jackson Hole, as well as state and federal officials, to begin feeding in the winter of 1910–11. On August 10, 1912, Congress appropriated $45,000 for the purchase of lands and maintenance of a "winter game (elk) reserve," which subsequently became the National Elk Refuge.

The Role of Bison

Bison in the Jackson Hole area are popular with visitors and residents as a symbol of the West, and they are central to the culture and traditions of many American Indian tribes. Because there are so few opportunities to see bison in the wild, viewing and photographing these animals in Grand Teton National Park is a unique opportunity for many of the valley's visitors, especially with the Teton Range serving as a backdrop.

The presence of prehistoric bison remains indicates that bison had long inhabited the Jackson Hole area. But by the mid-1880s they were extirpated outside Yellowstone National Park. In 1948, 20 bison from Yellowstone were reintroduced to the 1,500-acre Jackson Hole Wildlife Park near Moran. Over the next two decades bison were maintained in a large exclosure. In 1968 the herd (down to 11 animals) escaped from the wildlife park, and a year later the decision was made to allow them to range freely. In 1975 the small bison herd (then 18 animals) began wintering on the National Elk Refuge. The use of standing forage by bison on this natural winter range was viewed as natural behavior and was not discouraged by managers. In 1980, however, the bison began eating supplemental feed that was being provided for elk.

Since discovering this supplemental food source, the Jackson bison herd has grown to over 1,000 animals, increasing by 10%–14% each year. Bison on the elk feedlines have at times disrupted feeding operations and displaced and injured elk. In order to minimize conflicts between bison and elk, managers have provided separate feedlines for bison since 1984, but this has become increasingly difficult as the bison population has grown. It is not clear how large the population could become in the absence of human control measures.

Concerns about the rapidly increasing bison herd include greater damage to habitats, competition with elk, risk of disease transmission to elk and

domestic livestock, risk to human safety, damage to private property, and costs of providing supplemental feed for bison. Many of the management issues surrounding the bison herd are controversial. Because of its distribution, the herd falls under the wildlife management jurisdictions of Grand Teton National Park, the National Elk Refuge, and the Wyoming Game and Fish Department. In addition, the Wyoming Livestock Board has authority to remove bison from some public and private lands if there are conflicts with landowners.

Purpose of and Need for Action

Purpose

The purpose of the *Bison and Elk Management Plan* is to provide managers with goals, objectives, and strategies for managing bison and elk on the National Elk Refuge and in Grand Teton National Park for the next 15 years. The plan will contribute to the missions and management policies of the U.S. Fish and Wildlife Service and the National Park Service. Given the substantial contributions that the refuge and the park make to the Jackson bison and elk herds and the effects that the herds can have on surrounding habitats, the plan will also contribute to the herd objectives set by the Wyoming Game and Fish Department, as well as to several goals and objectives established by the U.S. Forest Service related to elk, bison, and their habitat in Bridger-Teton National Forest.

The identification of current issues does not discount the highly successful past and present efforts to conserve elk and bison in Jackson Hole. The success of the management program over the long history of the refuge and the park is due in large part to issues being identified and resolved, a process that is and should be ongoing.

Need

The plan considers changes in how the bison and elk herds are currently managed on the National Elk Refuge and in Grand Teton National Park in order to meet legal obligations, to address problems related to high animal concentrations and effects on habitat, and to take advantage of unmet opportunities. The need for action comes from many directions, as described below.

1998 Lawsuit to Stop Bison Hunting — In 1996 a *Jackson Bison Herd Long-term Management Plan and Environmental Assessment* was completed by the National Park Service and the U.S. Fish and Wildlife Service, with the Wyoming Game and Fish Department and the U.S. Forest Service participating as cooperating agencies. The selected alternative called for public hunting on the refuge and in Bridger-Teton National Forest to control the rapidly growing bison population and the artificial concentration of bison during the winter. Both of these factors were contributing to the increased risk of disease transmission, competition with elk and other wildlife, property damage, erosion, and overgrazing.

Elk migration on the National Elk Refuge.

Neotropical migratory birds nest on the refuge and in the park.

Before the plan was implemented, the Fund for Animals successfully sued in 1998 to prevent any "destructive management" of bison for population control until the effects of the refuge's winter feeding program on bison were more fully analyzed in accordance with the National Environmental Policy Act.

Following the lawsuit, the U.S. Fish and Wildlife Service and the National Park Service decided to broaden the management planning process to include all aspects of elk management, in addition to bison management.

Issues Related to Elk/Bison Concentrations — While there have been many benefits associated with wintering large numbers of elk and bison on the refuge, high animal concentrations have created an unnatural situation that has contributed to the following problems:

- an increased risk of potentially major outbreaks of exotic diseases, including bovine tuberculosis and chronic wasting disease, neither of which has yet been documented in the Jackson herds
- damage to and loss of habitat due to browsing of willow, cottonwood, and aspen stands, with resultant reductions in wildlife associated with healthy stands
- unusually low winter mortality of bison and elk, which affects predators, scavengers, and detritivores and which necessitates intensive hunting programs
- a high level of brucellosis in the elk and bison herds

Winter Feeding as a Response to Insufficient Winter Range — All of the biological issues identified above stem from the winter feeding program on the National Elk Refuge. Even though winter feeding was started to mitigate the loss of former winter range to other land uses, it has benefited the elk population by reducing winter mortality and allowing the herd to grow. At the same time local ranchers' haystacks and livestock pastures have been protected from depredation by foraging elk. As previously discussed, supplemental feeding has also contributed to a growing bison population.

The need for winter feeding remains much the same as it was in 1912 — there is an insufficient amount of winter range to support the numbers of elk that occupy the Jackson Hole area, and this has been true for more than 100 years. Supplemental feeding to make up the deficit in native forage has also contributed to an expanding bison population, adding to the overall problem.

LEGAL AND POLICY GUIDANCE

National Elk Refuge

The National Elk Refuge is part of the National Wildlife Refuge System. The *fundamental* mission of this system, according to Congress, is the conservation of fish, wildlife, and plants, where conservation is defined as sustaining healthy populations of these organisms. Characteristics of a healthy wildlife population include a stable and continuing population (i.e., the population returns to an initial equilibrium after being disturbed) and a minimized likelihood of irreversible or long-term effects.

While the National Elk Refuge was established in 1912 as a "winter game (elk) reserve," over the years its purpose has been broadened to include "refuges and breeding grounds for birds, other big game animals, the conservation of fish and wildlife, the protection of natural resources, and the conservation of threatened or endangered species."

USFWS policy directs that wildlife population levels on national wildlife refuges be maintained

at levels consistent with sound wildlife management principles, that populations be managed for natural densities and levels of variation, and that population management activities contribute to the widest possible natural diversity of indigenous fish and wildlife, even when population management activities are implemented for a single species.

However, USFWS policy also requires that wildlife densities do not reach excessive levels that would result in adverse effects on habitat and other wildlife species, including increased disease risks.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway

The purpose of national parks, as stated in the NPS Organic Act, is "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."

Grand Teton National Park is dedicated to the preservation and protection of the Teton Range and its surrounding landscapes, ecosystems, and cultural and historic resources. The singular geologic setting makes the area and its features unique. Human interaction with the landscape and ecosystem has resulted in an area that is rich in natural, cultural, and historic resources and that represents the natural processes of the Rocky Mountains and the cultures of the American West. The purpose of Grand Teton National Park is to protect the area's native plant and animal life, its cultural and historic resources, and its spectacular scenic values, as characterized by the geologic features of the Teton Range and Jackson Hole.

John D. Rockefeller, Jr., Memorial Parkway was established to commemorate the contributions to the cause of conservation made by John D. Rockefeller, Jr. The purpose of the parkway is to conserve the scenery and natural and historic resources and to provide for their use while leaving them unimpaired for future generations.

In accordance with NPS *Management Policies 2006*, the focus of natural resource conservation in all National Park System units will be at an ecosystem level, emphasizing natural abundance, diversity, and genetic and ecological integrity of native species in an ecosystem. Normally, the Park Service will not intervene in natural biological or physical processes except when an ecosystem's functioning has been disrupted by human activities or when park-specific legislation authorizes particular activities (such as livestock grazing and elk herd reductions in Grand Teton National Park).

For migratory species, such as the elk and bison in Grand Teton, NPS policies encourage the adoption of resource preservation and use strategies to maintain natural population fluctuations and processes. The survival of the species in national parks also depends on the existence and quality of habitats outside the parks. Thus, the Park Service must work with other land managers to encourage the conservation of the populations and habitats of these species outside parks whenever possible.

Moulton barn in Grand Teton National Park.

PLANNING PROCESS

Public, Tribal Governments, and Other Stakeholder Issues

Seven significant issues were identified during the public involvement process and tribal government consultation. These issues were considered in the formulation of the objectives and strategies for the plan.

1. *Bison and Elk Populations and Their Ecology* — Most members of the public generally want healthy bison and elk herds,

whether for the abundance of recreational opportunities or for the benefit of the animals themselves and the ecosystem. There was no agreement about how many animals should be in each herd, or how to reach those numbers.

2. *Restoration of Habitat and Management of Other Species of Wildlife* — Some people want to see habitat restored and improved, but opinions differ on the specifics of this goal.
3. *Winter Feeding Operations for Bison and Elk* — Some stakeholders disagree with the concept of providing supplemental feed to elk and bison, while others believe supplemental feed should be provided every year.
4. *Disease Prevalence and Transmission* — Brucellosis and the high rates of infection in both the bison and elk herds is of concern because of the economic effect it could have on livestock producers if cattle contract the disease. Some stakeholders are concerned about the potential of more serious non-endemic diseases, such as bovine tuberculosis or chronic wasting disease, getting into the herds.
5. *Recreational Opportunities* — Many people are concerned that changes in the management of elk and bison on the National Elk Refuge and in Grand Teton National Park would impact hunting and viewing opportunities.
6. *Cultural Opportunities, Traditions, and Lifestyles* — Tribal representatives and other members of the public have stated that American Indian tribes should be actively involved in decisions regarding bison. Some Native Americans have traditions and spiritual values that are closely associated with both elk and bison. Local residents are also concerned about how changes in elk and bison management would affect their own traditions and lifestyles, which are in part dependent on wide-open spaces and plentiful wildlife.
7. *Commercial Operations and the Local and Regional Economy* — Wildlife viewing and hunting opportunities contribute to the local economy, and many businesses, including outfitters and dude ranchers, depend on abundant wildlife.

Elk feedline on the refuge.

COMMENTS AND RESPONSES ON THE DRAFT AND FINAL ENVIRONMENTAL IMPACT STATEMENTS

Draft Environmental Impact Statement

The *Draft Bison and Elk Management Plan and Environmental Impact Statement* was available for public review from July 21, 2005, to November 7, 2005. In late August 2005 the U.S. Fish and Wildlife Service and the National Park Service held a series of public open houses and formal hearings in Bozeman, Montana; Jackson, Wyoming; and Riverton, Wyoming. In addition to the public hearing testimony, public comments were also received in the form of letters, e-mails, form letters, and petitions.

During the comment period, the agencies received over 11,900 written comments and public testimony from 241 individuals, 37 governmental agencies and organizations, and 1,751 form letters or petitions. While many issues were raised, most of the concerns focused on the following topics:

- Population management
- Habitat management
- Supplemental feeding
- Disease
- Public use and economics
- Legal mandates and jurisdiction
- Native American tradition and history

The most common concerns or issues expressed in individual comments (including form letters) were:

1. Support for protecting and restoring wildlife migration routes

2. Opposition to the use of existing vaccines
3. Suggestion that bison should be managed like other big game species
4. Suggestion that supplemental feeding should be phased out
5. Suggestion that populations should be managed with hunting and habitat protection
6. General concerns about disease
7. Concern that a disease outbreak could jeopardize local outfitting and ranching opportunities
8. Support for supplemental feeding
9. Concern about impacts to other species if elk and bison feeding was reduced
10. Support for reducing the size of the bison herd

This list does not include issues in letters from agencies or organizations, which were responded to separately.

Final Environmental Impact Statement

Responses by the U.S. Fish and Wildlife Service and the National Park Service to all substantive comments (including individual comments, agency comments, and form letters) on the *Draft Environmental Impact Statement* were included in the *Final Environmental Impact Statement.* A list of the significant changes made from the *Draft Environmental Impact Statement* can be found in the "Planning Process" chapter of this document.

The *Final Bison and Elk Management Plan and Environmental Impact Statement* was published on February 2, 2007, and the 30-day waiting period ended on March 12, 2007. A total of 938 e-mails were received from individuals and 5 letters from organizations. The majority of e-mails were petitions in support of Alternative 6 with changes, while two individuals opposed hunting. A total of 4,738 comments (including signers of petitions) were recorded. In addition, a meeting was held with the Shoshone-Bannock Tribes on March 9, 2007, at Fort Hall, Idaho, to discuss the tribes' concerns about the *Final Plan and Environmental Impact Statement.*

Moose in Grand Teton National Park.

Comments on the *Final Plan and Environmental Impact Statement* focused on the following concerns:

- Supplemental feeding
- Adaptive management framework
- Legal mandates
- Fencing
- Bison
- Vaccination
- Tribal concerns
- Hunting

Issues raised about supplemental feeding, legal mandates, bison population objectives, habitat modeling assumptions, vaccination, and hunting were addressed in *Volume 2: Responses to Comments on the Final Plan and Environmental Impact Statement*, and changes were made in the final plan. Other issues that warrant further clarification are discussed below.

- *Adaptive Management Framework* — The plan does not identify whether or not feeding will be phased out within 15 years; instead, it focuses on achieving the desired conditions that have been identified through an adaptive, progressive, and collaborative approach that incorporates different objectives and tools (strategies) for managing these populations.

Riparian habitat along Pilgrim Creek in Grand Teton National Park.

- *Fencing* — The need for additional fencing on the refuge other than that identified in the final plan is not anticipated, but there is flexibility to work with adjacent landowners, the state, and others to identify strategies (including fencing) for reducing elk and bison conflicts on private lands.
- *Tribal Concerns* — The option of potentially allowing the tribes to take a small number of bison for the purposes of a ceremonial event remains a sensitive issue for the state as well as the tribes. The population objectives for bison and the subsequent analysis would remain unchanged regardless of whether a small taking for ceremonial purposes was eventually allowed, and discussions with the tribes will continue. Other tribal concerns were addressed in volume 2 of the *Final Plan and Environmental Impact Statement.*

RECORD OF DECISION

The "Record of Decision" for the plan was signed by the Regional Directors of the U.S. Fish and Wildlife Service and the National Park Service on April 26, 2007.

The "Record of Decision" provides a summary of the planning and analysis process, including the purpose of and need for the plan, the issues identified during the public process, the alternatives that were considered and analyzed in the *Final Environmental Impact Statement*, the public input process, and the basis for the decision to implement the Preferred Alternative — Adaptively Manage Habitat and Populations, as described in this document under "Management Direction."

MANAGEMENT DIRECTION

DESIRED CONDITIONS

By the end of the 15-year implementation period, the National Elk Refuge and Grand Teton National Park provide winter, summer, and transitional range for large portions of the Jackson bison and elk herds. The environment supports a full complement of native plant, wildlife, and breeding bird species. Refuge and park staffs, working with others, adaptively manage bison and elk in a manner that contributes to the state's herd objectives yet allows for the biotic integrity and environmental health of the resources to be sustained. As a result, the public enjoys a variety of compatible, wildlife-dependent recreational opportunities.

MANAGEMENT GOALS

Four goals for the bison and elk management plan have been established. They are based on the purposes of the National Elk Refuge and Grand Teton National Park, the missions of the National Wildlife Refuge System and the National Park System, and other legal and policy directives. The goals also consider input from stakeholders.

Goal 1: Habitat Conservation

National Elk Refuge — Provide secure, sustainable ungulate grazing habitat that is characterized primarily by native composition and structure within and among plant communities and that also provides for the needs of other native species.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway — In concert with restoring and perpetuating natural ecosystem functioning in Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway, restore and maintain the full range of natural structural and compositional characteristics of native habitats used by bison and elk, emphasizing the plant species diversity that native habitats would support.

Goal 2: Sustainable Populations

National Elk Refuge — Contribute to elk and bison populations that are healthy and able to adapt to changing conditions in the environment and that are at reduced risk from the adverse effect of non-endemic diseases.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway — Perpetuate to the greatest extent possible natural processes and the interactions of bison and elk with natural environmental fluctuations that are influenced by fire, vegetation succession, weather, predation, and competition. At the same time support public elk reductions in Grand Teton National Park, when necessary, to achieve elk population objectives that have been jointly developed by the Wyoming Game and Fish Department, Grand Teton National Park, and the National Elk Refuge. Support elk hunting in the John D. Rockefeller, Jr., Memorial Parkway that is consistent with its establishing legislation.

Goal 3: Numbers of Elk and Bison

Contribute to the WGFD herd objectives for the Jackson elk and bison herds to the extent compatible with Goals 1 and 2, and the legal directives governing the management of the National Elk Refuge and Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway.

Goal 4: Disease Management

Work cooperatively with the state of Wyoming and others to reduce the prevalence of brucellosis in the elk and bison populations in order to protect the economic interest and viability of the livestock industry, and reduce the risk of adverse effects for other non-endemic diseases not currently found in the Jackson elk and bison populations.

Management Plan Overview: Adaptively Manage Habitat and Populations

The Jackson bison and elk herds and their habitat will be adaptively managed on the refuge and in the park, with an emphasis on improving winter, summer, and transitional range in the park and on the refuge and on ensuring that the biotic integrity and environmental health of the resources will be sustained over the long term. A dynamic framework for decreasing the need for supplemental feeding on the refuge will be developed and implemented in close cooperation with the Wyoming Game and Fish Department and will be based on existing conditions, trends, new research findings, and other changing circumstances. Population management, vegetation restoration, ongoing monitoring, and public education will be integral components of this framework.

The U.S. Fish and Wildlife Service and the National Park Service will collaborate with the Wyoming Game and Fish Department to maintain the Jackson elk herd at the state's objective of approximately 11,000 animals. Following the initial implementation of a phased approach, approximately 5,000 elk will be expected to winter on the refuge. As herd sizes and habitat objectives are achieved, further reductions in feeding or elk numbers may occur based on established criteria and changing social, political, or biological conditions. Bison and elk hunting on the refuge, and when necessary, the elk herd reduction program in the park, will be used to assist the state in managing herd sizes, sex and age ratios, and summer distributions.

The park and refuge will work with the Wyoming Game and Fish Department to maintain and ensure a genetically viable population of approximately 500 bison.

The Wyoming Game and Fish Department will be permitted to vaccinate elk and bison for brucellosis on the refuge as long as it is logistically feasible. Management actions will not be designed to specifically facilitate vaccination.

Elk in Grand Teton National Park.

SUPPLEMENTAL ACTIONS

The following ongoing activities will be taken independent of the plan:

- *Invasive Weed Control, Nonnative Plant Species Control, and Integrated Pest Management* — The control of invasive weeds and integrated pest management for both the refuge and the park will continue. The U.S. Fish and Wildlife Service and the National Park Service will continue working together and with the Teton County Weed and Pest Control District, the U.S. Forest Service, the Wyoming Game and Fish Department, and private landowners to manage invasive species. Efforts to eradicate cheatgrass and crested wheatgrass will continue on the refuge, much as they have in the recent past.
- *Jackson Hole Interagency Habitat Initiative* — The U.S. Fish and Wildlife Service and the National Park Service will continue to work cooperatively with other agencies in identifying opportunities to improve habitat for elk and bison.
- *Jackson Elk Studies Group and Greater Yellowstone Interagency Brucellosis Committee* — The U.S. Fish and Wildlife Service and the National Park Service will continue to participate in these groups to assess the risk for brucellosis transmission from elk or bison to livestock.
- *Livestock Grazing* — The plan will not change livestock grazing practices in the park, nor will it mandate that such use continue.
- *Chronic Wasting Disease* — Efforts will be coordinated with the Wyoming Game and Fish Department to increase the surveillance of elk for chronic wasting disease. If infection is found, WGFD strategies for state feedgrounds will be used to reduce the transmission risk. These strategies include removing infected elk, removing 50 animals within 5 miles when an infected animal is found, and removing an additional 50 animals within 10 miles if another infected animal is found during collection of the initial 50; enforcing carcass movement and disposal restrictions; decreasing duration of feeding and expanding the distribution of feeding to the extent possible; and potentially decreasing elk densities through hunting or other management strategies. Plans to follow the state CWD management plan have been made in deference to the state and could change if the National Park Service and/or the U.S. Fish and Wildlife Service adopted servicewide management requirements that differed from what is currently being done. Potential changes would be communicated to the state.
- *Strategies for Hunting/Reduction Programs* — The U.S. Fish and Wildlife Service and the National Park Service will work cooperatively with the Wyoming Game and Fish Department to achieve population objectives (including herd ratios and elk herd segment sizes), to develop hunting or reduction seasons, and to evaluate hunting or elk reduction areas. The Wyoming Game and Fish Department will formally establish objectives and strategies after public review and approval by the Wyoming Game and Fish Commission.

Photo courtesy of Terry J. Kreeger, WGFD

Elk with chronic wasting disease.

PLAN IMPLEMENTATION

Selected management actions and projects will be implemented as funds became available. This document does not constitute a commitment for funding, and future budgets could influence implementation priorities.

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Abbreviations

The following abbreviations are used in text bibliographic references or as adjectives:

APHIS	Animal and Plant Health Inspection Service, U.S. Department of Agriculture
BLM	Bureau of Land Management, U.S. Department of the Interior
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CWD	chronic wasting disease
EIS	environmental impact statement
EO	Executive Order
FHWA	Federal Highway Administration
GnRH	gonadotropin releasing hormone (fertility control hormone)
GTNP	Grand Teton National Park
GYIBC	Greater Yellowstone Interagency Brucellosis Committee
JIHI	Jackson Interagency Habitat Initiative
NEPA	National Environmental Policy Act
NER	National Elk Refuge
NPS	National Park Service, U.S. Department of the Interior
NWRS	National Wildlife Refuge System
PL	Public Law
PZP	porcine zona pellucida (fertility control hormone)
RB51	brucellosis vaccine for bison
Stat.	*United States Statutes at Large*
USC	*United States Code*
USFWS	U.S. Fish and Wildlife Service, U.S. Department of the Interior
USFS	U.S. Forest Service, U.S. Department of Agriculture
WGFC	Wyoming Game and Fish Commission
WGFD	Wyoming Game and Fish Department

INTRODUCTION AND BACKGROUND

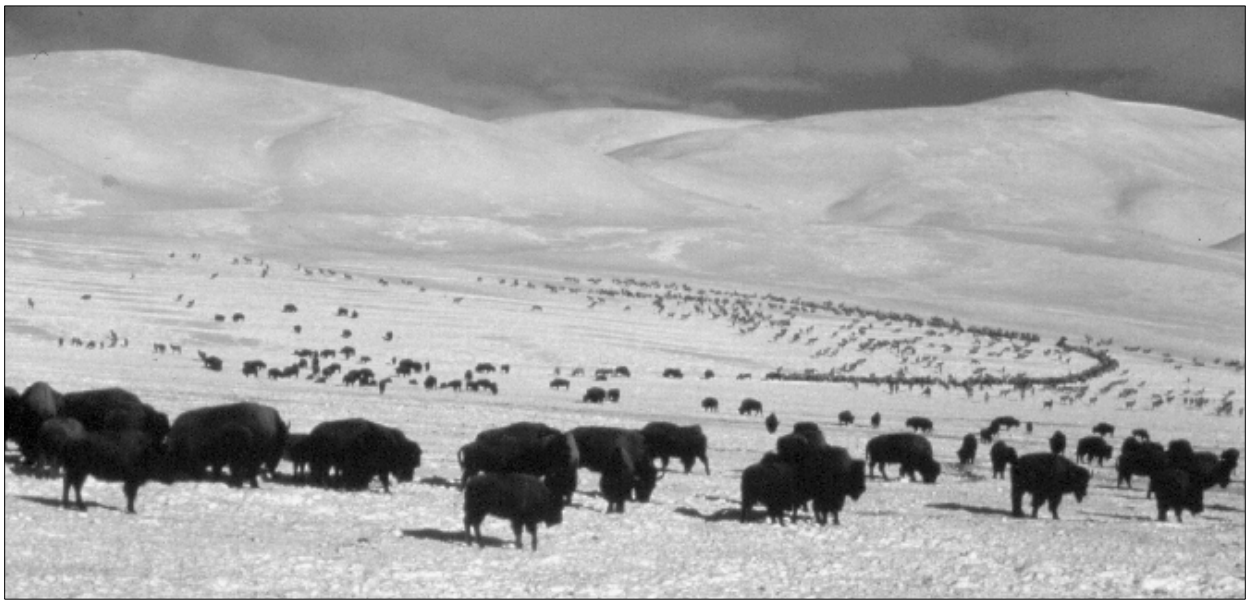
OVERVIEW

This *Bison and Elk Management Plan* has been selected as the course of action for managing bison and elk on the National Elk Refuge (refuge) and in Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway (the park) for a 15-year period. The plan is a result of a planning process begun by the U.S. Fish and Wildlife Service and the National Park Service in the spring of 2000.

The National Elk Refuge is a 24,700-acre unit of the National Wildlife Refuge System that is administered by the U.S. Fish and Wildlife Service. Grand Teton National Park is 309,995 acres, and John D. Rockefeller, Jr., Memorial Parkway is an additional 23,777 acres, for a total of 333,772 acres administered by the National Park Service. The areas are just north of the town of Jackson in northwestern Wyoming and in the southern portion of the greater Yellowstone ecosystem (see the "Greater Yellowstone Area" map).

There are an estimated 13,000 elk and over 1,000 bison in the Jackson elk and bison herds, one of the largest concentrations of these animals in North America. The elk migrate across several jurisdictional boundaries, including the National Elk Refuge, Grand Teton National Park, John D. Rockefeller, Jr., Memorial Parkway, Yellowstone National Park, Bridger-Teton National Forest, Bureau of Land Management (BLM) resource areas, and state and private lands. The bison range largely within Grand Teton National Park and the refuge, with some crossing into Bridger-Teton National Forest and onto state and private lands in the Jackson Hole area. Because of their large numbers, wide distribution, effects on vegetation, and their importance to the area's predators and scavengers, both species contribute significantly to the ecology of the southern greater Yellowstone ecosystem. Elk are the priority species on the refuge because they are the only species specifically mentioned in the refuge's enabling legislation.

In preparing this plan, the U.S. Fish and Wildlife Service and National Park Service worked closely with several cooperating agencies: the U.S. Forest Service and the Bureau of Land Management administer resource areas in the Jackson Hole area, and the U.S. Animal and Plant Health Inspection Service is in part responsible for preventing the introduction and spread of significant livestock diseases. These agencies provided significant contributions in the development of this plan.



Bison and elk on the National Elk Refuge.

Greater Yellowstone Area

map

Additionally, the Wyoming Game and Fish Department (WGFD) manages resident wildlife species throughout most of Wyoming and was a significant partner in this planning process. In Wyoming, wildlife management goals and objectives (e.g., bull-to-cow ratios, herd objectives, and hunting seasons) are set through a public review process that requires public input and a final recommendation to be approved by the Wyoming Game and Fish Commission (WGFC). Further information about the state's role in this planning process is discussed in greater detail in this chapter under "State Plans and Agreements."

Extensive opportunities were also provided to local governing bodies and agencies, tribal governments and organizations, nongovernmental organizations, and private citizens to provide input into the management planning process.

THE ROLE OF ELK

While Jackson Hole is probably best known for the splendor and ruggedness of the Teton Range, the Jackson elk herd certainly ranks among the top characterizing features of the valley. Elk figure prominently in Jackson Hole's history and culture. In the late 1800s, when elk populations all over North America were being extirpated, the residents of Jackson Hole diligently protected elk from "tusk hunters" and from large-scale commercial hunting operations. Elk are just as important to today's residents of the valley. Many people who have visited the town of Jackson remember it for the four arches made of elk antlers in the town square. Many local businesses include "elk" or "antler" in their names, and elk and elk antlers figure prominently in many of the items for sale and on display in town. Thousands of people each year have the opportunity to see elk at close range on the refuge while riding on horse-drawn sleighs. Thousands of pounds of shed elk antlers are sold at an annual antler auction each spring in the town square. Elk are important to backcountry users as well as to people that never leave the road. Jackson Hole is a popular destination for in-state and out-of-state elk hunters.

Winter feeding of elk in Jackson Hole began in 1910 and was originally initiated to reduce winter mortality of elk, thereby helping preserve a population of animals important to local residents

Historical photo of elk on the refuge.

and interest groups, as well as to minimize depredation of ranchers' hay. Although these immediate factors prompted the initiation of winter feeding, the need for the refuge's winter feeding program is a direct result of reduced access to significant parts of elk native winter range. According to some anecdotal historical reports, before Euro-American settlement, elk that summered in the area now inhabited by the Jackson elk herd wintered to some degree in the southern portion of Jackson Hole (present location of the National Elk Refuge and the town of Jackson) and could have used areas outside Jackson Hole, including the Green River and Wind River basins to the south and east, respectively, and the Snake River basin to the southwest in what is now eastern Idaho (Allred 1950; C. Anderson 1958; Blair 1987; Barnes 1912; Sheldon 1927). Migration to these wintering areas probably varied from year to year, but the historical accounts of anecdotal observations are not sufficiently detailed to delineate the specific routes and movement patterns or whether migration, in fact, occurred. Changes in land use and development in the upper and middle valleys of the Snake, Green, and Wind rivers, settlement and hay production in Jackson Hole, and overhunting reduced or eliminated the use of these areas by elk.

While not everyone agrees that elk migrations took place (G. F. Cole 1969; Boyce 1989), what is known for certain is that by the end of the 19th century the Jackson elk herd was largely confined to Jackson Hole and the immediately surrounding area. As a result, the herd was at the mercy of

sometimes severe winter weather, with subzero temperatures, snow accumulation, and other factors contributing to a harsh wintering environment. Compounded by the loss of available winter range in Jackson Hole due to ranching operations and a growing town, significant numbers of elk died during several severe winters in the late 1800s and early 1900s (prior to 1911). This prompted local citizens and organizations, as well as state and federal officials in Jackson Hole, to begin feeding elk in the winter of 1910–11. Congress heeded the appeals for assistance and on August 10, 1912, appropriated $45,000 for the purchase of lands and maintenance of a "winter game (elk) reserve" (37 Stat. 293). The first winter census in the area was conducted in 1912 and showed about 20,000 elk residing in Jackson Hole and the Hoback River drainage.

THE ROLE OF BISON

Bison are also popular with visitors and residents and were fairly recently reestablished in Jackson Hole after being extirpated in the mid-1800s. To many people, bison are a symbol of the West. Because there are so few opportunities to see bison in the wild, viewing and photographing them in Grand Teton National Park is a unique opportunity for many of the valley's visitors, especially with the Teton Range in the background. As with elk, bison figure prominently in items for sale and on display in the town of Jackson. There is a high level of interest in bison hunting; there are far more applicants for hunting licenses than what are available. Bison are of particular interest to nearby American Indian tribes and tribes in other parts of the United States because the animals are central to their culture and tradition.

Historically bison inhabited Jackson Hole, as evidenced by the presence of prehistoric bison remains. These animals were extirpated outside Yellowstone National Park by the mid-1880s. In 1948, 20 bison from Yellowstone National Park were reintroduced to the 1,500-acre Jackson Hole Wildlife Park near Moran. A population of 15–30 bison was maintained in a large enclosure there until 1963, when brucellosis was discovered in the herd. All the adult animals were destroyed, but four vaccinated yearlings and five vaccinated calves were retained. Twelve certified brucellosis-free bison were added soon afterward. In 1968 the herd (down to 11 animals) escaped from the confines of the wildlife park, and a year later the decision was made to allow them to range freely. In 1975 the small Jackson bison herd (then 18 animals) began wintering on the National Elk Refuge. The use of standing forage by bison on this winter range was viewed as natural behavior and was not discouraged by managers. In 1980, however, the bison began eating supplemental feed being provided for elk, and they have continued to do so every winter since.

The discovery of supplemental feed by bison has had several consequences, including a decline in winter mortality and an increase in the population's growth rate. The Jackson bison herd has grown to over 1,000 animals and since 1990 has on average increased about 10% to 14% each year, despite WGFD-managed efforts to harvest bison outside the refuge and the park since 1997. This means that, without additional harvest, the herd would double about every six to eight years. Bison on the elk feedlines have at times disrupted feeding operations and displaced and injured elk. To minimize conflicts between bison and elk, managers have provided separate feedlines for bison since 1984. As the population has grown, separating elk and bison on feedlines has become increasingly difficult, and the bison are now fed more than a maintenance ration to reduce displacement of elk from feedlines. It is not clear how large the population could become in the absence of human control measures.

The bison herd now represents a substantive presence in Jackson Hole. Many of the management issues surrounding the herd are

Bison in snow.

controversial, and a wide range of opinions have been expressed by various interest groups about how the herd should be managed. Because of its distribution, the herd falls under the land management jurisdictions of Grand Teton National Park, the National Elk Refuge, and Bridger-Teton National Forest, as well as private landowners. The herd is under the wildlife management jurisdictions of the park, the refuge, and the Wyoming Game and Fish Department. In addition, the Wyoming Livestock Board has authority to remove bison from some public and private lands if there are conflicts with landowners. Concerns voiced about the rapidly increasing bison herd include increased damage to habitats, competition with elk, risk of disease transmission to elk and domestic livestock, risk to human safety, damage to private property, and costs of providing supplemental feed for bison.

CONTEXT AND GUIDANCE FOR THE PLAN

PURPOSE OF AND NEED FOR ACTION

PURPOSE

This *Bison and Elk Management Plan* has two primary purposes:

- Provide managers with goals, objectives, and strategies for managing bison and elk on the National Elk Refuge and in Grand Teton National Park for the next 15 years, in support of the purposes for which the two areas were established.
- Contribute to the missions and management policies of the U.S. Fish and Wildlife Service and the National Park Service.

Given the substantial contributions that the refuge and the park make to the Jackson bison and elk herds and the effects that the herds can have on surrounding habitats, the plan will also contribute to the herd objectives set by the Wyoming Game and Fish Department, as well as to several goals and objectives set by the U.S. Forest Service related to elk, bison, and their habitat in Bridger-Teton National Forest.

NEED

The identification of current issues does not discount the highly successful past and present efforts to conserve elk and bison in Jackson Hole and, in fact, may ensure that management actions remain successful. The success of the program is due in large part to issues being identified and resolved over the long history of the refuge and park, a process that is and should be ongoing.


Poor condition cottonwood habitat.

This planning effort involves the consideration of changes in how the elk and bison herds are currently managed on the National Elk Refuge and in Grand Teton National Park in order to meet legal obligations, to address problems related to high animal concentrations and effects on habitat, and to take advantage of unmet opportunities. The need for action comes from many directions, and the following discussion treats each of these in some detail.

1998 Lawsuit to Stop Bison Hunting

In 1996 a *Jackson Bison Herd Long-term Management Plan and Environmental Assessment* was completed by the National Park Service and the U.S. Fish and Wildlife Service, with the Wyoming Game and Fish Department and the U.S. Forest Service participating as cooperating agencies. According to the *Environmental Assessment*, action was needed to address the rapidly growing bison population and the artificial concentration of bison during the winter. The growing bison population and its distribution were of concern because of the increased risk of disease transmission, competition with elk and other wildlife, property damage, erosion, and overgrazing (NPS and USFWS 1996). The selected alternative called for public hunting on the refuge and in Bridger-Teton National Forest to control the size of the herd.

Before the plan was implemented, in 1998 the Fund for Animals successfully sued to prevent the implementation of any "destructive management" of bison for population control on the National Elk Refuge until additional analysis in accordance with the National Environmental Policy Act (NEPA) had been conducted on the effects of the refuge's winter feeding program on the bison population (*Fund for Animals* v. *Clark*, Civ. No. 98-2355 RMU, D.D.C.). The U.S. District Court for the District of Columbia enjoined the culling of bison for population control purposes until the agencies

completed additional NEPA compliance. The court also noted that the refuge's winter feeding program for elk lacked a needed environmental analysis under the National Environmental Policy Act.

Following the lawsuit, the U.S. Fish and Wildlife Service and the National Park Service decided to broaden the management planning process to include all aspects of elk management (in addition to bison management) for several reasons:

- The Fish and Wildlife Service was scheduled to begin developing a comprehensive conservation plan for the National Elk Refuge, as required by the National Wildlife Refuge Improvement Act of 1997, and elk management would be a significant aspect of that plan. A decision was made to prepare a joint management plan between the U.S. Fish and Wildlife Service and the National Park Service to address the immediate concerns of bison and elk management on the National Elk Refuge and in Grand Teton National Park and then to prepare the comprehensive conservation plan for the refuge after the bison and elk management plan was completed. By conducting an analysis of the winter feeding program and all of the associated impacts in managing elk on the refuge during this planning process, a foundation would be provided for the subsequent development of the refuge's comprehensive plan.
- Conducting separate planning processes for the winter feeding of elk and bison would cause needless confusion to the public.

Issues Related to Ungulate Concentrations

The need for bison and elk management planning is also driven by current limitations on the ability of the U.S. Fish and Wildlife Service and the National Park Service to achieve refuge and park purposes, agency missions, and related legal responsibilities. While there have been many benefits associated with wintering large numbers of elk and bison on the refuge, high concentrations of these animals have created an unnatural situation that has contributed to the following:

- an increased risk of potentially major outbreaks of exotic diseases

An exclosure is used on the refuge to prevent browsing by elk and bison.

- damage to and loss of habitat due to browsing of willow, cottonwood, and aspen stands, with resultant reductions in wildlife associated with healthy stands
- unusually low winter mortality of bison and elk, which affects predators, scavengers, and detritivores
- a high level of brucellosis in the elk and bison herds

Of all the challenges related to bison and elk management on the refuge and in the park, the increased risk of possibly serious disease impacts and habitat damage have the greatest potential to hinder the ability of both the U.S. Fish and Wildlife Service and the National Park Service to meet their purposes and missions as they relate to the National Elk Refuge, Grand Teton National Park, and John D. Rockefeller, Jr., Memorial Parkway. Even though bovine tuberculosis and chronic wasting disease, two of the more pronounced future risks, have not been documented in the Jackson herds, the distribution of chronic wasting disease continues to expand in the western United States, and tuberculosis would be a threat to the herds if it was introduced. Each disease is believed to be spread through contact with infected animals or contaminated environments. The introduction of either disease or other non-endemic diseases into ungulate populations inhabiting the refuge or the park could have major adverse consequences, given the crowded conditions on the refuge during winter feeding operations. Also, brucellosis is a concern to the State of Wyoming and the livestock industry.

A considerable amount of research and monitoring has indicated that the large, annual concentration of elk over the last 90 years is a major contributor to habitat alteration. Habitat loss is one concern for the National Elk Refuge because since 1921 one of the major purposes of the refuge has been to provide a "refuge and breeding ground" for birds. Willow, cottonwood, and aspen are key habitats for native birds. Grand Teton National Park has also experienced some damage to aspen habitats due in part to the large elk population, and there is concern that some aspen stands may be lost in the future.

The U.S. Fish and Wildlife Service and the National Park Service also desire to ensure that any actions to reduce or otherwise control elk numbers on the refuge would not measurably affect elk numbers in the Yellowstone National Park and Teton Wilderness segments of the Jackson elk herd. At present, the Grand Teton herd segment comprises a large proportion of the elk that winter on the National Elk Refuge. At the same time, it is more difficult to regulate the Grand Teton segment through hunting than it is to regulate other herd segments, and this has at times resulted in higher hunting pressure on herd segments outside the park. Because the winter feeding program on the refuge results in minimal mortality, it necessitates an elk reduction program in the park in order to help meet state objectives for the Jackson elk herd.

The high concentrations of bison and elk have contributed to the prevalence of brucellosis in the herds. The risk of transmitting brucellosis from bison and elk to livestock is a significant issue for the livestock industry, the State of Wyoming, and other western states. Wyoming lost its brucellosis class-free status in 2004, which was a considerable concern to the state and the livestock industry. The state regained class-free status in September 2006 after complying with testing and surveillance requirements. As a member of the Greater Yellowstone Interagency Brucellosis Committee, the U.S. Department of the Interior has committed to work toward achieving the goal of protecting the public interests and economic viability of the livestock industry in Idaho, Wyoming, and Montana while at the same time protecting and sustaining the existing free-ranging elk and bison populations in the Greater Yellowstone Area (Wyoming et al. 1995; NPS 2000).

Supplemental Winter Feeding as a Response to Insufficient Winter Range

All of the biological issues identified above stem from the winter feeding program on the National Elk Refuge. Winter feeding of elk began just prior to the refuge being established in 1912 (USFWS 1999b). Feeding was started to mitigate the conversion of former winter range to other land uses. Winter feeding reduced winter mortality and kept elk numbers high, while at the same time reducing elk depredation of haystacks and livestock pastures in Jackson Hole.

The need for winter feeding remains much the same as it was in 1912 — to address the fact that there is an insufficient amount of winter range to support the numbers of elk that have existed in Jackson Hole since the early 1900s (USFWS 1999b). Supplemental feeding has also contributed to an expanding bison population, adding to the overall problem.

Another factor that must be considered in the plan is the desire to not markedly impact the Wyoming Game and Fish Department's ability to annually meet their Jackson elk herd objective, while at the same time meeting legal requirements imposed on the U.S. Fish and Wildlife Service and the National Park Service.

Recognizing (1) the large proportion of elk that overwinter on the National Elk Refuge (roughly half of the population in recent years), (2) the importance of the Jackson elk herd and the desire

Elk feeding effort in the early 1900s.

Storage shed and Quonset hut used for alfalfa pellets.

to avoid marked changes in the numbers of elk sustained in the Jackson herd unit (to the extent possible), and (3) the requirement to evaluate alternatives to winter feeding, the range of alternatives must include other means of overwintering a large portion of the Jackson elk herd, as well as addressing elk management in the context of the entire herd. Also, because winter feeding has such a large effect on the park elk and bison herds, alternatives to the current winter feeding program must be developed in consideration of the park's purposes, as well as the National Park Service's mission and wildlife conservation policies.

LEGAL AND POLICY GUIDANCE

As federal agencies, the U.S. Fish and Wildlife Service and the National Park Service operate under a set of laws and policies that direct, guide, and limit the actions they are able to take. Legal directives refer to provisions of laws, executive orders, policies, and regulations that require managers to proceed in a certain direction or to achieve certain targets or end products.

The U.S. Fish and Wildlife Service is the primary federal agency responsible for conserving and enhancing the nation's fish and wildlife populations and their habitats. Although the Fish and Wildlife Service shares this responsibility with other federal, state, tribal, local, and private entities, it has specific trust responsibilities for migratory birds, threatened and endangered species, and certain anadromous fish and marine mammals. The Fish and Wildlife Service also has similar trust responsibilities for the land and waters it administers to support the conservation and enhancement of fish and wildlife. The Fish and Wildlife Service is required to manage the National Elk Refuge to meet refuge purposes and to contribute to the agency's mission-related mandates.

Similarly, the National Park Service must manage Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway in accordance with the NPS Organic Act and the establishing legislation for the parks.

It is critical that the goals and objectives adopted in this process reflect legal directives because if they do not, then resulting management actions will not be consistent with the directives. Likewise, if the scope of goals and objectives is expanded to address issues that are beyond the scope of the established purposes and missions, then management actions could proceed in a different direction than that identified in the legal directives.

Trust Resources and Native American Indian Policies

The United States government has a unique legal relationship with federally recognized American Indian tribes, based on the recognition of the inherent powers of tribal sovereignty and self-government. The U.S. Fish and Wildlife Service and the National Park Service are committed to upholding this special relationship and implementing its activities in a manner consistent with it.

The United States government has an Indian trust responsibility to protect and maintain rights reserved by or granted to Indian tribes or individuals by treaties, statutes, and executive orders. The U.S. Fish and Wildlife Service and the National Park Service share in this responsibility. The Fish and Wildlife Service is also guided by its "Native American Policy" (USFWS 1994a). A list of laws, policies, and treaties affecting cultural resources and American Indians that pertain to this plan can be found in Appendix A.

National Elk Refuge

National Wildlife Refuge System Mission and Related Directives

Like all other national wildlife refuges, the National Elk Refuge is governed by the National Wildlife Refuge System Administration Act of 1966, as amended (16 USC 668dd et seq.). The act formally defines the mission of the Refuge System as the administration of a

> national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (16 USC 668dd(a)(2)).

In passing the act, Congress clarified that the *fundamental* mission of the Refuge System is the conservation of fish, wildlife, and plants (House of Representatives Report 105-106, sec. 5), where conservation is defined as sustaining healthy populations of these organisms (16 USC 668ee(4)). Characteristics of a healthy wildlife population include a stable and continuing population (i.e., the population returns to an initial equilibrium after being disturbed) and a minimized likelihood of irreversible or long-term effects (50 CFR 100.4). USFWS policy echoes this emphasis, noting that "wildlife conservation is the singular National Wildlife Refuge System mission" (601 FW 3.7a).

Other requirements of the Refuge System Administration Act are to (1) ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained; (2) recognize that wildlife-dependent recreational uses, such as hunting and wildlife viewing, are legitimate and appropriate public uses of the Refuge System when these uses are compatible with the Refuge System mission and refuge purposes; (3) provide opportunities for compatible wildlife-dependent recreation within the Refuge System; and (4) coordinate the development of plans with relevant state conservation plans for wildlife.

Pronghorn on the National Elk Refuge.

Refuge Purposes

The National Elk Refuge was established in 1912 as a "winter game (elk) reserve" (37 Stat. 293, 16 USC 673), and the following year Congress designated the area as "a winter elk refuge" (37 Stat. 847). In 1921 all lands included in the refuge or that might be added in the future were reserved and set apart as "refuges and breeding grounds for birds" (Executive Order [EO] 3596), which was affirmed in 1922 (EO 3741). In 1927 the refuge was expanded to provide "for the grazing of, and as a refuge for, American elk and other big game animals" (44 Stat. 1246, 16 USC 673a). These purposes apply to all or most of the lands now within the refuge. Several parcels have been added to the refuge specifically for the conservation of fish and wildlife (Fish and Wildlife Act of 1956), and for opportunities for wildlife-oriented recreational development oriented to fish and wildlife, the protection of natural resources, and the conservation of threatened or endangered species (Refuge Recreation Act of 1962, 16 USC 460k-1).

USFWS Management Policies

The U.S. Fish and Wildlife Service has other policies that govern or otherwise influence elk and bison management on the National Elk Refuge. Those that pertain directly to some of the key issues being addressed in this planning process are discussed below.

USFWS policy directs that wildlife population levels on refuges be maintained at levels consistent with sound wildlife management principles (701 FW 1.3), that populations be managed for natural densities and levels of variation, while ensuring that densities of

endangered or otherwise rare species are sufficient for maintaining viable populations (601 FW 3.14.C), and that population management activities contribute to the widest possible natural diversity of indigenous fish and wildlife, even when population management activities are implemented for a single species (701 FW 1.3). Managing for natural densities of elk may be done in a landscape context. In the context of contributing to natural population levels, it is permissible to "compromise elements of biological integrity, diversity, and environmental health at the refuge scale in support of the same components at larger landscape scales," if this is done in pursuit of refuge purposes (601 FW 3.7.C). At present, the wintering of unnaturally high densities of elk on the refuge helps sustain a more natural population level at the larger landscape level by mitigating the loss of winter range.

However, USFWS policy also requires that wildlife densities do not reach excessive levels that would result in adverse effects on habitat and other wildlife species, including increased disease risks (601 FW 3.14.E). Any resulting irreversible or long-term adverse impacts would conflict with the Refuge System Administration Act (16 USC 668dd(a)(2) and 668ee(4)), as well as with USFWS policy (601 FW 3.14.E, 701 FW 1.3, 7 RM 7.2.A). In essence, high elk and bison densities are not permitted to reach levels that would compromise other refuge purposes (16 USC 668dd(a)(3)(A) and (4)(D)). These mandates mean that a balance must be struck, whereby all refuge purposes are to be met to a reasonable degree, taking into account their priority ordering.

Other USFWS Legal Policy Constraints

Lands within the National Wildlife Refuge System are different from other federal lands because they are closed to all public uses unless specifically and legally opened. Refuge uses, including recreational and economic activities, are not allowed unless a compatibility determination is made and the refuge manager determines that the use will not materially interfere with or detract from the fulfillment of the mission of the National Wildlife Refuge System or the purposes of the refuge. Refuge management activities by the Fish and Wildlife Service, such as prescribed fire, scientific monitoring, and facility maintenance, are not subject to compatibility

Sagebrush shrubland on the National Elk Refuge.

determinations. Compatibility determinations are also not required for state wildlife management activities on a national wildlife refuge pursuant to a cooperative agreement where the refuge manager has made a written determination that such activities support fulfilling the refuge purposes or the system mission (USFWS 2000).

After compatibility determinations are written, they are signed and dated by the refuge manager, with concurrence by the regional chief of the National Wildlife Refuge System, stating that a proposed use or existing use of a national wildlife refuge is or is not a compatible use. Compatibility determinations are typically completed as part of the comprehensive conservation plan process. Because the bison and elk management plan is being completed prior to the start of the comprehensive plan, two compatibility determinations (relating to elk and bison hunting) are included in the appendix for this document. Once a final compatibility determination is made by the refuge manager, with the regional chief's concurrence, it is not subject to administrative appeal.

As mentioned previously, after the completion of the bison and elk management plan, the U.S. Fish and Wildlife Service expects to begin developing a comprehensive conservation plan for the National Elk Refuge. This is a 15-year plan that describes the desired future conditions of the refuge and provides long-range guidance and management direction for all programs on the refuge. The bison and elk management plan will be incorporated as part of the comprehensive conservation plan. The U.S. Fish and Wildlife Service also prepares

additional plans, called step-down management plans, that are more detailed and are related to specific topics such as fire management, hunting, and public use. Step-down plans are developed as the need arises and require further compliance with USFWS planning policies and procedures, including opportunities for public review and comment. One of the first step-down plans likely to be completed following this process is a detailed plan that addresses chronic wasting disease management on the National Elk Refuge.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway

Implementing Legislation for the National Park Service

The National Park Service receives its basic mandate from the NPS Organic Act (16 USC 1, 2–4) and the General Authorities Act of 1970, as amended (16 USC 1a-1 through 1a-7):

> The Service thus established shall promote and regulate the use of the Federal areas known as National Parks . . . by such means and measures as to conform to the fundamental purposes of the said Parks . . . which purpose is 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 (16 USC 1).

The 1978 amendments to the General Authorities Act affirm the basic tenets of the Organic Act and provide additional guidance for National Park System management:

> The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established (16 USC 1a-1).

According to NPS *Management Policies 2006*, management decisions for National Park System units are based primarily on the park's mission, mission goals, and management prescriptions (NPS 2006, sec. 2.2, 2.3.1.2).

Grand Teton National Park and the Snake River.

Park Purposes and Mission

Grand Teton National Park was originally established in 1929 when Congress set aside approximately 150 square miles of the Teton Range (45 Stat. 1314). In 1943 Jackson Hole National Monument was established by presidential proclamation, thus placing additional lands under federal protection (Proc. No. 2578, 57 Stat. 731). In 1950 Public Law (PL) 81-787 combined the original park and the monument into a new Grand Teton National Park. Section 6 of the law required the Wyoming Game and Fish Commission and the National Park Service to develop a program for the permanent conservation of elk within the park, and it further required the approval for such a program by both the Secretary of the Interior and the Governor of Wyoming (PL 81-787, 16 USC 673c). As set out in the law, hunters participating in the controlled reduction of elk (when necessary for proper management) are licensed by the state and deputized as park rangers.

Section 5 of Public Law 81-787 authorized the continuation of livestock grazing permits that existed prior to September 14, 1950 (16 USC 406d-2). Additional details on livestock grazing legislation and agreements are provided in the "Existing Plans and Agreements" section below.

Grand Teton National Park is dedicated to the preservation and protection of the Teton Range and its surrounding landscapes, ecosystems, and cultural and historic resources. The singular geologic setting makes the area and its features unique on our planet. Human interaction with the

landscape and ecosystem has resulted in an area that is rich in natural, cultural, and historic resources as well as one that represents the natural processes of the Rocky Mountains and the cultures of the American West.

The purpose of Grand Teton National Park is to protect the area's native plant and animal life, its cultural and historic resources, and its spectacular scenic values, as characterized by the geologic features of the Teton Range and Jackson Hole (NPS 2005b).

John D. Rockefeller, Jr., Memorial Parkway was established on August 25, 1972, for the purpose of commemorating "the many significant contributions to the cause of conservation . . . made by John D. Rockefeller, Jr., and to provide both a symbolic and desirable physical connection between the world's first national park, Yellowstone, and the Grand Teton National Park" (PL 92-404). Hunting and fishing are permitted in accordance with applicable state and federal laws in the part of the parkway that was administered by the U.S. Forest Service prior to its inclusion in the National Park System. However, the Secretary of the Interior may designate zones where, and periods when, no hunting or fishing shall be permitted for reasons of public safety, administration, or public use and enjoyment.

The purpose of John D. Rockefeller, Jr., Memorial Parkway is to conserve the scenery and natural and historic resources and to provide for their use while leaving them unimpaired for future generations (NPS 2005b).

NPS Management Policies

Current policy guidance for the National Park Service is provided in the NPS *Management Policies 2006* (NPS 2006). The policies interpret the laws, regulations, and executive orders governing the National Park System.

The NPS *Management Policies 2006* reaffirm that the fundamental purpose of the National Park System is the conservation of park resources and values (NPS 2006, sec. 1.4.3). Park managers are also to provide for the enjoyment of resources and values by the public, and they retain the discretion to allow impacts when needed to fulfill this or other requirements of a park, so long as the impact does not constitute impairment (sec 1.4.4).

An overriding policy of the National Park Service is to preserve the natural resources, processes, systems, and values of units of the National Park System in an unimpaired condition, to perpetuate their inherent integrity, and to provide present and future generations with the opportunity to enjoy them. In so doing, the Park Service strives to "understand, maintain, restore, and protect the inherent integrity of the natural resources, processes, systems, and values of the parks" (NPS 2006, sec. 4.0). The Park Service is required to return human-disturbed areas to the natural conditions and processes characteristic of the ecological zone in which the damaged resources are situated (sec. 4.1.5).

The policies also indicate that under normal circumstances the focus of natural resource conservation in parks will be at an ecosystem level, emphasizing natural abundance, diversity, and genetic and ecological integrity of native species in an ecosystem. Except for an endangered or threatened species, the Park Service will not attempt to preserve individual species or individual natural processes (NPS 2006, sec. 4.1). Normally, the Park Service will not intervene in natural biological or physical processes. A relevant exception to this policy is when an ecosystem's functioning has been disrupted by human activities or when park-specific legislation authorizes particular activities, for example, livestock grazing and elk herd reductions in Grand Teton National Park.

For species that migrate into and out of national parks, such as the elk and bison in Grand Teton, the National Park Service is to adopt resource preservation and use strategies designed to maintain natural population fluctuations and processes that influence the dynamics of these wildlife populations (NPS 2006, sec. 4.4.1.1). For these migratory populations, national parks provide only one of several major habitats they need, and survival of the species in national parks also depends on the existence and quality of habitats outside the parks. Thus, the Park Service must work with other land managers to encourage the conservation of the populations and habitats of these species outside parks whenever possible. The Park Service is required to protect natural

resources from impacts caused by external activities by working cooperatively with federal, state, and local agencies; American Indian authorities; user groups; adjacent landowners; and others to identify and achieve broad natural resource goals.

NPS Legal and Policy Constraints

The National Park Service must ensure that strategies and actions do not impair biological, cultural, or historical resources and values within Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway. Ultimately, it is the Secretary of the Interior's absolute duty, which is not to be compromised, to take whatever actions may be necessary to ensure that park resources are not impaired (NPS 2006, sec. 1.4.2). Thus, actions being considered for the National Elk Refuge that could potentially impair the resources of Grand Teton National Park, the parkway, or Yellowstone National Park must also be evaluated relative to impairment requirements.

In considering the restoration of previously farmed areas in Grand Teton National Park, the National Park Service can only consider the use of native plant species (whereas the U.S. Fish and Wildlife Service can consider the use of nonnative species on the National Elk Refuge).

EXISTING PLANS AND AGREEMENTS

Several existing plans and agreements were considered in the formulation of goals, objectives, and strategies. While plans and agreements are not as binding as legal directives, they can offer important management insights. It is possible that one or more of the plans and agreements may require modification (e.g., the interim goals and objectives for the National Elk Refuge, the 1974 cooperative agreement between the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department, and the "Supplemental Feeding Handbook" for the refuge [USFWS 1981, 1986]).

USFWS PLANS

Fulfilling the Promise, The National Wildlife Refuge System

Fulfilling the Promise (USFWS 1999a) identifies visions for managing wildlife, habitat, and public use in the National Wildlife Refuge System, provides guidance and principles to achieve this vision, and identifies specific action items to be accomplished.

National Elk Refuge Plans

The National Elk Refuge's most recent *Master Plan* was completed in 1965 (USFWS 1965). Although it identifies a few goals and objectives for wildlife and habitat management, the plan primarily deals with plans for the construction of buildings, the appropriation of water rights and improvements to water control facilities, and land acquisition.

An interim set of goals and objectives for the National Elk Refuge was finalized and approved in 1999 (USFWS 1999b). These interim goals and objectives will be superseded by those adopted as a result of this planning effort.

The "Supplemental Feeding Handbook," as revised (USFWS 1986), describes the procedures and guidelines for feeding elk and bison on the refuge and the duties and responsibilities of NER personnel. It also provides tables showing the amount of feed to distribute at different ration levels and herd sizes.

The *Fire Management Plan and Environmental Assessment* (USFWS 2002b) identifies fire management goals and objectives, fire management units, fire prevention strategies, fire suppression guidance and direction, and prescribed fire management strategies.

The *Irrigation System Rehabilitation Plan Environmental Assessment* (USFWS 1998) outlines improvements to the refuge irrigation program. The plan proposed converting approximately 1,200 acres of cultivated fields from the existing flood-irrigation system to sprinkler irrigation, which would result in higher water use efficiency, producing four times more forage while using less water than the current system. That

Using prescribed fire on the National Elk Refuge.

proposal was not implemented, but an experimental program was approved for 260 acres. A lack of funds has allowed only 60 acres to be irrigated with two side-roll irrigation lines.

NPS Plans

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway

Grand Teton National Park's *Master Plan*, approved March 19, 1976, describes the park's legislative background, including commitments, the resource, land status, and regional considerations (NPS 1976). The *Master Plan* classifies lands according to existing or allowable uses and development levels, and it subdivides the park into visitor experience zones. *Statements for Management* update issues and strategies for both the park (1989) and the parkway (1986).

Livestock Grazing Legislation and Agreements

Cattle and horses owned by private parties are grazed in Grand Teton National Park under authority of Public Law 81-787 and Public Law 105-81. Public Law 81-787 authorized the continuation of livestock grazing permits that existed prior to September 14, 1950. Livestock grazing permits for private ranches outside the park were to continue for 25 years, and thereafter for the lifetime of the people possessing the livestock grazing permits and the lifetime of their heirs, successors, and assigns who were immediate family members as of 1950. Grazing permits for private ranch base lands within the park boundaries are to be renewed until the title of the lands vests in the United States. In 1950 there were 29 legislated permittees grazing approximately 4,230 animals on 67,640 acres in the park. Since then, the number of permittees has decreased to two as a result of permits expiring in accordance with the park's establishing legislation, ranches ceasing to operate, and for other reasons. The legislation establishing the park intended for livestock grazing to be eventually eliminated from the park.

In 1997 Public Law 105-81 required a study of livestock grazing use and open space within and adjacent to the park. It also extended livestock grazing privileges for several permits under the 1950 law, pending implementation of recommendations made as a result of an open space study, except that the extensions would be canceled when land subject to the study was no longer used for ranching or other agricultural purposes (NPS 2001).

Fire Management Plan

In 2004 Grand Teton National Park completed a *Fire Management Plan* to provide direction and flexibility for fire management that is consistent with updated policy guidance and scientific understanding (NPS 2004a). The *Fire Management Plan* allows fire management staff to use multiple tools available (i.e., prescribed fire, mechanical treatments, wildland fire use, and suppression) to manage fire. Planned actions would on average include the mechanical treatment of 60–100 acres per year for the next four to six years (mostly in Wildland-Urban Interface areas). The prescribed fire treatments are predicted to be close to the current annual 10-year average of 1,486 acres. A small portion (0–300 acres annually) may be part of the hazard fuel reduction program. The focus of prescribed fires would be sagebrush/grassland and mixed aspen/conifer communities, but concerns about burning in sage grouse habitat would likely limit treatment options in the near term.

Wildland fire use would be expanded as a result of the ability to use fire throughout the park, adaptive management, and enhanced flexibility to use prescribed and mechanical treatments as tools to reduce risks associated with wildland fire use. An adaptive fire management process would allow

fire within the ecosystem based on broader, more clearly defined resource objectives (NPS 2004a).

STATE PLANS AND AGREEMENTS WITH OTHER AGENCIES

The U.S. Fish and Wildlife Service and the National Park Service actively involve state and other federal agencies in planning processes and in working cooperatively to protect natural resources from impacts caused by external activities (e.g., 16 USC 668dd(e)(3); NPS 2006, sec. 4.1.4). Outcomes of cooperative efforts must be consistent with legal directives and other legal and policy requirements governing the management of the National Elk Refuge and Grand Teton National Park.

Specific to Grand Teton National Park, responsibilities of the Wyoming Game and Fish Commission would continue to include: (1) development of a program, in cooperation with the National Park Service, that includes elk reductions when necessary and that ensures the permanent conservation of elk within the park; (2) in cooperation with the National Park Service, yearly submission of joint recommendations for the management, protection, and control of the elk to the Governor of Wyoming and the Secretary of the Interior; (3) promulgation of the appropriate orders or regulations necessary to effectuate the management plan, once approved; and (4) issuance of elk licenses in accordance with the management plan.

WGFD Herd Objectives and Strategic Habitat Plan

The Wyoming Game and Fish Department's management goals and objectives (e.g., bull-to-cow ratios, herd objectives, and hunting seasons) are set through a public review process that requires public input and a final departmental recommendation to be approved by the Wyoming Game and Fish Commission. The department does not have a management or conservation plan for either the Jackson elk herd or the bison herd, but the agency has established population objectives for both herds.

- The Jackson elk herd objective is 11,000. The herd unit encompasses the southern end of Yellowstone National Park, Grand Teton National Park, John D. Rockefeller, Jr., Memorial Parkway, the National Elk Refuge, a large portion of Bridger-Teton National Forest, and various parcels managed by the Bureau of Land Management, the state, and private landowners in the Jackson Hole area.
- The Jackson bison herd objective is 350–400 animals. The herd's distribution is nearly entirely within Grand Teton National Park and the National Elk Refuge. Some bison venture onto Bridger-Teton National Forest, state, and private lands in the vicinity of Kelly and north of Jackson.

1958 Memorandum of Understanding

A memorandum of understanding dated March 31, 1959, between the Wyoming Game and Fish Commission, the U.S. Department of Agriculture (for the Forest Service), and the U.S. Department of the Interior (for the National Park Service and the Bureau of Sport Fisheries and Wildlife, which is now the U.S. Fish and Wildlife Service), relates to the maintenance and management of the Jackson elk herd. The agreement establishes an advisory council and a technical committee for a program known as the "Jackson Hole Cooperative Elk Studies Group." There is no established time limit for the memorandum, which became effective July 1, 1958.

1974 Cooperative Agreement

A cooperative agreement was signed by the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department in 1974 (USFWS and WGFD 1974). It outlines a cooperative working relationship for managing the National Elk Refuge where there is mutual concern, including (1) fish habitat and fishing regulations, (2) elk hunting regulations, (3) elk feeding, (4) elk herd numbers, (5) habitat conditions for elk, and (6) studies related to elk and fish.

Article III of the agreement states that the refuge manager and the WGFD district supervisor will annually determine whether a hunting season on the refuge is necessary. Article IV of the agreement lists biological criteria to be considered in determining when winter feeding should begin in a given year. It requires USFWS and WGFD biologists to jointly monitor the specified biological parameters and to provide

recommendations to the refuge manager and the WGFD district supervisor based on these criteria. The NER manager and the WGFD district supervisor are jointly responsible for determining when to initiate feeding on the refuge, along with procedures when they do not agree. Additionally, the agreement specifies that NER personnel are responsible for obtaining, storing, and distributing the supplemental feed, and that the state is responsible for paying at least half the cost of the feed.

Article V states that elk numbers are not to exceed 7,500 animals on the refuge, and that the Game and Fish Department is responsible for keeping elk numbers below 7,500 through hunting. The agreement specifies that the number of animals could be revised based on habitat conditions, forage production and use, and other data. It also outlines provisions for culling seriously crippled and diseased animals, regardless of herd numbers.

Article VI outlines joint responsibilities with respect to collecting and synthesizing data required to determine habitat conditions, forage production and use, and trends on the refuge.

Greater Yellowstone Interagency Brucellosis Committee

The Greater Yellowstone Interagency Brucellosis Committee (GYIBC) was formed in 1995 to protect and sustain the existing free-ranging elk and bison populations in the Greater Yellowstone Area and to protect the public interests and economic viability of the livestock industry in Idaho, Montana, and Wyoming. The mission of the committee is to facilitate the development and implementation of brucellosis management plans for elk and bison, and their habitat, in the Greater Yellowstone Area.

Jackson Interagency Habitat Initiative

The Jackson Interagency Habitat Initiative (JIHI) is a cooperative interagency effort focused on identifying potential treatment opportunities and management options for the long-term sustainability of native ungulates and their winter and transitional ranges in the Jackson Hole area. It involves biologists from the Wyoming Game and Fish Department, the National Elk Refuge, Grand Teton National Park, and Bridger-Teton National Forest. The group was formed in response to concerns about reduced habitat effectiveness on ungulate winter and transitional ranges and the desire to address such issues at a scale relevant to elk and in a manner emphasizing healthy, functioning ecosystems and using a cooperative, solution-oriented approach. The group's overall goal is

> to maximize the effectiveness of native winter range for ungulates and a diversity of wildlife indigenous to this region through identification of habitat management opportunities. Emphasis will be placed on enhancing distributions of elk on winter and transitional ranges. The emphasis on elk distribution stems from their current concentrations on and near feedgrounds and disease issues related to these concentrations (JIHI 2002).

The primary function of the group is to identify opportunities to improve the effectiveness of winter and transitional habitats used by elk (and other wildlife species). If an individual agency chooses to propose a project, it is responsible for any additional planning, NEPA and other compliance, and implementation. The Jackson Interagency Habitat Initiative would provide support for any of these tasks as requested.

PLANNING PROCESS

SCOPING PROCESS AND ISSUES

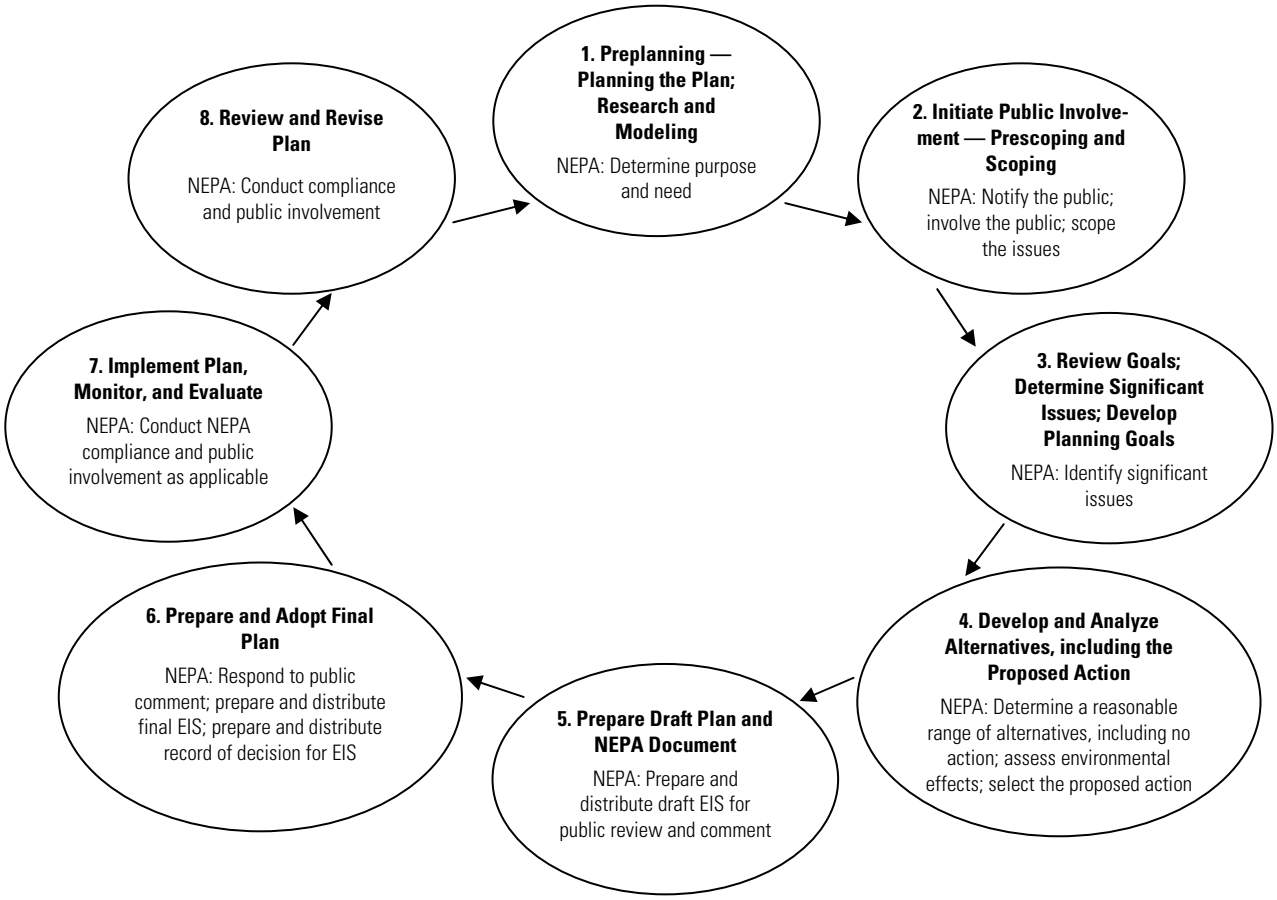
The *Bison and Elk Management Plan* was developed in accordance with the National Environmental Policy Act and the implementing regulations of the Council on Environmental Quality. Steps in the planning process for scoping for the identification of significant issues, the development of alternatives, and the review process for the *Draft* and *Final Environmental Impact Statements* are described in this chapter.

The scoping process involved the public, cooperating agencies and partners, as well as USFWS and NPS staff. Following scoping, additional public and interagency workshops and meetings were held, which allowed the planning team to develop and refine the range of alternatives; the process is illustrated in Figure 1.

SCOPING PROCESS

Important considerations in the development of goals, objectives, and strategies were the opinions, perspectives, and values of the stakeholders and the general public. The U.S. Fish and Wildlife Service and the National Park Service engaged in extensive public outreach, in addition to tribal and agency consultation, in an effort to ensure that all interested stakeholders had the opportunity to be involved in the planning process. The term stakeholder is used to refer to individuals (including private citizens and ranchers); organizations (including those for conservation, sportsmen, outfitters, animal rights, and education); Native American tribes; and federal, state, and local governmental agencies.

FIGURE 1: BISON/ELK MANAGEMENT PLANNING PROCESS AND NEPA COMPLIANCE



Several efforts were undertaken to gain a better understanding of future conditions that people would like to see with respect to elk, bison, and their habitat, and the strategies that people felt were necessary to achieve these conditions (Koontz and Hoag 2005; U.S. Institute for Environmental Conflict Resolution [USIECR] 2000). Results of the research were used to identify and fill potential gaps between the alternatives and stakeholder preferences.

Outreach focused on the identification of issues and information sharing; development of the planning process (preplanning); identification of how people wanted to be involved in the process; descriptions of the conditions people would like to see in the future with respect to the elk and bison populations, their habitat, and associated recreational opportunities on the National Elk Refuge and in Grand Teton National Park; the identification of alternative management approaches, strategies, and actions; and input on the *Draft* and *Final Bison and Elk Management Plan and Environmental Impact Statements.* Each of these efforts is described in more detail below.

INTRA- AND INTERAGENCY MEETINGS AND BRIEFINGS

Interagency Working Group Meetings

Interagency working group meetings were held as needed starting in October 2000. The main purposes of the meetings were to help the lead agencies design and carry out the prescoping and scoping process (using input from the public), monitor progress being made in the public involvement process, examine information obtained from the public, and help develop preliminary problem definitions, goals, and alternatives to provide templates for public involvement.

Other Interagency and Agency Meetings

Representatives of the planning team met regularly and provided briefings at other interagency meetings. Planning team representatives attended annual Elk Studies Group meetings and provided background information and status updates. Planning team representatives also provided briefings on project status at meetings of the Greater Yellowstone Interagency Brucellosis Committee.

TRIBAL INVOLVEMENT AND CONSULTATION

As stated under "Legal and Policy Guidance" (see page 11), the agencies are committed to upholding their relationship with American Indian tribes and to implementing their activities in a manner consistent with each agency's policies. As such, tribes were afforded an opportunity to be involved in the planning process. Several tribal representatives participated in the situation assessment and attended stakeholder meetings. Each of the 11 tribes with known traditional association to the project area were sent project initiation letters and were faxed news releases notifying them of each of the stakeholder/public meetings. Affiliated tribes include the Arapaho, Blackfeet, Crow, Chippewa-Cree, Gros Ventre, Assiniboine, Sioux Tribes of the Fort Beck Indian Reservation, Nez Perce, Northern Cheyenne, Confederated Salish and Kootenai Tribes, and Eastern Shoshone.

Briefings were provided at meetings of the Montana-Wyoming Tribal Fish and Game Commissioners (Nov. 29, 2001; Apr. 25, 2002), Montana-Wyoming Tribal Leaders Council (Feb. 27, 2001), Intertribal Bison Cooperative (Oct. 5, 2001; Feb. 13, 2002; Feb. 14, 2002), Northern Arapaho Business Council (July 31, 2001), Shoshone-Bannock Business Council (Aug. 9, 2001), the Eastern Shoshone Business Council (Aug. 9, 2001; Jan. 24. 2002), and the Yellowstone National Park government-to-government consultation meeting (Oct. 2, 2001).

A meeting in Jackson, Wyoming (April 16, 2002) was held for all the affiliated tribes to solicit input on alternatives for the document. The meeting included a tour of the National Elk Refuge and Grand Teton National Park to familiarize the tribal representatives with current management practices.

Situation Assessment

In the fall of 1999 the Fish and Wildlife Service and the Park Service enlisted the services of the U.S. Institute for Environmental Conflict Resolution (based in Tucson, Arizona) to obtain input from 130 people from various agencies,

tribes, organizations, governing bodies, and private citizens on issues of interest to them and to assess how people wanted to be involved in the planning process. Based on this input, the institute developed a preliminary list of issues and a set of recommendations for public involvement. To develop those recommendations, several cooperators were used, including the University of Wyoming Institute for Environmental and Natural Resources. The final report, or "Situation Assessment," contains recommendations as well as an overview of specific viewpoints and concerns expressed by a wide range of government and private stakeholders in the Jackson elk and bison herds (USIECR 2000). Copies of the report are on file at the National Elk Refuge headquarters in Jackson, Wyoming.

PLANNING UPDATES

Brochures

Two planning update brochures were created for use in the February 10, 2001, and March 10, 2001, prescoping meetings. Update #1 described background information and a timeline for the planning process. Update #2 summarized results of the February 10 meeting and included ideas on how to involve the public, desired future conditions, and desired strategies.

A "Scoping Brochure" summarized the background and the purpose of and need for the management plan, as well as the status of the planning process. It listed all the agencies involved and the affected programs. The decision area was described and contrasted to the analysis area. The missions and management objectives of the National Elk Refuge and Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway were defined. The brochure contained a brief summary of the prescoping meetings and a timeline for actions and products of the planning process. A schedule of the scoping meetings was included. This brochure was mailed to everyone on the mailing list in July 2001.

An "Alternative Development Brochure" summarized prescoping and scoping results, solicited additional public involvement in developing the range of alternatives to be presented in the environmental impact statement, and revised the estimated timeline for actions and products. This brochure was mailed to everyone on the mailing list in October 2001.

Additional planning update brochures were created throughout the planning process to inform the public about the progress of the planning process.

Website

A website for the bison and elk management plan was set up at <http://www.fws.gov/bisonandelkplan> and was linked to the National Elk Refuge's website at <www.nationalelkrefuge@fws.gov>. Information on the planning process, news releases, schedules and timeline, highlights of the public meetings (including all comments made by the public), background information, map of the project area, project documents, and how to contact the Interagency Working Group were posted.

PUBLIC AND TRIBAL MEETINGS

Prescoping Meetings

Eight prescoping meetings were held from February 10 to May 5, 2001, in Wyoming (Jackson, Riverton, Casper, Cheyenne, and Rock Springs). During these meetings the agencies introduced the planning process and explained the background and history leading up to the need for the planning effort. Two basic questions were posed: "What conditions would you like to see in the future?" and "How do you want to be involved in the planning process?"

In later meetings information was provided in response to public requests about the need for more information about disease, habitat, carrying capacity, and many other topics.

Scoping Meetings

Ten scoping meetings were held throughout the country from July 20 to August 3, 2001; six meetings were held in Wyoming plus meetings in Idaho, Montana, Colorado, and Virginia to reach a national audience.

Participants were asked to focus their comments on the major management issues that had been identified during prescoping. The public

expressed a wide variety of opinions on bison and elk herd sizes, population controls, winter feeding, habitat, recreation, and disease management.

Alternative Development Meetings

Two alternative development meetings were held on November 28 and 29, 2001, in Riverton and Jackson, Wyoming. Input was similar to that expressed during the scoping meetings, with a wide variety of opinions represented on all management issues. A list of all the comments received by the public to date was handed out.

Other Meetings and Discussions

Several groups took the initiative to organize meetings with other groups to discuss issues. For example, the Jackson Hole Outfitters and Guides Association invited several conservation and environmental organizations to identify areas of potential common ground (June 28, 2002). The National Wildlife Federation sponsored a panel discussion about wildlife management in the Jackson area, with an emphasis on the bison and elk management planning process (July 12, 2001). The Adaptive Management Practitioner's Network held their annual meeting in Jackson (Jan. 14–17, 2001). They sponsored a two-day forum on the use of adaptive management and collaborative processes in the Greater Yellowstone Area, with a focus on the bison and elk management planning process.

Individual Meetings and Discussions

Numerous one-on-one discussions and field trips were held. Agency representatives answered questions and spoke with individuals who called or stopped by offices. Agency representatives gave briefings and status updates to attendees of special interest group meetings, for example, the County Commissioners Monthly Agency Briefing (April 24, 2001), Chamber of Commerce (April 25, 2001), and the Jackson Hole Outfitters and Guides Association (May 3, 2001).

Agency representatives also spoke periodically to individuals and representatives of other agencies, tribes, other governing bodies, and special interest groups, one-on-one and in small groups.

Results of Scoping and Alternatives Meetings

The planning team received 25 letters from organizations and approximately 1,000 letters from the general public expressing their views on a variety of issues relating to management practices, goals, and desired outcomes, as summarized below.

PUBLIC, TRIBAL, AND STAKEHOLDER ISSUES

Seven significant issues were identified during interagency meetings, meetings with USFWS and NPS staff, meetings with tribal governments and organizations, and stakeholder meetings that involved the public. These issues were considered in the formulation of alternative sets of objectives and strategies, and the planning team made every effort to ensure that the range of alternatives encompassed the viewpoints expressed in the issue statements.

1. *Bison and Elk Populations and Their Ecology*

   Most members of the public generally agreed that they want healthy bison and elk herds, whether for the abundance of recreational opportunities that this would sustain or for the benefit of the animals themselves and the ecosystem. There was considerable disagreement over how many animals in each herd would be desirable or needed. Some people thought that there are too many bison. Others felt that numbers for both herds should be determined by the carrying capacity of the environment and not arbitrarily set by humans. Some people thought that the current state objectives of 350–400 bison and 11,000 elk for the entire Jackson herds were just about right; others disagreed.

   Public bison and elk hunting was recommended as an important management tool that keeps population numbers in check and offers recreational opportunities. Some stakeholders were against hunting of any kind, however, and felt that contraception is the only acceptable means of population control. Some felt that Native Americans should be allowed to take bison either by hunting or by relocating the animals to reservations.

Predation by native predators was viewed by some individuals as the preferred method of population control, while other stakeholders worried that wolves and a growing grizzly bear population would decimate the elk population. Some people concerned about growing populations of wolves and bears would like to see the maximum number of elk on the refuge increased to offset predator impacts. Others stated that predators are a vital part of the ecosystem and that viewing wolves and bears is important to many visitors and contributes to the economy.

2. *Restoration of Habitat and Management of Other Wildlife Species*

   Some people wanted to see habitat restored and improved, but opinions differed on the specifics of this goal. Some wanted the planning process to look at winter habitat throughout the region (that is, taking an ecosystem approach) and to encourage migration out of Jackson Hole to better distribute the herd. Others emphasized improving habitat in Grand Teton National Park and Bridger-Teton National Forest by eliminating cattle grazing, allowing wildfires to burn within prescription, and/or improving habitat on the National Elk Refuge through continued prescribed fires and increased irrigation, or conversely through the planting of only native plants and decreased irrigation. Some people said that a thorough analysis of the effects of both herds on vegetation in the valley is needed to determine the carrying capacity. However, some citizens pointed out that forage "under 4 feet of snow" is not available to ungulates, no matter how rich or diversified it may be. Some people expressed concerns about the adverse effects that elk and bison may be having on native habitats (especially willow, aspen, and cottonwood communities) and associated wildlife.

3. *Winter Feeding Operations of Bison and Elk*

   Comments regarding feeding covered every possible scenario, from not feeding bison or elk at all, to feeding every winter. Some stakeholders did not want bison to be fed on the National Elk Refuge where they might compete with elk. Feeding in Grand Teton National Park was suggested as an alternative. Other people recommended that the agencies consider phasing out feeding over the long term, taking into account forage production, habitat improvement, and expansion of winter range. Some stakeholders felt that winter feeding on the refuge should continue, but the way in which elk and bison are fed should change (e.g., switching from pellets to hay, increasing the number of feeding locations, and feeding earlier to protect habitat).

Collecting antlers for the annual Jackson auction.

4. *Disease Prevalence and Transmission*

   There was discussion about brucellosis and the high rates of infection in both the bison and elk herds. This disease is of concern because of the economic effect it could have on livestock producers if contracted by cattle. Suggestions for dealing with the problem included conducting additional research; vaccinating elk, bison, and cattle; enforcing health certificate requirements on the Department of the Interior; removing cattle from the area; and treating bison and elk equally when considering the risk of disease transmission to cattle. Some stakeholders were concerned about the potential of other more serious diseases getting into the herds. They felt there is a need to assess this risk with regard to the feeding program, and one person suggested developing a contingency

plan for any epidemic that may occur. Encouraging elk to leave the National Elk Refuge and migrate to other public lands was one suggested method of alleviating this risk, while other individuals felt that well-fed elk were less likely to contract diseases. Many agreed that more research on diseases was warranted.

5. *Recreational Opportunities*

   Many people expressed concern that changes in the management of elk and bison on the National Elk Refuge and in Grand Teton National Park would impact hunting and viewing opportunities. Hunting was identified as a popular form of recreation, but viewing wildlife, specifically bison and elk, was also recognized as an important recreational pastime for all visitors. The agencies were encouraged to consider and manage the conflicts between winter recreation and wildlife. Although some people felt these conflicts were an educational matter, others felt that all recreation impacts on wildlife should be limited to avoid stressing animals during a critical period in their life cycle.

6. *Cultural Opportunities, Traditions, and Lifestyles*

   Tribal representatives and other members of the public have stated that American Indian tribes should be actively involved in decisions regarding bison. Some Native Americans have traditions and spiritual values that are closely associated with both elk and bison. Local residents also expressed concern about how changes in elk and bison management would affect their own traditions and lifestyles, which are in part dependent on wide-open spaces and plentiful wildlife.

7. *Commercial Operations and the Local and Regional Economy*

   Wildlife viewing and hunting were identified as contributing to the local economy. Many businesses depend on abundant wildlife, and outfitters and dude ranchers in particular rely on elk and bison to provide hunting opportunities. Some people expressed concerns about the effects of changes in bison and elk management on the local economy and the quality of life in Jackson Hole.

AREAS OF POTENTIAL COMMON GROUND AMONG THE PUBLIC, TRIBES, AND STAKEHOLDER GROUPS

The U.S. Fish and Wildlife Service and the National Park Service are required to consider public, tribal, and stakeholder perspectives. While there is increasing emphasis on working toward decisions that accommodate the interests of the greatest number of people, public opinion cannot be adequately represented in one set of perspectives.

Potential areas of common ground were identified to a certain extent, and the results were considered in formulating alternatives. Although many of the opinions were widely divergent, there were several common themes. Based on pre-scoping, scoping, and alternative development meetings and the "Situation Assessment" (USIECR 2000: 25), the following areas of potential common ground were identified.

1. The public, tribes, and stakeholders generally want sustainable and healthy herds of elk and bison.
2. Habitat is critical for elk and bison conservation, and winter range in the Jackson Hole area should be maintained and enhanced.
3. To the extent that elk begin to use enhanced winter range, some stakeholders otherwise opposed to reductions in supplemental feeding may be willing to accept a reduction as long as numbers of elk in the Yellowstone, Teton Wilderness, and Gros Ventre herd segments can be maintained at or close to existing levels on an annual basis.
4. Most groups would like to see continued access to elk and bison for a variety of uses (recognizing that some stakeholders are opposed to hunting).
5. The bison and elk herds are important to people in the Jackson area, the state, American Indian tribes, and the nation.
6. To the extent that changes are made in management, there is a general desire for incremental, rather than drastic or premature, changes in management.

THE DRAFT AND FINAL ENVIRONMENTAL IMPACT STATEMENTS

RANGE OF ALTERNATIVES

Based on the scoping process, the U.S. Fish and Wildlife Service and the National Park Service developed six alternatives for in-depth analysis in the *Draft Environmental Impact Statement.* These alternatives included the following:

- *Alternative 1* — No action
- *Alternative 2* — Minimal management of habitat and populations, with support for migrations
- *Alternative 3* — Restore habitat, support migration, and phase back supplemental feeding
- *Alternative 4* — Restore habitat, improve forage, and phase back supplemental feeding (proposed action)
- *Alternative 5* — Restore habitat, improve forage, and continue supplemental feeding
- *Alternative 6* — Restore habitat, adaptively manage populations, and phase out supplemental feeding

COMMENTS ON THE DRAFT PLAN/EIS

The *Draft Bison and Elk Management Plan and Environmental Impact Statement* (*Draft Plan/EIS*) was available for public review from July 21, 2005, to November 7, 2005. In late August 2005 the U.S. Fish and Wildlife Service and the National Park Service held a series of public open houses and formal hearings in Bozeman, Montana; Jackson, Wyoming; and Riverton, Wyoming. In addition to the public hearing testimony, public comments on the *Draft Plan/EIS* were also received in the form of letters, e-mails, form letters, and petitions.

During the comment period, the agencies received over 11,900 written comments and public testimony from 241 individuals, 37 agencies or organizations, and 1,751 form letters or petitions. The most common comment topic was alternative preference. About 65% of the commenters expressed a preference for Alternative 6, while about 12% preferred Alternative 5 (fewer than 1% expressed support for Alternative 4). Many of the commenters, however, did not express a preference for any particular alternative.

While many issues were raised, most of the concerns were centered around the following topics:

- Population management
- Habitat management
- Supplemental feeding
- Disease
- Public use and economics
- Legal mandates and jurisdiction
- Native American tradition and history

Besides alternative preferences, the most common concerns or issues expressed in individual comments (including form letters) were:

1. Support for protecting and restoring wildlife migration routes
2. Opposition to the use of existing vaccines
3. Suggestion that bison should be managed like other big game species
4. Suggestion that supplemental feeding should be phased out
5. Suggestion that populations should be managed with hunting and habitat protection
6. General concerns about disease
7. Concern that a disease outbreak could jeopardize local outfitting and ranching opportunities
8. Support for supplemental feeding
9. Concern about impacts to other species if elk and bison feeding was reduced
10. Support for reducing the size of the bison herd

This list does not include issues in letters from agencies or organizations, which were responded to separately.

The U.S. Fish and Wildlife Service and the National Park Service responded to all substantive comments (including individual comments, agency comments, and form letters) in the *Final Environmental Impact Statement.*

MEETING WITH SHOSHONE-BANNOCK TRIBES

The agencies received one request from the tribes for a consultation meeting. The agencies met with the Shoshone-Bannock Tribes on October 12, 2005, to brief tribe members and to discuss their concerns regarding the *Draft Plan/EIS.*

SIGNIFICANT CHANGES TO THE DRAFT PLAN/EIS

The following discussion summarizes significant changes that were made in the process of developing the *Final Environmental Impact Statement.*

1. **Inclusion of a statement that clarifies the desired conditions to be achieved by the end of 15-year plan for managing the bison and elk populations.** This statement reflects the agencies' purposes, missions, goals, and other legal requirements. As a result, the management goals more effectively describe the general targets for achieving the desired conditions. In addition, the management goal for sustainable populations in Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway was modified to include the role of the Wyoming Game and Fish Department in achieving population objectives for the Jackson bison and elk herds.
2. **Modification of Alternative 4 (Preferred Alternative) to include more of the adaptive management emphasis found in Alternative 6.** The agencies, in cooperation with the Wyoming Game and Fish Department and others, would use existing conditions, trends, new research findings, and other changing circumstances to provide the basis for developing and implementing a dynamic framework for decreasing the need for supplemental feeding on the National Elk Refuge in order to achieve the desired conditions over the long term.
3. **Modification of Alternative 4 to allow more flexibility in reducing feeding and achieving population objectives.** The number of years that feeding would take place (in above-average winters, estimated to be 5 out of 10 years) was deleted in order to emphasize a process for achieving desired conditions by the end of the plan. A phased approach would be used to reduce herd size and the need for supplemental feeding. Following implementation of the first phase, approximately 5,000 elk would be expected to winter on the refuge. As herd sizes and objectives were achieved, further reductions in feeding or elk numbers could occur, based on established criteria and changing social, political, or biological conditions.
4. **Development of a structured framework under Alternative 4 for identifying specific criteria that would have to be met for progressively transitioning from intensive supplemental winter feeding to greater reliance on free-standing forage.** The framework, which would be developed collaboratively with the Wyoming Game and Fish Department, would provide a basis for determining herd sizes, ratios, and mitigation measures for bison/elk and cattle co-mingling on private lands. The framework would be based on winter distribution patterns of elk and bison, prevalence of diseases, and public support.
5. **Modification of Alternative 4 to include the mitigation components of Alternative 6 to minimize conflicts with adjacent landowners.** Mitigation would include an emphasis on developing partnerships to provide human and/or financial resources to manage co-mingling and reduce crop depredation by elk and/or bison on private lands.
6. **Modification of bison population objectives for Alternatives 4 and 6.** For Alternative 4 the agencies would work cooperatively with the Wyoming Game and Fish Department to maintain and ensure a genetically viable population of approximately 500 bison (400 is generally considered to be the minimum

recommended size to maintain heterozygosity of the herd over the long term). Monitoring of habitat conditions and health of the herd would be used to make recommendations regarding herd size. For Alternative 4 a public bison hunt would be implemented to reduce the bison population in accordance with Wyoming's licensing regulations and an approved refuge hunting plan. The U.S. Fish and Wildlife Service could potentially allow for the removal of a small number of bison for ceremonial purposes by Native American tribes. The recommended population objective for Alternative 6 was also modified to be 500 bison instead of 400.

7. **Use of RB51 vaccine for bison population under Alternative 4.** The Wyoming Game and Fish Department could vaccinate elk and bison for brucellosis on the refuge under Alternative 4 as long as it was logistically feasible and safe for wildlife.
8. **Initiation of a public outreach effort to build understanding of natural elk and bison behavior, ecology, distribution, disease implications, and effects to other species for Alternative 4.** An option to consider opening the southern portion of the refuge in the fall to wildlife observation in order to increase harvest efficiency was dropped from consideration due to safety issues with the ongoing hunting program. The option to open the southern portion of the refuge for an early season hunt was retained.

COMMENTS ON THE FINAL PLAN/EIS

The *Final Bison and Elk Management Plan and Environmental Impact Statement* was published on February 2, 2007, and the 30-day waiting period ended on March 12, 2007. A total of 938 e-mails were received from individuals and 5 letters from organizations. The majority of e-mails were petitions in support of Alternative 6 with changes, while two individuals opposed hunting. A total of 4,738 comments (including signers of petitions) were recorded. In addition, a meeting was held with the Shoshone-Bannock Tribes on March 9, 2007, at Fort Hall, Idaho, to discuss the tribes' concerns about the *Final Plan/EIS.*

None of the comments raised new issues or presented reasonable alternatives to those presented in the *Final Plan/EIS* or provided additional information relevant to the analysis.

SUMMARY OF FEIS COMMENTS

1. **Supplemental Feeding.** While the *Final Plan/EIS* acknowledged that many biological issues on the refuge are related to supplemental feeding, Alternative 4 made no commitment to phase out supplemental feeding.
2. **Adaptive Management Framework.** The proposed adaptive management framework to reduce reliance on supplemental feeding was not adequately described and analyzed, and it presented no observable benchmarks or standards by which the public could gauge progress.
3. **Legal Mandates.** Alternative 4 does not conform to the existing laws and policies that govern management of the National Elk Refuge.
4. **Fencing.** The Preferred Alternative should include additional fencing and/or partnerships to reduce property damage and co-mingling of elk and bison with livestock.
5. **Bison.** Population targets for bison should be higher, and bison should be allowed to distribute over a larger geographic area than what was proposed in Alternative 4. The agencies should consider other habitat modeling data in determining the carrying capacity for bison.
6. **Vaccination.** Some commenters were opposed to the use of vaccines (Strain 19 or RB51) in elk or bison
7. **Tribal Concerns.** A process was not been identified for how the tribes would participate in a ceremonial hunt. Alternative 4 only provided the potential that tribal ceremonial take could occur, and the numbers of bison that could be taken by the tribes (5 or possibly more, depending on need) was too low. The importance of traditions and cultural values was not adequately addressed in the *Final Plan/EIS*, and the agencies' trust responsibilities, including treaty and subsistence rights, were not addressed.
8. **Other.** Comments opposed hunting.

DISCUSSION OF FINAL PLAN/EIS COMMENTS

Issues raised about supplemental feeding, legal mandates, bison population objectives, habitat modeling assumptions, vaccination, and hunting were addressed in *Volume 2: Responses to Comments on the Final Plan/EIS,* and changes were made in the *Final Plan/EIS*. These issues are not new and are not discussed further. Other issues that warrant further clarification are discussed below.

Adaptive Management Framework

The Preferred Alternative identified in the *Final Plan/EIS* was modified from the Proposed Action identified in *Draft Plan/EIS* as a result of the public comments. The Preferred Alternative provides substantial guidance and direction for managing the Jackson bison and elk herds for the next 15 years. Even though this plan does not constitute a commitment for future funding, any significant deviation from Alternative 4 will require further public review and analysis.

The most significant issue identified throughout the planning process is that there is not enough winter forage to support the Jackson bison and elk herd sizes that are desired by the public and the State of Wyoming. Further complicating the issue is that these populations migrate across several jurisdictional boundaries, requiring cooperation and coordination among agencies and jurisdictions with differing legal mandates and constituents.

The Preferred Alternative clearly states that the Fish and Wildlife Service intends to progressively reduce the use of supplemental feeding on the National Elk Refuge, and specific objectives and strategies were outlined to address habitat conservation and wildlife management in order to achieve a greater reliance on free-standing forage. Many of the commenters on the *Final Plan/EIS* wanted a definitive answer about eliminating the use of supplemental feeding, and many agencies and stakeholder groups, as well as the public, have divergent opinions about phasing out supplemental feeding. The plan does not identify whether or not feeding will be phased out within 15 years; instead, it focuses on achieving the desired conditions that have been identified through an adaptive, progressive, and collaborative approach that incorporates different objectives and tools (strategies) for managing these populations. No management tool will be precluded in the effort to resolve current bison and elk management issues, nor will any predictions be made about how fast the first phase of this plan can be implemented. When the biological, social, and political conditions enable the Fish and Wildlife Service to consider a phaseout of feeding, this adaptive framework will provide flexibility; success will not be possible without the continued cooperation and coordination with other federal/state agencies, including the Wyoming Game and Fish Department.

The integral components of the management framework described in the *Final Plan/EIS* — population management, habitat restoration, public education, and monitoring — are not linear, separate components. They are dynamic and interwoven and require adaptable and workable solutions to changing biological, social, and political conditions. The primary considerations in developing a structured framework are identified in greater detail in the *Final Plan/EIS*. Successful implementation of the Preferred Alternative will require additional discussions between the agencies, particularly between the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service to address issues such as criteria for feeding, vaccination procedures, management of the bison and elk hunts, and continued coordination and cooperation between the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service. The outcome of these discussions will be documented in a new memorandum of understanding or other appropriate agreement document, which will be made available to all stakeholders.

Fencing

The need for additional fencing on the refuge other than what was identified in the Preferred Alternative is not anticipated, but there is flexibility within the alternative to work with adjacent landowners, the Wyoming Game and Fish Department, and others to identify strategies (including fencing) for reducing conflicts on private lands.

Tribal Concerns

The option of potentially allowing the tribes to take a small number of bison for the purposes of a ceremonial event was included in the Preferred Alternative; however, this remains a sensitive issue for the State of Wyoming as well as the tribes. The population objectives for bison and the subsequent analysis would remain unchanged regardless of whether a small taking for ceremonial purposes was eventually allowed, and discussions with the tribes will continue. Other tribal concerns were addressed in volume 2 of the *Final Plan/EIS*.

RECORD OF DECISION

The Record of Decision for the plan was signed by the Regional Directors of the U.S. Fish and Wildlife Service and the National Park Service on April 26, 2007. A copy is reprinted in this document as Appendix F.

A DESCRIPTION OF THE NATIONAL ELK REFUGE AND GRAND TETON NATIONAL PARK

THE PHYSICAL ENVIRONMENT

The National Elk Refuge is 6 miles at its widest point and 10 miles from southwest to northeast; elevations range from 6,200 to 7,200 feet. The northern half of the refuge consists of steep rolling hills. The southern half is glacial washout material, with one resistant formation (Miller Butte) rising approximately 500 feet above the valley floor. The town of Jackson borders the refuge on the south, and the town of Kelly lies near its northern boundary. Lands to the south and west are mostly privately owned. East of the refuge are lands administered by Bridger-Teton National Forest, including the nearby Gros Ventre Wilderness.

Grand Teton National Park is 22.5 miles wide and 41 miles long from north to south. Elevations range from 6,420 feet on the valley floor to 13,766 feet (the summit of Grand Teton). The park is bordered to the northwest, west, and southwest by Targhee National Forest. On the south the park surrounds a wedge of private land and a small section of Bridger-Teton National Forest. The Teton Wilderness in the national forest borders the park to the northeast.

The John D. Rockefeller, Jr., Memorial Parkway extends for 82 miles from West Thumb in Yellowstone National Park to the north entrance of Grand Teton National Park. The management area between the two parks includes 7.5 miles of parkway and 23,778 acres.

The southern portion of Yellowstone National Park inside the Jackson elk herd unit ranges from about 6,900 feet in elevation near the park's south entrance to about 10,300 feet in the Red Mountains.

Ecologically, the National Elk Refuge, Grand Teton National Park, John D. Rockefeller, Jr., Memorial Parkway, and Yellowstone National Park are part of a larger area referred to as the greater Yellowstone ecosystem.

Most of the remainder of the Jackson elk herd unit is comprised of the Buffalo and Jackson ranger districts of Bridger-Teton National Forest. Elevation ranges from about 6,300 feet to nearly 12,200 feet at the headwaters of the Yellowstone River.

SOILS

Over 20 different soil types are found on the National Elk Refuge (Young 1982). Soils at lower elevations are alluvial, generally sandy loam or loam, and are shallow and permeable. Soils at higher elevations are also loamy, with considerable areas of gravelly soils and cobblestone on south-facing slopes and ridges. Greyback gravelly loam, a deep, somewhat excessively drained soil, occurs in irrigated areas of the refuge. About 20% of the irrigated area includes areas that have a cobbly loam surface layer but that are otherwise similar to Greyback gravelly loam. Permeability is moderately rapid, and available water capacity is low. Roots penetrate to a depth of 60 inches or more. On 0% to 3% slopes the surface runoff is slow, and the erosion hazard is slight. On 3% to 6% slopes the surface runoff is medium, and the erosion hazard is moderate.

The Natural Resources Conservation Service has classified and mapped 44 soil types in Grand Teton National Park, ranging from shallow to deep loamy and stony soils to mostly deep, very cobbly and very stony soils. The soils of outwashes, tarns, terraces, and bottomlands include deep loamy and silty soils formed on loess or recent alluvium on gentle, rolling, and steep slopes to predominantly deep loamy and silty soils, which occur on moderately steep footslopes of the mountains.

CLIMATE

Jackson Hole is characterized by long, cold winters with deep snow accumulations, and short, cool summers. January is the coldest month with an average daily maximum temperature of 24°F and a minimum temperature of 1°F at low elevations. Temperature extremes vary from summer highs of 92°F to 98°F to winter lows of –40°F to –63°F.

Precipitation levels are relatively steady throughout the year, with a total average annual accumulation of 15.2 inches in Jackson Hole. Average monthly precipitation levels range between 1 and 2 inches, with May and December being wettest, and July and February driest. Jackson Hole averages 90 inches of snowfall per year, accounting for 60% of annual precipitation.

Snowfall varies considerably throughout the area of the Jackson elk herd unit. On the National Elk Refuge average snowfall ranges from 6 to 18 inches at the southern end up to 48 inches at the northern end. In Grand Teton National Park maximum snow depths range from 41–63 inches at low elevations (6,800 feet), to 82–98 inches at intermediate elevations (7,300–8,500 feet), and progressively deeper at higher elevations. Maximum snow depth is reached between March 15 and April 1 (Martner 1977). Elk tend to favor slopes with a southerly aspect during winter months because they can be snow free due to sunshine and southwest winds (Skovlin, Zager, and Johnson 2002).

One factor affecting forage availability for elk and bison is the amount of water contained within the snowpack, referred to as snow-water equivalents or how much water in inches is contained in the snowpack. Deep, light snow allows elk easier access to underlying vegetation than does a shallower, heavy snow. For modeling purposes, a snow-water equivalent of 6 inches was the threshold at which no forage would be available and elk would be unable to acquire sufficient food resources to survive on their own (Hobbs et al. 2003). Areas receiving 6+ inches of snow-water equivalents in one season would be unsuitable for elk winter range during that year. Temperature conditions that cause snow crusting would make forage less available at lower snow-water equivalent levels.

During an average winter, an estimated 51,000 acres in the Jackson elk herd unit area would likely be suitable as elk winter habitat (Wockner, pers. comm. 2002). Most of this acreage would be in the Gros Ventre River basin, with about 8,500 acres on the refuge, as well as in the Buffalo Valley area. Suitable habitat in years when snows were above average would decline to an estimated 20,000 acres, most of which would be in the Gros Ventre River basin and an estimated 2,600 acres on the refuge. In a severe winter suitable habitat would decline to an estimated 12,000 acres, with less than 700 acres on the refuge.

A number of scientific studies indicate that in the past century the climate is becoming warmer and drier in northern Yellowstone National Park (Balling, Meyer, and Wells 1992a, 1992b). If this warming trend continues, it could have far-reaching effects on the flora and fauna of the greater Yellowstone ecosystem (Romme and Turner 1991).

An analysis of precipitation records from 1921 to 2002 gathered by a National Oceanic and Atmospheric Administration weather station in Jackson, Wyoming, showed no significant trends, either increasing or decreasing (Smith, Cole, and Dobkin 2004). Although temperature readings from 1931 to 2002 increased, calculations using the 1949–2001 Keetch-Byram Drought Index (KBDI) values, which evaluate upper level soil moisture content, revealed a "minor decline in drought conditions" (Smith, Cole, and Dobkin 2004, p. 98).

WATER RESOURCES

NATIONAL ELK REFUGE

Surface Water

Surface hydrologic features on the National Elk Refuge include the Gros Ventre River, Flat Creek, Cache Creek, Nowlin Creek, and several other small creeks and springs. The Gros Ventre River flows westerly through the northern portion of the refuge, forming much of the northern boundary of the refuge. Flat Creek flows east to west and nearly bisects the refuge. In addition to natural watercourses, there are many miles of irrigation ditches. Three wells and an enclosed water storage reservoir are used by the town of Jackson.

The Gros Ventre River, which drains approximately 600 square miles of eastern Jackson Hole and the mountains farther east, is the largest watercourse on the refuge. The relatively wide river channel is heavily braided in areas where geologic materials are of low erosional resistance, as is the case on the refuge. The numerous gravel bars in the river channel have little or no vegetative cover as a result of annual flooding and erosion.

Flat Creek originates in the Gros Ventre Mountains east of the refuge and drains approximately 120 square miles. Flows vary seasonally due to runoff, input of irrigation water diverted from the Gros Ventre River, diversions by irrigators, and losses due to infiltration. The porous nature of refuge soils through which a section of Flat Creek flows causes high infiltration losses and results in a seasonally dry channel bed in this area.

Water from Cache Creek reaches the refuge by way of an underground diversion that surfaces into a cistern located near NER headquarters. Nowlin Creek is a small spring-fed tributary of Flat Creek. From the southeastern portion of the refuge, the creek flows westerly through four constructed impoundments to its confluence with Flat Creek. Smaller water features include Twin Creek and Holland Spring near the southeastern boundary, Romney and Peterson springs in the western portion, and other miscellaneous springs throughout the refuge.

Surface water quality in Teton County is believed to be high but can be adversely affected by both point source pollution (e.g., a gasoline station along Flat Creek) and non-point source pollution (e.g., overland runoff of fecal matter from winter concentrations of livestock). Existing or future urban development has little or no potential for influencing surface water quality on the refuge. Lower Cache Creek, however, flows through Jackson, and a diversion from this watercourse (the Cache Creek pipeline) enters the refuge and is used for irrigation. This section could be affected by urban runoff, potentially affecting downstream water quality (Jackson / Teton County, WY 1994).

While there is no information about water quality in Cache Creek in the vicinity of the refuge, two ongoing studies on sections of the creek flowing through Jackson closer to its confluence with Flat Creek have determined that petroleum hydrocarbons (from vehicles) and sodium (probably from compounds used by local road departments for ice melting) are entering Flat Creek along with city stormwater, and a similar situation may be occurring on Cache Creek. Zinc, the only heavy metal found in stormwater samples, is also flowing into Flat Creek from the town, but its source is unknown (Norton, pers. comm., as cited in USFWS 1998). Hydrocarbon input might be reduced by using stormwater retention cisterns.

Another possible non-point source of pollution affecting refuge water quality, although not documented as a problem, is the large amount of fecal material produced by wintering elk and bison. The high concentration of waterfowl in the Nowlin marsh area is also suspected of contributing to decreased water quality in the lower section of Flat Creek on the refuge.

The Teton County Conservation District has conducted water quality sampling on several sites within the refuge (see Table 1). Nitrates are of particular concern. Although data from 1996 to 2002 showed nitrate levels consistently below EPA drinking water standards (10 ppm), detected levels in 1997 and in 2002 were higher than expected for typical western Wyoming waters (Stottlemeyer, pers. comm. 2003; Stottlemeyer et al. 2003). Activities such as irrigation, fertilization, and elk/bison fecal material could be contributing to these elevated nitrate concentrations, but further study is needed.

In 2002 the Teton County Conservation District implemented some source tracking of fecal coliforms. Results from DNA analysis showed that 34% of the coliforms came from rodents, 13% from bison, 13% from elk, 13% from unknown sources, 7% from canines, and 7% from birds.

Farming practices such as disking, seeding, sprinkler and drip irrigation, herbicide and fertilizer application, and crop harvesting may affect water quality and quantity. About 3,000 acres are also annually dragged using a blanket harrow to break up and help decompose deposited elk and bison fecal matter and aerate the soil.

The elk refuge has about 105 cubic feet per second (cfs) of adjudicated water rights for about 7,500 acres of irrigable land. The major water rights pertain to the Gros Ventre River (5.0 cfs), Flat Creek (74.4 cfs), Cache Creek (7.2 cfs), and Nowlin Creek (4.4 cfs). Other water rights include Twin Creek, Holland Spring, Romney Spring, Peterson Spring, and several other springs on refuge land. The refuge uses a negligible amount of the water that is diverted from the Gros Ventre River,

TABLE 1: AVERAGE VALUES OF SELECTED WATER QUALITY PARAMETERS IN OR NEAR THE NATIONAL ELK REFUGE (1996–2002)

Monitoring Site	Flat Creek Control (near NER-BTNF boundary)	Flat Creek 1 (just above Fish Hatchery)	Nowlin Creek[1]	Flat Creek 2 (outside NER southwest boundary)[2]	Standard
Temperature (°F)	42.2 (8)	45.3 (10)	46.5 (4)	46.2 (11)	68
Dissolved Oxygen (mg/L)	11.2 (7)	10.5 (9)	9.51 (4)	9.8 (10)	
Turbidity (NTU)	0.0 (3)	1.1 (4)	1.4 (4)	26.8 (4)	
pH (units)	8.29 (8)	8.00 (10)	8.05 (4)	8.14 (11)	6.5–9.0
Nitrate as N (mg/L)	<0.1 (6)	0.14 (7)	<0.1 (5)	<0.1 (7)	10
April 2000 Sample					
Fecal Coliform (col./100ml)	3	53	55	60	200
E. coli (col./100ml)	1	45	49	29	126

NOTE: The number in parentheses is the number of samples tested.

1. The Nowlin Creek monitoring site is below the third pond, next to the barn and corral.
2. The second Flat Creek site is outside the refuge's southwest boundary, below the Dairy Queen, and subject to numerous outside influences (such as a major highway and gas station).

getting most of the water used for irrigation from Flat, Cache, and Nowlin creeks.

Irrigation on the refuge is accomplished by sprinkler irrigation and through a flood irrigation system using contour and lateral ditches controlled by headgates. Of the water that is being diverted annually, only an estimated 5%–10% actually reaches its destination (Kremer, pers. comm., as cited in USFWS 1998). This loss is due in part to the porosity of refuge soils and to the state of disrepair of ditches and headgates. This, as well as annual precipitation, staffing, other refuge activities, and access to and availability of water, affect how many acres are irrigated on the refuge. In 1997 no fields were irrigated, and in 1993 a maximum of about 2,000 acres were irrigated; the annual average is about 960 acres.

Groundwater

Water-level contours indicate that groundwater flows from high areas southwest through the valley toward the Snake River. Data for the alluvial valley aquifer indicate excellent water quality, supporting utilization for drinking water supplies, recreation, and other commercial uses. Much of the aquifer exhibits high permeability and significant interconnection to the rivers and lakes, making it vulnerable to contamination from facilities, visitor use, and transportation corridors in the recharge areas.

Groundwater resources on the National Elk Refuge as a whole are considered of high quality and are not subject to septic-related pollution concerns except perhaps in the vicinity of Twin Creek Ranch and other inholdings. Residential and commercial development in Jackson and elsewhere in the county may cause local reductions in groundwater quality (Jackson / Teton County, WY 1994). Although Jackson and surrounding areas use centralized wastewater treatment facilities, the perceived major threat to groundwater supplies elsewhere in the county is pollution from individual septic systems (Jackson / Teton County, WY 1994).

GRAND TETON NATIONAL PARK

Surface Water

All surface and groundwater in the park drains into the Snake River, which originates in the highlands of the Teton Wilderness, flows north and west through Yellowstone National Park, south through John D. Rockefeller, Jr., Memorial Parkway, and into Jackson Lake. From Jackson Lake, the river flows east and then south for about 25 miles before leaving the park. The Buffalo Fork of the Snake River enters the park at Moran Junction. Eight major streams drain highlands in Bridger-Teton National Forest north and east of the park and flow into Jackson Lake or the Snake River within the park.

Approximately 1.98 million acre-feet of water (average daily flow is 2,740 cfs) flow out of the park annually via the Snake River. Annual flow of the Gros Ventre River is about 345,000 acre-feet (average daily flow is 475 cfs). These water

Map

Management Units and Surface Hydrology of the NER

resources contribute to vegetative diversity (including aquatic, wetland, and riparian plant communities), irrigation and forage production, groundwater discharge, and the scenic viewshed. They also provide important habitats for various wildlife species.

Water diversion on the Gros Ventre River, although permitted by water law, does contribute to dewatering the river, which has negative consequences to invertebrates, fish, and other wildlife dependent on in-stream flow. As previously discussed, the National Elk Refuge uses a negligible amount of water from the Gros Ventre River for irrigation, with most coming from Flat, Cache, and Nowlin creeks. Dewatering due to use by private ranchers is beyond the scope of this document.

Surface waters within the park are of exceptionally high quality and are designated as Class 1 (the highest of four water quality classifications) by the Wyoming Department of Environmental Quality (NPS 1998).

Many of the lakes and streams in the greater Yellowstone ecosystem are very weakly buffered against pH lowering, which could be induced by acidic rain or snowmelt. Activities that can impact water quality and aquatic and riparian habitats include recreational activities, timber harvest, flood control, grazing by native and domestic ungulates, mining, and recreation facility development. A 2000 water quality study revealed high levels of fecal coliforms in irrigation diversions within the Elk Ranch area of Grand Teton National Park (O'Ney, pers. comm. 2001). Through DNA source tracking, 32% of these coliforms came from bovine sources, 9% from bison, 9% from elk, 26% from unknown sources, and the rest from rodents, foxes, birds, horses, geese, and waterfowl.

Groundwater

Much of the eastern and central portions of the park (particularly areas covered by glacial outwash) have extensive groundwater resources (McGreevy and Gordon 1964; Cox 1974). Water tables vary from near the surface on floodplains to 30 to 60 feet below the surface on outwash flats and deeper in most upland areas. Numerous springs emerge along the park's east boundary, including several thermal springs near Kelly and East Gros Ventre Butte.

VISUAL RESOURCES

The quality of visual resources is an important part of the recreational experience (USFS 1982). The visual appearance of a landscape is often the first thing to which a viewer responds.

The National Elk Refuge and Grand Teton National Park, and the vast expanses of undeveloped national forest land surrounding the refuge and the park, offer spectacular scenic views of the Teton and Gros Ventre mountain ranges, the Sleeping Indian (Sheep Mountain), Jackson Peak, Cache Peak, Snow King, East Gros Ventre Butte, and the Gros Ventre hills in the northern portion of the refuge. The Gros Ventre River along the northern refuge boundary supports a cottonwood-dominated riparian zone along its drainage.

NATIONAL ELK REFUGE

The most prominent view of the refuge, which is seen by several million visitors annually as they drive to and from Jackson on U.S. 26/89, is the expansive Nowlin meadow area. During winter thousands of elk make the refuge an important visual and ecological resource for the region. Although bison are fed in areas that are not visible to the public, they can be viewed along the fence north of the Fish Hatchery and in the McBride area before Flat Creek Road is closed in December. As the bison herd grows, bison are more frequently seen in the southern sections of the refuge.

Features related to bison and elk management that may detract from the visual quality of the refuge include the following:

- an 8-foot fence that runs for approximately 8 miles along the south and west boundaries of the refuge and that keeps elk and bison from entering the town or migrating to the cattle ranches in Spring Gulch
- a powerline that parallels the highway north of Jackson for about 2 miles
- feed trucks and feed sheds

- a fish hatchery, Refuge Road, refuge housing, and private homes that are clearly visible from U.S. 26/87.

Grand Teton National Park

The park viewshed is dominated by the spectacular Teton Range. Bison, elk, moose, bears, and a variety of smaller wildlife can all be spotted foraging near the roads that wind through the park.

Structures associated with private residences, park housing, and concessions are visible in some areas of the park. Some of these developments are part of the historical scene, and there may be cultural landscapes associated with historic districts listed on or eligible for listing on the National Register of Historic Places, while others, such as irrigation equipment near Triangle X Ranch, are more modern developments that intrude on the natural landscapes. Approximately 5,600 acres of previously cultivated park lands are unappealing to some people because the areas are dominated by smooth brome, musk thistle, and other nonnative invasive species.

HABITAT

NATIONAL ELK REFUGE

PLANT SPECIES OF SPECIAL CONCERN

No plant species in Teton County have been federally listed or proposed for listing as threatened or endangered species. There are 13 Wyoming plant species of special concern on the National Elk Refuge (see Table 2).

TABLE 2: WYOMING PLANT SPECIES OF SPECIAL CONCERN — NATIONAL ELK REFUGE

Scientific Name	Common Name
Aster borealis	Rush aster
Astragalus terminalis	Railhead milkvetch
Carex buxbaumii	Buxbaum's sedge
C. parryana	Parry sedge
C. sartwellii	Sartwell's sedge
C. scirpoidea scripiformis	Canadian single-spike sedge
Eriophorum viridicarination	Green-keeled cotton-grass
Heterotheca depressa	Teton golden aster
Lesquerella carinata	Keeled bladderpod
Muhlenbergia glomerata	Marsh muhly
Salix candida	Hoary willow
Scirpus rollandii	Pygmy bulrush
Utricularia intermedia	Flat-leaf bladderwort

SOURCE: Fertig 1998.

PLANT COMMUNITIES

Thirty-three plant community types have been classified on the National Elk Refuge, 23 of which are dominated by indigenous plants and 10 by cultivated species that were introduced or are being perpetuated due to agricultural activities. While some communities have adapted to natural conditions, most cultivated species are supported by continued flood irrigation.

For the purposes of this analysis, vegetative communities on the refuge may be classified into one of six general categories: wetlands (marshlands, wet meadows, and open water), native grasslands, sagebrush shrublands, riparian and aspen woodlands, conifer forests, and cultivated fields (see Table 3, and the "Plant Communities of the National Elk Refuge" map and the "Vegetation of the National Elk Refuge and Grand Teton National Park" map). Appendix B lists scientific names for plant species.

TABLE 3: PLANT COMMUNITY TYPES — NATIONAL ELK REFUGE

Habitat	Acres
Wetlands (2,676 total acres)	
Marshlands	630
Wet Meadows	1,720
Open Water	326
Native Grasslands	8,092
Sagebrush Shrublands	8,010
Riparian Aspen Woodlands	3,227
Conifer Forest	160
Cultivated Fields	2,400
Total	**24,565**

Wetlands (Marshlands, Wet Meadows, and Open Water)

The National Elk Refuge contains approximately 2,676 acres of wetlands, including marshlands, wet meadows, and open water. Wetlands function as a natural sponge that stores and recharges groundwater supplies. They moderate stream flow by releasing water to streams (especially important during droughts), and they reduce flood damage by slowing and storing floodwater. Wetland plants protect streambanks against erosion because the roots hold soil in place and the plants break up the flow of stream or river currents. Wetlands improve water quality by filtering sediment, pollutants, and excess nutrients from surface runoff. Wetlands are one of the most biologically productive ecosystems in the world. The nutrient-rich environment of wetlands provides food and habitat for a variety of wildlife.

Wetlands on the National Elk Refuge are some of the most diverse and important in the valley due to their water-regulating functions, visual qualities, and importance to wildlife, especially resident and migratory birds. Most wetland areas receive moderate to heavy use by elk but are generally considered to be in good condition. A few limited areas receive extremely heavy use, and they are considered to be in fair condition. Bison rarely used wetlands in the past but recently have begun to graze wet areas adjacent to the Poverty Flats feedground and wet meadows near the fish hatchery.

Map

Plant Communities of the National Elk Refuge

Map

Vegetation of Grand Teton National Park and
the National Elk Refuge

Marshlands

Marshlands are low-lying and concave or occur on gentle slopes with seepage. They are inundated frequently or continually with water but are most often persistently saturated. Marshes are characterized by emergent soft-stemmed vegetation (such as sedges, rushes, cattails, and bulrushes) that is adapted to living in shallow water or in moisture saturated soils. Spring-inundated sites, which dry by fall, are also included in this category. Marshland communities presently occur on approximately 630 acres of the refuge and are considered to be in good condition (Cole, pers. comm. 2002). Good condition marshland habitats are dominated by bulrush, cattail, and sedge species. These stands develop to full stature each year depending on water availability. In marshland habitats considerable residual material remains under the bases of growing plants from the previous years' herbaceous growth, except in areas that have been burned. There is very little nonnative plant species invasion in marshlands.

Wet Meadows

Wet meadow habitats currently occur on approximately 1,720 acres on the refuge and they are considered in good condition. Plant communities include shrubby cinquefoil and sedges, and typical grasses include foxtail barley, timothy, Kentucky bluegrass, tufted hairgrass, and common horsetail. Approximately 1,450 of the 1,720 acres contain willow plants less than 1.5 feet tall, indicating that mature willow stands have been converted to other plant communities because of decades of heavy elk browsing (Smith, Cole, and Dobkin 2004). Large numbers of elk on the refuge prevent these suppressed willow plants from growing out of the browse zone. Of importance, however, is the fact that the root systems of these willow plants remain and continue to attempt to regenerate by producing suckers.

Good condition wet meadow communities are dominated by nearly 100% cover of native sedge species and water-tolerant grasses. In some wet meadow habitats, shrubby cinquefoil is a major component of the cover. There is often very little residual cover due to heavy grazing by elk. The amount of residual cover in wet meadow communities varies from year to year depending on the depth of snow cover and grazing pressure. There is very little invasion from nonnative weed species. However, nonnative species, such as Kentucky bluegrass, fowl bluegrass, and clover (*Trifolium*) are present in wet meadow habitats.

Open Water

Open water accounts for 326 acres on the refuge and consists of stream and river channels and sites where standing water persists through most years, including pools and ponds.

Native Grasslands

Native grasslands occur where there is sufficient precipitation to grow grasses but not trees, or where drought, frequent fires, grazing by large mammals, or human disturbances have prevented trees or shrubs from becoming established. Native grasslands are important plant communities on the refuge because they provide winter forage for elk and bison, which are primarily grazers. Native grasslands, including some bluegrass, wheatgrass, and needlegrass species, cover approximately 8,092 acres. Except for localized areas, native grasslands are in good condition, especially in the northern part of the refuge (Cole, pers. comm. 2002).

On the south end of the refuge there is little residual growth on bunchgrasses from the previous year of ungulate grazing during the grass's dormant season. This removal can result in increased production of some perennial bunchgrass plants, although standing dead plant material has been shown to be beneficial to plant health by some authors (Sauer 1978; Briske 1991).

The largest continuous segment of native grassland occurs in the central part of the refuge northeast of the Nowlin Creek marshlands, and northwest, west, and east of Flat Creek Road. This area is being invaded by crested wheatgrass, a nonnative wheatgrass that was once cultivated on the refuge. Crested wheatgrass currently covers approximately 650 acres. While this nonnative plant is very palatable to bison and elk in the spring, it has very little nutritional value to wildlife as winter forage. Its spread is a concern because the refuge is a winter range for ungulates. Although grassland condition in

crested wheatgrass areas is good in terms of relative forage production, minimal erosion, and vigorous grass growth, the cover of native grass species has been reduced by 50% to 90% and replaced by crested wheatgrass in these areas (Cole, pers. comm. 2002). Therefore, the invasion of crested wheatgrass has the potential to degrade the condition of native grassland habitats on the refuge.

Cheatgrass has invaded an estimated 250 acres of native grassland on the refuge. This is an annual grass that is a prolific seed producer and cures out early in the summer, producing sharp pointed seeds that can injure the eyes and mouths of grazing animals. Cheatgrass may provide forage for bison and elk in the spring during green-up, but has little nutritional value as winter forage. It is considered a serious problem because the dry grass is highly flammable, and after a fire, cheatgrass spreads very quickly. In the past, cheatgrass was not considered a problem in Jackson Hole because the climate was too wet; the recent drought, however, has allowed cheatgrass to expand rapidly.

Most native grassland habitats are dominated by native perennial bunchgrass species with native woody species such as broom snakeweed and green rabbitbrush. There is little invasion by tap-rooted forbs between grass plants. Soil between grasses is not eroding on most native grasslands on the refuge. Additional plant species commonly found in native grasslands include rushes, smooth brome, brome snakeweed, yellow salsify, June grass, green rabbitbrush, fringed sage, and alfalfa. These communities, while heavily used by elk and bison, are considered to be in good condition. The Poverty Flats grasslands receive heavy use by elk, and Miller Butte receives moderate to heavy use. The grasslands on the northern end of the refuge receive much less use due to snow depth and hunting.

Sagebrush Shrublands

Sagebrush shrublands encompass approximately 8,010 acres and are scattered throughout the refuge, with the largest concentrations in the east-central and northeastern portions. Sagebrush shrublands are in good condition in the northern half of the refuge, with some small areas in fair condition in the McBride and Peterson management units (Cole, pers. comm. 2002). In the southern half of the refuge they are in poor condition due to over-browsing by bison and elk and mechanical damage by bison, elk, and feed equipment. Good condition sagebrush shrubland communities in a late stage of succession have a relatively high diversity and cover of herbaceous plants. It is possible that late seral sagebrush shrubland on the refuge is over-represented due to a history of fire suppression. Prior to Euro-American settlement, sagebrush habitats burned on average about every 25 years (Houston 1973).

Sagebrush shrublands usually receive more precipitation (or grow on sites with more soil moisture) than grasslands but less than forested areas. Some areas have extremely tall sagebrush cover (in excess of 9 feet tall), and some areas have shorter and younger age classes. Communities are made up of shrubs and short trees and are fairly open, and there is a diversity of native perennial grasses and native forbs growing between sagebrush plants. Common species in this vegetative grouping include big and three-tipped sagebrush, bluegrass, snowberry, wild rose, and smooth brome. Douglas rabbitbrush is found throughout the refuge but occurs as a subdominant. Additional plant species commonly found in sagebrush shrubland communities on the refuge include needlegrass, wheatgrass, snakeweed, and rubber rabbitbrush.

Riparian and Aspen Woodlands

Four habitat classes have been defined for willow, aspen, and cottonwood communities, as shown in Table 4. Class I indicates good habitat quality; Class II, fair habitat quality; and Classes III and IV, poor condition habitat. Generally, the classes describe the extent of browsing, the condition of the vegetation type, and the extent of bird life as an indicator of community health.

In addition to elk and bison, numerous other herbivore species feed on woody vegetation communities, including mule deer, moose, beavers, porcupines, small mammals, birds, and insects. The individual impacts of each species have not been measured, but these impacts on woody plant communities would continue in addition to the impacts of elk and bison.

TABLE 4: HABITAT TYPES AND CLASSIFICATION OF WILLOW, ASPEN, AND COTTONWOOD COMMUNITIES

Class	Definition	Condition
Willows		
Class I	Very lightly browsed (0%–10% consumption). Habitat maximizes height of willows (averaging 6.9 feet), with large crown sizes; canopy cover averages 78%. Willows grow to the edges of streams and benefit the stream aquatic ecosystem by shading streamsides and producing large amounts of leaf and shoot litter-fall. Habitat has high abundance and diversity of birds, dominated by a number of bird species that are habitat specialists.	Good
Class II	Moderately browsed (11%–20% consumption). Habitat is still healthy and abundant, but the average height of willows is 4.9 feet, and canopy cover is reduced to an average of 65%. Willows generally do not grow over streamsides, provide much less shade to streams, and do not provide as much cover or litter inputs into the stream. Class II habitat provides less habitat and nutrient inputs to aquatic invertebrates and fish. Fewer bird species that are habitat specialists are present.	Fair
Class III	Heavily browsed (21%–35% consumption). Willow size and production is dramatically reduced. Willows average 3.7 feet tall (only 54% of Class I willow habitat); canopy cover averages 31% of Class I. Bird species are more likely to be habitat generalists.	Poor
Class IV	Severely over-browsed (more than 35% consumption). Willow plants are short (averaging 3 feet). Some willows, severely hedged and scattered in small patches, are no taller than surrounding grass. Canopy cover averages 26%. Willow communities have lost most of their ecological function, and bird habitat is vastly different than in Class I. Class IV willow habitat on the National Elk Refuge is classified as wet meadow habitat. Habitat contains a simple bird community, dominated by habitat generalists or bird species more typical of wet meadow or native grassland habitats. On the National Elk Refuge 1,450 acres of Class III and Class IV willow habitat occurs in what are now wet meadow communities.	Poor
Aspens		
Class I	Lightly browsed. Robust aspen trees and shrubs of varied sizes and age classes, standing dead trees are present but not numerous, and there is a dense herbaceous layer of forbs, sedges, and grasses. Tree overstories are relatively dense. Recruitment of young trees and shrubs is evident. Young aspen trees occur at the periphery of stands and in areas where trees have died due to disturbances, such as lightning strikes or blowdown. Habitat contains a diverse bird community. Another example of a Class I stand would be a young, vigorous aspen stand that develops after a stand-replacing fire. Although most aspen stems would be of the same age class, this would still be a good condition stand.	Good
Class II	Moderately browsed. Fewer age classes of aspen trees. The overstory is sparser than Class I, but more than 50%. The understory is getting sparse, with fewer species of shrubs, forbs, sedges, and grasses. There is reduced recruitment of young trees and shrubs. Fewer bird species that are habitat specialists are present.	Fair
Class III	Heavily browsed. Sparse, decadent overstory of aspen trees, scattered clumps of decadent, pedestaled shrubs, and the complete absence of recruitment by woody species. Snags do not remain standing for long and are relatively common. Most of the birds are woodpeckers and generalist species that occur in many different habitats as well as in human-disturbed landscapes. Some Class III aspen on the National Elk Refuge has more than 50% overstory but no understory and no successful regeneration of aspen trees.	Poor
Class IV	Severely overbrowsed. Few live trees, few snags, and deadwood present on the ground. The overstory is comprised of sagebrush and snowberry/rose shrubs or dry native bunch grasses. The bird community is dominated by species typical of sagebrush shrubland or native grassland habitats. Some Class IV aspen habitat is converting to conifer forest. Conifer species, which are shade tolerant, encroach on aspen habitat and shade out the aspen suckers, which need direct sunlight to grow. The combination of long periods without disturbances to provide open areas for aspen sucker growth and heavy browsing by ungulates allows conifer species to encroach.	Poor
Cottonwoods		
Class I	Lightly browsed. Robust cottonwood trees and shrubs of varied sizes and age classes, standing dead trees are present but not numerous, and there is a dense herbaceous layer of forbs, sedges, and grasses. Tree overstories are relatively dense, and midstories are dense and continuous. Recruitment of young trees and shrubs is evident. Habitat contains a diverse bird community.	Good
Class II	Moderately browsed. Fewer age classes of cottonwood trees. Sparser overstory than class I, but more than 50%. The understory is getting sparse, with fewer species of shrubs, forbs, sedges, and grasses. There is reduced recruitment of young trees and shrubs. Fewer bird species that are habitat specialists are present.	Fair
Class III	Heavily browsed. A sparse, decadent overstory of cottonwood trees; scattered clumps of decadent, pedestaled shrubs; and the complete absence of recruitment by woody species. Snags do not remain standing for long and are relatively common. Most of the birds are woodpeckers and generalist species that occur in many different habitats as well as in human-disturbed landscapes.	Poor
Class IV	Severely overbrowsed. Few live trees, few snags, and deadwood present on the ground. The overstory is comprised of sagebrush and snowberry/rose shrubs or dry native bunch grasses. The bird community is dominated by species typically occurring in sagebrush shrubland or native grassland habitats.	Poor

SOURCE: Willow class definitions from Singer and Zeigenfuss (2003). Aspen and cottonwood class definitions formulated from Dobkin 1994; Dobkin, Singer, and Platts 2002; and field observations by E. K. Cole, National Elk Refuge biologist.

Riparian and aspen woodland communities occur on approximately 3,240 acres of the refuge. This habitat type has been declining in condition and acreage throughout refuge history. Riparian woodland habitat consists of approximately 300 acres of willow habitat and about 1,090 acres of cottonwood communities. An additional 1,450 acres of suppressed willow plants occur in what are now wet meadow communities, but were once willow habitat. Decades of winter browsing by elk have reduced these willows to remnant plants less than 18 inches high. Aspen woodland habitat consists of approximately 1,850 acres of aspen-dominated communities on hillsides usually some distance from water.

Riparian woodlands occur along the Gros Ventre River and Flat Creek. Aspen-dominated woodlands are scattered on the Gros Ventre hills throughout the northern part of the refuge and on the eastern edge of the refuge in the south, adjacent to the Gros Ventre Wilderness. Riparian and aspen woodlands are particularly important as wildlife habitat and have been affected by elk and bison browsing.

Riparian and aspen woodlands include stands of quaking aspen, narrowleaf cottonwood, and willows. Sedges, brome species, Douglas-fir, pinegrass, snowberry, rose species, bluegrasses, and big sagebrush in some areas may be codominants (those species that influence the kinds of other species that may exist in an ecological community). Engelmann spruce are scattered throughout the woodland stands but are subdominants. Additional plant species commonly found in riparian and aspen woodlands include species of rushes, Muhly, horsetail, yellow salsify, wheatgrass species, mountain timothy, needlegrass, serviceberry, chokecherry, buffaloberry, bearberry honeysuckle, and bitterbrush.

Poor condition willow habitat.

Poor condition cottonwood habitat.

Poor condition aspen stand.

Dobkin, Singer, and Platts (2002) state that aspen, willow, and cottonwood stands on the National Elk Refuge have been degraded due to overbrowsing by ungulates; this is based on historical photographs, written records, and an understanding of the ecology of these communities. Dieni et al. (2000) and Smith, Cole, and Dobkin (2004) also note the growing experimental evidence that ungulate browsing is the cause of declines in aspen and cottonwood communities. Studies of the effects of browsing on woody vegetation that began in 2000 on the refuge are continuing, and changes in woody plant communities will be monitored every five years.

Dobkin, Singer, and Platts (2002) also found that willow sites on the National Elk Refuge were "mostly poorly functioning or nonfunctioning ecologically." They concluded that although willow habitat is influenced by flooding, hydrologic

conditions, ungulate use levels, fire frequencies, and precipitation patterns, the decline of willows on the refuge appears to be mostly related to heavy browsing (28%–55% removal of annual growth). The decline of willows along Flat Creek in the southern portion of the refuge has exceeded 95% (Smith, Cole, and Dobkin 2004). Shrubby cinquefoil, a less palatable woody species, is abundant in this prior range of willows and has probably increased as willows declined. In contrast, willows in the north end of the National Elk Refuge are in fair to good condition. Many stands are moderately browsed, and some willow plants do not reach their full height potential. Growth of new willow stems out of the browse zone is sporadic, and there is some space between most willow clumps.

Elk browsing in cottonwood communities has removed understory, and cottonwood trees are not regenerating. Cottonwood stands close to the McBride feedground experience higher snag density and higher down woody debris cover. Cole did not find a difference in the number of woody plant species in stands closer to feedgrounds as compared to stands farther away (E. K. Cole 2002a, 2002b).

Many aspen stands are characterized by mature trees, with little if any aspen understory. Aspen recruitment is prevented by heavy elk browsing on aspen suckers that prevents most suckers from growing out of the browse zone. Many aspen stems are approximately 120 years old, which is approaching the maximum life span of 150 years. Most of these stands will eventually convert to sagebrush shrubland habitat, primarily in the form of snowberry/rose stands. A few stands may convert to native grassland habitat, depending on their location and the understory condition. Although shrub and woodland stand health improve with increasing distance from feedgrounds, aspen woodland stands are in poor condition refugewide, as evidenced by low understory height measurements, regardless of the distance from feedgrounds (Smith, Cole, and Dobkin 2004).

Cottonwood and aspen saplings grow inside exclosures (fenced areas) on the upper section of Flat Creek, indicating that these trees can replace themselves if ungulates are totally excluded. Aspen stands in the northern hills of the refuge appear to be declining slowly, but some aspen communities escape browsing, and stand replacement is occurring periodically.

Conifer Forest

Conifer forests on the refuge cover 160 acres and consist of Douglas-fir, lodgepole pine, junipers, wheatgrasses, and other plant species. These forests are in good to fair condition in terms of the conifers' ability to regenerate, but subdominant species that are much more palatable, such as serviceberry, are in poor condition. Conifer forests occur mostly on the extreme eastern edge of the refuge in the north and the south on hillsides adjacent to Bridger-Teton National Forest and on the northern slopes of the Gros Ventre hills.

Additional plant species commonly found in conifer forests on the refuge include snowberry, June grass, bluegrass species, buffaloberry, mountain boxwood, and serviceberry.

Elk use the conifer forests on the refuge and the adjacent forestland for cover and shelter from winter storms and also graze on palatable understory shrubs and grasses. Bison rarely use conifer stands.

Cultivated Fields

Ten plant community types are found in cultivated fields (approximately 2,400 acres) in the south and central part of the refuge. Current plant species include intermediate wheatgrass, Russian wild rye, Kentucky bluegrass, sub-irrigated bluegrass, smooth brome, and alfalfa. Smooth brome, the most common, provides moderate-quality standing forage but is undesirable because of its inability to remain erect in heavy snow. It also requires irrigation in drought years and may spread to suitable sites in other cultivated fields and native grassland habitats. Cultivated grasslands, which are planted specifically to augment native forage that is available for elk in the winter, are used extensively by elk and bison. Cultivated species are chosen based on their palatability, persistence, ability to compete with weeds, low probability that they will invade native grasslands, and their ability to stand up after a heavy snowfall. Experiments with other plant species are continuing in an effort to find more productive crops. Only a portion of the

TABLE 5: GRASSES FOUND IN THE SIX IRRIGATION PROJECT AREAS ON THE NATIONAL ELK REFUGE

Irrigation Project Area / Grasses	Acres
Chambers	
Wheatgrass / bluegrass (*Elymus* spp. / *Poa* spp.)	60
Kentucky bluegrass *(Poa pratensis)*	75
Intermediate wheatgrass (*Elytrigia intermedia*)	195
Subtotal	330
Ben Goe	
Subirrigated bluegrass (*Poa* spp.)	59
Smooth brome / alfalfa (*Bromus inermis* / *Medicago sativa*)	382
Crested wheatgrass (*Agropyron cristatum*)	14
Subtotal	455
Petersen	
Smooth brome (*Bromus inermis*)	145
Great Basin wild rye *(Elymus cinereus*)	21
Intermediate wheatgrass (*Elytrigia intermedia*)	17
Kentucky bluegrass (*Poa pratensis*)	6
Wheatgrass / needlegrass / bluegrass (*Elymus* spp. / *Stipa* spp. / *Poa* spp.)	59
Subtotal	248
McBride	
Wheatgrass / mixed grasses	268
Smooth brome / alfalfa	132
Intermediate wheatgrass (*Elytrigia intermedia*)	98
Russian wild rye (*Elymus junceus*)	30
Subtotal	528
Nowlin	
Intermediate wheatgrass (*Elytrigia intermedia*)	54
Subirrigated bluegrass (*Poa* spp.)	54
Wheatgrass / mixed grasses (*Elymus* spp. /	267
Kentucky bluegrass (*Poa pratensis*)	32
Subtotal	407
Headquarters	
Subirrigated bluegrass (*Poa* spp.)	24
Crested wheatgrass (*Agropyron cristatum*)	53
Smooth brome / mixed grasses (*Bromus inermis* /	101
Creeping foxtail *(Alopecurus arundinaceus)*	42
Intermediate wheatgrass (*Elytrigia intermedia*)	30
Subtotal	250
Total	**2,218**

approximately 2,400 acres available for cultivation would likely be cultivated in any particular year.

Of the 33 plant communities on the refuge, 25 occur in the six irrigation project areas that would be affected by changes in the irrigation system. Native grasslands, cultivated grasslands, and invasive crested wheatgrass are the only vegetative classes present in the six project areas (see Table 5). Some community types have changed since being mapped in 1986; for example, several fields in the Chambers area that were once vegetated in wheatgrass and smooth brome are now virtual monocultures of crested wheatgrass.

Irrigation Systems

Most cultivated fields on the refuge are flood irrigated using the ditch system created by original homesteaders but with some recent modifications. Current flood irrigation involves diverting water from Flat, Cache, and Nowlin creeks, or other water sources, conveying this water through open irrigation ditches, and then directing water onto fields by using permanent water control structures or temporary check dams. A total of 60 acres of cultivated fields are irrigated using a side-roll sprinkler irrigation system.

Currently, the National Elk Refuge flood irrigates approximately 665 to 2,000 acres per year, with a 10-year average of 930 acres per year. Sprinkler irrigation could increase to 260 acres under existing authority. Cultivated fields that are not irrigated vary from an estimated 500 to 2,400 acres per year (with a 10-year average of about 1,400 acres per year).

Forage production in any given year depends on crop species planted, the number of years since seeding occurred, infestation by insect herbivores such as grasshoppers, fertilizer application, precipitation, amount of water available for irrigation, and number of staff available for irrigation activities. The time of year that precipitation occurs is also important. Rain in the spring and early summer is more beneficial than later in the year. Water available for irrigation depends more on snowpack than growing season precipitation.

Experimental Exclosures

Experimental exclosures are designed to measure the growth of forage when large herbivores are excluded. Exclosures on the refuge currently enclose about 20 acres of woody habitat.

Forage Production outside Exclosures

Forage production on the refuge varies annually, depending on precipitation, temperature, insects, fields allowed to lie fallow, and other factors. Estimates of both herbaceous and total forage production between 1987 and 2002 are presented in Table 6. The refuge produces an estimated average of 22,195 tons of forage annually, about 18,049 tons

TABLE 6: TOTAL FORAGE AND HERBACEOUS FORAGE PRODUCTION ESTIMATES FOR THE ENTIRE NATIONAL ELK REFUGE, 1987–2002

	Herbaceous Forage		Total Forage		Cultivated Fields	
Year	Lbs	Tons	Lbs	Tons	Lbs	Tons
1987	29,642,000	14,821	35,898,000	17,949	NA	NA
1988	29,582,000	14,791	33,616,000	16,808	NA	NA
1989	41,650,000	20,825	50,736,000	25,368	6,362,000	3,181
1990	40,038,000	20,019	49,658,000	24,829	6,622,000	3,311
1991	40,904,000	20,452	47,712,000	23,856	8,140,000	4,070
1992	38,576,000	19,288	45,782,000	22,891	6,306,000	3,153
1993	55,168,000	27,584	74,192,000	37,096	11,232,000	5,616
1994	37,592,000	18,796	45,660,000	22,830	3,756,000	1,878
1995	45,461,000	22,730	53,782,000	26,891	7,892,000	3,946
1996	42,378,000	21,189	53,782,000	23,295	5,930,000	2,965
1997	46,282,000	23,141	51,048,000	25,929	7,250,000	3,625
1998	39,294,000	19,647	44,730,000	22,365	6,900,000	3,450
1999	31,700,000	15,850	39,254,000	19,627	5,640,000	2,820
2000	22,598,000	11,299	33,580,000	16,790	1,852,000	926
2001	18,118,000	9,059	28,994,000	14,497	1,968,000	984
2002	18,606,000	9,303	28,184,000	14,092	3,242,000	1,621
Average	36,099,312	18,049	44,788,000	22,195	5,193,250	2,597

SOURCE: NER staff.

(81%) of which is herbaceous forage. This estimate is most meaningful for elk management in terms of usable and preferred forage. However, not all herbaceous forage produced on the refuge is available to or used by wintering elk. Factors such as topography, location, snow accumulation and condition, species preference and palatability, growth form of vegetation, hunting pressure, and other factors work in concert to influence forage availability and elk use.

Forage Production Monitoring Data

Forage production has been monitored on the refuge for the past 17 years, with data collected annually along 51 transects throughout the refuge to determine production rates associated with community types (see Table 6). From this information, refuge-wide production estimates have been extrapolated. There is a degree of variability in terms of site-specific range condition and forage production, and the generalized data are not well suited to predict forage production outside transect locations. Retrospective analysis of forage production data against several possible explanatory variables found that precipitation accounted for most of the annual variability. For example, record-breaking precipitation in 1993 resulted in increased forage production. Another variable is grasshopper populations, which are typically associated with drought; they play a lesser role in forage production, but their exact effect is more difficult to quantify.

NONNATIVE INVASIVE PLANT SPECIES

Many nonnative plant infestations on the refuge are a direct result of abandoned livestock feeding areas and corrals, old homesites, and roadbeds. At least 19 species of invasive nonnative plants are present (see Table 7). Such species reduce the diversity and number of native plants and modify habitats (i.e., replacing a grass community with a forb community). Studies in Montana indicate that bison and deer reduced their use of a particular habitat by 70%–82% when it was invaded by leafy spurge. Elk forage in bunchgrass sites was decreased by 50%–90% after a spotted knapweed invasion (Teton County, WY, Weed and Pest 2002). Nonnative invasive plants also fail to protect and hold soil because they generally have a shallow root system, leading to increased erosion and sedimentation in streams. This in turn affects water quality and decreases fish production.

The refuge and park both use biological, mechanical, and chemical means to control invasive plants. Nonnative plants on the refuge have not substantially affected forage conditions, but spotted knapweed and musk thistle invasions in the park are considered serious (Haynes, pers. comm. 2002).

TABLE 7: NONNATIVE INVASIVE WEED SPECIES ON THE NATIONAL ELK REFUGE

Scientific Name	Common Name	Minimum Acreage	Maximum Acreage
Cardaria draba	Whitetop	5 acres	30 acres
Carduus nutans	Musk thistle	35 acres	125 acres
Centaurea maculosa	Spotted knapweed	25 acres	120 acres
Centaurea repens	Russian knapweed	< 1 acre	
Centaurent diffusa	Diffuse knapweed	< 1 acre	
Cirsium arvense	Canada thistle	0.1 acre	15 acres
Cirsium vulgare	Bull thistle	<0.5 acre	10 acres
Convolvulus arvensis	Bindweed	< 0.1 acre	
Cynoglossum officinale	Hound's tongue	0.2 acre	2 acres
Hyoscyanus niger	Black henbane	<0.2 acre	
Lepidium latifolium	Perennial pepperweed	0.1 acre	
Leucanthemum vulgare	Oxeye daisy	< 0.1 acre	
Linaria dalmatica	Dalmation toadflax	0.2 acre	2 acres
L. vulgaris	Yellow toadflax	< 1 acre	
Matricaria perforata	Scentless chamomile	<0.2 acre	
Onopordum acanthium	Scotch thistle	0.1 acre	1 acre
Sonchus arvense	Marsh sow thistle	5 acres	20 acres
Tanacetum vulgare	Common tansy	<0.5 acre	
Verbascum thapsus	Wooly mullein	1 acre	15 acres

GRAND TETON NATIONAL PARK

PLANT COMMUNITIES

More than 1,000 vascular plant species (Shaw 1992b) and over 200 fungi species (McKnight 1980) occur in Grand Teton National Park or nearby Teton County. There are 117 nonnative species that have migrated within the last 75–100 years or remain from previous cultivation (Shaw 1992a).

From 1986 to 1988 the vegetation of the national park and the parkway was classified and mapped. Sixty-three plant community types were identified, which are classified under nine general categories: wetlands (marshlands, wet meadows, and open water), native grasslands, sagebrush shrublands, riparian and aspen woodlands, conifer forest, agricultural lands, human development, bare rock and krummholz, and tundra (see Table 8). Elk occur in most habitat types throughout the national park, except for alpine peaks. Bison use native grassland communities, agricultural lands, and sagebrush shrubland habitats, which occur on the southeastern side of the park from the border with the National Elk Refuge, north to the south side of Emma Matilda Lake, and certain riparian corridors within that area. Although elk and bison use coniferous forests for cover, these forests are more affected by management actions than by ungulate grazing. Because the bare rock and krummholz and the tundra communities will not be affected by bison and elk management, they are not discussed further.

The park primarily provides spring, summer, and fall habitat for elk and bison. However, some elk and bison winter in the areas of the Snake River bottomlands in the southern end of the park, Spread Creek, and some portions of Buffalo Valley (elk only), which are south/southeast and east of Moran, respectively.

TABLE 8: PLANT COMMUNITY TYPES — GRAND TETON NATIONAL PARK AND JOHN D. ROCKEFELLER, JR., MEMORIAL PARKWAY

Habitat	Acres
Wetlands (65,852 total acres)	
Marshlands	16,970
Wet Meadows	13,390
Open Water	35,492
Native Grasslands	8,093
Sagebrush Shrublands	56,843
Riparian and Aspen Woodlands	22,324
Conifer Forest	123,093
Agricultural Lands	5,610
Human Development	597
Bare Rock and Krummholz	58,640
Tundra	5,635
Total	**333,295**

Wetlands (Marshlands, Wet Meadows, and Open Water)

Marshlands

Marshland communities, which occur on approximately 16,970 acres in Grand Teton National Park, are considered to be in good condition (Haynes, pers. comm. 2003). As on the refuge, these stands develop to full stature each year depending on water availability. There is considerable residual material in marshlands from previous years' herbaceous growth under the bases of growing plants. There is very little invasion from nonnative invasive species in marshlands.

Wet Meadows

Grand Teton National Park contains approximately 13,390 acres of wet meadow habitats. Wet meadow communities are considered to be in good condition except for localized areas. A study by McCloskey and Weidner (2002) in three wet meadow sites may indicate that heavy ungulate use is negatively affecting plant reproductive capacity, flowering height, canopy cover, and percent bare ground in some wet meadow habitats. Kentucky bluegrass, a nonnative grass species, and oxeye daisy, a nonnative invasive species, occur in wet meadow habitats and are preferred forage for elk and other ungulates. They have low growing points and can spread by sending out stems that creep along the surface or under the surface of the soil and do not need to make seed to reproduce. Kentucky bluegrass and oxeye daisy can be grazed to the ground yet thrive and expand. Heavy grazing pressure on the edges of these meadows appears to be allowing both of these nonnative invasive species to outcompete native grasses and to expand their range (Haynes, pers. comm. 2003).

Open Water

Open water consists of stream and river channels and sites where standing water persists through most years, including pools, ponds, and lakes.

Native Grasslands

Native grassland communities cover approximately 8,093 acres in Grand Teton National Park. This category includes dry grassland meadows, high-elevation meadows, moist grass meadows, and forb meadows. A variety of grasses, sedges, and rushes are abundant. Depending on moisture and elevation, vegetation may be dense to open, and low to moderately saturated. Elk and bison graze this plant community extensively. Native grasslands are generally in good condition except for localized areas. Good condition native grassland habitats are dominated by native perennial bunchgrass species, with native woody species such as broom snakeweed and green rabbitbrush also present in some areas at low densities. Soil between grasses is not eroding on most native grasslands in the park, although heavily grazed areas have up to four times as much bare ground as areas that are lightly grazed.

Sagebrush Shrublands

Sagebrush shrubland habitat in Grand Teton National Park covers approximately 56,843 acres, and a high amount is in an advanced stage of succession. Sagebrush dominates the porous, cobbly flatland of the valley floor. Moist sagebrush sites occur on moist benches, floodplains, and hillsides with north and east exposure. For the most part, mountain big sagebrush dominates these sites, with three-tip sagebrush dominant in some areas. Silver sagebrush and shrubby cinquefoil are possible co-dominants in moist sites. Dry sagebrush sites occur on convex or even topography and generally south-facing exposed hillsides. Native perennial grasses and forbs grow at fairly high density (depending on moisture) in the spaces between sagebrush plants. Bare ground is often evident, particularly in dry sites. Elk and bison graze this plant community extensively.

Under natural conditions, sagebrush shrubland habitat would burn on average about every 25 years in this area (Houston 1973), and the fire-return interval is currently much lower than this. Late succession sagebrush communities are generally in good condition, with a diversity of herbaceous vegetation in the understories.

Riparian and Aspen Woodlands

Riparian and aspen woodlands occur on approximately 22,324 acres in Grand Teton National Park. Bands of cottonwood, willow, aspen, and spruce line the meandering courses of

the Snake River and its tributaries. Willows grow on floodplains and along streamsides. Tall willow species, usually more than 60 inches at maturity, are characteristic of dominant shrubs in the floodplain. Alder and birch may be present in some areas; undergrowth is varied. Aspen stands occur in upland areas. Other deciduous shrubs such as willow, serviceberry, chokecherry, rose, and gooseberry species in cottonwood stands also show a decline in height, density, and regeneration.

Elk browse on the aspen, willow, and cottonwood communities, especially in the spring. Bison may shelter in the cool river bottoms. Most willow habitats in the park appear to be in good to excellent condition. However, cottonwood communities along the Snake River are being encroached on by conifers due to a change in the flood regime since the Jackson Dam was built in 1910. Ungulate browsing and trampling is also impacting some cottonwood stands. In addition, the combined effects of fire suppression, ungulate browsing, and climate change are threatening to limit the ability of aspen stands to regenerate in the park (McCloskey and Sexton 2002).

Additional plant species commonly found in riparian and aspen woodlands include species of rushes, Muhly, horsetail, yellow salsify, wheatgrasses, mountain timothy, needlegrass, serviceberry, chokecherry, buffaloberry, bearberry honeysuckle, and bitterbrush.

Conifer Forest

Conifer forest habitat covers approximately 123,093 acres in the national park. Elk use the forest for cover and shelter, particularly from storms. The mountain slopes and the lower prominences rising from the floor of the valley are covered largely by conifers — limber, lodgepole, and whitebark pine, Engelmann spruce, sub-alpine fir, and Douglas-fir. The slopes of morainal ridges, and such mountain-peak remnants as Blacktail Butte, are also forested. The condition of this habitat type is considered to be good.

Agricultural Lands

Agricultural lands include 5,610 acres of historically cultivated lands in the Elk Ranch area in the northern part of the national park and the Kelly hayfields, Mormon Row, and Hunter-Talbot areas in the southern part of the park. Most of the fields were planted in the 1890s and early 1900s to produce pasture and hay for cattle in the winter months. An estimated 1,100 acres continue to be irrigated in the Elk Ranch area, and planted species include smooth brome, bluegrass, timothy, and occasionally alfalfa. The fields no longer cultivated are dominated by nonnative invasive plants such as the common dandelion, Canada thistle, and musk thistle.

Human Development

Development sites include areas where the natural environment has been modified as a result of human activities, typically to the point of eliminating most native vegetation. The 597 acres of development sites include lodges, subdivisions, airports, home sites, farm and ranch buildings, and paved highways.

PLANTS SPECIES OF SPECIAL CONCERN

There are 52 Wyoming plant species of special concern in Grand Teton National Park (see Table 9).

NONNATIVE INVASIVE PLANTS

As described for the National Elk Refuge, many nonnative plant infestations in Grand Teton National Park are a direct result of abandoned human developments. Much of the valley floor is now under NPS management, but these lands have not yet been restored. Twenty species of nonnative invasive plants are present, 12 of which are the same as on the National Elk Refuge (black henbane, common tansy, Canada thistle, Dalmation toadflax, diffuse knapweed, hound's tongue, musk thistle, oxeye daisy, perennial pepperweed, Russian knapweed, spotted knapweed, and yellow toadflax). Other species include Dyer's woad, leafy spurge, orange hawkweed, St. John's wort, sulfur cinquefoil, tamarisk, whitetop, and yellow hawkweed.

TABLE 9: WYOMING PLANT SPECIES OF SPECIAL CONCERN — GRAND TETON NATIONAL PARK

Scientific Name	Common Name	Scientific Name	Common Name
Adiantum pedatum	Aleutian maidenhair fern	*J. tweedyi*	Tweedy's rush
Agoseris lackschewitzii	Pink Agoseris	*Kelloggia galioides*	Milk Kelloggia
Aspidotis densa	Pod-fern	*Lesquerella fremontii*	Keeled bladderpod,
Astragalus terminalis	Railhead milkvetch	*L. paysonii*	Payson's bladderpod
A. shultziorum	Shultz's milkvetch	*Lemna valdiviana*	Pale duckweed
Athyrium distentifolium americanum	American alpine lady fern	*Listera convallarioides*	Broad-leaved twayblade
Carex leptalea	Bristly-stalk sedge	*Luzula glabrata hitchcockii*	Smooth wood-rush
C. cusickii	Cusick sedge	*Marsilea vestita oligospora*	Pepperwort
C. diandra	Lesser panicled sedge	*Najas guadalupensis*	Southern naiad
C. echinata	Little prickly sedge	*Orobanche corymbosa corymbosa*	Flat-top broomrape
C. laeviculmis	Smooth-stemmed sedge	*O. ludoviciana arenosa*	Louisiana broomrape
C. sartwellii	Sartwell's sedge	*Paeonia brownii*	Brown's peony
Draba borealis	Boreal draba	*Porterella carnosula*	Western porterella
D. crassa	Thick-leaved Whitlow-grass	*Potamogeton obtusifolius*	Blunt-leaf pondweed
Drosera anglica	English sundew	*P. friesii*	Fries pondweed
Dryopteris expansa	Spreading woodfern	*P. zosteriformis*	Flatstem pondweed
Eleocharis bella	Delicate spikerush	*Salix eriocephala mackenzieana*	Mackenzie's willow
Epipactis gigantea	Giant helleborine	*Senecio hydrophiloides*	Sweet-marsh butterweed
Equisetum fluviatile	Water horsetail	*Sparganium minimum*	Small bur-reed
Eriophorum viridicarinatum	Green keeled cotton-grass	*Spirodela polyrhiza*	Common water-flaxseed
E. gracile	Slender cotton-grass	*Stellaria crispa*	Crimped stitchwort
Gymnocarpium dryopteris	Oak-fern	*Torreyochloa pallida fernaldii*	Fernald alkali-grass
Heterotheca depressa	Teton golden aster	*Triteleia grandiflora*	Large flower triteleia
Hieracium scouleri	Scouler hawkweed	*Utricularia minor*	Lesser bladderwort
Huperzia selago	Fir clubmoss	*Viola pedatifida*	Western rough-leaved violet
Juncus filiformis	Thread rush	*Xerophyllum tenax*	Western beargrass

SOURCE: Fertig and Beauvais 1999.

THE JACKSON ELK HERD

Elk, as well as bison, play an important ecological role in Jackson Hole and are recognized as vital elements of the native biota that interact dynamically with their environment.

There is some indication that grazing by elk and bison can increase the productivity and stability of grassland systems, enhancing the nutrient content of grazed plants (Frank and McNaughton 1993; Singer 1995; Wallace 1996). They may contribute to new plant growth by distributing seeds, fertilizing by recycling nutrients through their waste products, and breaking up soil surfaces with their hooves and wallows (bison only). As prey and carrion, elk and bison provide sustenance to a host of carnivores and scavengers.

HISTORY OF ELK IN JACKSON HOLE

When Europeans arrived in North America, an estimated 10 million elk roamed the forests and plains from the east to the west coast (Seton 1953) and were categorized into six subspecies. By the early 1900s the elk herds of North America had dwindled to less than 50,000, most being concentrated in the greater Yellowstone ecosystem (Seton 1953).

Historically, elk probably persisted in Wyoming's mountain ranges longer and at higher numbers than in any other state (Murie 1951). The extensive mountain ranges surrounding Jackson Hole and Yellowstone National Park were among areas noted for particularly abundant elk (O'Gara and Dundas 2002).

The first homesteaders settled Jackson Hole in 1884. Prior to that time, trappers' journals are the only documentation of large elk herds in the valley. Some people believe that most of the Jackson elk herd wintered in the valley, despite its often severe winters. Others, based on a number of historical accounts, believe that some if not most of the Jackson elk herd did not winter in Jackson Hole (Allred 1950; Murie 1951; Cromley 2000). Early settlers told of seeing long lines of elk migrating into areas where snow depths were lower and forage more accessible, both west into the Teton Valley, and also east into the Green River valley and continuing south to the Green River basin and farther south to the Red Desert, as shown on the "Possible Historical Elk Migration" map (Cromley 2000; C. Anderson 1958). The following discussion describes the basis for this belief in more detail.

Historical reports indicate that the herd summered in the higher country surrounding Jackson Hole and as far north as southern Yellowstone National Park, and at the onset of winter moved into Idaho, the Star Valley, the upper Gros Ventre Basin, and South Park in southern Jackson Hole (Murie 1951). Some elk continued through the Gros Ventre Basin into the Green River area and others through and beyond the Hoback Basin. In severe winters elk were reported in parts of the Red Desert in southern Wyoming.

Although there are many anecdotal reports about migration, there is no direct evidence to substantiate these reports to say unquestionably that elk in Jackson Hole migrated to the Green River Basin or the Red Desert (G. F. Cole 1969; Boyce 1989). Cromley (2000) summarized a large number of historical accounts and biological information that indicates migration did occur, and several biologists who spent many years studying elk in the Jackson Hole area came to similar conclusions (Allred 1950; Murie 1951; C. Anderson 1958; B. L. Smith, pers. comm. 2004). What is known is that by the late 1800s (Saylor 1970) human settlement and conversion of winter range to use by domestic livestock shortened migration routes and caused elk to remain in the climatically severe and less populated Jackson Hole. Competition between starving elk and livestock for haystacks, combined with excessive hunting, trapping of elk for shipments to the east, and poaching (including "tusk" hunting) also influenced elk numbers and movements (Craighead 1952; Cromley 2000; F. K. Nelson 1994; Blair 1987).

A number of severe winters in the late 1800s and early 1900s meant greater depredation losses and high mortality among the Jackson elk herd. In 1909 the people of Jackson appealed to the

Map

Possible Historical Elk Migration

government for help, and the Wyoming legislature appropriated money for elk feed. Additional money was sent in 1911 by the U.S. Congress, which also sent biologist E. A. Preble to investigate the situation. His subsequent report (Preble 1911) was instrumental in the establishment of the National Elk Refuge in 1912. The first winter census in Jackson was conducted in 1912, and showed about 20,000 elk residing in Jackson Hole and the Hoback River drainage.

THE NATIONAL ELK REFUGE

Elk are the primary wildlife species occupying the National Elk Refuge, and their conservation is the reason the refuge was established. The creation of Yellowstone National Park in 1872 and the National Elk Refuge in 1912 were crucial in terms of protecting elk and their winter ranges in the greater Jackson Hole area. Supplemental elk feeding was initiated to mitigate the loss of natural winter range and impacts to livestock operations. By the 1930s the feeding program had successfully stabilized the elk population. The creation of Grand Teton National Park in 1929, as well as its expansion in 1950, consolidated and protected elk summer ranges within this area.

The initiation of feeding in any given year depends on elk numbers, the timing of migration, winter temperatures, snow depths, and the accessibility of standing forage. Non-feeding years have occurred irregularly and infrequently. Since the refuge was established in 1912, there have been nine years when no feeding was provided. The last such winter was in 1980–81.

Elk were fed hay during at least a portion of most winters from 1912 to 1975. In 1975, after several years of testing, a switch was made to alfalfa pellets (Smith and Robbins 1984). Biologists evaluate several factors to determine whether feeding is needed, and if so, when it should begin and end. Since 1912, the period of supplemental feeding has ranged from "no feeding" to a maximum of 147 days. Elk currently are fed an average of 70 days annually.

HUNTING

Hunting is the primary management tool used to control the size of the Jackson elk herd and its main source of mortality. The first hunting season on the National Elk Refuge occurred in 1943, but hunting did not become an annual event until 1955. When Grand Teton National Park was expanded in 1950, fears of a burgeoning elk population resulted in the addition of language in the legislation to allow an elk reduction program in the park east of the Snake River when it was considered necessary for management of the herd.

From 1998 to 2002 about 2,300 to 3,300 elk were harvested annually, resulting in approximately 16% of the pre-hunt Jackson elk herd population being removed each year. The 2005 harvest of 1,776 elk removed about 14% of the estimated 13,000 elk in the herd. Hunting on the refuge and the elk reduction program in Grand Teton National Park, along with WGFD harvests in Bridger-Teton National Forest and on non-federal lands, take place from mid-October to mid-December. These methods are used to bring total elk numbers as close as possible to the WGFD herd objective of 11,000. Over the last 20 years harvests in the park have contributed about 25% to the total harvest, and those on the refuge, about 10%. The remaining 65% of the harvest takes place mainly in the national forest.

ELK NUMBERS IN JACKSON HOLE AND ON THE REFUGE

The most recent modeled population estimate for the Jackson elk herd was 12,855 for 2005–6 (Brimeyer, pers. comm. 2005). The herd was estimated to be as high as 19,657 elk in the mid 1990s, but annual harvests have gradually reduced it to current levels, within 2,000 animals of the WGFD objective of 11,000.

In winter 2005–6 the portion of the herd that wintered on refuge lands numbered approximately 6,800. The number of elk on refuge feedgrounds from 1991–92 to 2005–6 has been about 7,100, although numbers have ranged from 3,300 to 11,000. The remainder of the herd winters in Grand Teton National Park, on state feedgrounds, and on native winter range. Native winter range outside the refuge and the park includes Bridger-Teton National Forest for the most part, plus a small percentage of private lands. Estimates of elk numbers on native winter range vary from 3,600 to 9,400. The average

number of elk on native winter range from 1989 through 2002 has been about 5,500, according to estimates based on WGFD computer modeling. Herd objectives for the native winter range are 2,900 to 5,200, or 3,700 on average. The park receives more snow and supports relatively fewer wintering elk than does the refuge. An average of 536 elk (a range of 206 to 1,299 elk) have wintered in the park (WGFD post-hunt classification counts for 1989–2003). Herd objectives are for an average number of elk in the park of about 356, with numbers ranging between 137 and 857. Factors influencing winter elk distribution include greater snow depths and smaller amounts of available forage in the park (Farnes, Heydon, and Hansen 1999; Hobbs et al. 2003), the attraction of elk to irrigated and cultivated lands on the refuge, and many years of supplemental feeding on the refuge and WGFD feedgrounds (B. L. Smith 2001).

HABITAT AND FORAGE

Elk are versatile generalists (Houston 1982) and use a mixture of habitat types in all seasons. Having evolved as an ecotone species in cold, temperate climates, elk retain features adaptive to both wooded and plains environments; they prefer open areas (Geist 1982) but also use dense coniferous forests for shelter (Clark and Stromberg 1987).

G. F. Cole (1969) found that elk distribution in winter was related to elevation, suitable forage, distribution of other elk, human disturbance, and weather variables. Elk can cope with a wide variety of deep and crusted snow conditions (Barmore 1980).

Classified as intermediate feeders, elk are less selective than either browsers or grazers (Baker and Hobbs 1987). Forage availability during winter (Jenkins and Wright 1988), and differences in nutritive value during other seasons are important influences on food choices (Merrill 1994; Cook 2002). In winter elk primarily use open grassland, preferring cured grasses when these are available, but using browse species as well (Murie 1951); they may also be found in forests where they prefer shrubs (G. F. Cole 1969). In spring they use relatively open grassland with some timber, and in late summer and fall they use a variety of grassland and forest types.

Grass comprises most of the diet in all seasons. G. F. Cole's (1969) examination of the Jackson herd found that forage proportions within the average yearlong diet were 51% grass and grasslike plants (sedge and rush species), 26% forbs, and 23% shrubs. Shrub species included willow, narrowleaf cottonwood, aspen, and silverberry.

Supplemental feeding bolsters the nutritional status of 68% to 91% of the Jackson herd in most winters and staves off weight loss. Elk on native winter range may lose from 5%–15% of body mass in an average winter (Wisdom and Cook 2000) and 25% or more in severe winters. Various mechanisms, such as reduced activity levels and metabolic rates, insulating winter fur, behavioral adaptations, and catabolism of body fat, allow ungulates to cope with the energetic costs of winter and avoid death when supplemental feeding is not available (Mautz 1978).

Bailey (1999) collected empirical data on fat reserves and overwinter body condition in elk from the Jackson herd over two winters (1996–1997 and 1997–1998) and found that both free-ranging and supplementally fed elk were in good to excellent condition. He noted that he did not collect animals that appeared unhealthy, hence the study may not have been entirely representative of the condition of the Jackson elk herd.

DISTRIBUTION AND MOVEMENTS

Adaptable foragers with a mixed diet, elk frequent a variety of habitats and move about seasonally. While they make short movements in the fall after the first frosts occur, they generally remain on summer range until heavier snow covers forage, stimulating migrations to lower wintering areas. A few elk forgo migration and winter on wind-swept, more exposed parts of their summer range.

Elk use extensive spring, summer, and fall ranges to the north, west, and east in Grand Teton National Park, Bridger-Teton National Forest (including the Teton Wilderness), and as far away as southern Yellowstone National Park (Smith and Robbins 1994). According to Boyce (1989), these ranges provide nearly unlimited supplies of

forage. Smith later estimated that summer distribution of the Jackson herd is approximately 30% Grand Teton National Park, 30% Gros Ventre, 25% Yellowstone National Park, and 15% Teton Wilderness (B. L. Smith 2000).

Approximately half of the elk wintering on the refuge summer in Grand Teton National Park (Smith and Robbins 1994); in some years about 200 elk summer on the refuge. Fall migrations begin in October or November and end in mid-December (Smith and Robbins 1994). Elk move southward from their summer ranges toward the National Elk Refuge, channeled in some places by steep terrain and lakes (see the "Jackson Elk Herd Unit and Fall Migration Routes" map).

Some Jackson elk move hardly at all because their ranges are nearer the refuge, while others cover up to 60 miles between summer and winter ranges, probably farther than other elk herds in North America (Preble 1911; Murie 1951; Boyce 1989). Migrations may occur over periods of a few days to several weeks.

Winter range includes areas north of Ditch Creek, the Spread Creek-Uhl Hill areas, the Buffalo River valley, the Gros Ventre River and Snake River floodplains, as well as public lands east of the National Elk Refuge and Grand Teton National Park. Variation in annual snowfall affects elk distribution; for example, when snowfall is particularly heavy, a larger portion of the herd can be found wintering on the refuge and utilizing WGFD feedgrounds, three of which are distributed along the Gros Ventre River drainage. Conversely, in years of little snowfall, fewer elk migrate as far south as the refuge and more of them remain on native winter range.

Spring migrations to calving and summer range begin when the snow recedes and new vegetation appears, usually in April and May (G. F. Cole 1969). Hazing has been used to encourage animals inclined to remain on the refuge to move northward in the spring. Several studies have been conducted to determine seasonal distribution of elk that wintered on the National Elk Refuge. These studies showed elk were dividable into four herd segments: the Grand Teton (48%), the Yellowstone (28%), the Teton Wilderness (12%), and the Gros Ventre River drainage (12%) (Smith and Robbins 1994).

Although many elk migrate to "traditional" summer ranges, some individuals are more exploratory and move beyond areas known to them or their mothers (Murie 1951). Radiotelemetry studies provide evidence of long-distance movements as far away as the Wind River drainage and Targhee Creek, 15 miles from West Yellowstone, Montana. Movement patterns of elk in the Gravelly-Snowcrest Mountains of southwestern Montana revealed interchange between that population and adjacent Montana, Idaho, and Wyoming elk populations, including Grand Teton National Park and the National Elk Refuge (Hamlin and Ross 2002). Idaho Fish and Game monitoring studies have also documented mule deer and elk movements (Huffaker, pers. comm. 2005 for mule deer; Brown 1985 for elk) between eastern Idaho and western Wyoming.

BEHAVIOR AND SOCIAL INTERACTIONS

An elk avoids predators by "rapid and sustained flight while trying to disorient pursuers by various tricks and, thereby to lose itself in vast expanses" (Geist 2002). For calves to survive, they must be large at birth and grow quickly (Geist 1986, 1991, 2002). Elk feed on grasslands and in open areas, but they also rely on wooded areas for cover and hiding newborns (Geist 2002).

Male and female elk are ecologically separated throughout much of the year due to differing adaptive strategies: females favor security, while large, quickly growing young males focus on food intake to maximize body size and antler growth (Geist 1982, 2002). Although considered herd animals, group size fluctuates widely (Murie 1951). In the spring elk cows may be alone, or in small groups of two or three when calves are born. When calves can move well, larger groups of cows, calves, and young bulls form. During the summer cows, calves, and young bulls are found in mixed-sex groups varying in size from 20 to 300 elk or more. At the same time, older bulls are often alone, but some may also form small groups. During the fall rut, cows and calves are found in smaller groups that can be managed by one mature bull. Younger bulls sometimes band together, but some remain near the herd and are able to join groups later in the season. Elk again form large groups during the fall migration and may maintain large herds throughout the winter,

Map

Jackson Elk Herd Unit and Fall Migration Routes

depending on the weather and forage availability. Elk may also be found as individuals, in small groups, or in larger herds at any time of the year (Murie 1951).

Elk respond to hunting by moving from open to closed areas or by remaining in areas closed to hunting if they are there when hunting begins in the fall (Martinka 1969).

BREEDING, CALVING, AND AGE AND SEX RATIOS

The breeding season or rut begins in September and lasts through October. The rut changes elk social structure. Older bulls join the cows, and younger animals and groups become smaller. During the rut a breeding bull attempts to sequester and maintain control of a herd of 6 to 30 or more individuals, including 10 to 15 cows (Murie 1951). While bulls as young as two or three may be sexually mature, they are unable to compete successfully against older, heavier males. The largest bulls in prime condition (usually six to eight years old) are the most successful at gathering harems and fending off challengers.

Based on winter counts from 1989 through 2003, there have been an average of 20 mature bulls per 100 cows. Ratios from 2001 to 2005 ranged from 18 to 25 bulls per 100 cows.

For bulls, fending off rivals with chases and sparring matches, and herding females and keeping them in a guardable harem, are energetically demanding activities. Bulls also expend energy and time with attention-getting activities such as urine spraying, wallowing, bugling, and vegetation horning (thrashing vegetation with antlers). Mature bulls eat less than usual during this period, entering 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). When the mating season ends, harems disband, cows rejoin their herd, and bulls form bachelor groups.

Most calving takes place during the transition between winter and summer ranges (see the "Elk Calving Areas" map). After a gestation period of about 8.5 months, elk give birth in late May to early June. Although twins occur occasionally, most cows give birth to a single calf (Murie 1951).

Cow elk use various habitats for calving but seem to prefer sagebrush habitats on gentle slopes near the forest edge and close to water (Johnson 1951; C. Anderson 1958). They seek solitude when calving and habitat that will provide cover to hide newborns from predators. High mortality occurs in the first two months of life because calves have not yet acquired the stamina and speed to escape coyotes, bears, or other predators. An estimated 70% of all calves do not survive beyond eight or nine months (USFWS 2002a). While elk often return year after year to the same calving areas, snow levels can alter this behavior.

During the last 15 years, calf-to-cow ratios on the refuge have averaged 20 calves per 100 cows. Calf-to-cow ratios in the Jackson elk herd have averaged 25 per 100 cows, ranging from 20 to 31 per 100 cows. Reasons for lower ratios in some years are unknown but may have included increased harvest of female elk, predation, and/or drought (WGFD "2002 Annual Big Game Herd Unit Report").

OTHER FACTORS INFLUENCING ELK NUMBERS, DISTRIBUTION, AND HEALTH

AMOUNT, QUALITY, AND AVAILABILITY OF WINTER AND TRANSITIONAL RANGE

Seasonal availability of suitable habitat profoundly affects the distribution and health of many species, including elk. As winter approaches, ungulates migrate to lower elevations and gradually alter their diets, adding plant species of decreasing palatability and nutritional quality as preferred foods become less available (Leopold 1933; Halfpenny and Ozanne 1989).

The amount, quality, and availability of winter and transitional range depend on temperature and precipitation, both of which are highly variable. Halfpenny and Ozanne (1989) cited temperature, snow depth, snow density, duration of winter, and lateness of spring as critical factors affecting moose survival in Grand Teton National Park.

According to Halfpenny and Ozanne (1989), ungulates generally start migrating when snow

Map

Elk Calving Areas

depth reaches mid-calf height on the leg of a mature animal, or 2–3 inches snow-water equivalent (Farnes, Heydon, and Hansen 1999). During 1968–81 northern range bison and elk in Yellowstone National Park generally foraged in areas with less than 6 inches snow-water equivalent, although a snow depth of 1–2 inches snow-water equivalent was enough to initiate migration by at least some of the herd (Farnes, Heydon, and Hansen 1999). For the purposes of this planning process, a snow-water equivalent measure of 6 inches was used as the threshold between usable and unusable winter grazing habitat (Hobbs et al. 2003). Snow crusting events that reduce access to forage would lower this threshold.

EXISTING AND POTENTIAL DISEASES

Diseases for both elk and bison are described in this section since they tend to be similar in both species. Diseases could affect the numbers, distribution, and health of the elk and bison herds in several ways, as summarized below. Infectious diseases in the Jackson elk herd are also of concern because of potential transmission to domestic animals (mainly cattle and horses).

Tests indicate that three documented viral microparasites — bovine viral diarrhea, parainfluenza virus-3, and bovine respiratory syncytial virus — are present in Jackson Hole elk and bison. Infrequent clinical disease consistent with bovine viral diarrhea has been observed in Jackson bison, but its cause is unknown. The contribution of these viruses, if any, to mortality related to respiratory bacteria or septic conditions like hemorrhagic septicemia is unknown. Because these diseases do not appear to be of major concern in wildlife, they are not likely to result in detectable impacts from elk and bison management efforts (Disease Expert Meeting 2002).

Vesicular stomatitis, an undocumented viral microparasite, is not analyzed in detail because no impacts are likely to be associated with this disease in elk (Disease Expert Meeting 2002). Foot-and-mouth disease and rinderpest are also not analyzed in detail because there are no records of these undocumented viral microparasites in the United States, and if either became established in this country, the national response would be major and very aggressive (Disease Expert Meeting 2002).

Documented Bacterial Microparasites — Bovine Brucellosis, Septicemic Pasteurellosis, Necrotic Stomatitis

Bovine Brucellosis

Elk, bison, and cattle, as well as many other mammals, are susceptible to infection by the bacteria *Brucella abortus*, which causes brucellosis (Davis 1990; Thorne 2001). The Jackson bison and elk herds are chronically infected with the disease. Brucellosis has been present in elk on the National Elk Refuge since at least 1930 (Murie 1951), and even though bison were declared brucellosis free in 1968 after several years of testing, samples collected in the late 1980s revealed that they had been reinfected either by the mid-1970s when they began wintering on the refuge, or possibly after they discovered the feedgrounds about 1980.

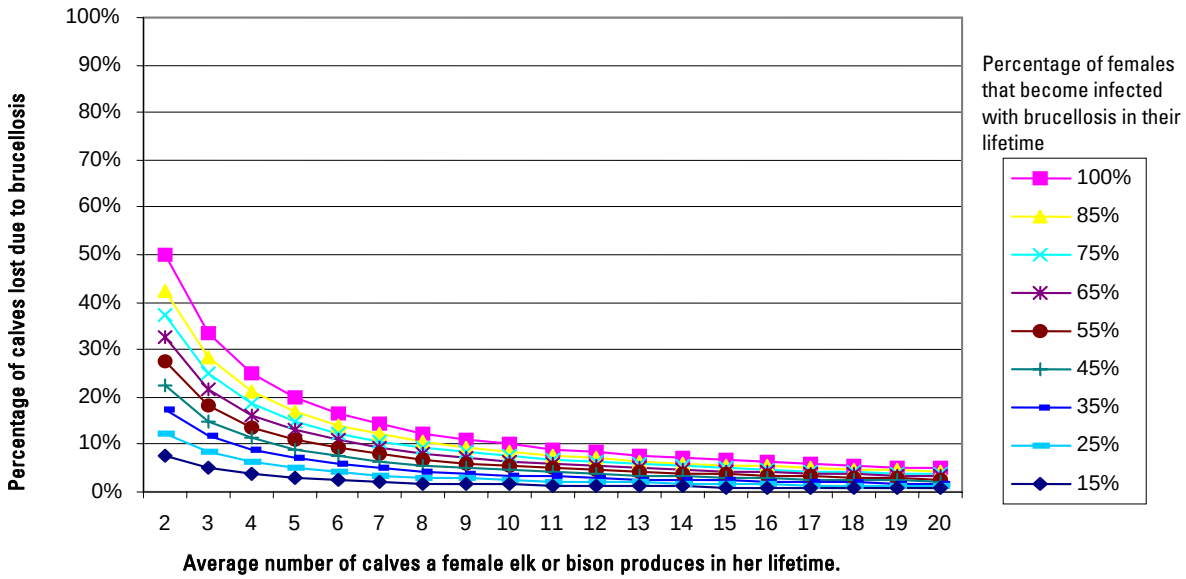
Although both sexes can contract the disease, transmission of brucellosis occurs by means of pregnant females when susceptible animals contact and ingest the bacterium *B. abortus* from infected aborted fetuses, fetal fluids, fetal membranes, or vaginal discharges (GYIBC 1997; Thorne 2001). Abortion is the characteristic sign of acute brucellosis, and there is no feasible treatment or cure for the disease (GYIBC 1997). Studies indicate between about 50% of female elk and 90% of female bison abort their first calf after infection (Thorne, Morton, and Ray 1979; Davis et al. 1990, 1991), but second and third pregnancies following infection tend to progress normally. This means that the higher the number of calves produced by females, on average, the smaller the impact brucellosis will have on overall calf production in a population. For example, if a female produces an average of 10 calves over her lifetime, and if 100% of all females become infected with brucellosis at some point in their lifetime, the estimated loss in calf production in the herd would be approximately 10%.

Opportunities for brucellosis transmission among bison are high because animals tend to congregate. For example, the prevalence of brucellosis in infected free-ranging bison herds varies from 25% in Wood Buffalo National Park in

Canada (Tessaro, Forbes, and Turcotte 1990) to 70.3% in Yellowstone National Park ranges (Roffe, Rhyan, et al. 1999). In the Jackson bison herd, which is much smaller than these other herds, winter feeding does occur, and measurements of seroprevalence in the herd range from 58% (Clause, WGFD, unpubl. data) up to 84% (Cain et al. 2001; GTNP unpubl. data). Therefore, brucellosis prevalence in bison herds can be high with or without winter feeding, and regardless of herd size. Still, winter feeding may exacerbate the infection by increasing the chance of contact with an aborted fetus or birth site (Disease Expert Meeting 2002). Meyer and Meagher (1995) contend that the primary route of transmission among bison is through the milk to calves, rather than from aborted fetuses. However, chronically infected herds still have abortion rates in the single digits (Herriges et al. 1989; Peterson, Grant, and Davis 1991a, 1991b; Smith and Robbins 1994). The frequency of brucellosis-induced abortions in the Jackson herd is not known (GYIBC 1997), although there is no evidence that this is negatively affecting the growth rate of the bison herd.

Brucellosis transmission among elk is generally thought to be largely influenced by high concentrations of elk associated with winter feeding programs. Without winter feeding, Wyoming elk in areas adjacent to feedgrounds have an average prevalence of 2.3% (1990–2005) of the population, whereas refuge elk average 17% (1997–2005, excluding 1999; WGFD unpubl. data). No elk populations outside the Greater Yellowstone Area are known to be infected with brucellosis. This is because elk under normal (non-feedground associated) circumstances isolate themselves during birth and clean up birthing products at the site (Thorne 2001). Also, birth usually takes place in the spring. However, like bison, both experimentally infected (Thorne et al. 1978) and naturally infected elk (Thorne, Morton, and Ray 1979; Thorne 2001) are known to abort as a result of brucellosis and can do so in winter while supplemental feeding is being provided. Transmission risk may also be increased if elk aborting during earlier stages of pregnancy behave differently from elk near the end of their pregnancy by not seeking seclusion. During a study of Strain 19 vaccine efficacy (Roffe et al. 2004), the researchers noted that infected elk aborting earlier in their term rarely segregated from other elk, whereas normally calving and stillbirthing elk did (Roffe, pers. comm. 2006). Brucellosis-induced abortions of elk calves in the

FIGURE 2: ESTIMATED PROPORTION OF ELK AND BISON CALVES THAT COULD BE LOST DUE TO BRUCELLOSIS
Based on the Average Number of Calves a Female Produces in Her Lifetime



NOTE: These values are based on the fact that a female usually aborts her first calf following infection with brucellosis, and subsequent calves are born normally. Therefore, on average, each infected cow may lose one calf.

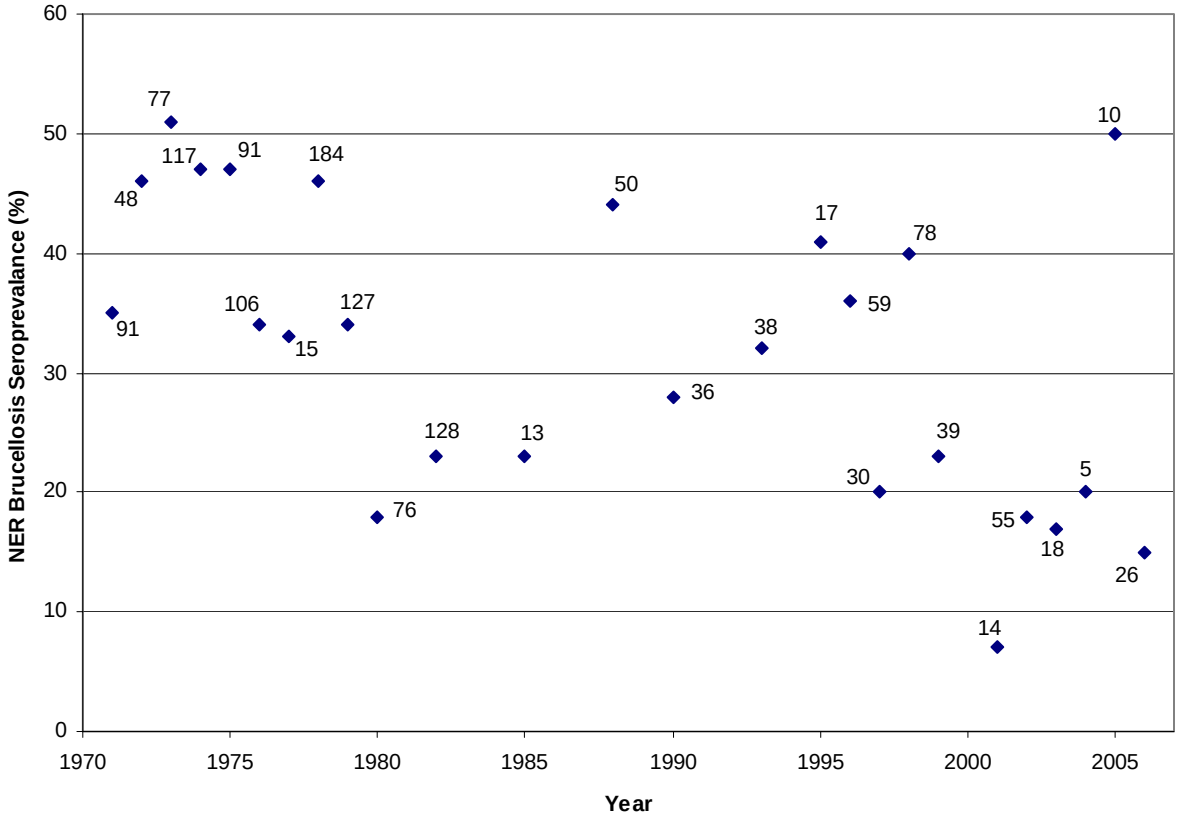
Jackson elk herd are estimated to account for 5%–7% calf loss (Oldemeyer, Robbins, and Smith 1993). A single brucellosis-induced abortion on a crowded elk feedground could expose many elk to brucellosis (Thorne 2001). Consequently, brucellosis in elk is primarily a problem among elk that utilize winter feedgrounds (B. L. Smith 2001; Thorne 2001).

Transmission of brucellosis from elk to cattle (Thorne, Morton, and Ray 1979) and from bison to cattle (Flagg 1983) has been documented in confined spaces, but rarely in nature. One cattle herd in eastern Idaho recently contracted brucellosis from infected elk (Hillman 2002). Elk in Wyoming presumably infected a cattle herd in Sublette County in 2003 and at least one of two Teton County herds infected in 2004. Transmission from elk or bison to cattle would likely only occur when (1) infected pregnant elk or bison feed during the winter with cattle on a cattle feedground (Thorne 2001) and (2) cattle contact an aborted fetus and/or fluids, or an environment contaminated by infected birthing material during the period when abortions or birth may occur (for elk, February through June; for bison, mid-December through mid-June). As previously stated, transmission of brucellosis from elk to cattle is very unlikely during normal parturition because elk are meticulous about cleaning up their birth sites (Thorne 2001). Also, elk normally tend to isolate themselves when giving birth, further reducing the chance of cattle coming in contact with any contaminated material.

The Greater Yellowstone Interagency Brucellosis Committee has identified the following factors for the risk of brucellosis transmission from elk or bison to livestock (GYIBC 1997):

1. Separation in space and time reduces the potential for transmission. In addition to management separation, separation may

FIGURE 3: PERCENTAGE OF BRUCELLOSIS-POSITIVE ELK TRAPPED ON THE NATIONAL ELK REFUGE, WINTERS 1970–71 THROUGH 2005–6



NOTE: The total number of elk tested each year is shown adjacent to each data point. Sample sizes varied from less than 30 in some years (1977, 1985, 1995, 1997, 2001, 2004, 2005, and 2006) to 184. Data from small samples should be interpreted with caution because the information is too limited to provide confidence that the information is accurate. These data do not represent prevalence in the Jackson elk herd as a whole.

occur as a result of differences in behavior, habitat selection, geographic features, and distribution in response to weather.

2. Risk of *B. abortus* transmission increases as the number and density of infectious animals in the host population increases.
3. Risk of *B. abortus* transmission increases as more susceptible animals associate with infectious animals.
4. The risk of transmission is affected by environmental factors. Outside its host, the *Brucella* organism has limited viability, although discharges will remain infectious for longer periods during cold weather. Direct sunlight quickly kills the organism. Scavenging by other wildlife reduces the occurrence of infectious tissues, but scavengers may also transport infected tissues.
5. The risk of *B. abortus* transmission from elk or bison to cattle is almost certainly confined to contamination by a birth/abortion event by adult females.
6. The risk of transmission may be reduced by vaccination, contraception, and herd size management.
7. Susceptibility varies with species, and some individual animals may be naturally resistant to infection.

Recent studies have added to information available on transmission potential related to the length of time the bacteria and/or aborted fetuses remain in the environment. Preliminary findings from 2001–3 studies in the Greater Yellowstone Area indicated that the bacteria persisted in the environment for varying periods depending on time of year and sun exposure (NPS et al. 2005). A study that simulated live bacteria with bison fetuses immersed in *B. abortus* strain RB51 vaccine and caged to protect them from scavengers found that the bacteria persisted longer in shady locations, on the bottom side of carcasses, and longer in February (from a few days to as long as 80–90 days) compared to mid-May (up to 20–30 days). UV-B radiation and temperature were environmental factors directly affecting bacterial survival.

Another study was done to determine how long it took for bison fetuses to be scavenged and disappear from the environment. Uninfected fetuses were placed both inside and outside Yellowstone National Park in 2001 and only in areas outside the park in 2002 and 2003. The flash from a motion-sensing camera that monitored half of the 2001 sites significantly deterred scavenging. On average, scavengers removed fetuses within 15 days but a few were not scavenged and remained until they decomposed 50 days later. In 2001 average disappearance rates were faster within the park than in adjacent areas, possibly due to human disturbance outside the park and differences in scavenger distribution and abundance (NPS et al. 2005).

The primary factor to consider when examining the risk for transmission of brucellosis from elk or bison to livestock is whether or not these species come into contact with each other or infectious birthing materials. In order to contract brucellosis, it is usually necessary for susceptible cattle to be present, or to arrive at the place where infected bison or elk abort or give birth. Therefore, any management alternative that reduces the chance for contact between bison or elk and livestock will reduce the risk to livestock.

No reliable data exist regarding exactly how the risk of intra- and interspecific brucellosis transmission decreases as a function of decreasing *B. abortus* prevalence in the bison or elk herd (GYIBC 1997), so a quantitative analysis of risk was not performed. Seroprevalence serves as a useful index to actual *B. abortus* prevalence in these populations.

In general, brucellosis prevalence in bison and elk is more dependent on the intensity of a winter feeding program than on numbers of animals. When elk and bison are on feedlines, densities are much higher than what would be found on native winter ranges. Therefore, the primary management actions that could be implemented to reduce prevalence and transmission of brucellosis in these populations include greater dispersion of bison and elk through reductions in numbers or increasing movement and distribution. Vaccinating elk, bison, and cattle; providing forage in elevated feeders; and testing and removing seropositive bison and elk could further reduce prevalence and the potential for

transmission. In areas where both elk and bison are present, and there is no supplemental feeding program, interspecies transmission is low (Ferrari and Garrott 2002).

Septicemic Pasteurellosis

Pasteurellosis refers to several localized and systemic disease conditions of wild and domestic birds and mammals caused by various strains of *Pasteurella* (Thorne et al. 1982). The septicemic form of the disease is sometimes confused with hemorrhagic septicemia, a highly fatal disease of cattle and other ruminants.

Strains of *P. multocida* may be recovered from healthy elk, and if the elk are exposed to stressors such as infection by some other disease agent, or factors such as poor forage, overcrowding, or inclement weather, clinical disease may develop (Thorne et al. 1982; Thorne et al. 2002). Once the clinical disease develops, the infected animal sheds great numbers of *P. multocida* in saliva and feces. It is transmitted by direct contact with feces, saliva, or aerosols of clinically infected animals. In acute cases, death is often the first clinical sign observed (Thorne et al. 1982).

Periodic outbreaks of septicemic pasteurellosis have occurred in the elk population on the National Elk Refuge in recent years, and there is some indication that increased stress (nutritional or environmental) increases susceptibility and may contribute to disease outbreak (Franson and Smith 1988; Thorne et al. 2002). The epidemiology of septicemic pasteurellosis in elk is not well understood, and it is not clear if the initiation of outbreaks is density dependent (B. L. Smith 2001; Disease Expert Meeting 2002). Outbreaks on the refuge have been related with extreme or harsh weather events (Franson and Smith 1988; B. L. Smith 2001). During the winter 1985–86 an outbreak occurred following several days of windy, rainy conditions, and then warm weather, which caused extremely muddy conditions. Mortality from this disease has been low on the refuge to date (B. L. Smith, pers. comm. 2003), and deaths from even the largest outbreak, which killed 160 elk in 1992–93, represented a negligible loss (1.8%) of elk wintering on the refuge (Smith and Anderson 1998).

Necrotic Stomatitis and Footrot

Necrobacillosis refers to an array of diseases caused by the bacterium *Fusobacterium necrophorum*, of which necrotic stomatitis is one (Thorne et al. 2002). The bacterium inhabits the gastrointestinal tract and is excreted in feces. Disease occurs after a break in the skin or mucosa caused by abrasion or laceration allows the bacteria to invade. Necrotic stomatitis occurs in elk when punctures in the soft tissue of the mouth or throat, caused by eating coarse woody vegetation or grasses with large awns and seeds, become infected with *F. necrophorum* (Leighton 2001). Murie (1951) discovered that the primary cause of necrotic stomatitis on the refuge during the 1920s–1940s was the poor quality of grass hay being fed. Necrotic stomatitis should be considered a traumatic disease associated with consumption of poor forage rather than strictly a bacterial disease. In serious cases the infections become chronic, and the animals may lose teeth and eventually die of starvation. Bison are likely susceptible to other forms of necrobacillosis such as foot rot, but the thorough review of disease literature conducted for this document found no documented cases of necrobacillosis or necrotic stomatitis in bison; therefore, the analysis in this document focuses on elk.

Currently there are only two to three elk mortalities per year from necrotic stomatitis on the refuge (Disease Expert Meeting 2002). Using high-quality feed (alfalfa pellets), improving native winter range, and reducing elk densities have nearly eliminated the disease on the refuge.

In winter 2005–6 an outbreak of footrot occurred among refuge elk during the feeding period. Compacted, icy snow conditions and feedgrounds, which are typically heavily contaminated with feces despite management attempts to feed in clean areas, likely contributed to elk susceptibility. Of total refuge mortalities from November 1, 2005, to April 18, 2006, 36% (48 of 220 elk) were associated with footrot.

Documented Macroparasites — Psoroptic Scabies, Helminths, and Lungworms

Psoroptic Scabies

Mites of the genus *Psoroptes* cause psoroptic scabies in a wide range of wild and domestic ruminants. Psoroptic scabies, also called psoroptic

mange, is widespread in Wyoming among free-ranging populations of desert bighorn sheep, Rocky Mountain bighorn sheep, white-tailed deer, and elk, and it occurs in the Jackson elk herd (B. L. Smith 1985, 1998), where 4%–5% of males may be infected (Disease Expert Meeting 2002). Approximately 65% of bull elk that die on the refuge have been afflicted with scabies (Smith and Roffe 1994); however, not all animals exhibit clinical disease from infection with the mites.

Psoroptic mites are spread through direct contact, and prevalence in a herd is likely density related (Disease Expert Meeting 2002). Mature bull elk are more susceptible to psoroptic mites due to increased stress resulting from energy expended while rutting, poor nutrition following the rut, cold weather, crowding, and other diseases (Samuel, Welch, and Smith 1991). In severe cases skin damage from the mites may result in the animal's inability to maintain body core temperature, potentially leading to hypothermia (Samuel, Welch, and Smith 1991). In conjunction with other infections, psoroptic scabies may be a contributing factor, resulting in death in some cases (Franson and Smith 1988).

Murie (1951) described scabies as a common winter phenomenon, affecting about the same proportion of the Jackson elk herd each winter but not an important factor in elk losses during average winters since many elk recover once spring and new green forage return. The condition affects individuals in poorer physical condition and with lowered resistance, and scabies may exacerbate the effects of other diseases. Murie considered the best precaution against scabies to be avoidance of overstocking and maintenance of "a good, productive elk range" (Murie 1951). Smith believed that physiological stress and malnourishment during the rut, not summer or winter nutritional status, was the most important factor in scabies-related mortalities (B. L. Smith 1985).

During the winter of 2001–2, 61 mature bull elk on the refuge were classified as having scabies during a February survey; five bulls with clinical scabies had died earlier in the season. This amounted to 5.8% of mature bulls on the refuge. Nineteen (1.9% of branch-antlered bulls on the refuge) died during the winter 2005–6 (NER files).

Helminths and Lungworms

The lungworm, *Dictyocaulus viviparus*, is thought to be the most detrimental parasitic helminth (parasitic roundworm or tapeworm) known to occur in the Jackson elk herd (Smits 1991; Worley 1979). Other gastrointestinal parasites and helminths are only incidental in the Jackson elk and bison herds, and the effects on elk and bison are expected to be minimal.

Loads of lungworms in elk can be high, and lungworm infection is density dependent (Disease Expert Meeting 2002). Winter-feeding would contribute to high elk density, and lungworm infections would be greatest under winter-feeding conditions because lungworm larvae are shed in the feces. Elk are infected when they accidentally ingest larvae with vegetation (Thorne et al. 2002). Lungworm infection may lead to secondary infections and in conjunction with other stress factors such as severe weather, poor nutrition, forage depletion, or tick infestations may result in death (Thorne et al. 2002).

Undocumented Bacterial Microparasites — Bovine Tuberculosis, Bovine Paratuberculosis, Anthrax

Bovine Tuberculosis

Bovine tuberculosis, which is caused by the bacterium *Mycobacterium bovis*, has a worldwide distribution, and most mammals, including wild and domestic ruminants and humans, are susceptible (Clifton-Hadley et al. 2001). It has been reported in bison, elk, moose, mule deer, and white-tailed deer (Hadwen 1942; Disease Expert Meeting 2002; Schmitt et al. 1997; Choquette et al. 1961; Broughton 1987). Free-ranging carnivores such as wolves, coyotes, bears, raccoons, and bobcats may become infected by consuming the carcasses of infected ungulates (Bruning-Fann et al. 2001); however, it is not likely to become established in predator and scavenger populations because these are dead-end hosts and do not transmit the disease (Disease Expert Meeting 2002). Currently, bovine tuberculosis is nearly eradicated from domestic cattle (Demarais et al. 2002), and no captive cervid herds in the United States are known to carry tuberculosis. In North America the only known reservoirs of bovine tuberculosis in the wild are white-tailed deer in

Michigan, bison and other species in Wood Buffalo National Park, and an elk herd in Manitoba (Demarais et al. 2002).

This disease is normally chronic and is spread by means of aerosols or the consumption of contaminated food (Clifton-Hadley et al. 2001; Demarais et al. 2002). Transmission is directly dependent on the density of susceptible animals, and animals concentrated around feed troughs would further contribute to transmission (Demarais et al. 2002). Bovine tuberculosis has a long incubation period and can be difficult to detect in populations (Thorne et al. 2002). Therefore, it may be present within a herd long before it is detected; for this reason close monitoring is needed to detect the disease as early as possible. Currently, there is no evidence of bovine tuberculosis in the Jackson elk and bison herds (Rhyan et al. 1997; Williams et al. 1995). In northern Michigan it is thought that high deer densities caused by winter feeding serve to maintain bovine tuberculosis in the herd (Schmitt et al. 1997; O'Brien et al. 2002).

The prevalence of bovine tuberculosis in white-tailed deer in Michigan was 2.5% (O'Brien et al. 2002), and in elk at Wood Buffalo National Park in Alberta, where elk occurred in the same area as infected bison, it was 5.5% (Hadwen 1942). The gregarious nature of bison leads to a high functional density, allowing for high transmission and infection rates, and high disease prevalence. Joly, Leighton, and Messier (1998) found that bovine tuberculosis prevalence in Wood Buffalo National Park bison was 51%.

Bovine Paratuberculosis

Bovine paratuberculosis, or Johne's disease, is caused by the bacterium *Mycobacterium paratuberculosis* and is a disease of ruminants worldwide. *M. paratuberculosis* and *M. bovis* are similar and related diseases. Like tuberculosis, paratuberculosis is a chronic disease that develops very slowly and may take several years before clinical signs become evident. The majority of infected animals never develop the clinical disease, but may shed the organism in feces (Williams 2001), and in the environment the bacteria may remain viable for a year or more under favorable conditions (Thorne et al. 1982). Once an animal develops clinical symptoms, it usually dies (Thorne et al. 1982). Transmission generally occurs from the ingestion of the bacterium (Thorne et al. 1982), and a high density of susceptible animals increases the likelihood of transmission (Williams 2001). The disease is primarily a disease of bison, with only rare, scattered instances of paratuberculosis-positive elk reported without documentation of mortality (Roffe, pers. comm. 2005).

Paratuberculosis has been reported sporadically in elk, both captive and free-ranging elk herds, and it is known to exist in a population of Tule elk in California (Jessup, Abbas, and Behymer 1981). It is also known to be present in several herds of bighorn sheep and mountain goats in one area of Colorado (Williams, Spraker, and Schoonveld 1979). There is no evidence of bovine paratuberculosis in the northern Greater Yellowstone Area (Rhyan et al. 1997) or in the Jackson elk and bison herds.

Anthrax

Anthrax, caused by the endospore-forming *Bacillus anthracis*, is an acute infectious and often-fatal disease in a wide array of wildlife, domestic animals, and humans (Gates, Elkin, and Dragon 2001). Cattle, bison, and elk are generally more susceptible to anthrax than humans, scavengers, and carnivores. When carcasses are torn apart by predators or scavengers, *B. anthracis* is released into the environment. Some of the bacilli may sporulate and remain viable in the environment for decades before colonizing new hosts. Endospores tend to concentrate in pools, wallows, and depressions, and anthrax outbreaks typically occur during warm, dry conditions when endospores are most concentrated. Animals typically contract the disease when they ingest spores off the soil. Under suitable soil and temperature conditions (pH higher than 6.0, moist soils, air temperature above 15.5°C) spores may multiply (Thorne et al. 1982). For these reasons, anthrax is not likely to be contracted during the winter when temperature and moisture conditions do not favor spore multiplication. Direct animal-to-animal transmission of the organism does not occur; therefore, interspecies transmission is not a concern.

Anthrax has not been observed in the Jackson elk and bison herds, but it has been observed in cattle and moose in the Green River drainage southeast of Jackson Hole. These few individual cases suggest that, although anthrax is present, the disease cycle does not maintain itself well in this area (Roffe, pers. comm. 2003). The management plan would do little to affect the prevalence of anthrax in Jackson elk and bison herds.

Undocumented Viral Microparasites — Malignant Catarrhal Fever

Domestic sheep are thought to be the source of the malignant catarrhal fever virus in bison and elk, and it is believed transmission may occur by means of aerosols (Thorne et al. 1982). Malignant catarrhal fever is probably the most infectious disease of captive bison in the United States, especially at high animal densities (Heuschele and Reid 2001; Haigh, Mackintosh, and Griffin 2002). The development of the clinical disease is generally stress related (density, starvation, inclement weather) (Haigh, Mackintosh, and Griffin 2002), and once clinical signs develop, mortality may be nearly 100% (Thorne et al. 1982). The west slope of the Teton Range is currently the closest location to Jackson Hole where domestic sheep grazing occurs.

Studies have shown that bighorn sheep are frequently seropositive for malignant catarrhal fever virus, but it is unknown if it can be transmitted from bighorn sheep to elk or bison. Other wildlife, including black-tailed deer, elk, mule deer, white-tailed deer, pronghorn, and moose, have tested seropositive for the disease, but the clinical disease has rarely been observed in these species (Zarnke, Li, and Crawford 2002). There are no reports of malignant catarrhal fever occurring in the Jackson bison or elk herds.

Undocumented Prion Diseases — Chronic Wasting Disease

Chronic wasting disease, a transmissible spongiform encephalopathy (TSE) like mad cow disease (bovine spongiform encephalopathy [BSE]) and scrapie, could infect the elk herd. Its origin is unknown, although it is more similar to sheep scrapie than to other transmissible spongiform encephalopathies. Eventually fatal and with no known treatment options, chronic wasting disease is especially concerning because it also contaminates the soil, where it is endemic. Current management options are limited; several states have quarantined and/or depopulated infected captive herds. Although originally limited to north-central Colorado and southeast Wyoming, recent outbreaks in other states and expansion in Wyoming have heightened concern about the disease's spread because it could be a significant mortality factor for elk. In addition, the TSE group of diseases has caused public concern for human health. A TSE in humans, variant Creutzfeldt-Jakob disease, has been linked to consumption of BSE-infected beef. Currently the World Health Organization and the U.S. Centers for Disease Control and Prevention have advised the public that "the risk to humans from CWD is extremely small, if it exists at all," but that people should avoid consuming meat from sick animals or those known to be infected with chronic wasting disease (Belay et al. 2004).

Chronic wasting disease is caused by a deleterious prion protein and is both infectious and contagious to mule deer, white-tailed deer, and elk (Williams, Miller, et al. 2002). A free-ranging moose was confirmed positive for chronic wasting disease in September 2005, but moose social habits make them a species that would likely have only rare occurrences of the disease (Colorado Division of Wildlife 2005). In instances when pronghorn, moose, bighorn sheep, mountain goats, cattle, sheep, and goats were in the same facilities as infected deer and elk or when they resided in facilities where chronic wasting disease had occurred, none developed the disease (Williams, Miller, et al. 2002).

The disease is transmitted by animal-to-animal contact or through contact with a contaminated environment, but the exact mode of transmission is unknown (Williams, Miller, et al. 2002). The dynamics of this disease in elk and deer populations are still poorly understood. Transmission may be influenced by animal numbers, the time infected animals occupy a given space, and the amount of space occupied by infected animals. It may also be related to the density of susceptible hosts. The density of animal populations would likely play a role through faster and greater seeding of the environment with the prion agent and more animal-to-animal contact.

Chronic wasting disease was first identified in mule deer in the late 1960s at captive research facilities in Colorado (Williams and Young 1980). In the early 1980s the disease was found in free-ranging elk in Wyoming and mule deer in both Wyoming and Colorado (Williams, Miller, et al. 2002). Its spread in North America has been unpredictable (Williams, Miller, et al. 2002) and far reaching. As of June 2005, chronic wasting disease has been found in free-ranging elk, mule deer, and white-tailed deer in Colorado, Illinois, Nebraska, New Mexico, South Dakota, Utah, Wisconsin, West Virginia, Wyoming, and Alberta and Saskatchewan, Canada (see the "Chronic Wasting Disease in North America (2002–2005)" map). Kansas was added in early 2006. In Colorado and Wyoming chronic wasting disease has been moving westward for the past several years and is now found west of the Continental Divide (see the "Chronic Wasting Disease in Wyoming (2003–2005)" map).

In Wyoming new positive deer locations were found in 2003 near Worland and in 2005 in the Owl Creek drainage, both north and west of Thermopolis. The westernmost case was about 20 miles due west of Thermopolis on the Wind River Indian Reservation. These locations indicate that the disease is within approximately 90 miles of the Jackson elk herd unit boundary. Statewide surveillance was initiated in 2003, and chronic wasting disease has not been detected in the Jackson elk herd or mule deer herd.

Mule deer in Jackson Hole migrate south and east to spend the winter on the mesa south of Pinedale, Wyoming. This migration could be a potential way for chronic wasting disease to be transported into Jackson Hole. However, chronic wasting disease may not necessarily become established in the elk herd if an infected animal is present, because an infected animal could spend the summer and winter in low-density situations, where it might die without transmitting the disease.

The spread of chronic wasting disease to the Jackson elk herd is possible, and it may be just a matter of time until it is introduced. In many cases infected captive deer and elk herds have been depopulated or quarantined, but some infected herds may remain. With increasing awareness of this disease, states are beginning to place moratoriums on the movement of captive cervids, and the U.S. Department of Agriculture is adopting a herd certification program (Williams, Miller, et al. 2002). With the increasing concern over the effect of chronic wasting disease on deer and elk populations, many states have instituted bans on translocations of cervids and have banned the import of cervid carcasses and high-risk carcass parts from CWD-affected states. Within affected states, the movement of animals and/or carcass parts from affected areas or zones is generally forbidden.

The prevalence of chronic wasting disease in free-ranging Wyoming elk ranged from 2.3% to 9.6% among elk hunt areas where the disease was sampled from 1997 to 2005, with an overall prevalence in these areas of about 4% (WGFD, unpubl. data 2005). Wyoming mule deer and white-tailed deer prevalence, combined, ranged from 2.9% to 7.6%; overall prevalence in deer was 6.5% (6.1% in mule deer and 10.6% in white-tailed deer). Examined separately, yearly total prevalence ranged from 4% to 7% in mule deer and from 6.0% to 18.1% in white-tailed deer (WGFD, unpubl. data 2005). None of the 55 Wyoming moose tested from 2003 to 2005 was positive (WGFD, unpubl. data 2005).

In confined situations prevalence can be much higher. In a small captive elk herd, 71% (5 of 7 animals) died of chronic wasting disease (Miller, Wild, and Williams 1998). In a captive mule deer herd, more than 90% died or were euthanized due to the disease (Williams and Young 1980). Few game farm prevalences have been published, and prevalence is highly variable, depending on management and duration of infection. The prevalence in game farm elk may reach up to 59% (Peters et al. 2000).

If chronic wasting disease does become present in the herd, environmental contamination will become a major concern due to the disease's ability to persist in the environment for a long period of time, even after intensive efforts to eradicate it.

Transmission occurs between animals and from contaminated environments to animals (Williams and Miller 2002). Earliest detection of the prion agent is in the gut-associated lymphoid tissues (Sigurdson et al. 1999), and the pathogenesis appears to be related to uptake by these tissues

Map

Chronic Wasting Disease in North America
(2002–2006)

Map

Chronic Wasting Disease in Wyoming (2003–2005)

from oral ingestion of the prion agent. Because of this pathway, and the ability to detect the CWD prion in gut-associated lymphoid tissues, shedding via the alimentary tract (feces or saliva) appears to be a likely method for dissemination into the environment (Williams, Miller, et al. 2002). However, no one has determined the pathways by which the CWD prion exits the host. Data on infection caused by environmental contamination at the Sybille research unit in Wyoming and research facilities at Fort Collins, Colorado, indicated that the infectious agent is long lasting (Madson 1998). Previously unexposed deer and elk were infected within five years after being placed in Sybille pens that had been empty of infected animals for six months to a year. At the Fort Collins facility, 2 of 12 elk calves became infected and died within five years of being placed in sanitized pens (pens that had been plowed, sprayed repeatedly with a strong disinfectant, and left empty for a year before the calf introduction).

The U.S. Fish and Wildlife Service and the National Park Service can do little to prevent Jackson Hole mule deer and elk from contracting chronic wasting disease from other ungulates outside the Jackson elk herd unit and transporting it into Jackson Hole. Some precautionary measures, such as reducing densities and numbers of elk and increasing dispersion, could reduce the chance of major adverse impacts if the disease became established (Roffe, pers. comm.).

HUNTING

Hunter harvest accounted for nearly 90% of adult mortality in the Jackson elk herd during the 1990s (B. L. Smith 2000). The harvest rate has averaged 20% of the herd during the last 20 years. Annual harvest from 1998 to 2002 ranged from about 2,300 to 3,300, and approximately 16% of the pre-hunt Jackson elk herd population was removed. Smith and Anderson (1998) found that females one year or older outsurvived males in the same age class during the fall hunting season (0.890 and 0.729, respectively).

Harvest rates from 1978 to 1984 differed for elk summering in Grand Teton National Park (17%) and those summering outside the park (24%) (Smith and Robbins 1994). Later harvests (1991–93) showed the same percentage for elk in the park, but outside the park seasons were more restrictive, and the harvest rate decreased from 24% to 16% (Smith and Anderson 1998).

In addition to WGFD harvests in Bridger-Teton National Forest and on nonfederal lands, hunting occurs on the refuge each fall, along with the elk reduction program in the park. Over the last 20 years harvest in the park has contributed about 25% to the total harvest, and harvest on the refuge has contributed about 10%. The remaining 65% of the harvest takes place mainly in the national forest.

PREDATION

Predators were not considered an important influence on ungulate populations throughout much of the 20th century because of low numbers in many areas (Raedeke, Millspaugh, and Clark 2002; Murie 1951; Boyce 1989). However, the colonization of Jackson Hole by wolves reintroduced into Yellowstone National Park in 1995 and recent range expansion by grizzly bears in the southern greater Yellowstone ecosystem have increased interest in the effects of predators on elk.

As of the winter of 2004, the total number of elk killed by wolves each winter in the Gros Ventre area was estimated to represent less than 1% of the herd (WGFD 2003). From 2000 through 2005 researchers monitored radio-collared wolves and tracked wolves in snow, documenting 231 ungulates, including elk, killed in winter by wolves in Bridger-Teton National Forest, Grand Teton National Park, and on state-managed feedgrounds in the Gros Ventre River drainage (Jimenez et al. 2006). Of the 231 animals killed, 97% (225) were elk and 3% (6) were moose. Of the 225 elk killed by wolves, 47% were calves, 43% cows, and 10% bulls. The average age of adult elk killed was 9.3 years; the oldest was 23.

In the winter of 1998–99 wolves preyed on elk on the National Elk Refuge for a two-month period, killing 1% of the elk counted on the refuge feedgrounds. Because the winter census was identified as only a partial count of the refuge feedground elk, the percentage actually killed was likely less than 1%. Since then, wolves have preyed only incidentally on the refuge up until the winter of 2004–5, when wolf activity increased and one pack of 3–4 wolves killed 18 elk. In 2005-6 two packs (totaling 16–20 animals) wintered on the

Map

Existing Elk Hunting Areas

refuge. There were 63 documented wolf-killed elk, which represented 0.9% of elk classified during the winter count. Wolf predation accounted for 29% of total refuge mortalities. An accurate count of wolf-kills is not available for the 2006–7 winter. Winter kill rates have been shown to be variable during the winter, as well as between winter seasons (D. W. Smith et al. 2004). Because little is known about summer kill rates in any ecosystem, winter data should not be extrapolated to estimate annual rates (WGFD 2003). In 2005 researchers extended their field season throughout the year to determine wolf food habits in seasons other than winter (Jimenez et al. 2006) and located 90 ungulate carcasses, 93% (84) of which were elk and 7% (6) were moose. Of the 84 wolf-killed elk, 47% were calves, 39% cows, and 14% bulls.

Some studies have indicated that predators may affect specific age and sex classes of elk and that influences differ among predator types (Raedeke, Millspaugh, and Clark 2002). Calves in particular are vulnerable, especially during the first 30 days of life (Singer et al. 1997) and are preyed on mainly from mid-May through early July by grizzly bears in Yellowstone National Park (Gunther and Renkin 1990). Preliminary results from a northern Yellowstone elk calf mortality study indicated that during 2003 and 2004 bears accounted for 55%–60% of tagged calf mortalities, and coyotes and wolves each accounted for about 10%–15% (Barber, Mech, and White 2005). Hornocker (1970) found that cougars killed more bulls and calves than adult and yearling cows. In and near Glacier National Park in Montana wolves and cougars mainly killed the most vulnerable prey, for example, the young, old, or poor-conditioned, and did so more than hunters did (Kunkel et al. 1999). Carbyn (1983) also reported that one wolf pack in Riding Mountain National Park in Manitoba killed a high percentage of older elk (47% were 11 years of age or older), and as winter progressed, they killed more adult cows than earlier in the season.

Predators on elk in the Jackson area include wolves, cougars, grizzly bears, black bears, and coyotes. Black bears primarily prey on calves, and only occasionally on adult elk (Barmore and Stradley 1971, cited in Boyce 1989). Coyotes prey on calves opportunistically but are often unable to do so because adult elk are large-bodied and, if nearby, capable of defending their young against these relatively small carnivores (Geist 1982). More detailed discussion about individual predator species is in the "Predators and Scavengers" section (beginning on page 98).

Elk Recruitment and Wolves

This subject is treated in some detail because of public concern about the recent decline of calf-to-cow ratios in the Jackson and northern Yellowstone herds and requests to address the effects of a growing wolf population on calf recruitment.

Pregnancy rates, birth rates, and calf survival affect elk recruitment, which is reflected in calf-to-cow ratios. These parameters are in turn influenced by a number of factors such as elk density, habitat loss, habitat condition, nutrition, predation, environmental conditions, disease, cow condition, bull and cow age structure, birthday, birth weight and condition, bull/cow ratios, human disturbance, and legal and illegal human harvest (Caughley 1974; Mitchell and Crisp 1981; Caughley and Sinclair 1994; Thorne, Dean, and Hepworth 1976; Cook et al. 1996; Zager and Gratson 1998; Smith and Anderson 1996, 1998). These factors interact in complex ways, making it difficult to determine the cause of population fluctuations. The influence of predators on their prey may vary from one area to another, at different times, and for different reasons (WGFD 2003). Ongoing research in Washington, Oregon, Idaho, and the greater Yellowstone ecosystem is looking at how these factors affect recruitment in elk herds.

Of Washington State's 10 elk herds totaling approximately 56,000 Roosevelt and Rocky Mountain elk, 8 herds are below objective (Washington Department of Fish and Wildlife 2002), and several of these have lower calf-to-cow ratios than they did in the 1970s or 1980s. Factors attributed to the declines include the loss of habitat from development and prevention of fires, increased hunting, conflicts with agriculture, and predation by mountain lions and black bears (J. Nelson 2001). Although elk populations in Oregon are generally doing well, those in the northeastern part of the state (Wallowa and north Umatilla counties) have seen calf-to-cow ratios decline from a high of 42 calves/100 cows in 1979

down to 19 calves/100 cows in 2000 (Oregon Department of Fish and Wildlife 2001). The cause of the decline is unclear, but climate, density-dependent interactions, habitat degradation, and predation by mountain lions and black bears have all been proposed as potential causes. Many game management units in north-central Idaho also experienced chronically low or declining elk recruitment since the 1980s or early 1990s, before wolves were reintroduced (Gratson and Johnson 1995). Although most elk herds in Montana are at or above herd objectives (Lemke, pers. comm. 2003), herds across almost all areas of elk habitat have experienced declines in calf-to-cow ratios of 30% to 50% from historical averages (Montana Fish, Wildlife and Parks [MFWP] 2002). This includes elk herds both where wolves do and do not occur.

All Wyoming elk herds adjacent to Yellowstone National Park have been over WGFD objectives for several years (WGFD 1990–2002). Some of these herds are experiencing lower calf-to-cow ratios or declines in numbers, but the relative degree to which wolves, the drought, high elk densities, habitat decline, hunter harvest, or other factors are causing the decline is not known. Declines in Montana are occurring both where wolves are present and where they are not. Four elk herds in Wyoming not subject to wolf predation are also experiencing declining calf-to-cow ratios, although their ratios are currently higher than those in the Jackson herd or the northern Yellowstone herd. These are the South Bighorn elk herd, the Rattlesnake elk herd, the Iron Mountain elk herd, and some units of the Sierra Madre elk herd (WGFD "2002 Annual Big Game Herd Unit Report").

The northern Yellowstone elk herd has received particular scrutiny in recent years because of public concern that the wolf population will reduce elk numbers (*Billings Gazette* 1999, 2002). Surveys have shown that pre-wolf variability in this herd was high, and elk numbers have ranged from less than 9,000 to about 19,000 since the 1970s. The annual winter count typically changes 10%–20% from year to year, but sometimes by as much as 30%–40% (MFWP 2002). Compared to other elk herds in Montana, the northern Yellowstone herd has been more dynamic and has not exhibited clear, long-term trends. The herd is subject to natural population influences on half or more of its range.

The greatest single factor affecting elk numbers in the northern Yellowstone herd is periodic, large winter-kill events that do not occur in other Montana elk herds, even in harsh winters. These winter kills result from several factors particular to this herd and this area, including severe winter conditions, an older age structure in the population, high elk densities, and complete reliance on native forage with no agricultural base (MFWP 2002). The northern herd has demonstrated the ability to recover from periodic population declines, growing from 3,200 elk remaining after decades of elk reduction ceased in Yellowstone in 1968 to over 12,000 by 1976. Elk numbers typically recover from winter kill events within five to six years (MFWP 2002).

Biologists have concluded that the data suggest that elk abundance has decreased since 1988 (Northern Yellowstone Cooperative Wildlife Working Group, cited in MFWP 2002), and like other areas of Montana, calf-to-cow ratios have also dropped in the northern herd, from an average of 32 calves per 100 cows to a low of 14 calves per 100 cows in 2002. However, calf recruitment in Yellowstone varies widely from year to year, ranging from 14 to 48 calves per 100 cows. Yellowstone elk have also typically had lower recruitment than other elk herds in Montana due to higher predation rates from all predators, lower pregnancy rates, an older age structure in the female segment of the herd, long stressful winters, and the general physical condition of elk, which varies with forage availability and quality (MFWP 2002). The herd does not appear to be outside the normal range of variability. Montana Fish, Wildlife, and Parks has concluded

> While there are many factors that affect elk herd numbers (i.e., winter severity, weather during hunting season, drought conditions, predation, and hunter pressure), the available data on the northern Yellowstone elk herd suggests that current herd size, hunter effort, and hunter success are within the general ranges seen before reintroduction of wolves (MFWP 2002).

In the winter 2005–6 the Jackson elk herd was estimated at approximately 12,855, about 2,000 elk over the objective of 11,000. The herd has been over objective since 1987, and hunter harvest has been liberal in the last 10 years to intentionally bring the number down to the objective.

Approximately 50% of the elk that feed on the refuge come from Grand Teton National Park, while 25% each come from Yellowstone and Bridger-Teton National Forest. Elk summering in the park experience very little non-winter wolf predation for at least six months of the year (Jimenez, pers. comm. 2003); whereas elk summering in Yellowstone and the national forest experience predation from wolves even when not on the Gros Ventre feedgrounds.

Before wolves recolonized the southern Greater Yellowstone Area, elk calf-to-cow ratios in the Gros Ventre River drainage decreased from 1989 through 1999; the average over this 10-year period was 28.8 calves per 100 cows (Jimenez et al. 2006). These ratios have averaged 25.5 calves per 100 cows.

The calf-to-cow ratios on the Gros Ventre feedgrounds and the refuge appear to fluctuate regardless of whether wolves are present (see Figure 4). On the Gros Ventre feedgrounds the calf-to-cow ratios actually increased the first year after wolves arrived at that location (winter 2000–2001), declined in the following two winters, rose in 2003–4 and again in 2004–5 (in this year to a ratio higher than during the 1989–99 period, with 32 calves per 100 cows), and then decreased again in 2005–6. The National Elk Refuge ratio has also been variable, rising, declining, and then rising again from 2000–2001 through 2005–6. The decline in calf-to-cow ratios on the refuge and in the Jackson herd is therefore apparently linked to a combination of factors, such as prolonged drought, human harvest, older cows, and other predators, in addition to wolves. Before any definitive conclusions can be drawn about the effects of wolves on their prey, more research must be done, taking into consideration the multiple environmental and human factors that affect prey populations.

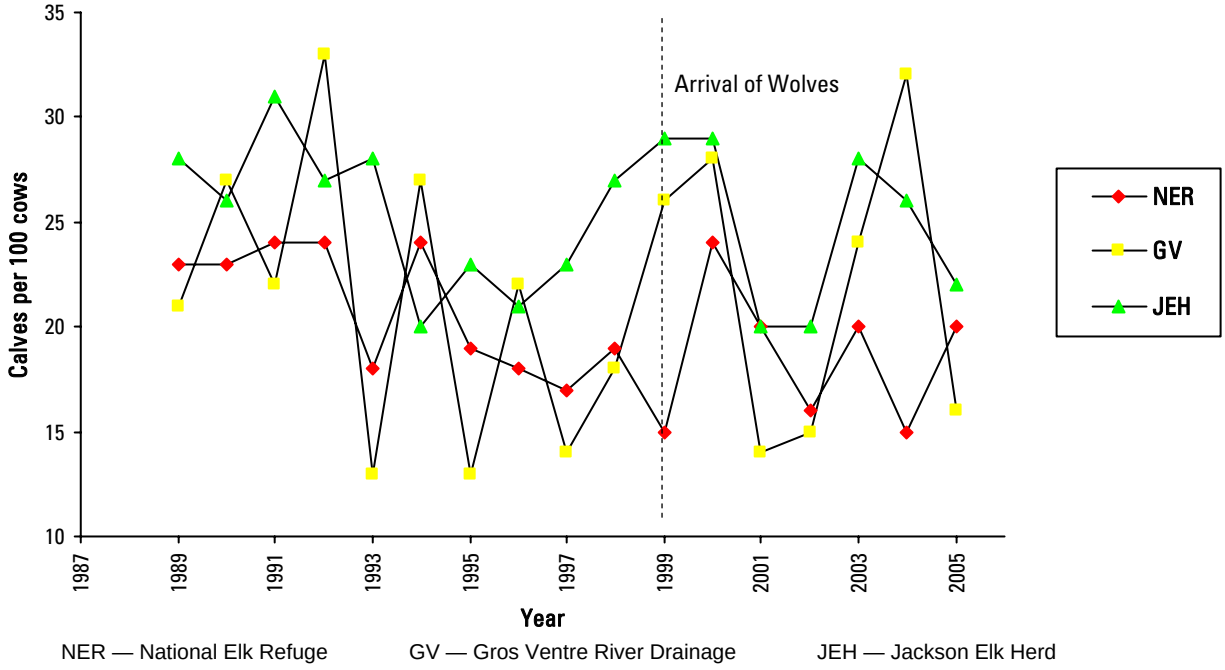
FACTORS AFFECTING CALF-TO-COW RATIOS

HABITAT AND HIGH ELK DENSITIES

When elk densities increase above what the habitat can support, elk become nutritionally stressed, which can result in lower pregnancy rates, reabsorbed fetuses, low-weight newborns, and calves that grow at slower rates (Houston 1982; Merrill and Boyce 1991; B. L. Smith, pers comm. 2002). In Idaho statewide aerial surveys indicate that elk density negatively affects elk recruitment on a broad scale (Gratson and Johnson 1995; Bomar et al. 2000). When elk densities were decreased experimentally, recruitment rates went up (Gratson and Zager 1994). High elk densities and reduced recruitment rates have also been documented for the northern Yellowstone elk herd (Houston 1982; Merrill and Boyce 1991; Coughenour and Singer 1996), and the Jackson elk herd (Boyce 1989). Although analyses by Smith and Anderson (1998, 2001) did not find that the Jackson elk herd density from 1990 to 1994 influenced juvenile survival and dispersal, analysis of data from 1980 to 2002 indicated that neonate (young in the first few months of life) survival decreased at higher population sizes (Lubow and Smith 2004). The density influence was weak at current population size and recent supplemental feeding levels.

Habitat sets the potential upper limit on elk density (Caughley 1977; Caughley and Sinclair 1994). Intrinsically poor habitat will not support even moderate or low elk densities and will result in low recruitment rates. On the other hand, high elk densities can degrade habitat conditions, affecting elk nutrition and leading to calves in poor condition with higher rates of starvation, predation, and disease. Coughenour and Singer (1996) found that winter calf mortality rates increased with population density. These findings agree with the 1991 study by DelGiudice, Mech, and Seal, which indicates that nutritional deprivation was related to high ungulate densities, deep snow, and declines in calf-to-cow ratios from early to late winter.

FIGURE 4: NUMBER OF CALVES PER 100 COWS ON WINTER FEEDGROUNDS ON THE NATIONAL ELK REFUGE, IN THE GROS VENTRE RIVER DRAINAGE, AND IN THE JACKSON ELK HERD OVERALL



NOTE: Years are biological years. Ratios are based on counts made during early winter of the following calendar year.

CALF CONDITION

The condition of elk calves can depend on the condition of cows while pregnant and lactating, which in turn is related to the condition of the habitat. A nutritionally stressed cow may give birth to a lower birth weight or weak calf or have insufficient milk to feed it, increasing the calf's chances of dying from starvation, disease, accident, or predation (Clutton-Brock, Guinness, and Albon 1982; Clutton-Brock, Albon, and Guinness 1989; Clutton-Brock, Price, and MacCall 1992; Kunkel and Mech 1994; Smith, Peterson, and Houston 2003), or reducing its growth rate. If nutritious forage is scarce, elk calves will be unlikely to successfully compete with adult elk (Knight 1970; Houston 1982).

The time of year that a calf is born can affect its potential for survival. Calves born out-of-season, either earlier or later than normal, may be at greater risk from predators and may be born before or after the peak season for forage production, leaving them at a nutritional disadvantage. Calves born late in the season will go into their first winter smaller and weaker than average and less likely to survive severe winter conditions (Clutton-Brock, Guinness, and Albon 1982; Clutton-Brock et al. 1987). Winter supplemental feeding has been found to increase survival of Jackson elk calves (<1 year old) (Smith and Anderson 1998).

Some studies have tried to determine if predation on calves is additive or compensatory. In other words, if wolves kill calves that ultimately would have died from starvation or disease, the predation is said to be compensatory mortality. A western Wyoming study by Smith, Peterson, and Houston (2003) suggests that the predation mortality on elk calves was at least partially compensatory because predators tended to select inferior calves with lower-than-average growth rates. A second study in Idaho supports this conclusion, finding that wolves, even more than cougars, took prey that was malnourished and in a weakened condition (USFWS et al. 2003).

This compensatory/additive issue, which needs more long-term study, is important because if

predation is largely compensatory, the Jackson elk population will continue to be only negligibly affected by wolf predation, and the number of elk available for human harvest will not change. If wolf predation is largely additive, hunter harvest may need to be adjusted to compensate for the increased mortality due to the expansion of wolves and grizzly bears, or wolf and grizzly bear populations may need to be managed at a lower level.

Weather

Weather conditions in the spring and summer can also affect calf condition and calf recruitment. During the late 1990s cooler April temperatures and larger elk numbers coincided with declining weight gains and lower survival of calves in the Jackson elk herd (B. L. Smith et al. 2006). Coughenour and Singer (1996) found that forage biomass and calf recruitment increased with higher precipitation levels. While severe winter conditions can negatively impact adults and calves, calves are even less likely to be able to cope with high snow levels and compete with adults for the limited forage available.

Habitat Successional Changes

Forest management practices can influence habitat suitability for elk and other ungulates. Elk generally do well in habitat that is in early to mid-successional stages (J. Nelson 2001).

As timber harvest practices change and more land is allowed to shift to late successional stages, the forests become less productive for elk. Fire suppression has also accelerated the shift to late successional stages (Fowler 2001).

The spread of nonnative invasive plants is threatening forage conditions in many areas. Roads and off-road vehicle use facilitate the spread of nonnative invasive plants that compete with palatable native forage (Fowler 2001)

Human Disturbance

Inactivity in winter provides an energetic advantage to animals exposed to cold weather, while forced activity caused by human disturbance exerts an energetic cost (Canfield et al. 1999). The expression of this cost may manifest in an increase in general alertness, slow retreating movement, and outright flight. Actual displacement of animals may not be necessary to cause high energy expenditures (Chabot 1991). Tests on various ungulates confirm that an increased heart rate as a result of even minor, seemingly harmless human disturbance causes increased energy expenditures (Freddy 1984; Weisenberger et al. 1996; Fancy and White 1985a, 1985b; Moen, Whittemore, and Buxton 1982; Ward and Cupal 1976; Lieb 1981; MacArthur, Geist, and Johnston 1982; Geist, Stamp, and Johnston 1985; Cassirer, Freddy, and Ables 1992). Intentional or unintentional human harassment may be debilitating to ungulates, resulting in illness, decreased reproduction, and even death (Geist 1978). Excessive road density limits habitat suitability in most managed forests, allowing access by recreationists and illegal human harvest (J. Nelson 2001; Malaher 1967).

A general increase in human disturbance (including hiking, bird-watching, photography, hunting, and antler hunting), and in particular an increase in snowmobile and four-wheel vehicle use, may cause considerable stress to elk, especially during the breeding season and the winter when elk need to conserve energy to compete in the rut and survive harsh weather conditions (Fowler 2001). Indiscriminant off-road vehicle use not only causes environmental damage, but can reduce the size of ungulate home ranges, force ungulates into less preferred habitat, physically stress animals, and frighten calves from their beds, exposing them to predators (Dorrance, Savage, and Huff 1972; Geist 1971). Limiting vehicular access has been shown to reduce human disturbance and poaching of elk (Cole, Pope, and Anthony 1997; J. L. Smith et al. 1994; Phillips and Alldredge 2000).

Cow Age Structure

Cow elk are thought to typically decline in reproductive fitness after the age of 12–14 years, but pregnancy rates may vary from population to population (Raedeke, Millspaugh, and Clark 2002). In a Michigan study Rocky Mountain elk older than 7 years had a pregnancy rate of 53%, while elk from 3 to 7 years had a pregnancy rate of 84% (Moran 1973). Eight female elk over the age of 11 years were examined in western Oregon and none

was reported pregnant (Trainer 1971). Populations with large numbers of old cows are likely to have lower calf-to-cow ratios and lower recruitment. Estimates of the pregnancy rate in the northern Yellowstone elk herd vary, between 70% (Lemke, pers. comm., 2003) and 95% (White, pers. comm. 2003). The pregnancy rate for the Jackson herd is 87%, but the actual number of calves born in the spring (the natality rate) is approximately 63% (Smith and Robbins 1994). The southern Yellowstone and Grand Teton segments of the Jackson elk herd are thought to have a higher number of old cows due to supplemental feeding in the winter and little or no exposure to human harvest. Many elk in these herd segments avoid the fall elk reduction program by staying on the west side of the Snake River and crossing to safe zones on the National Elk Refuge at night (B. L. Smith, pers. comm. 2002).

BULL AGE STRUCTURE AND BULL-TO-COW RATIOS

Some studies indicate that elk populations exhibit lower pregnancy rates when there are few older bulls and when much of the breeding is performed by less efficient yearling bulls (Cheatum and Gaab 1952; Greer 1966; Greer and Hawkins 1967). It is hypothesized that these populations will also have conception dates that are later and more spread out, resulting in later-born calves and higher over-winter calf mortality (Follis 1972; Prothero 1977; Kimball and Wolfe 1979; Noyes et al. 1996). Data from seven national parks showed a ratio of about 50 bulls to 100 cows, with about two-thirds of the bulls older than yearlings (DeSimone, Vore, and Carlsen 1993). Bubenik (1985) suggested that a ratio of 25 mature bulls to 100 cows was needed for satisfactory calf-to-cow ratios, while research by Noyes et al. (1996) indicated that a ratio of 18 mature bulls to 100 cows was adequate. A study in Colorado found that calf-to-cow ratios declined when there were fewer than 10 mature bulls per 100 cows (Freddy 1987).

LEGAL AND ILLEGAL HARVEST

Some hunt programs allow the taking of calves during the hunting season, likely resulting in lower post-season calf-to-cow ratios. Poaching may also take a toll, but it is hard to determine what the effect on the calf population may be.

PREDATION

Newborn calves may be taken by black bears, grizzly bears, mountain lions, wolves, and coyotes (Gese and Grothe 1995; Myers et al. 1998; Singer et al. 1997; Smith and Anderson 1998; Smith, Peterson, and Houston 2003). Black bears appear to cause a substantial amount of mortality in the first months of a calf's life, causing a documented 42%–72% of mortality in marked calves in various studies (Smith and Anderson 1996; Schlegel 1976; Zager, White, and Gratson 2002). See the discussion under "Predators and Scavengers," beginning on page 98, for more detail.

SUMMARY OF OTHER CAUSES OF MORTALITY

Besides hunting, disease, and predation, other causes of mortality include motor vehicle collisions and natural causes such as drowning (particularly in the spring when river water levels are high) and becoming mired in bogs (a relatively rare occurrence).

GENETICS

Long-term population genetic variability, which affects population fitness, is strongly influenced by population size and rates of immigration (the addition of animals from other populations). For genetically isolated populations, as population size decreases, inbreeding coefficients and the potential for deleterious effects on fitness increase. Population size is important in preserving variability as well. If a population is not genetically variable, it may not be able to survive changing environmental conditions.

Although no work on Jackson elk genetics has been done, viability of the Jackson herd has not been of concern due to large numbers of elk and the potential for mixing with individuals from Yellowstone and other adjacent populations. Microsatellite mtDNA data suggest that Yellowstone National Park elk are among the most genetically diverse in North America (Polziehn, pers. comm. 1999, cited in O'Gara and Dundas 2002).

AREAS OF COMPETITION WITH BISON

Singer and Norland (1994) found a low to moderate degree of diet overlap between bison and elk, although the two species share a high degree of habitat overlap. During a period in which both species increased rapidly following release from artificial control, neither bison nor elk appeared to suffer any decrease in population growth due to competition from the other species. It is possible that stimulation of production and nutrition in grasses may have resulted in a beneficial effect for both species at observed population levels (Singer and Norland 1994).

THE JACKSON BISON HERD

HISTORY OF BISON IN JACKSON HOLE

BISON POPULATIONS PRIOR TO EURO-AMERICAN SETTLEMENT

The American bison is native to Jackson Hole (Fryxell 1928; Ferris 1940; Skinner and Kaisen 1947; Haines 1955; Hall and Kelson 1959; Long 1965; Love 1972; Wright et al. 1976; McDonald 1981). Prehistoric bison remains have been found throughout the valley, along the Gros Ventre River, on the west slope of the Gros Ventre Range, on the National Elk Refuge, and along the Snake River south of Jackson (Fryxell 1928; Ferris 1940; Love 1972). Historically, bison likely inhabited the northern areas of Jackson Hole as well, especially in summer. Areas where bison remains have been found represent key ungulate wintering areas, where most bison mortality would be expected to occur.

The number of bison that once inhabited the valley is unknown. At least one reference exists, however, for an observation of "a large herd of buffalo in the valley" during June 1833 (Ferris 1940). The near extinction of the American bison occurred throughout the 19th century. By the 1820s bison were confined almost exclusively to lands west of the Mississippi River. Many of these herds began to decline after 1830, as market hunting for hides accelerated, and prolonged drought in the 1840s further reduced bison numbers. After the Civil War, competition from domestic cattle and greatly intensified market hunting for "buffalo" robes and tongues decimated the Great Plains herds. Tourists on railroad shooting excursions killed thousands more. A final contributing factor was the introduction of cattle-borne contagious diseases, which reached epidemic proportions in 1881 and 1882. The combination of cattle, hunting, and epidemic disease all but eradicated the once immense western herds. Bison were mainly extirpated from the Jackson Hole and Greater Yellowstone area by the mid-1880s (Trenholm and Carley 1964). A small herd continued to exist in Yellowstone National Park (Bailey 1930, as cited in Long 1965; Wright 1984).

By 1890 only about 300 bison remained in the United States (Malone, Roeder, and Lang 1976). While private herds existed throughout the United States, by 1902 no more than 23 individual bison remained of the thousands that had occupied the Yellowstone area since prehistoric times (Callenbach 1996). A small group of 8–12 free-ranging bison, whose origin is unknown, persisted in west-central Wyoming's Red Desert until the mid-1950s (Love, pers. comm., as cited in NPS and USFWS 1996).

The Jackson bison herd is of special importance as one of the last remnants of the extensive wild herds that once roamed much of North America. As bison continue to inhabit the landscape of what remains of the western frontier, a part of the unique American experience is preserved for future generations.

JACKSON HOLE WILDLIFE PARK

With the exception of three Yellowstone bison that wandered south into Jackson Hole in 1945 (Simon n.d.), bison were absent from Jackson Hole from at least 1840 until 1948. That year 20 animals (3 bulls, 12 cows, and 5 calves) from Yellowstone were reintroduced to the 1,500-acre Jackson Hole Wildlife Park near Moran. This was a private, nonprofit enterprise sponsored by the New York Zoological Society, the Jackson Hole Preserve, Inc., and the Wyoming Game and Fish Commission (Simon n.d.). It served as an exhibit of important large mammals, as well as a biological field station for the Rocky Mountain area. The 20 bison were considered the property of Wyoming.

In 1950 the expansion of Grand Teton National Park took in the Jackson Hole Wildlife Park, and management of the bison shifted to the National Park Service. By 1963 the Park Service coordinated most management actions with the Wyoming Game and Fish Department. Management actions consisted primarily of winter feeding, capturing bison that escaped the confines of the wildlife park (which occurred several times annually), and routine brucellosis testing and vaccination. A population of 15–30 bison was maintained in a large enclosure until 1963, when

brucellosis was discovered in the herd. Several months later, all 13 adults in the population were destroyed in order to rid the herd of the disease. Four yearlings that had been vaccinated against brucellosis as calves and five new calves, which were also vaccinated, were retained.

In 1964, 12 certified brucellosis-free bison (6 adult males and 6 adult females) from Theodore Roosevelt National Park were added to the Moran population, bringing the total number of animals to 21. These bison represented the latest in a long line of introductions from several herds (Shelley and Anderson 1989). In 1968 the population was down to 11 adults, all of which tested negative for brucellosis, and 4 or 5 calves. Later that year the entire herd escaped the confines of the wildlife park. The herd was eventually allowed to free-range in 1969, partially as a result of recommendations contained in a report commissioned by the Secretary of the Interior on wildlife management in the national parks (Leopold et al. 1963).

Bison on the National Elk Refuge

The free-ranging bison established fairly well-defined movement patterns in Grand Teton National Park, spending summers in the Potholes / Signal Mountain / Snake River bottoms area and wintering in the Snake River bottoms and farther south (see "Jackson Hole Bison Herd Seasonal Ranges" map). During the early 1970s they wintered in the river bottoms north of Moose and in the Kelly hayfields vicinity, east of Blacktail Butte. Since the winter of 1975–76, however, most of the herd has wintered on the National Elk Refuge (except during the mild winter of 1976–77).

Herd Management Actions

Between 1969 and 1985 few bison management actions were taken. The size of the herd and its sex and age composition were documented on an opportunistic basis. Soon after the bison began wintering on the National Elk Refuge, they discovered the supplemental feed put out for the elk. Although efforts to haze the animals away from feeding areas took place, they were largely unsuccessful. Consequently, the refuge staff resorted to liberally feeding bison to keep them away from elk feedlines and to minimize conflicts.

The Fish and Wildlife Service was concerned about bison wintering on the refuge because of (1) increased consumption of supplemental feed and associated costs, (2) conflicts with the elk-feeding program and management guidelines for the refuge, (3) human safety concerns near the refuge visitor center, along the refuge road, and in the town of Jackson when bison approached the refuge's south entrance, and (4) property damage (e.g., fences and signs).

In the 1970s and 1980s bison on private land, or animals that were a threat to human safety or property, were shot. In 1989 the Wyoming legislature authorized a wild bison reduction season.

Bison Numbers: Explosive Population Growth and Further Attempts at Management

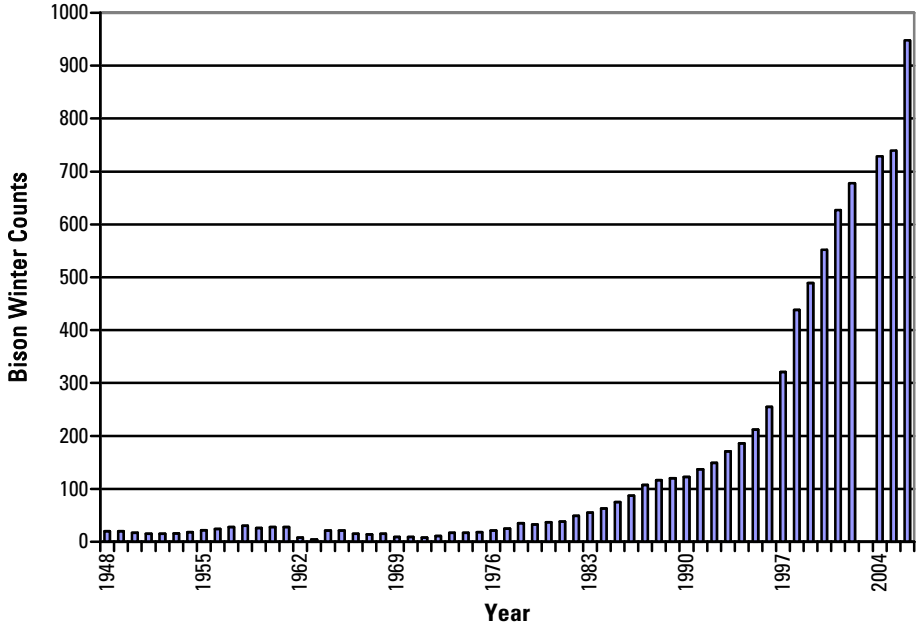
Since discovering the elk feedlines on the refuge in 1980, the bison herd has greatly increased in size (see Figure 5), and the U.S. Fish and Wildlife Service has both culled them (taking 16 bison) and conducted a special permit hunt (taking 19 bison) in an effort to reduce it. However, as previously discussed, litigation brought hunting to an end on the National Elk Refuge.

Herd reductions have not taken place since 1990 on the National Elk Refuge, and the bison population has continued to grow at a rapid rate, increasing annually by approximately 10%–14%. To slow population growth, the Wyoming Game and Fish Department reinitiated hunting in 1998 outside the National Elk Refuge and Grand Teton National Park, where bison could legally be hunted. Few bison have been killed, however, because the animals are mainly distributed within the park and refuge lands. The annual number of bison harvested ranged from a low of 4 in 1998 to a high of 47 in 2002.

Present Conditions

Bison are counted annually on the refuge in the winter and in the park in the summer. As of February 2006, the herd numbered 948. A study was initiated in 1997 to determine more about bison demography, reproduction, and effects of brucellosis on the population.

FIGURE 5: BISON HERD GROWTH SINCE 1948



In 2002 the Wyoming Game and Fish Commission and the Wyoming Livestock Board defined two wild bison management areas, one for the Absaroka herd and the other for the Jackson herd. The state has jurisdiction over bison from the Jackson wild bison herd in "all lands in Lincoln, Sublette and Teton Counties west of the Continental Divide, excluding Grand Teton National Park, Yellowstone National Park and the National Elk Refuge." The U.S. Fish and Wildlife Service has jurisdiction over wildlife on the elk refuge (16 USC 668dd) and the National Park Service over wildlife in the park (16 USC 1).

HABITAT AND FORAGE

During the summer bison primarily use nonforested areas of grassland and sage-steppe in the park's central valley, including the Snake River bottoms, where open meadows and forest adjoin. Bison may also be found on the forested hills on the eastern edges of the park and the refuge. Most of the herd winters on the refuge, although some use open grasslands, the hills beyond the eastern boundary of the refuge, and the hills and open sage-steppe land east of Elk Ranch. During spring and fall transitional periods bison may be found throughout both summer and winter range. In addition, more bison spend time west of the Snake River in the Potholes region of the park during these seasons (Cain et al. 2001).

Bison are primarily grazers whose diet is composed of grasses, sedges (*Carex* species, which grow in moist areas), some forbs, and rarely shrubs, and they appear to need water every day (Cooperrider, Boyd, and Stewart 1986). A dietary study conducted on shortgrass plains in northeastern Colorado noted that bison consumed at least 85% grasses and sedges (Peden et al. 1973). Bison preferred warm-season grasses and added shrubs to their diet when grasses were not available.

DISTRIBUTION AND MOVEMENTS

Radio-telemetry studies have shown that the Jackson bison have very consistent seasonal distributions and movements (GTNP unpubl. data). Most of the herd winters on the National Elk Refuge, where they eat natural forage and, for approximately two months, supplemental alfalfa pellets. After feeding operations are discontinued in late winter or early spring, many of the bison move to the northern end of the National Elk Refuge and the southern end of Grand Teton National Park. Hazing has been used to encourage animals inclined to remain on the refuge to move northward in the spring.

Map

Jackson Hole Bison Herd Seasonal Ranges

During April and May the herd typically is found in the vicinity of the Kelly hayfields, the Hunter-Talbot area, and the Teton Science School, as well as on the northern edge of the refuge. Small areas of Bridger-Teton National Forest near Shadow Mountain and Ditch Creek are also used occasionally. Much of the Kelly hayfields and Hunter-Talbot area is composed of previously cultivated agricultural lands (primarily for the cultivation of smooth brome and alfalfa). Northward migrations through Antelope Flats and the Snake River bottoms to primary summering areas continue during May and June. Because the majority of calving takes place during the transition between winter and summer ranges, births can happen anywhere from the National Elk Refuge to the northern portions of the summer range in Grand Teton National Park (GTNP unpubl. data).

Most of the Jackson bison herd summers in Grand Teton National Park in sagebrush/grassland areas in the Potholes, around Cow Lake, and along the Snake River between Deadman's Bar and Moran, where cottonwood/spruce riparian areas are also used. Occasional movements (usually by bulls) into the lower drainages of Pacific Creek and Pilgrim Creek are also observed. Bison often are found in open grasslands such as Elk Ranch Flats and, increasingly as the herd expands in size, in surrounding areas, including Uhl Hill, Wolff Ridge and the rolling hills to the east of Elk Ranch. In July and August large numbers of bison often congregate along U.S. 287 just south of Moran, where they are a major tourist attraction. Cows, calves, subadult males, and some adult males are quite gregarious throughout the year and rarely stray from well-defined seasonal ranges. Older adult males, however, often become solitary, especially during the summer, and are occasionally observed outside these areas. Periodically adult male bison have been found wandering near Marbleton, Wyoming (one in 1988), and Cora, Wyoming (three in 1990 and two in 1992); it is suspected these bison were from the Jackson herd.

From late August through September bison begin moving south along the same migration routes used during spring. Typically large numbers of bison are present in the Mormon Row, Kelly hayfields, and Hunter-Talbot areas throughout September and October, with some on the National Elk Refuge during this time. The herd uses all of these areas throughout the fall, and during some years they may remain in the park into November. Generally, most bison move onto the refuge by December, where they subsist on native winter range and forage produced on irrigated fields until supplemental feeding begins, usually in late January.

BEHAVIOR AND SOCIAL INTERACTIONS

Like most species, bison are driven by instincts for survival and mating. Distinct behaviors vary with age and sex. Cow/calf herds, for example, are most pronounced in the spring, during calving. This herding instinct may be motivated primarily to protect calves against predators because adult bison have few natural predators. The social bonds formed by cow/calf herds are strong and usually are broken only by severe environmental conditions.

Young bulls (up to six years of age) often separate from the cow/calf herds after the rut to form small fraternal groups. They generally coexist peacefully with each other for most of the year, but as the rut approaches, increased competition and fights for dominance occur. Older bulls (more than 10 years of age) are often solitary individuals that may move long distances.

Bison are quite sociable, as long as the habitat allows them to aggregate. Large herds of bison of mixed sex and age classes may congregate on range with suitable forage, especially during the rut, but herds seldom spend much time in any one place. Because bison live on large quantities of forage, herds are constantly on the move. They seek out higher quality forage, but those sources are generally available only on a short-term, seasonal basis.

In winter the greater Yellowstone ecosystem is the most severe North American habitat supporting a viable population of free-ranging bison (Meagher 1971).

BREEDING, CALVING, AND AGE AND SEX CLASSES

The breeding season begins in mid-July and peaks during August. Most females breed at 2.5 years of age (GTNP unpubl. data), while males do not usually become part of the active breeding

Bison calf.

population until they are about 6 years old. Bison males display and fight each other as they compete for access to receptive females. Although younger bulls are capable of siring offspring, larger older bulls are dominant and monopolize females.

Typically, bison are born in the spring. Calving begins by mid-April, but most births occur during May and June, and 95% are completed by the end of July. Sex ratios in the Jackson bison herd have been approximately equal, with a slight favoring of females over males in most years.

Annual winter classification counts provide information on the age structure of the Jackson bison population. From 1998 through 2004 adults have constituted 64% of the herd, with yearlings at 15%, calves at 19%, and unclassified at 2% (GTNP unpubl. data). Herd composition estimated from the February 2006 classification was 60% adults, 9% yearlings, 19% calves, and 6% unclassified. Sex and age composition was estimated at 75 bulls per 100 cows and 45 calves per 100 cows (GTNP unpubl. data).

OTHER FACTORS INFLUENCING BISON NUMBERS, DISTRIBUTION, AND HEALTH

Amount, Quality, and Availability of Winter and Transitional Range

Like other species, seasonal availability of suitable habitat profoundly affects the distribution and health of bison. As winter approaches, bison migrate to lower elevations and gradually alter their diets, adding plant species of decreasing palatability and nutritional quality as preferred foods become less available (Leopold 1933; Halfpenny and Ozanne 1989).

The amount, quality, and availability of winter and transitional range depend on temperature and precipitation. Halfpenny and Ozanne (1989) found temperature, snow depth, snow density, duration of winter, and lateness of spring to be critical factors affecting moose survival in Grand Teton National Park. These factors would also be critical for bison, although perhaps to a lesser extent due to bison's ability to move snow aside with their heads to get at vegetation. Farnes (unpubl. data, cited in Farnes, Heydon, and Hansen 1999; NPS and USFWS 1996) noted that the northern range Yellowstone bison and elk during 1968–81 generally foraged in areas with less than 6 inches snow-water equivalent. A snow depth of 1 to 2 inches snow-water equivalent was enough to initiate migration by at least some of the herd.

Snow-water equivalents averaged for areas within the park from 1961 to 1990 reveal few locations with averages below 6 inches (Farnes, Heydon, and Hansen 1999). Although Moosehead Ranch, for instance, had averages of 3.9 to 4.7 and Antelope Flats, 4.3 to 4.7, most park areas had higher averages, making them unsuitable for wintering bison or elk.

Diseases

Because both elk and bison would be affected by many of the infectious diseases discussed in this document, this topic was covered for both species in the disease section under elk (see the discussion beginning on page 66).

Hunting

Bison hunting is currently permitted only on federal lands in Bridger-Teton National Forest, state lands, and private lands; these areas constitute only a fraction of the herd's range. From 1997 through December 2005, hunters harvested 225 bison in Bridger-Teton National Forest. There is no legal authority for bison hunting in Grand Teton National Park.

As the bison population has grown, the herd's range has expanded eastward to some extent, and hunting success has improved since 1998.

PREDATION

Predation has not been a significant cause of death in the Jackson bison herd. Even though grizzly bear ranges have expanded in recent years to include the southern portion of Grand Teton National Park, no cases of predation are known in this area. Wolf predation may have caused the death of one marked cow bison near the eastern boundary of the National Elk Refuge, but the actual cause is unknown. Before the carcass was discovered, the cow had been seen in very poor physical condition after having isolated herself from other bison.

Preliminary studies in Yellowstone indicate that some wolves prey on bison (D. W. Smith, Murphy, and Guernsey 1999) although the level is not significant. Smith and others suggest that for some wolves, Yellowstone bison may become a regular prey item, particularly during late winter and spring.

SUMMARY OF OTHER CAUSES OF MORTALITY

Known mortality averaged 6% from 1997 through 2003. Of 257 deaths documented from 1997 through 2003, hunter harvest accounted for the greatest number (164), but the cause of many deaths (37) was unknown. Vehicle collisions killed 26, and natural causes were responsible for 18 deaths. Wolf predation may have caused the death of one marked cow, but the actual cause is unknown.

Mortality in the sub-sample of female bison studied from 1997 to 2003 and monitored through radio-telemetry averaged 7%, including harvest (5% excluding harvest deaths; methods from Heisey and Fuller 1985). The total number of known deaths (13) was small; 4 were killed by hunters, 1 was killed by a vehicle, and 8 died of natural causes. Annual survival rates were high (95% without harvest mortality and 93% with it).

Winter-kill is the primary cause of mortality for bison in Yellowstone National Park, where bison are not artificially fed in winter. Winter-kill results from the combined effects of climatic stress, low forage availability, and declining physiological condition of individual animals. Bison expend most of their body fat in early to midwinter. As winter progresses, some bison cannot acquire enough of the nutrients needed to survive the remainder of the season. The old, sick, and young generally are the first to die during the winter, and relatively few members of the Yellowstone National Park population reach "old age," e.g. 12 to 15 years (Fuller 1959).

In contrast, there are few examples of obvious winter-kills in the Jackson population. Although winters can be severe in the southern greater Yellowstone ecosystem, Jackson bison follow the terrain south from Grand Teton National Park to the National Elk Refuge, where there is less snow. Milder climatic conditions, plus supplemental feeding on the refuge, make them better able to fend off the stresses caused by winter.

GENETICS

Genetic variability allows populations to evolve under different selection pressures and is influenced by population size and composition as well as random events (Berger and Cunningham 1994). If a population is not genetically variable, it may not be able to survive changing environmental conditions. Populations that have decreased levels of genetic variation may also suffer from inbreeding effects. To avoid these effects over a long time, Frankel and Soulé (1981) suggested that the estimated size of a minimum viable population should not allow greater than 1% loss of the genetic variation per generation. However, not all populations with low genetic diversity are suffering inbreeding effects. For instance, there is no evidence of inbreeding effects in black-tailed prairie dogs or black bears, despite low levels of genetic variation in some populations (Hoogland 1992; Paetkau and Strobeck 1994).

Studies indicate that a large proportion of genetic variability in North American bison may already have been lost (Berger and Cunningham 1994). When the bison were driven to near extinction in the late 19th century, bison experienced an extremely large "bottleneck" (Roe 1970), where the genetic material that had been in an entire species of millions was now narrowed to only that in the remaining 300 individuals. While it is presumed this also significantly lowered the species' genetic variability, it is unknown whether this is the case since genetic material from the larger herd was never taken. In fact, other large

mammal species in northern temperate regions that have not gone through a large human-induced bottleneck also have low genetic variability (Sage and Wolff 1986).

Although some researchers have investigated a tentative relationship in cattle between a gene, NRAMP1 (now known as SLC11A1 [Derr et al. 2002) and natural resistance to brucellosis, there is no apparent association in bison (Halbert, pers. comm. 2006).

Some genetic analyses have been done on the Jackson bison herd, primarily focused on gene diversity and introgression for cattle genes. In limited analyses completed to date (39 bison sampled), no evidence was found for cattle genetic introgression. Analysis of additional samples would add to confidence in this negative finding (Halbert, pers. comm. 2006). Management would continue to focus on maintaining genetic diversity, not specific genes, because unknown effects could be obtained by the selection of closely linked traits.

Estimating a minimum viable population for bison requires accounting for selective pressures on the population. These pressures include the influences of sex ratio on breeding adults, the reproductive success of males and females, and population fluctuations. In addition to genetic factors, the minimum viable population is also affected by demographic and environmental randomness and catastrophes. How these factors affect different taxa depends on their respective ecology and life history traits, so there is no uniform estimate of a minimum viable population. However, management prescriptions that result in nonrandom selective removal of bison from the population through lethal and nonlethal mechanisms (for example, selective removal of pregnant females, or prime breeding-age bulls) can negatively influence the genetic integrity and viability of a population. For the purposes of this analysis, it was assumed that genetic viability would be threatened if the bison herd dropped below 400 animals and effective population size decreased below 100 (Berger 1996).

A recent modeling report (Gross et al. 2006) analyzed genetic diversity retention in several NPS bison herds and similarly concluded that 400 was the minimum herd size at which bison would be able to meet a long-term goal of achieving a 90% probability of retaining 90% of genetic heterozygosity for 200 years. (Heterozygosity is defined as the proportion of individuals in a population that are heterozygous, i.e., having more than one version of a gene at a chromosome locus.) Because results were based on simulations of precise management scenarios, the authors cautioned that management under field conditions should be designed to accommodate natural variation and advised retaining a larger herd size. They also suggested that herd sizes must be as large as 1,000 for a 90% probability of retaining 90% of allele diversity for 200 years. However, at this time this recommendation has not received wide support, and there is no consensus about if or how it should be incorporated into public herd management plans.

OTHER WILDLIFE

The categories of species most likely to be affected by bison and elk management are (1) other ungulates, in terms of competition for food, habitat changes, and potential for disease transmission, (2) predators and scavengers, in terms of their food base, potential for disease transmission, and vaccine safety issues, and (3) other species that could be affected by changes in habitat (e.g., Neotropical migratory birds). Altogether 48 native species of mammals inhabit the National Elk Refuge, while 61 occur in Grand Teton National Park, plus one exotic species, the mountain goat.

THREATENED, ENDANGERED, AND SPECIAL CONCERN SPECIES

The U. S. Fish and Wildlife Service is directed by the Endangered Species Act to identify and protect threatened or endangered animal and plant species. The U. S. Forest Service has adopted policies to ensure that no agency actions result in the need to list sensitive species as threatened or endangered, and the State of Wyoming has identified species of special concern that are considered high priorities for conservation attention. These species are identified in the following discussion.

Bison and elk management on the National Elk Refuge and in Grand Teton National Park has the potential to affect endangered, threatened, and special concern species both directly and indirectly. Indirect effects include disturbance caused by shooting and hazing bison and elk, the alteration of habitat used or potentially used by threatened or endangered plants or wildlife, the introduction of disease agents into the environment through vaccination of bison and elk, and changes in numbers and distribution of bison and elk, which serve as live prey or carrion for threatened or endangered animals.

NPS policy requires that impacts on state and locally listed species also be considered. Species of special concern are defined as those species for which data are sufficient to document that the species is in decline, or a species that because of its unique or highly localized habitat requirements warrants special management. Species of special concern do not receive the same degree of protection as endangered or threatened species, although decreasing numbers or loss of habitat makes them of concern to federal land management agencies.

The following species would not be affected by the management plan: lynx, wolverines, river otters, fishers, American martens, and whooping cranes.

The "Biological Opinion," which documents the effects of implementing this plan, is included in Appendix E.

GRAY WOLF

Gray wolves *(Canis lupus)* were deliberately exterminated from the greater Yellowstone ecosystem by the 1930s and were placed on the endangered species list in 1973. After years of scientific research and public debate, 66 gray wolves from Canada were reintroduced into the Yellowstone area (31 wolves) and central Idaho (35 wolves) in 1995 and 1996 (USFWS et al. 2003). They were classified as a nonessential, experimental population in accordance with the Endangered Species Act. This means that the species is treated either as proposed for listing in a national forest or as threatened in a national park or a national wildlife refuge (50 CFR 17). This nonessential, experimental population designation allows federal, state, and tribal agencies and private citizens more flexibility in managing the wolf population. There are currently six known wolf packs in the Jackson Hole area and the Gros Ventre River drainage, totaling approximately 54 wolves.

Wolves began dispersing from Yellowstone National Park to Grand Teton National Park in 1997. The Teton pack and the Gros Ventre pack ranged widely throughout the park during the winter of 1998–99. Both packs and the Soda Butte pack (now called the Yellowstone Delta pack) used the Pacific Creek drainage as a corridor between Yellowstone and Grand Teton. The Teton pack moved much less than the other two packs, remaining primarily in the northeastern part of the park, where they denned in

the spring of 1999 and produced pups. They or their descendants have denned in the northeastern part of the park every year through 2005 except for 2000. The Teton pack currently has 10 members, and the pack's home range encompasses the northeastern corner of Grand Teton National Park and extends into the Gros Ventre River drainage. The Soda Butte (or Delta) pack returned to Yellowstone National Park and has since remained primarily inside that park. The Gros Ventre pack denned in the Gros Ventre River drainage outside Grand Teton, but did not den or produce pups in 2003 or 2004. The Gros Ventre pack ranged throughout the Gros Ventre River drainage, overlapping with the home range of the Teton pack near the three WGFD feedgrounds. The entire Gros Ventre pack was killed by government authorities in 2004 after preying on livestock (Jimenez, pers. comm. 2004). Wolf packs and individuals within packs typically fluctuate over time, particularly when expanding into unoccupied habitats.

The National Elk Refuge was visited from time to time by the Gros Ventre pack and since January 2003 by the Teton pack. Wolves on the refuge have generally been a rare sight except for the winter of 1998–99, when the Gros Ventre and the Soda Butte packs hunted on the refuge for two months. Since 1999 the Gros Ventre and the Teton packs have routinely hunted in the Gros Ventre River drainage, including the WGFD feedgrounds. In January 2003, for the first time since their arrival in the valley, five members of the Teton pack were observed on the refuge. This visit occurred shortly after 17 wolves from a Yellowstone pack were spotted in the northern part of the refuge. Neither pack remained on the refuge for more than a few days. The following winter (2003–4) four wolves spent most of the season on the northern end of the refuge, and in the winter of 2004–5 three wolves appeared to be residing on the refuge. One of these canids has been identified as a dispersing wolf from the Druid Peak pack in Yellowstone. In 2005–6 two packs (totaling 16–20 animals) wintered on the refuge.

Recent winter studies in and adjacent to Yellowstone have documented that elk comprise more than 85% of wolf kills, followed by bison, moose, deer, and pronghorn (USFWS et al. 2003; Jaffe 2001; Mech et al. 2001). Elk are also the preferred prey of wolves in Jackson Hole during all seasons of the year (B. L. Smith, pers. comm. 2002). However, WGFD personnel have stated that to date wolves have not had a substantial impact on the Jackson elk herd (WGFD 2003).

Studies from November to March on the northern range of Yellowstone National Park documented a three-year average kill rate of 1.8 animals per wolf per 30-day study period, with elk comprising 90% of the kills (USFWS et al. 2003). Reestablishing and expanding wolf populations characteristically have higher kill rates than most wolf/ungulate systems (Jaffe 2001). These figures should not be used to estimate annual kill rates for the greater Yellowstone wolf population because kill rates in winter do not necessarily reflect kill rates during other times of the year when prey are less stressed by weather conditions and forage is plentiful. Kill rates of wolves in summer had not been studied in any ecosystem until recently. In 2005 researchers expanded their field season throughout the year to determine wolf food habits in seasons other than winter (Jimenez et al. 2006). This research is ongoing.

Grizzly Bears

Grizzly bears *(Ursus arctos horribilis)* in the lower 48 states were listed as threatened in 1975. In the 1980s a recovery plan was developed, and in recent years their numbers have increased to the point that delisting is expected in the near future. Grizzly bears occur in the park, but they have not been sighted on the refuge since 1994. The ecosystem's grizzly bears number an estimated 600, and their distribution has been increasing over the past two decades. They widely use the northern two-thirds of Grand Teton National Park, but can occur throughout the park and surrounding areas.

Grizzly bears are omnivores that feed on nutritious succulent vegetation, grubs, insects, fish, newborn ungulates, and carrion. In Yellowstone National Park from March through May, ungulate carrion (mostly elk and bison) is an important food source (Mattson 1997). This is not currently the case in Grand Teton National Park. Elk and bison in the Jackson herds have a low winter mortality rate due to the supplemental feeding program on the National Elk Refuge and in the Gros Ventre Range. Grizzly bears in Grand Teton National Park do not

appear to depend as heavily on meat in the early spring compared to grizzlies to the north in Yellowstone National Park.

By mid-May grizzly bears begin preying on newborn elk calves (Singer et al. 1997; Gunther and Renkin 1990). Even though grizzly predation on elk calves has not been documented in Grand Teton National Park, it likely occurs.

Grizzly bears dominate other scavengers at carcasses (Servheen and Knight 1990), but many carcasses are consumed prior to being found by a bear (Green 1994). Individual bears are most likely to get their largest meals from adult moose and elk that are prey and from adult female bison that are scavenged (Mattson 1997).

BALD EAGLES

The bald eagle *(Haliaeetus leucocephalus)* is currently listed as federally threatened and is protected under the Migratory Bird Treaty Act (16 USC 703) and the Bald Eagle Protection Act (16 USC 668). It is also a Wyoming priority 2 species of special concern. Bald eagle winter habitat is generally associated with areas of open water, where fish or waterfowl congregate (Swenson, Alt, and Eng 1986), or ungulate winter range where eagles scavenge on carcasses of large mammals. The majority of nesting territories in Jackson Hole are along major rivers or lakes within 3 miles of their inlets or outlets, or along thermally influenced streams or lakes. Nearby food, suitable perches, and security from human activities are important habitat components for both nest and roost sites.

Two bald eagle nesting territories occur on or near the National Elk Refuge. During the fall as many as 35 bald eagles have been seen at one time in the cottonwood trees near the southern boundary for the elk hunt area on the refuge (Griffin, pers. comm. 2002). These eagles feed on gut piles left by hunters. Typically only five bald eagles remain on or near the refuge throughout the winter.

Grand Teton National Park contains 12 known nesting territories and pairs; however, not all pairs nest in the park each year. Known territories are along the shorelines of the Snake River and Jackson Lake. No bald eagles are known to nest within the John D. Rockefeller, Jr., Memorial Parkway, although the upper Snake River is used extensively for foraging year-round (Alt 1980). Bald eagles that nest along the Snake River in Grand Teton National Park may remain in their nest territories throughout the year, occasionally leaving during the nonbreeding season to exploit abundant or ephemeral food sources elsewhere. Lake-nesting birds may remain in their territories for most of the time that Jackson Lake is free of ice. Other winter foraging areas in Grand Teton National Park include the Buffalo Fork and Cottonwood Creek.

In 2004 bald eagles occupied 11 of 12 established nesting territories in Grand Teton National Park. Ten of these nests were active, and five nests successfully produced a total of six fledglings (NPS 2005a). The nest that is adjacent to the National Elk Refuge produced one fledging in 2004.

YELLOW-BILLED CUCKOO

In 2001 the U.S. Fish and Wildlife Service determined that the yellow-billed cuckoo (*Coccyzus americanus*) population in the western United States meets the criteria to qualify as a distinct population segment and is consequently warranted protection under the Endangered Species Act. However, the agency's current workload precludes listing at this time.

The yellow-billed cuckoo is a Neotropical migratory bird that historically was distributed throughout most of the United States, southern Canada, and northern Mexico. The cuckoo's population is highly fragmented and at dangerously low levels. It is considered a rare summer resident of Wyoming. Little is known about the historic distribution of cuckoos in Wyoming, and documented observations have been few. However, Wyoming is on the periphery of the cuckoo's range, and the species may never have been abundant in Wyoming due to its breeding requirement for relatively large tracts of woody riparian habitat below 7,000 feet (Wyoming Natural Diversity Database 2002). Yellow-billed cuckoos rarely occur in Jackson Hole, and there is no documentation of nesting (Wachob, pers. comm. 2004). A few were seen at Toppings Meadow west of Mount Leidy in the 1970s and near the Gros Ventre campground about 15 years ago during breeding bird censuses (Raynes, pers.

comm. 2002). The last documented sighting was in 2000 when one was caught in a mist net near Ditch Creek in Grand Teton National Park (Wachob, pers. comm. 2004).

The loss of woody riparian habitat on the National Elk Refuge and the loss of dense understory vegetation in Grand Teton National Park and Bridger-Teton National Forest due to heavy browsing by ungulates and other factors could be contributing to the decline of yellow-billed cuckoos.

OTHER UNGULATES

The greater Yellowstone ecosystem supports large migratory herds of numerous ungulates due to its climate, geology, elevational and vegetational diversity, and relatively undeveloped state. In addition to bison and elk, pronghorn, mule deer, bighorn sheep, and moose occur within the primary analysis area. As previously discussed, white-tailed deer are not abundant, and nonnative mountain goats have little habitat overlap with bison and elk.

In the greater Yellowstone ecosystem, as in most areas, winter is the critical period for ungulates. Snow depth and density limit the amount of range accessible for use (Gilbert, Wallmo, and Gill 1970). The severity of the winters also makes ungulates more vulnerable to other stresses. Unfamiliar human activity on winter range can be extremely draining on energy reserves compared to predictable and habitual activities, or to disturbances occurring during other seasons.

Bighorn sheep on the National Elk Refuge.

BIGHORN SHEEP

In Grand Teton National Park bighorn sheep are found in isolated bands at high elevations along the western park boundary and among the major peaks. The Teton bighorn sheep herd is nonmigratory and is composed of two subpopulations: one in the north (west of Jackson Lake), and one in the south (west of Phelps Lake). The entire herd is a marginally viable, remnant population that is geographically isolated from other herds and persists in a harsh environment. There may be limited interchange between the two subpopulations, which together number about 125 (Wolff, pers. comm. 2004).

Bighorn sheep on the National Elk Refuge are primarily winter residents that migrate from the Gros Ventre Mountains. From November to May they occur on the eastern slopes of Miller Butte, along the eastern side, and in the northern portions of the National Elk Refuge in the vicinity of Curtis Canyon. As many as 55 sheep have been observed during previous winters on the National Elk Refuge (NER files). In 2004, 30 bighorn sheep were seen, and in 2005, 31.

On the National Elk Refuge and in Grand Teton National Park the diet of bighorn sheep may overlap that of elk and bison, but habitats overlap in relatively few areas. Competition with elk and bison is limited under existing management (B. L. Smith, pers. comm. 2002).

PRONGHORN

In the past as many as 450 pronghorn summered on Jackson Hole lands (including the National Elk Refuge, Grand Teton National Park, and Bridger-Teton National Forest). For unknown reasons, the number of pronghorn has recently declined to approximately 175 (Berger, pers. comm. 2002). Most pronghorn migrate south out of the valley through the Gros Ventre Mountains to winter range in the Green River basin. Small numbers of pronghorn (up to 15 in some years) reside on the northern part of the refuge in the mixed sagebrush and grassland communities. Occasionally, as many as 33 pronghorn have wintered on the refuge and the adjacent slopes of East Gros Ventre Butte. Harsh winter conditions common to the valley, as well as predation by coyotes, have significantly reduced the number of animals surviving the

winter. In Grand Teton National Park pronghorn inhabit the flat grasslands and sagebrush-steppe communities extending from Moran south to the National Elk Refuge during summer months.

Because most pronghorn migrate out of the valley in winter, they are not sympatric with elk and bison on winter range. During summer pronghorn, elk, and bison occupy the same habitats in Grand Teton National Park. Pronghorn may benefit from the presence of elk and bison in the summer because grazing by the larger ungulates may keep grasses from outcompeting the more preferred forbs and shrubs (Berger, pers. comm. 2002).

MULE DEER

Mule deer in Jackson Hole belong to the Sublette deer herd, whose estimated population was 32,000 in 2004 (Clause, pers. comm. 2004). The Sublette deer herd ranges from the Wind River Mountains north to the Gros Ventre Range, west to the Wyoming Range, southwest to the Green River drainage, and southeast to the Little Colorado Desert. A small proportion of these deer come into the Jackson Hole area, and they are not counted separately from the Sublette herd as a whole. Some mule deer winter in Jackson Hole and can often be seen in the town of Jackson and on East Gros Ventre Butte.

On the National Elk Refuge mule deer winter primarily on Miller Butte, but their numbers have greatly declined since the refuge closed an old feed shed that allowed deer access to alfalfa pellets. No deer were seen on Miller Butte during winters from 2001–2 to 2004–5; eight were seen in the winter of 2005–6. In spring, summer, and fall a small number of mule deer can be found on the northern part of the refuge in the Gros Ventre Hills and along the Gros Ventre River. These deer may leave this area at the beginning of elk hunting season in October. In Grand Teton National Park deer are relatively common.

MOOSE

Experts disagree about the exact number of moose in the Jackson Hole area but most believe it is about half of what it was at its peak in 1992, when it numbered approximately 3,500 (Brimeyer, pers. comm. 2003). Moose range includes the National Elk Refuge, Grand Teton National Park, and Bridger-Teton National Forest. In the past 20 to 30 years moose used riparian habitat along the Gros Ventre River on the refuge during the winter.

In Grand Teton National Park moose can be found at higher elevations in the summer and in riparian areas throughout the year. In the winter moose are often seen in sagebrush-steppe habitat in Antelope Flats, along the Snake River and Gros Ventre River corridors, and in the Willow Flats / Hermitage Point area. The parkwide population during summer is unknown, but most moose that summer within the park probably remain for the winter (NPS 1995).

Both moose and elk browse on willow and aspen and other woody shrubs. Bison do not typically browse on woody vegetation (except near feedgrounds), but they rub against trees and seek shelter in riparian areas. The decrease in woody vegetation due to large numbers of elk on the refuge likely has had a negative effect on moose on the refuge over the long term.

PREDATORS AND SCAVENGERS

COYOTES

Coyotes are plentiful in the greater Yellowstone ecosystem, including the National Elk Refuge, Grand Teton National Park, and Bridger-Teton National Forest. Several family groups live year-round on the refuge, but the number increases to nearly 100 as “transients” follow the elk herds to the refuge in the winter (Camenzind, pers. comm. 2003). Coyotes also occur year-round in all areas of the park. Coyotes are opportunistic predators that readily feed on carrion, but they also catch a variety of small mammals from mice, squirrels, and rabbits to fawns and calves, and they also feed on insects and fruit. In winter elk and occasionally bison carrion on the refuge are an important part of their diet. In the spring coyotes may take elk calves during the first month of life. They rarely have the opportunity to kill bison calves due to the presence of the herd and protective mothers.

Coyote and magpies scavenging on an elk carcass.

COUGARS

Cougars occur throughout the greater Yellowstone ecosystem, including the refuge, the park, and the national forest. Cougars feed mainly on ungulates, primarily deer, throughout much of their distribution, but they can take elk, moose, and bighorn sheep. Where elk are abundant, they can become a large part of the cougar diet (Ruth 2004). They have also been known to feed opportunistically on wild horses, beavers, porcupines, raccoons, and hares, indicating one of the most varied diets of any predator in the Western Hemisphere (Hansen 1992). A cougar (also known as a mountain lion or puma) and her three kittens were seen frequenting a cave on Miller Butte on the refuge for two months during the winter of 1999. She was a skilled elk and deer hunter and provided a great wildlife watching opportunity.

Cougars prey mostly on a combination of deer and elk in the Jackson Hole area, relying more on elk than in other areas of the country due to the large elk herd (Moody, pers. comm. 2002; Quigley, Craighead, and Jaffe 2005). The Teton Cougar Project* was initiated in January 2001 and is focusing field investigations on cougar predation. Information collected to date show that elk made up approximately 80% of 86 cougar kills from 2000 to 2004 (Quigley, Craighead, and Jaffe 2005). Although it is apparent that elk are a major prey species in Jackson Hole, a larger sample size is needed to draw statistically valid conclusions (Gray, pers. comm. 2002; Quigley, pers comm. 2005). Cougar research in Jackson Hole will continue until 2007 under the auspices of Beringia South.

The exact number of cougars in the analysis area will never be known. The Teton Cougar Project estimated 28 resident adult cougars based on an examination of the home ranges of radio-marked cougars in the Buffalo Valley and the lower Gros Ventre River drainages, the home ranges of known or suspected unmarked residents, and the quality of habitat in the balance of the analysis area as compared to the Buffalo Valley and the lower Gros Ventre.

* Originally operated by the Wildlife Conservation Society and now operated by Beringia South.

BLACK BEARS

Black bears are common in Grand Teton National Park and Bridger-Teton National Forest, but rarely occur on the National Elk Refuge. Inhabiting forested areas, they feed on nutritious, succulent vegetation and on grubs, fish, newborn ungulates, and carrion. Elk and bison carrion may occasionally provide valuable protein. Black bears are known to successfully prey on elk calves. Smith and Anderson (1996) reported that 22 of 145 radio-collared calves died before July 15 from 1990 to 1992; black bears were responsible for 11 of these mortalities. During the late 1990s black bears were responsible for 16 of 42 calf deaths (B. L. Smith, pers. comm. 2003). In a north-central Idaho study, black bears killed 38 of 53 marked calves or 72% (Schlegel 1976). Bison calves are not usually vulnerable to black bears because bison cows can adequately defend their young. While black bear numbers are unknown, their population is considered stable.

OTHER MAMMALIAN PREDATORS AND SCAVENGERS

Other mammalian predators inhabiting the refuge and the park include badgers, mink, long-tailed weasels, red foxes, skunks, and bobcats. All of these species prey on small mammals. A few may opportunistically feed on elk or bison carrion, but they do not depend on it as a food source. Mink are not known to feed on elk or bison carrion. Bobcats may take an occasional elk calf, but calf-mortality studies indicate that this is not a significant cause of mortality (Smith and Anderson 1996).

AVIAN PREDATORS AND SCAVENGERS

Golden eagles, peregrine falcons, prairie falcons, red-tailed hawks, Swainson's hawks, American kestrels, rough-legged hawks, and other raptors are resident species in Jackson Hole. Eagles and hawks are all predators, but their preferred prey varies widely. Small hawks typically feed on insects, while larger hawks feed on birds and small mammals. Eagles may take prey as large as foxes. Falcons often specialize on birds but may also take rodents and insects. Some of these raptors feed opportunistically on carrion, especially in winter.

Black-billed magpies and common ravens are omnivores that eat a wide variety of insects, rodents, lizards, and frogs, as well as eggs and hatchlings of other birds. They often feed as scavengers on carrion and human garbage. Elk carrion is an important source of food in the winter for avian scavengers on the refuge.

SMALL MAMMALS

Small mammals in the Jackson Hole area are abundant and include ground squirrels, mice, voles, shrews, chipmunks, tree squirrels, muskrats, northern pocket gophers, pikas, cottontails, and snowshoe hares. Suitable habitat is the most important factor influencing the distribution and abundance of small mammal populations. Many small mammals occupy a wide variety of habitats, while others have specific requirements that limit their distribution (see Table 10). In general, most species prefer more mesic environments. Edge habitats generally support more species than interior habitats.

TABLE 10: SMALL MAMMALS THAT OCCUR IN VARIOUS HABITATS

Habitat	Common Mammals
Native Grasslands / Cultivated Fields	Northern pocket gopher, desert cottontail, Wyoming ground squirrel, Merriam's shrew, long-tailed vole, deer mouse, Uinta ground squirrel, yellow pine chipmunk, sagebrush vole
Sagebrush Shrublands	Northern pocket gopher, Wyoming ground squirrel, least chipmunk, desert cottontail, yellow pine chipmunk, masked shrew, dusky shrew, Merriam's shrew, meadow vole, montane vole, deer mouse, sagebrush vole, Uinta ground squirrel, long-tailed vole, mountain (Nuttall's) cottontail, heather vole
Riparian and Aspen Woodlands	Long-tailed vole, montane vole, meadow vole, water vole, desert cottontail, snowshoe hare, mountain cottontail, northern pocket gopher, Wyoming ground squirrel, Uinta ground squirrel (aspen), yellow pine chipmunk, masked shrew, golden-mantled ground squirrel, Uinta chipmunk, red squirrel, northern flying squirrel, southern red-backed vole, western jumping mouse, vagrant shrew, dusky shrew, water shrew, heather vole, deer mouse, muskrat

SOURCE: Based on the University of Wyoming, Geographic Information Science Center, *Species Atlas,* 2003.

Small mammals depend on grasses for forage, as well as for cover from predators. Overgrazing by large numbers of elk and bison could limit the numbers of rodents that can survive in sagebrush and grassland habitats.

Riparian and aspen zones typically support a greater abundance of small mammals and a greater diversity of species, although many of these species can be found in other habitats. Browsing by elk and bison has greatly altered some small mammal habitats on the National Elk Refuge, which likely has changed the type of species found in affected areas.

A small mammal study conducted on the National Elk Refuge in the summers of 2000 and 2001 identified four species inhabiting cultivated fields — deer mice, voles, shrews, and shorttail weasels (Swanekamp, pers. comm. 2002).

Grazing by elk and bison reduces residual cover that would otherwise be available to small mammals. Irrigation, especially flood irrigation, designed to increase elk forage, also negatively affects small mammals by flooding burrows. Elk and bison are probably not affected by small mammal populations. However, large numbers of elk and bison, along with management activities designed to produce more forage for elk and bison, could decrease rodent populations, which would adversely affect avian and mammalian predators.

LARGE RODENTS

Large rodents that occur in Jackson Hole are yellow-bellied marmots, porcupines, and beavers. Marmots occupy rocky slopes of upper elevations, living in burrows in open areas and eating a variety of green vegetation. Porcupines inhabit wooded areas, feeding on leaves, twigs, and green plants during the summer. In the winter they subsist by

chewing through the rough outer bark of trees to feed on the inner bark. Beavers inhabit rivers, streams, marshes, lakes, and ponds. They feed on green plants and the bark of certain hardwoods, such as aspen and willow.

Beavers are common in woody riparian areas that provide suitable habitat. Historically, beavers occurred on the southern end of the refuge, but as willow habitat along Flat Creek declined in acreage and condition, beavers disappeared. Currently, beavers that have dispersed from the park or national forest occasionally occur in ponds on the northern part of the refuge.

Porcupines are common, occurring in riparian and aspen woodland communities. They are less common on the refuge, but are occasionally seen in upland shrub communities and riparian and aspen woodland habitats.

Bison and elk probably do not affect marmots, but the decline of woody vegetation on the National Elk Refuge due to browsing by elk and bison has likely reduced the amount of habitat available for porcupines and beavers.

BIRDS

More than 300 species of birds have been observed in Grand Teton National Park and approximately 175 species on the National Elk Refuge.

NEOTROPICAL MIGRATORY BIRDS

Of particular interest to this planning process are Neotropical migratory birds, which breed in North America and spend their winters in the tropics. Throughout their range, these migrants have been experiencing population declines (USGS 1999; Terborgh 1989). Habitat fragmentation and degradation, as well as destruction of winter range, are among the factors believed to be responsible for these declines (Dobkin and Wilcox 1986; Dobkin 1994; Martin and Finch 1995; George and Dobkin 2002).

Many species of Neotropical migratory birds are declining in North America due to an inability to raise young successfully rather than due to mortality of adult birds (Herkert et al. 1993). Loss of habitat has long been suspected as contributing to nest failure and poor survival of young birds, but habitat fragmentation plays an important role (Kaufmann 1996). In fragmented landscapes, Neotropical species suffer high rates of nest predation by mammals and birds, and also high rates of nest parasitism by brown-headed cowbirds. Researchers have shown that habitat size, shape, and amount and type of edge can all affect breeding success. Edge habitats also support a larger variety and higher density of predators (Lompart, Riley, and Fieldhouse 1997).

Potential nest predators, such as foxes, raccoons, skunks, cats, magpies, crows, and ravens are attracted to habitat edges, often preying on eggs and young birds in small woodlots, narrow strips of riparian habitat, and near edges of larger forests (Wilcove 1985; Yahner 1988). In some forests this edge-enhanced nest predation has been documented to extend more than 300 feet into the interior of the forest patch (Wilcove 1985). Martin (1988, 1993) found that nest predation can account for, on average, 80% of nesting failures, and Donovan et al. (1997) established that where habitats are fragmented, predators gain greater access to nests at forest edges.

Brown-headed cowbirds are common in Jackson Hole, and cowbird parasitism can be a serious problem for many Neotropical migratory bird species. Cowbirds lay their eggs in the nests of other birds, often removing a host egg before laying one of their own. Cowbird chicks hatch earlier and grow faster than host chicks, which results in the cowbird young receiving most of the food and parental care from the foster parents. Female brown-headed cowbirds prefer edge habitats and can lay up to 77 eggs in a single season (Jackson and Roby 1992). Edge-tolerant songbird species can often recognize cowbird eggs and remove them from the nest, or they may abandon parasitized nests. These edge-tolerant species are often permanent residents or short-distance migrants and can nest several times in a season. This increases their chances of raising a successful brood since cowbirds rarely parasitize late season nests (Ehrlich, Dobkin, and Wheye 1988). In contrast, interior forest birds, which are usually long-distance migrants and only nest once or twice a year, often fail to raise any young of their own when forced to nest in edge habitats because they have not evolved behaviors to cope with nest parasitism.

As a result, interior forest species, such as the veery and the American redstart, disappear from small patches of forest habitat, and edge-tolerant species such as the American robin and house wren, greatly increase (Herkert et al. 1993).

On the National Elk Refuge small or narrow patches of riparian and aspen woodland habitats are often in poor condition due to overbrowsing by ungulates. However, even if these patches are protected in some manner resulting in improved condition, Neotropical migratory birds may not benefit because of the size and shape of the individual patches for the reasons discussed above. In order to both improve the condition of the plant community and benefit the survival and reproduction of Neotropical migratory birds, care must be taken to ensure that preserved habitats are large enough to prevent the habitat patch from becoming a population sink.

An example of a narrow habitat patch would be the cottonwood community along upper Flat Creek. This long riparian strip may always be too narrow to provide forest interior habitat for Neotropical migratory birds that require forest interior conditions for successful nesting. Some species of birds may avoid such areas and not attempt to nest, while others may make unsuccessful nesting attempts. For those birds that attempt nesting but fail to fledge young due to high predation and parasitism rates, this area may become (or possibly has always been) a population sink. Nevertheless, small or narrow tracts of riparian and aspen woodland habitat are still valuable to a variety of birds as stopover sites during migration.

Sagebrush Shrublands and Native Grasslands

Sagebrush and grassland plant communities provide important breeding habitat between May and mid-July to some Neotropical migrant species, and these cover types are abundant on the refuge and in the park.

Typical bird species that nest in the sagebrush shrublands community are sage thrashers, Brewer's sparrows, and sage sparrows. Many sagebrush bird species are declining as habitat throughout the west is converted to farmland and development. As aspen and riparian habitats on the National Elk Refuge are converted to sagebrush habitat due to heavy elk and bison browsing, more sagebrush shrubland habitat will become available to bird species dependent on this habitat. Efforts to restore cultivated areas to native sagebrush communities on the refuge and in the national park would also benefit sagebrush-dependent bird species.

Riparian and Aspen Woodlands

In the arid West riparian and aspen woodland habitats with a shrub understory support the most species-rich communities of breeding birds (Dobkin and Wilcox 1986; Knopf et al. 1988; Saab et al. 1995; Mitton and Grant 1996; Tewksbury et al. 2002), provide critical migration habitat for migratory landbirds (Dobkin 1994), and are centers for biological diversity (Brussard, Charlet, and Dobkin 1998). These habitats are critical for breeding habitat and migration stopovers for 80% of migratory bird species (Krueper 1992) because they are used extensively for feeding, nesting, shelter, and travel corridors. The open canopies allow sunlight to reach the ground, producing a rich understory of shrub and herbaceous species offering structural diversity. The layered structure of these woodlands provides numerous niches for birds. Cavity nesters use snags for nest sites, while predatory birds perch on dead trees to scan for prey. Neotropical birds nest at different levels, and they feed on the diversity of insects found in aspen and riparian woodlands.

The ecological health of a woody plant community can be directly measured by avian species composition, relative abundances, and breeding success (Dobkin, Singer, and Platts 2002). Riparian and aspen woodlands shelter many bird species that have relatively narrow breeding-habitat requirements. These species may occur chiefly or exclusively in these willow, aspen, and cottonwood communities. In the southern portion of the greater Yellowstone ecosystem an ecologically intact riparian or aspen woodland can have 76 species of birds closely associated with it during the nesting season, and 23 "core" species will be common and relatively abundant (Dobkin, Singer, and Platts 2002). All of these 23 core species are Neotropical migrants.

Cattle and wildlife grazing and browsing, especially in arid systems, can greatly affect the quality of

Woodpecker on the National Elk Refuge.

riparian habitat for Neotropical migrants (Roath and Krueger 1982; Taylor 1986; Saab et al. 1995; Ammon and Stacey 1997). Upland aspen has been declining in Jackson Hole for the last several decades (Loope and Gruell 1973), as well as throughout the West (Kay 1998). Fire suppression is a major factor in the reduction of aspen (Loope and Gruell 1973; White, Olmstead, and Kay 1998; Kay 1998), but on the National Elk Refuge ungulate browsing has greatly accelerated this decline (E. M. Anderson 2002; Dieni et al. 2000).

The mixture of riparian and upland aspen habitats found on the National Elk Refuge and in Grand Teton National Park is important to a variety of species. Wallen (pers. comm. 1994, as cited in USFWS 1998) found that riparian and wetland habitats in Grand Teton generally contain the highest density of Neotropical migrants. Anderson observed 25 bird species in riparian woodland habitats and 54 species in upland aspen habitat in the Jackson Hole vicinity (E. M. Anderson 2002).

Riparian and aspen woodlands that lack recruitment, such as those found on the National Elk Refuge, are structurally simplified and support a less diverse community of bird species. Birds found in this simplified habitat generally have habitat requirements that can be met in a wide variety of habitat types. Trabold and Smith (2001) found that European starlings on the National Elk Refuge overwhelmingly dominate the cottonwood riparian habitat along Flat Creek. This is typical of highly fragmented cottonwood habitat and the species-poor avifauna it supports (Gutzwiller and Anderson 1987). Many native cavity nesters cannot successfully compete with the highly aggressive starling. Aspen stands on the refuge also have low abundances of key native species that are aspen obligates, such as red-naped sapsucker and MacGillivray's warbler (Anderson and Anderson 2001). Some widespread habitat specialists are completely absent, including the broad-tailed hummingbird, calliope hummingbird, rufous hummingbird, veery, Swainson's thrush, orange-crowned warbler, black-headed grosbeak, fox sparrow, and song sparrow (Dieni and Anderson 1997).

The decline of woody vegetation on the National Elk Refuge and the resultant decline in Neotropical migrants is attributed to 90 years of heavy browsing by elk and more recently by bison. Anderson conducted a study in and around Jackson Hole specifically to determine the effect, if any, that supplementally fed elk were having on landbird distribution in upland aspen and riparian habitats (E. M. Anderson 2002). His results are summarized below:

Aspen woodland habitats that were browsed heavily by elk were characterized by (1) less understory volume of vegetation, (2) lower densities of non-sapling live and dead trees, (3) greater proportions of dead aspen trees (non-sapling), (4) more regeneration of suckers less than 0.5 meter, (5) less recruitment to overstory, (6) a lower density of aspen saplings, (7) a lower proportion of the stands with saplings, (8) higher rates of sucker browsing, (9) a lower proportion of suckers, (10) more damage to bark, (11) a higher density of dead trees, and (12) a higher proportion of the stands with dead aspen trees. Aspen woodland habitats heavily browsed by elk were also characterized by (1) fewer species of birds that nest and feed in the understory, (2) fewer species of

birds that nest and feed in forest canopies, (3) fewer ground-nesting species, and (4) a greater abundance of cavity-nesting birds, probably due to the higher rates of aspen decay and mortality. Aspen stands on the National Elk Refuge that received high elk use (i.e., stands with the longest duration of high elk densities) had a significantly lower diversity of birds, and birds were less abundant as compared to aspen stands with low elk use. When aspen stands are converted to sagebrush shrubland habitat by high elk use, there is an exchange of approximately 20–40 bird species for 3–5 bird species that are generally more common than those found in aspen stands.

Riparian woodland habitats that are heavily browsed by elk are characterized by (1) lower willow volume, (2) lower willow shrub diameter, (3) fewer willow habitat bird specialists, (4) fewer species that nest in willow, and (5) fewer aerially foraging species. Riparian areas closest to feedgrounds receive the heaviest elk use and experience the greatest loss in bird species that are riparian obligates, such as willow flycatchers, yellow warblers, MacGillivray's warblers, fox sparrows, and song sparrows. Species of birds that are abundant near feedgrounds include those that typically nest in sagebrush or grasslands, such as savannah sparrows, vesper sparrows, western meadowlarks, and Brewer's blackbirds. Nest predators, such as common ravens and black-billed magpies, were also more common near feedgrounds, possibly due to the greater availability of elk carcasses. These nest predators may accelerate the decline of Neotropical migrants. Anderson emphasized that recruitment of aspen and willow was extremely rare both on the National Elk Refuge and near the WGFD Gros Ventre feedgrounds (E. M. Anderson 2002).

Cultivated Fields

Neotropical migrants that can be found in the cultivated fields on the National Elk Refuge and formerly agricultural lands in Grand Teton National Park include western meadowlarks, savannah sparrows, Brewer's sparrows, and vesper sparrows. These species also occur in native grasslands.

GALLINACEOUS BIRDS

Greater Sage Grouse

On the National Elk Refuge the sage grouse population has been sporadically monitored since 1977. Only one of two historical leks remain active on the refuge, and numbers of sage grouse counted in the leks have ranged from a high of 157 to a low of 2 (NER files). In spring 2005, 37 grouse were counted. The maximum number of males counted on the refuge was 18 in 2005 and 30 in 2006. The north end of the refuge contains valuable breeding and nesting habitat for the Jackson Hole sage grouse population.

In Grand Teton National Park the sage grouse population has been monitored annually since 1986, and earlier surveys date to the 1940s. The sage grouse decline in Grand Teton is at 79% (NPS 2002); only three of eight historical leks were active in 2005. In other areas changes in habitat are thought to be the primary cause of the observed declines, but the amount of sagebrush habitat within the park has changed little since surveys began in the 1940s. A survey was conducted in the park from 1999 to 2003 to determine the causes of this precipitous decline. During that time Halloran and Anderson (2004) found that sage grouse population growth in the park was essentially stable, and that a 6% increase in female annual survival combined with an 18% increase in productivity could result in a 10% annual population increase and viable population levels in approximately six years. Sagebrush habitat with increased residual grass cover, live and residual grass height, and forb cover and diversity was more likely to produce successful nests. Chick survival would be positively correlated with increased forb cover and diversity, plus numbers of optimally sized insects (Halloran and Anderson 2004). They identified winter habitat, which consists of relatively flat south- to west-facing slopes with increased sagebrush canopy cover and height, as a potential limiting factor for sage grouse population growth in Jackson Hole. In addition, the airport lek population has been affected by construction, sagebrush clearing, strikes by aircraft, and possibly fencing that provides predators with a convenient perch.

Greater sage grouse nest only in sagebrush habitat, using bunch grasses and sagebrush plants as cover (Kaufman 1996). Other important habitats include meadows and grasslands close to sagebrush habitat.

In Jackson Hole the sage grouse population has decreased by 70% in recent years (Bohne, pers. comm. 2002). Factors that may be contributing to this local decline are loss of habitat to human development, prescribed burning of winter range, airstrikes at the airport, and browsing and grazing by livestock and large numbers of elk and bison.

Forest Grouse

Ruffed grouse are generally widespread and common, occurring in deciduous and mixed woodlands. Conifer forests may be used for shelter, while deciduous habitats are primarily used for food. Because elk browse on the woody vegetation that ruffed grouse rely on for their winter diet, changes in woody vegetation may affect ruffed grouse populations on the refuge.

Blue grouse are fairly common inhabitants of deciduous and mixed forests in the mountains during the summer. Blue grouse, elk, and bison share deciduous and mixed forest habitat in summer, but there is probably little competition between them since they feed on different plants.

Waterfowl, Shorebirds, Rails, and Cranes

Waterfowl, shorebird, rail, and crane species in the analysis area are diverse and in most cases have habitat linked to aquatic or wetland features. They are vulnerable to predators because of their location on the ground, and they must rely on dense vegetation for camouflage or water levels high enough to impede nest raiders.

Several species of waterfowl — trumpeter swans, Canada geese, mallards, green-winged teal, gadwalls, American widgeons, common and Barrow's golden-eyes, and common mergansers — are year-round residents on refuge wetlands, but most waterfowl and shorebird species in the Jackson Hole area are seasonal migrants. Rocky Mountain Canada geese nest on wetlands throughout Jackson Hole, and fall populations on the refuge number 300–500, with 100 or so overwintering. Duck populations range from 200 to 500 annually, with gadwall, mallard, ring-necked duck, green-winged teal, cinnamon teal, and Barrow's golden-eye the largest contributors. Fall peak waterfowl populations

Trumpeter swan nesting on the National Elk Refuge.

number near 3,000, and about 200–300 birds overwinter on the refuge. The greater sandhill crane nests in small numbers in Jackson Hole, and fall concentrations of more than 150 birds have been observed on the refuge.

REPTILES AND AMPHIBIANS

Only 11 reptile and amphibian species are present in the Jackson Hole Valley, because of the high altitude and its associated cool climate. Most species are observed throughout the valley floor and foothill regions, especially along the Snake River, Buffalo Fork, and Gros Ventre River floodplains; some also inhabit the mountains up to 10,000 feet elevation. Several of the reptile species are rare, with apparently restricted distributions, including the northern sagebrush lizard, the valley garter snake, and the gopher snake. The nonnative bullfrog is known to exist only in the Kelly warm springs and nearby areas, where it was introduced decades ago (Koch and Peterson 1995).

Amphibian surveys conducted in 2000–2003 documented the occurrence of five species of amphibians — the blotched tiger salamander, the boreal toad, the boreal chorus frog, the Columbia spotted frog, and the nonnative bullfrog (Patla and Peterson 2004).

Recent surveys conducted in the Flat Creek and Gros Ventre River drainages on the National Elk Refuge have documented breeding sites for four amphibians (the blotched tiger salamander, boreal toad, boreal chorus frog, and Columbia spotted frog) and the occurrence of the wandering garter snake (Patla 1998, 2000). Tiger salamanders are rare on the refuge, although they are quite common in Bridger-Teton National Forest. Boreal toads are widespread on the refuge, with breeding populations in the Flat Creek and Gros Ventre watersheds (Patla 1998, 2000, 2004b). There are few Columbia spotted frogs in the Flat Creek drainage, but they are widespread in the Gros Ventre River drainage. The most widespread amphibian on the refuge is the boreal chorus frog, which occurs in both drainages at multiple sites, but their breeding populations are unexpectedly small and scattered (Patla 2000).

The most significant and disturbing result of the amphibian surveys for the National Elk Refuge was the discovery in 2000 of amphibians killed by chytrid disease. This disease is caused by an aquatic fungus that has been associated with mass die-offs and population declines in many areas and may be contributing to the continuing and potentially escalating amphibian declines throughout the United State and the world (Patla 2000). This is the first time that this disease has been documented in northwestern Wyoming, and boreal toads are particularly susceptible. The boreal toad populations of southern Wyoming and Colorado are candidates for listing as federal endangered species and a state endangered species in Colorado (Patla 2000). A veterinarian with U.S. Geological Survey has stated, "The diagnosis of chytridiomycosis has potentially dire implications for all species of frogs and toads in the National Elk Refuge and, possibly, western Wyoming" (Green, pers. comm., as quoted in Patla 2000).

Since the discovery of chytrid disease on the National Elk Refuge in 2000, chytrid fungus has been found in several locations in Grand Teton and Yellowstone national parks and one location in Bridger-Teton National Forest. On the refuge live amphibians were tested for the presence of chytrid fungus on their skin; in 2003, 66% of the sampled amphibians tested positive for the fungus and in 2004, 71% (Patla 2004a, 2004b). Testing for chytrid also occurred in two park locations during the 2004 field season, with rates of 30%–85% among individuals tested (NPS 2004b). However skin tests on live animals may not accurately determine whether the amphibian is actually infected. As of the end of summer 2004, chytrid had not decimated the toad populations at the two main breeding sites on the refuge, and no indicators of a population decline on the refuge (such as mass mortality events or failed reproduction) have been observed (Patla 2004b).

Concentrated numbers of elk and bison may affect amphibians and their habitat by decreasing water quality, increasing streambank erosion, altering marsh and riparian vegetation, and possibly transporting chytrid fungus on their hoofs. Conversion from flood irrigation to sprinkler irrigation could reduce the amount of standing water available for amphibians. Human disturbance of ponds, wetlands, and the surrounding areas could result in adverse effects to amphibian habitat.

Amphibian species of special concern are the boreal toad *(Bufo boreas boreas)* and the northern leopard frog *(Rana pipiens)*. The boreal toad is thought to have declined in abundance in the greater Yellowstone ecosystem, and the northern leopard frog, documented to breed in Grand Teton National Park, is now extremely rare or absent (Koch and Peterson 1995). Both of these species inhabit a wide range of aquatic habitats, including ponds, wetlands, streamsides, riparian zones, forests, and meadows. They could be impacted by water pollution, chemical herbicides, or pesticides, wetland and streambank disturbances, and diseases.

Two reptile species are of special concern in Jackson Hole. The northern sagebrush lizard *(Sceloporus graciosus graciosus)* is found at elevations up to 8,300 feet and is commonly associated with thermal areas in Yellowstone (NPS 1998a). The rubber boa *(Charina bottae)* often inhabits riparian zones and could be adversely affected by soil compaction or vegetation loss.

HUMAN HISTORY AND CULTURAL RESOURCES

INDIGENOUS PEOPLE OF WESTERN WYOMING

During prehistoric times, no one tribe occupied Jackson Hole. Native Americans living on surrounding lands used this neutral valley primarily during the warm months. Traditional uses of the lands included hunting or fishing, collection of plants and minerals, and ceremonial activities.

The most prominent groups that occupied the eastern Idaho and western Wyoming area prior to settlement by Euro-Americans were the Bannock, Northern Shoshone, and Eastern Shoshone. Other American Indian tribal groups have some historic or continued association with lands now within the National Elk Refuge and Grand Teton National Park, including the Assiniboine, Athabascans, Comanche, Salish, Kiowa, Kootenai, Crow, Gros Ventre, Teton Sioux, Umatilla, and Nez Perce. In addition, the Arapaho, Blackfeet, Cheyenne, and other Siouan groups and people of the Plains made excursions into the region for hunting, warfare, and trade (Walker in prep.).

The Bannock are related to the Northern Paiute and are Uto Aztecan speakers who migrated from Oregon into the area of the Snake River plains. There they lived in peaceful cooperation among the Shoshone speakers who had arrived from the Plains. The merged Bannock and Northern Shoshone developed a single amalgamated culture that exhibited strong Plains Indian influences.

The Bannock and Shoshone occupied areas currently designated as eastern Idaho and western Wyoming. This area, the upper Snake River plains, received higher rainfall, providing adequate grasses and forage for bison to exist. Bison were by far the greatest food resource, providing an endless supply of food, clothing and shelter materials, and weapon and tool products.*

* Bison were also viewed as an earthly link to the spiritual world. For many tribes even today bison represent power and strength. For example, the Shoshone believe that spiritual power is concentrated in the physical form of the bison. Many contemporary tribes maintain a spiritual connection with bison.

An early depiction of Native Americans hunting.

Emigration, continuing warfare among tribes, and gradual loss of forage after the 1840s limited the amount of bison taken for food supplies. The bison herds west of the Continental Divide were greatly diminished and decimated by 1850, primarily by Euro-American immigrants.

Another principal food was fish, which were taken in the spring, when other food supplies were low, and were either eaten fresh or preserved by sun-drying or smoking.

Next in importance to buffalo and fish were elk. As the tribes began to compete for resources when emigrations diminished the major game on the plains, they turned to the mountains. The mountains still provided game for subsistence, whether it was elk, bighorn sheep, moose, or deer. In addition, berries were still found along the river banks, and roots could still be dug in the surrounding hills. Native plants were also important to the prehistoric inhabitants of the Greater Yellowstone Area. Today, modern tribes still collect and use these plants for ceremonial and traditional purposes.

The Shoshone entered into a treaty with the United States July 2, 1863, that set apart for the Shoshone Tribe a reservation of 44,672,000 acres located in Colorado, Utah, Idaho, and Wyoming. However, the Treaty of Fort Bridger of 1868 pared this down to less than 2.8 million acres, and it established both the Fort Hall Reservation in

Idaho and the Wind River Reservation in Wyoming.

The Treaty of Fort Bridger also designated reservations for the Bannock, a suitable one to be selected for them in their present country. The Bannock chose to stay on the Fort Hall Reservation.

The Bannock and Shoshone experienced extreme hardship subsequent to the treaties and later agreements that separated them from their aboriginal territories. Prohibitions of off-reservation hunting and meager rationing and diseases adversely affected the tribal populations and social health.

> The Indians herein named . . . will make said reservations their permanent home, and they will make no permanent settlement elsewhere; but they shall have the right to hunt on the unoccupied lands of the United States so long as game may be found there on, and so long as peace subsists among the whites and Indians, on the borders of the hunting districts.
>
> — Article 4. *Treaty between the United States of America and the eastern band of Shoshonees and the Bannack tribe of Indians.*

By the end of the 1800s tribal land bases were greatly diminished, and tribal rights to hunt were curtailed. In *Ward v. Race Horse* (1896), tribal hunting beyond the exterior boundaries of the reservations was curtailed because the Supreme Court reasoned that this provision was temporary, and when Wyoming was admitted into the Union, it did so on an equal footing as all other states without lands within the state being encumbered.

After additional treaties, congressional acts, executive orders, and agreements, the Bannock and Shoshone now occupy the Fort Hall Reservation in eastern Idaho and the Duck Valley Reservation in southwestern Idaho. The Eastern Shoshone are on the Wind River Reservation in west-central Wyoming.

Other American Indian tribal groups (at least 15) have some historical or continued association with lands now within the National Elk Refuge and Grand Teton National Park (Walker in prep.). Traditional uses of the lands include hunting or fishing, collection of plants and/or minerals, and ceremonial activities.

EURO-AMERICAN HISTORY

John Colter, a member of the Lewis and Clark expedition and later an explorer and trader for the Manuel Fur Company, may have visited Jackson Hole in 1807. Other trappers and traders from the Missouri Fur Company trapped the rivers and streams of Jackson Hole in 1810–11 (Daugherty 1999). During the 1820s and 1830s Jackson Hole served as a crossroads of the fur trade in the northern Rocky Mountains.

Except for a few prospectors searching for gold, Jackson Hole was virtually deserted by Euro-Americans from the 1840s to the 1880s. However, three military surveys passed through the valley in the 1860s and early 1870s. These military surveys were followed by the Hayden surveys (1872, 1877, and 1878), which were sponsored by the U.S. Geological Survey and explored the Jackson Hole and Yellowstone country. It was during the first Hayden survey in 1872 that the first photographs of the Tetons were taken by William H. Jackson.

In 1884 the first permanent settlers arrived and built cabins along Flat Creek inside the boundaries of the present-day National Elk Refuge. By 1900, 638 people resided in Jackson Hole (Daugherty 1999). The first homesteaders planted crops and raised cattle on small family ranches throughout the valley. Long cold winters with deep snows, poor soils, and dry conditions that required digging irrigation ditches to water crops made homesteading in Jackson Hole a very difficult endeavor. By 1900 many of the original settlers had already left the valley (Daugherty 1999). In 1912, when the U.S. government allocated money to buy up homesteads to set aside land for the National Elk Refuge, many homesteaders willingly sold their property and moved into town. In other parts of the valley cattle ranching continued and expanded through the 1930s (Daugherty 1999) and remained the mainstay of the economy into the 1960s (Charture Institute 2003a).

In 1929, 96,000 acres were set aside to create a national park that included the Teton Range and

the six glacial lakes at the base of the range. In 1943 Jackson Hole National Monument was created from a donation of 35,000 acres by John D. Rockefeller, Jr., through his Snake River Land Company, plus some national forest land. Grand Teton National Park and the Jackson Hole National Monument were merged in 1950, forming an enlarged 310,000-acre park.

Before Euro-American settlement, some researchers believe that most elk migrated out of Jackson Hole in the winter, but homesteaders gradually forced elk off traditional winter ranges both inside and outside the valley (Craighead 1952; C. Anderson 1958; Cromley 2000) and cut and stacked elk winter forage in Jackson Hole to feed domestic livestock. Even before the Jackson Hole environment was changed by the arrival of homesteaders, early hunters and settlers noted that winters of unusually heavy snow caused thousands of elk to starve to death.

Bison played no role in early settlers' lives due to the fact that bison had been extirpated from the valley by the 1840s.

Historic photo of Jackson, ca. late 1800s.

CULTURAL RESOURCES

ARCHEOLOGICAL RESOURCES

Limited but documented archeological evidence indicates that Native Americans have used the Jackson Hole Valley for at least 11,000 years. Shifting climate patterns and the resulting change in plant and animal communities, along with drought and fire, determined how and when the valley was utilized. From 11,000 B.P. to around 5,800 B.P. American Indians occupied the valley sporadically to hunt and to obtain obsidian and other lithic material for tools. Numerous tools, fire hearths, and roasting pits have been found, particularly around Jackson Lake, dating after 5,800 B.P. These people lived a hunter-gatherer lifestyle and traveled in small groups. Tipi rings begin to appear in the archeological record after 5,000 B.P., and a few can be found on the National Elk Refuge and in Grand Teton National Park. Evidence of permanent settlements by Native Americans has not been found in Jackson Hole.

In the northern part of Jackson Hole most evidence indicates that large base camps were established along the shores of Jackson Lake, where a band of individuals lived during the spring and early summer (Wright 1984). As the weather improved, the band would disperse into family groups and move into the canyons and higher alpine meadows, following the emergence of edible plant species. After using the resources of the higher mountains, the entire band would move into areas such as Idaho to spend the winter. The peoples of southern Jackson Hole entered the valley from the Gros Ventre River drainage after wintering in the Green River, Wind River, or Big Horn basins of northwestern Wyoming. They followed the ripening plants south into the Gros Ventre Range and by the following winter had moved into the more mild inter-montane basins east of Jackson Hole (Daugherty 1999).

These prehistoric peoples primarily gathered plants for food, medicine, and manufacturing materials, but they also hunted mule deer, elk, bighorn sheep, and bison. Although bone does not preserve well, particularly in shallow soils, bison remains are present in 13 archeological sites in Jackson Hole and elk remains in 8 locations (Cannon et al. 2001).

Archeological Sites on the National Elk Refuge

The majority of the land within the National Elk Refuge has not been inventoried for cultural resources; to date 10 sites have been identified and surveyed. Several features occurring on the refuge fall under the jurisdiction of the National Historic Preservation Act. Four prehistoric archeological sites have been recorded, which include roasting pits, stone circles, and a bison kill site. Among the artifacts that have been

discovered are bones from bison and elk, numerous flakes, choppers, scrappers, and projectile point pieces.

Archeological Sites in Grand Teton National Park

Grand Teton National Park has an estimated 400 prehistoric sites, including hearths, roasting pits, tipi rings, lithic scatters, and sacred sites. A variety of projectile points, tools, cooking/storage vessels, and bison and elk bones have been uncovered at these sites.

ETHNOGRAPHIC RESOURCES

Currently, an ethnographic resource study is being conducted that pertains to past treaties and traditional cultural activities that occurred within Grand Teton National Park, Yellowstone National Park, and the National Elk Refuge (Walker in prep.). The final report could influence future cultural resource surveys and management on the National Elk Refuge and in Grand Teton National Park, and it could yield additional information on how tribes used these areas.

HUMAN HEALTH AND SAFETY

TRAFFIC ACCIDENTS CAUSED BY BISON AND ELK

Visitors in the Jackson Hole area may be injured in vehicle collisions with elk or bison, either from animals crossing roads or with cars whose passengers are stopping to view these species. In Grand Teton National Park there were 97 collisions with elk from 1997 through 2001 (with a maximum of 24 in a year), compared to 14 with bison (a maximum of 6 in a year). From the north end of the town of Jackson, to the south entrance of the park, 10 vehicles hit elk; no collisions with bison happened from 1997 through 2001 on this section of U.S. 26/89 (Riegel, pers. comm. 2003).

ELK AND BISON ENCOUNTERS WITH PEOPLE

Although elk have not been aggressive to humans in Grand Teton National Park or the National Elk Refuge, incidents have occurred elsewhere. Although generally tolerant of humans, elk may assume a dominant head-high body posture when passing humans closely, display threat postures, and when harassed or startled, may aggressively attack. Bulls in rut are especially inclined to respond aggressively (Geist 2002).

Bison may be dangerous to humans and can charge and gore people if approached too closely. To date, Grand Teton Nation Park has not had the problems that Yellowstone National Park has had with bison gorings and aggressive encounters with people (Campbell, pers. comm. 2003). In 1993 the resident of a cabin on an inholding in Grand Teton National Park was gored; another resident was cited for feeding bison.

Bison crossing U.S. 191 near Elk Ranch Flats.

Conflicts between bison and residents of Kelly have occurred, particularly during spring when bison move north into the park from the refuge. Concerned citizens have reported bison in their yards, and occasionally animals have been hazed out of town and into the park. There have been no human injuries. Reports of conflicts between bison and people in Kelly decreased in early 2003, possibly because of the prescribed burn area near the town. Bison may have been spending more time in a burned area and less in Kelly compared to previous years (Campbell, pers. comm. 2003). Bicyclists in this area of the park also risk potentially dangerous encounters with bison. A Kelly resident told of several incidents of bison charging him and other bicyclists along the Gros Ventre Road in 2005 and 2006; no one was injured in these encounters (Kerasote, pers. comm. 2006).

HUNTING ACCIDENTS

Hunting accidents have caused very few human injuries in the park or the refuge (Campbell, pers. comm. 2003; Griffin, pers. comm. 2003). To hunt in either area, a hunter safety course must be completed, and hunters must have a hunter safety certificate. Firearms must be carried unloaded, and they must be dismantled or cased while in transit. Hunters must wear fluorescent orange exterior garments, as prescribed by state regulations, while hunting on the refuge (USFWS 2002c), and they are strongly encouraged to wear these garments in Grand Teton National Park. Also, a 0.25-mile-wide area along U.S. 26, 89, 191, 287 is closed to all hunting. No firearms may be discharged within 0.5 mile of any building within Grand Teton National Park (see NPS and WGFC 2002). Clearly defined hunting areas and shooting hours also help prevent accidental injuries.

POTENTIAL FOR DISEASE TRANSMISSION TO HUMANS

BOVINE BRUCELLOSIS

Humans are susceptible to brucellosis, however, only two cases of brucellosis have been reported where hunters contracted the disease from elk (Thorne 2001). The primary risk of transmission from elk or bison to humans is from hunter contact with organs of an infected animal. During the fall the disease is localized in tissues that are removed during field dressing (Thorne et al. 1982). Therefore, under normal circumstances, the risk to humans would be low (Thorne et al. 1982). The risk would be highest if hunters field dressed a pregnant elk or bison. Preventive measures, such as wearing rubber gloves when field-dressing the animal and avoiding direct contact and handling of reproductive organs and lymph tissues, should minimize risk.

SEPTICEMIC PASTEURELLOSIS

Most *Pasteurella* infections in humans occur as wound infections following dog and cat bites (Thorne et al. 1982). Infections in the upper respiratory tract are possible, but uncommon (Thorne et al. 1982); with proper medical care these infections are readily treatable. Wearing rubber gloves when handling elk or bison that appear to be sick would help reduce risk of exposure.

BOVINE TUBERCULOSIS AND PARATUBERCULOSIS

Both bovine tuberculosis and paratuberculosis are slow developing, chronic diseases, and infected animals may not show clinical signs. Humans could contract these diseases during hunting through direct contact with the animals and internal organs. The probability of disease transmission to hunters, managers, or researchers who handle infected animals is likely low (Demarais et al. 2002). Wearing rubber/latex gloves when field dressing game animals would reduce the exposure risk.

Humans are susceptible to bovine tuberculosis, but infection is fairly rare (Thorne et al. 2002). This disease poses a greater risk to human health than does brucellosis because aerosol transmission is the primary route for transmission from animals to humans. Direct handling of elk or bison would pose the greatest risk. Humans have contracted bovine tuberculosis after handling infected elk (Clifton-Hadley et al. 2001; Fanning 1992; Stumpff 1982).

Bovine paratuberculosis is found in feces and is not transmitted via aerosols, although there may still be a risk that humans could contract this disease during the hunting season because of direct contact with the animal and its internal tissues. There has been speculation in recent years that bovine paratuberculosis may play a role in Crohn's disease in humans; however, the data are inconclusive (Van Kruiningen 1999). The importance of this disease to human health is currently unknown, and it is unlikely that humans would contract paratuberculosis from wild ungulates (Demarais et al. 2002).

ANTHRAX

Anthrax does not sustain itself in the Jackson Hole area. While humans can contract anthrax, hunting of elk or bison would likely not pose a risk. The course of the disease is so rapid that sick animals would probably die before hunters encountered them. Direct animal to animal transmission of the organism does not occur; hence, interspecies transmission is not a concern.

CHRONIC WASTING DISEASE

Chronic wasting disease is not known to be a human health risk. Thus far, no evidence of human infection with the CWD agent has been found, and ongoing research is attempting to definitively determine whether or not humans can be infected. The risk to human health appears to be extremely small, if present at all (Belay et al. 2004); however, the researchers noted that the species barrier may not prevent transmission completely, and that long-term surveillance for human prion diseases continues to be important. Kong et al. (2005) used transgenic mouse models to determine that a substantial species barrier exists between humans and elk. To be safe, the Centers for Disease Control and Prevention and wildlife officials in several states recommend that hunters not consume meat from animals that appear sick or test positive for chronic wasting disease.

People hunting in CWD-infected herds should use common sense measures to reduce risk in case transmission could occur. These measures include (1) not harvesting an animal that appears sick, (2) using

rubber gloves when field dressing an animal, (3) avoiding contact with the brain and spinal cord tissue, (4) thoroughly washing hands and knives, and (5) deboning meat (Williams, Yuill, et al. 2002).

Other Diseases

Diseases that would not affect humans are vesicular stomatitis, malignant catarrhal fever, necrotic stomatitis, bovine viral diarrhea, parainfluenza virus-3, bovine respiratory syncytial virus, helminths, and lungworms.

PUBLIC USES

RECREATIONAL OPPORTUNITIES

Biannual visitor surveys conducted by the Jackson Hole Chamber of Commerce consistently document that 80%–90% of valley tourists identify natural resource based activities (principally sightseeing and summer and winter outdoor sports and recreation) as their primary reasons for visiting Jackson Hole.

WILDLIFE VIEWING

National Elk Refuge

The National Elk Refuge had an average of 851,220 visitors per year from 1992 to 2001. In 2001 there were 881,361 visitors, of whom 780,299 participated in on-site interpretation and nature observation, including 24,664 sleigh riders, 304,987 stops at the visitor center, and 439,148 visitors using observational facilities such as auto turnouts. An additional 2,000 people participated in environmental education activities, and 99,062 people enjoyed recreational opportunities on refuge lands. Recreationists included 2,193 big game hunters, 3,600 anglers, and 93,394 people engaged in miscellaneous activities (including approximately 30,000 people walking, hiking, jogging, and biking on refuge roads). Except for certain main roads where most vehicular traffic and all foot traffic is confined, a large portion of the refuge is closed year-round to public use. Fishing is allowed on lower Flat Creek from August 1 to October 31 and throughout the regular fishing season on upper Flat Creek.

A 2002 survey of refuge sleigh ride visitors found that elk viewing was the most frequent local and nonlocal visitor activity, followed by sightseeing, snow skiing, and pleasure driving (Loomis and Koontz 2004). The survey also asked about the overall importance of activities in terms of deciding to take recreation trips to the Jackson Hole area. The numbers in Table 11 reflect the average importance of an activity and its relative importance in terms of attracting people to the Jackson Hole area. As shown in the table, viewing the mountains was rated as the most important activity by local and nonlocal refuge visitors, followed by viewing elk, other wildlife, and bison (Loomis and Koontz 2004).

TABLE 11: RELATIVE IMPORTANCE OF DIFFERENT RECREATIONAL ACTIVITIES IN VISITORS DECIDING TO COME TO JACKSON HOLE

	National Elk Refuge Sleigh Ride Visitors		Grand Teton Summer Visitors	
	Nonlocal Visitors	Local Visitors	Nonlocal Visitors	Local Visitors
Sample Size	457	43	765	57
Viewing elk	3.11	3.40	3.06	3.08
Viewing bison	2.80	3.18	3.07	3.07
Viewing birds and other wildlife	3.01	3.38	3.26	3.15
View mountains	3.41	3.65	3.81	3.56
Hiking, mountain climbing	2.09	3.00	2.93	3.09
Hunting elk	1.49	1.64	1.15	1.62
Hunting bison	1.30	1.16	1.10	1.34
Other hunting	1.43	1.53	1.12	1.54
Rafting/canoeing	2.02	2.51	2.40	3.22
Fishing	1.99	2.61	1.81	2.67
Snow skiing	2.78	2.79	1.51	2.83
Snowmobiling	2.17	1.36	1.24	1.79
Sleigh ride	2.98	2.64	1.55	2.12
Festivals	2.11	2.16	1.87	1.80
Horseback riding	1.66	1.82	1.75	1.69
Biking / mountain biking	1.54	2.50	1.54	2.31

SOURCE: Loomis and Koontz 2004.
NOTE: Visitors sampled in 2002. The numbers reflect a four-point scale, where one is not important and four is very important.

Grand Teton National Park

Grand Teton National Park had an average of 2,458,886 recreational visits from 1991 to 2001. In 2001 there were 2,535,108 recreational visits. Approximately 1,107,672 people visited the visitor centers at Moose, Jenny Lake, and Colter Bay. Interpretive rangers informally contacted 29,767 visitors while roving the park (Fedorchak, pers. comm. 2003). In 2001, 69,386 visitors attended formal interpretive talks, and another 12,056 visitors watched demonstrations of pioneer skills and history. A total of 2,099 hunting permits were issued in 2001 for the elk reduction program.

A 2002 survey of summer visitors found that sightseeing was the most frequent non-local visitor activity, followed by bison viewing, hiking, and pleasure driving, then by elk viewing (Loomis and Koontz 2004). For local visitors, sightseeing and hiking were the most frequent activities, while viewing bison ranked fifth and viewing elk sixth (Loomis and Koontz 2004). As a reason for visitors taking recreation trips to the Jackson Hole area, viewing the mountains was rated as the most important for local and nonlocal visitors (see Table 11), viewing bison ranked third for nonlocal visitors and fifth for local visitors, and viewing elk ranked fourth for both local and nonlocal visitors (Loomis and Koontz 2004).

Hunting / Park Elk Herd Reduction Program

Elk

National Elk Refuge

Elk hunting is allowed on the National Elk Refuge both to provide recreational opportunities to hunters and to help control the numbers of elk in the Jackson herd. Special permits are required, and hunting is confined to the northern portions of the refuge. Hunts are managed in cooperation with the Wyoming Game and Fish Department. Every Friday during hunting season hunters enter a lottery held at the Jackson Rodeo Grounds to acquire a permit to hunt for two or three days the following week. The first weekend of the season, usually in October, is a youth hunt (ages of 14 to 17). Bulls may be taken during the first week; the rest of the season is restricted to cow/calf hunting. From 1997 to 2001, an average of 2,116 permits to hunt were issued, with an average of 312 elk killed each season. In 2004, 1,806 permits were issued and 179 elk were killed.

Hunters on the National Elk Refuge.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway

Qualified and experienced hunters who are licensed by the state and deputized as rangers by the Secretary of the Interior are allowed to participate in a legislatively authorized elk reduction in Grand Teton National Park when necessary for the proper management and protection of the herd. Only park lands east of the Snake River and those lands west of Jackson Lake and the Snake River that lie north of the 1929 northern park boundary of Grand Teton National Park are open to the elk herd reduction program. Each licensed deputized ranger is allowed to kill one elk. The average number of permits issued from 1997 to 2001 was 2,484; the average number of elk killed was 665. In 2001, 2,099 permits were issued, and 375 elk were killed. Hunting for elk and other wildlife is legally authorized in John D. Rockefeller, Jr., Memorial Parkway and managed by the State of Wyoming.

Other Areas

The Jackson elk herd is also hunted on USFS lands in the Teton Wilderness and the Gros Ventre River drainage. Some wildlife managers believe that in the past the eastern migratory segment of the herd (those elk that migrate east of Grand Teton National Park during fall) were over-harvested, largely because of increased road and other access on national forest lands. At the same time, western migratory segments were believed to have grown, decreasing hunting opportunities as more elk migrated through protected park areas. Concerted attempts to

Map

Landownership in Western Wyoming

increase numbers in the eastern segments and to reduce numbers in the western segments by regulating hunting seasons and harvest strategies since the late 1980s to the present have met with some success. Nevertheless, the elk reduction program in the park and hunting on the refuge can affect hunting opportunities and numbers of elk outside these areas. Consequently, refuge and park personnel work closely with the Wyoming Game and Fish Department in the development of annual hunting quotas and regulations, so that management of the entire herd is based on a holistic framework that includes all land and wildlife management responsibilities.

Bison

Bison hunting was allowed on the refuge during the 1989–90 season and for a short time in the fall of 1990. A total of 39 bison were taken during these two seasons. As previously explained, bison hunts were stopped as a result of lawsuits pending additional analysis of the impacts.

Bison hunting is not allowed in Grand Teton National Park.

LIVESTOCK OPERATIONS

JACKSON HOLE AREA

The livestock industry in the Jackson Hole area and in the broader region is represented primarily by cow-calf operations. A portion of the cattle in the Jackson Hole area spend the summer in Bridger-Teton National Forest or Grand Teton National Park under grazing permits that authorize livestock grazing on federal lands. Cattle are returned to their home ranches at the end of the allotment period in the fall (or earlier due to snowfall or other reasons), where hay sources are more accessible.

Yearly phases of production include weaning calves, feeding or selling steers and surplus heifer calves, and culling old or unbred cows. Owners of cow-calf operations usually do not purchase cattle, with the exception of breeding bulls; rather they rely on replacement heifers from the same herd. Their incomes generally reflect the 10- to 12-year price cycle for beef. Income in some years may not cover expenses, but a positive cash flow is usually realized at the end of the cycle.

As of January 1, 2005, there were a total of 7,000 cattle on ranches and farms in Teton County, Wyoming, with a value of $7.1 million, which is less than 1% of the state total (the statewide average per head is $1,020, as of January 1, 2005; Wyoming Agricultural Statistics Service 2005). In 2002 there were 4,907 cattle on 35 ranches in Teton County, including 8 ranches with 200 or more cattle each. In 2002 the value of all cattle sold in Teton County was $5.3 million.

Table 12 shows the number of cattle (cow-calf pairs) permitted on federal grazing allotments in the park and national forest, as well as those allotments that were actually used in 2002. Permits typically specify the maximum number of cattle allowed to graze and the grazing dates. Permittees have the option of whether or not to use their allotments and to what degree.

As shown in Table 12, all of the allotments in the park that could have been used were, in fact, used by permittees in 2002. By contrast, only about two-thirds of the national forest allotments were actually used by permittees in 2002. Two ranchers hold the permits for all of the park allotments — one permittee with 160 pairs uses the Pacific Creek allotment and another permittee with 400 pairs uses the other allotments at varying times. Each allotment in the national forest essentially represents a different rancher.

The exact number of cattle currently being grazed on private lands in the Jackson Hole area is not available. However, the local agricultural extension office estimates that there are 10 to 15 ranchers in the Jackson Hole area who do not graze their cattle on public lands. These ranchers graze an estimated 1,500 to 2,500 cow-calf pairs total, starting from about May 15 to June 1.

As of January 1, 2002, there were no breeding sheep on Teton County farms or ranches. The most recent census data show that there were no farms with swine inventory and that there were five farms with sheep inventory in Teton County in 2002. There are no deer farms in Wyoming and only one elk farm that was grandfathered in when the statute forbidding elk and deer ranching was passed in 1975.

TABLE 12: NUMBER OF CATTLE (COW-CALF PAIRS) PERMITTED ON PUBLIC LAND GRAZING ALLOTMENTS IN GRAND TETON NATIONAL PARK AND BRIDGER-TETON NATIONAL FOREST

Public Allotment Name	Acreage	Number of Cattle	On/Off Date
Grand Teton National Park[1]			
Gros Ventre (south)[2]	3,114	400	5/15–6/15
Gros Ventre (north)	872	[2]	6/16–6/25
Lower Cunningham	456	[2]	6/26
West Elk Ranch	2,339	[2]	6/27–10/20
East Elk Ranch (south)[3]	500	[2]	7/1–10/20
Elk Ranch East (north)[3]	647	[2]	7/1–10/20
Pacific Creek	9,729	160	6/1–9/25
Total	17,657		
Bridger-Teton National Forest[4]			
Bacon Creek	66,777	168 +650 yearlings	6/11–10/15
Big Cow Creek	4,382	15	6/19–9/15
Ditch Creek	*35,567*	*390*	*7/1–10/31*
Lava Creek (excl. Burro Hill)	*25,347*	*320*	*6/1–10/15*
Lava Creek (Burro Hill)	1,208	55	6/1–10/15
Fish Creek	113,871	573	6/11–10/15
Kinky Creek	*22,964*	*174*	*7/1–8/30*
Miner's Creek	11,843	92	6/21–10/15
Pacific Creek[5]	11,646	249	6/1–8/22
Redmond/Bierer	7,200	30	6/15–9/26
Upper Gros Ventre	*67,358*	*550*	*6/18–10/8*
Granite Creek	25,750	300	6/16–10/5
Munger Mountain	*38,848*	*379*	*6/11–10/18*
Willow Creek	*38,773*	*250*	*7/1–9/30*
Porcupine Squaw Creek	*3,384*	*34*	*6/1–10/15*
Mosquito Fall Creek	*21,840*	*933*	*7/1–10/15*
Total	496,758		

NOTE: Rows in italics indicate allotments not used in 2002.

1. Two ranchers hold the permits for all of the park allotments — one permittee with 160 pairs uses the Pacific Creek allotment and another permittee with 400 pairs uses the other allotments at varying times. The latter's status is currently unknown. The herd was infected with brucellosis and depopulated in 2004. The permittee took non-use status for 2005 and 2006.
2. Only two of the three pastures that comprise Gros Ventre (south) were used in 2002. The 400 cattle listed for Gros Ventre (south) are moved among the Gros Ventre / Lower Cunningham / Elk Ranch allotments.
3. There is also a 113-acre sick cow pasture on Elk Ranch East that can accommodate up to 20 head at any given time, from July 1 to October 20.
4. Each allotment in the national forest essentially represents a different rancher.
5. Only 160 cattle are permitted to use the Pacific Creek allotment from June 11 to August 3.

BRUCELLOSIS

Brucellosis has been a key issue in this planning process because (1) the Jackson elk and bison herds and other elk herds in western Wyoming are chronically infected with the disease, (2) it is possible for the disease to be transmitted from elk and bison to cattle, and (3) brucellosis can adversely impact livestock production and affect human health. Brucellosis is a contagious disease whose main threat is to cattle and swine. The disease causes decreased milk production, weight loss, loss of young, infertility, and lameness. There is no cure for brucellosis in animals, nor is there a preventative vaccine that is 100% effective. (In humans the disease is known as undulant fever because of the severe intermittent fever and infection.)

In December 2003 brucellosis was confirmed in a herd near Boulder, Wyoming, about 100 miles southeast of Grand Teton National Park, and in January 2004, the disease was confirmed in a second herd near Worland, in north-central Wyoming. As a result, Wyoming lost its previous class-free brucellosis status and was downgraded to class A status under federal regulations. Class A status requires a negative brucellosis test no more than 30 days prior to interstate movement

Map

Bison Calving Area and Livestock Allotments

for test-eligible cattle and bison.* Class A status also requires a state to conduct adequate in-state surveillance to progress toward class-free status.

To comply with this regulation, Wyoming law required that test-eligible cattle and bison test negative for brucellosis no more than 30 days prior to a change of ownership. Prior to the downgrade in status (effective February 13, 2004), cattle in Wyoming were not required to be tested for brucellosis.

A state can apply to have its class-free status reinstated if it complies with the class A testing and surveillance requirements for a minimum of one year and no other brucellosis infection is found in the state during that time. However, even if able to re-attain class-free status, the state will still need to continue an acceptable level of surveillance testing in order to maintain that status and to satisfy its trading partners that a "clean" product is being provided. Because two more Wyoming cattle herds tested positive for brucellosis in 2004, the brucellosis-free timeline was restarted in December 2004. After complying with testing and surveillance requirements and applying for class-free status reinstatement, Wyoming was reinstated as class-free in September 2006.

Although difficult to assess, the brucellosis outbreaks do not appear to have had a major adverse impact on market prices for Wyoming cattle. Prices fell sharply in January 2004, but that decline has been widely attributed to the December 2003 discovery of bovine spongiform encephalopathy (BSE) in a dairy cow in Washington State. Since January 2004, Wyoming cattle prices have shown a general upward trend, notwithstanding the several brucellosis discoveries in the state in 2004. Prices for the first nine months of 2005 were well above those for the same period in 2003, a time when Wyoming's brucellosis status was class free. Wyoming will likely continue to reflect the strong overall cattle market that has been at or near record levels for the last several years due to tight cattle supplies (Gustafson, pers. comm. 2005).

Cattle producers in Wyoming with infected herds, as well as producers with herds in contact with or adjacent to the infected herds, have also faced the income-disrupting effects of quarantines and/or animal depopulations. The epidemiological investigations conducted following the outbreak in Wyoming necessitated the quarantine of approximately 15 contact and adjacent herds in that state. Furthermore, approximately 935 cattle in Wyoming (280 in the infected herd near Boulder, Wyoming, and 655 in the Teton County herds) were depopulated. (Cattle in the other initially infected herd near Worland were in a terminal feedlot destined for slaughter.) Even though the herd owner received indemnity payments, those payments probably do not fully compensate for lost future income that may have been predicated on years of selective breeding and culling. Producers with infected animals cannot be required to depopulate their herds, but they would be restricted in terms of where the herd could be moved.

The recent brucellosis discoveries in Wyoming have not had a crippling effect on the cattle industry statewide, given that brucellosis testing and testing-related costs represent only a small portion of annual production costs. Based on a test cost of $5.50 (after a $3.50 reimbursement by the State of Wyoming) and hidden costs of $6, total brucellosis testing and testing-related costs of $11.50 per animal represent only 1% of annual per animal production costs.** This is not to suggest

* "Test-eligible" cattle/bison include sexually intact vaccinated and non-vaccinated females and bulls 18 months of age and older, and all pregnant or post-parturient animals regardless of age.

A change from class-free to class A status also resulted in increased testing requirements for Wyoming dairy herds. In a class A state, the brucellosis ring test (BRT) must be conducted at least four times per year at approximately 90-day intervals. In a class-free state, the level of BRT surveillance is two brucellosis ring tests per year at approximately six-month intervals. A change from class-free to class A status meant that Wyoming's dairy producers faced added testing and handling costs. Because dairy cows comprise only about 1% of all cows in Wyoming, this plan focuses on the impacts for cattle that move out-of-state and change ownership.

** Data from the USDA Economic Research Service show that cow-calf production costs, per bred cow, for the Basin and Range Farm Resource Region of the United States (which includes western Wyoming) totaled $1,099.48 in 2004.

that all producers in Wyoming have experienced the same relative impact, as the financial circumstances of individual producers vary. Even before the downgrade in status, some producers in Wyoming performed brucellosis tests voluntarily to enhance the value of the cattle they sold.

Assuming that an additional 100,000 to 150,000 head have to be tested annually, it is estimated that cattle producers in Wyoming will have to spend an additional $1.2 million to $1.7 million per year to cover the costs of the required animal testing.

MANAGEMENT DIRECTION

OVERVIEW OF THE PLAN

DESIRED CONDITIONS

By the end of the 15-year implementation period, the National Elk Refuge and Grand Teton National Park provide winter, summer, and transitional range for large portions of the Jackson bison and elk herds. The environment supports a full complement of native plant, wildlife, and breeding bird species. Refuge and park staffs, working with others, adaptively manage bison and elk in a manner that contributes to the state's herd objectives yet allows for the biotic integrity and environmental health of the resources to be sustained. As a result, the public enjoys a variety of compatible, wildlife-dependent recreational opportunities.

Wetland woodland habitat in good condition.

BISON AND ELK MANAGEMENT PLAN: ADAPTIVELY MANAGE HABITAT AND POPULATIONS

The Jackson bison and elk herds and their habitat will be adaptively managed on the National Elk Refuge and in Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway, with an emphasis on improving winter, summer, and transitional range on refuge and park lands, while at the same time ensuring that the biotic integrity and environmental health of the resources will be sustained over the long term. A dynamic framework for decreasing the need for supplemental feeding on the refuge will be developed and implemented in close cooperation with the Wyoming Game and Fish Department and will be based on existing conditions, trends, new research findings, and other changing circumstances. Population management, vegetation restoration, ongoing monitoring, and public education will be integral components of this framework.

HABITAT CONSERVATION

- Habitat restoration projects will be initiated to improve native and cultivated forage and achieve desired conditions and goals.
- Woody vegetation on the refuge will be protected by rotating small exclosures until habitats have recovered. Prescribed fire may be used and logging allowed on the refuge inside exclosures.
- About 4,500 acres of previously cultivated areas in Grand Teton National Park will be restored to native plant communities.
- The U.S. Fish and Wildlife Service and the National Park Service will work with private and agency partners to minimize bison/elk conflicts with adjacent landowners (e.g., by providing human and/or financial resources to manage co-mingling and reduce crop depredation by elk and bison on private lands).
- A public education effort will be initiated to build understanding of natural elk and bison behavior, ecology, distribution, disease implications, and effects to other species
- Criteria for beginning and ending feeding each year will be identified in consultation with the Wyoming Game and Fish Department.
- A structured framework of adaptive management actions will be developed in collaboration with the Wyoming Game and Fish Department and will include established criteria for progressively transitioning from intensive supplemental winter feeding to greater reliance

on free-standing forage, based on some or all of the following considerations:

1. level of forage production and availability on the National Elk Refuge
2. desired herd sizes and sex and age ratios
3. effective mitigation of bison and elk co-mingling with livestock on private lands
4. winter distribution patterns of elk and bison
5. prevalence of brucellosis, chronic wasting disease, and other wildlife diseases
6. public support

- The U.S. Fish and Wildlife Service and the National Park Service will work in collaboration with the Wyoming Game and Fish Department to maintain the Jackson elk herd objective of 11,000 (after the initial phased approach, approximately 5,000 elk would be expected to winter on the refuge). As herd sizes and habitat objectives are achieved, feeding or elk numbers will be further reduced, based on established criteria and changing social, political, or biological conditions. Hunting will be used on the refuge, and when necessary, the elk herd reduction program in the park, to assist the state in managing herd sizes, sex and age ratios, and summer distributions.
- The agencies will recommend that the Wyoming Game and Fish Department establish a genetically viable bison herd of approximately 500 animals, with as close to an even sex ratio as possible to maximize maintenance of genetic variation over time. A WGFD-administered bison hunt will be initiated on the refuge.
- The Wyoming Game and Fish Department will be allowed to vaccinate elk and bison for brucellosis on the refuge as long as logistically feasible.

OTHER WILDLIFE-DEPENDENT RECREATION

- Over time wildlife viewing opportunities will be concentrated during some winters and will be more natural and sporadic during milder winters.
- The agencies will build public understanding and support for bison and elk management actions.

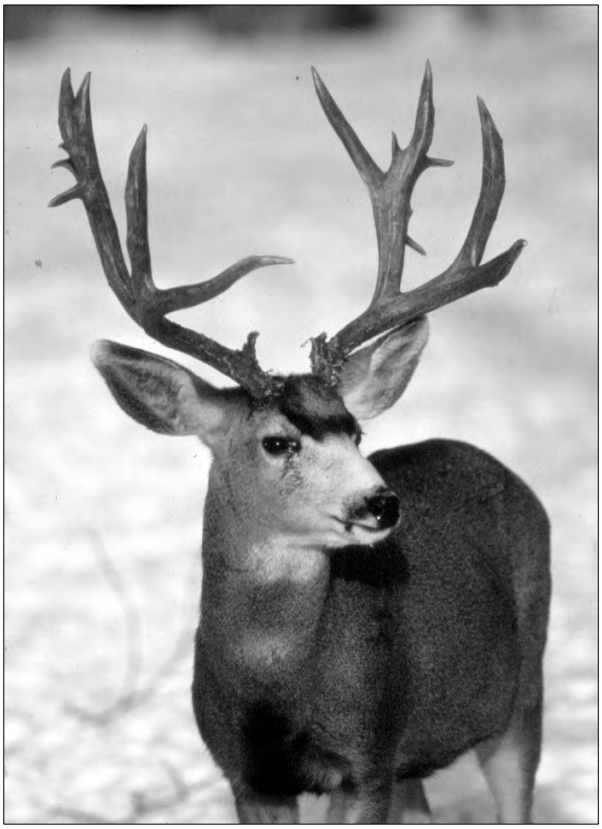
SUPPLEMENTAL ACTIONS

The following ongoing activities are independent of the bison and elk management actions:

- *Invasive Weed Control / Integrated Pest Management* — The control of invasive weeds and integrated pest management for both the refuge and the park will continue much as it has in the recent past using a variety of tools, including biological control, mechanical control, grazing by goats or sheep, and herbicides. The U.S. Fish and Wildlife Service and the National Park Service will continue to work in partnership with each other and with the Teton County Weed and Pest Control District, the U.S. Forest Service, the Wyoming Game and Fish Department, and private landowners.
- *Nonnative Plant Species Control* — Similar to the invasive weed control program, efforts to eradicate cheatgrass and crested wheatgrass will continue on the refuge, much as they have in the recent past. Management tools used may include mechanical control, herbicides, and biological control.
- *Jackson Hole Interagency Habitat Initiative* — The U.S. Fish and Wildlife Service and the National Park Service will continue to work cooperatively with other agencies in identifying opportunities to improve habitat for elk and bison.
- *Jackson Elk Studies Group and Greater Yellowstone Interagency Brucellosis Committee* — The U.S. Fish and Wildlife Service and the National Park Service will continue to participate in the Jackson Hole Elk Studies Group and the Greater Yellowstone Interagency Brucellosis Committee. As committee members, both agencies will pursue the development of risk assessment for brucellosis transmission from elk or bison to livestock.
- *Livestock Grazing* — The plan will not change livestock grazing practices in the park, nor is such use mandated to continue.
- *Chronic Wasting Disease* — Efforts will be made to coordinate with the Wyoming Game and Fish Department to increase surveillance in elk for chronic wasting disease (CWD), a fatal transmissible disease of white-tailed

deer, mule deer, and elk. The objective of surveillance will be to provide a 95% confidence level of discovering infection at 1% prevalence in the Jackson elk herd. If infection is found, strategies from the state's *Chronic Wasting Disease Management Plan* (WGFD 2006) will be implemented to reduce transmission. These strategies include removing clinically consistent elk, removing 50 animals within 5 miles of the index case, and another 50 within 10 miles if an additional positive animal is found during collection of the first 50; enforcing carcass movement and disposal restrictions; decreasing duration of feeding and expanding the distribution of feeding to the extent possible; and potentially decreasing elk densities through hunting or other management strategies. Plans to follow the state's *Chronic Wasting Disease Management Plan* have been made in deference to the state and could change if the National Park Service and/or the U.S. Fish and Wildlife Service adopted servicewide management requirements that differ from what is currently being done. Potential changes will be communicated to the state.

- *Winter Severity* — When winters are referred to as average, above-average, or severe in the text, snow accumulations would be similar to those used in modeling for the impact analysis (Hobbs et al. 2003). These rankings were based on 50 years of measuring inches of snow-water equivalent (the amount of water stored as snowpack) at the Hunter-Talbot hayfields in Grand Teton National Park (Farnes, Heydon, and Hansen 1999). Although various factors affect winter severity, snow-water equivalent was considered the best measure for predicting how ungulates would respond to winter conditions. Based on rankings of snow severity using the data by Farnes, Heydon, and Hansen, the winter of 1996 was designated as average, 1982 as above average, and 1997 as severe. (For more detailed information, see "Climate" on page 37.)



Mule deer — another ungulate species on the refuge.

Determining when or if supplemental feeding will begin in a given winter will be based on specific criteria, including pre-winter forage production, forage amounts, snow quality and depth, ambient temperature, and elk behavior and body condition. Mortality is not one of these criteria.

- *Hunting/Reduction Programs* — The U.S. Fish and Wildlife Service and the National Park Service will work cooperatively with the Wyoming Game and Fish Department to achieve population objectives (including herd ratios and elk herd segment sizes), to develop hunting seasons, and to evaluate hunting or elk reduction areas. The Wyoming Game and Fish Department will formally establish objectives and strategies after public review and approval by the Wyoming Game and Fish Commission.

Map

Management Plan Overview

PLAN GOALS, OBJECTIVES, AND STRATEGIES

Four goals for the bison and elk management plan were developed based on the desired conditions and purposes of the National Elk Refuge and Grand Teton National Park, the missions of the National Wildlife Refuge System and the National Park System, and other legal and policy directives. The goals also consider the input received from the public, American Indian tribes, and other stakeholder groups during the prescoping and scoping phases of the planning process. While public and tribal opinions vary greatly on how to manage the bison and elk populations, all recognize the significant resource and heritage values of these herds to the Jackson area, the state, tribal governments, and the nation. The plan is based on specific objectives and strategies to achieve these goals.

GOAL 1: HABITAT CONSERVATION

National Elk Refuge. Provide secure, sustainable ungulate grazing habitat that is characterized primarily by native composition and structure within and among plant communities and that also provides for the needs of other native species.

Basis and Intent for the Goal: Based on the legal policy mandates for the National Elk Refuge, a balanced conservation program is one that will ensure the following:

- Healthy, productive grassland and woodland habitat will be sustained for the benefit of elk and bison as an overriding target, which will also benefit other native wildlife communities.
- All activities aimed at sustaining elk and bison numbers above the natural carrying capacity of the land (e.g., farming and irrigation, winter feeding) will not prevent the Fish and Wildlife Service from accomplishing other refuge purposes and other legal directives pertaining to other wildlife species.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway. In concert with restoring and perpetuating natural ecosystem functioning in Grand Teton National Park and the parkway, restore and maintain the full range of natural structural and compositional characteristics of native habitats used by bison and elk, emphasizing the plant species diversity that native habitats would support.

Basis and Intent for the Goal: The conservation of park resources and values, and the maintenance of resources and values in an unimpaired condition, are the primary responsibilities of the National Park Service. Specifically, NPS managers are required to preserve natural components and processes of ecosystems in natural condition to the greatest extent possible, including natural change over time (NPS 2006, sec. 4.1).

Furthermore, the National Park Service does not attempt to solely preserve individual species (e.g., bison and elk) outside the context of preserving natural ecosystems. Rather, it attempts to maintain all components and processes of naturally evolving park ecosystems. This is why the goal to restore and maintain natural habitat conditions for bison and elk is prefaced by "in concert with restoring and perpetuating natural ecosystem functioning in Grand Teton National Park."

OBJECTIVES AND STRATEGIES

National Elk Refuge

Land Protection on the Refuge

Objective

- Within one year identify any private lands within the approved boundary of the refuge that could be protected through a habitat-protection partnership, a trade, or a willing-seller / willing-buyer transaction to prevent development of these lands and to provide additional elk winter range.

Rationale: This management plan does not constitute a commitment for funding the protection of additional lands within the approved refuge boundary. The Fish and Wildlife Service's land acquisition policy is to obtain the minimum interest necessary to

Flood-irrigated field on the National Elk Refuge.

satisfy refuge objectives. If lands within the approved boundary become available, the service will seek ways to either protect them or acquire them for additional elk winter range.

Strategies

- Educate stakeholders at local, regional, national levels as to the importance of protecting private lands within the refuge to sustain the Jackson elk and bison herds, breeding habitat for birds, and habitat for other native wildlife.
- Identify future funding necessary to acquire lands.
- Work with local landowners to identify and carry out mutually acceptable options to minimize adverse impacts on wintering elk and bison.

Elk and Bison Grazing Habitat

Objectives

- Based on annual monitoring of transitional and winter range and starting the first phase of plan implementation, annually produce on sprinkler-irrigated fields on the refuge an average of 5,000 pounds of forage per acre on about 400 acres and an average of 2,500 pounds per acre on 700 acres. Plant communities in these areas will be dominated by species with a high level of palatability and preferred by wintering elk and bison, will have high nutritional value and productivity, and will be able to remain upright under moderate snowpack.
- Based on annual monitoring of transitional and winter range and starting the first phase of plan implementation, on flood-irrigated fields annually produce a minimum average of 2,500 pounds of forage per acre on up to 500 additional acres on the refuge, with the plant communities in these areas dominated by species exhibiting the characteristics listed above.
- For all plant communities that are grazed by elk and bison on the refuge, annually minimize the composition of invasive nonnative plant species; specifically:
  - ◊ Prevent new infestations of noxious weeds (spotted knapweed, diffuse knapweed, Russian knapweed, leafy spurge, dyer's woad, field bindweed, musk thistle, Canada thistle, sow thistle), crested wheatgrass, and cheatgrass.
  - ◊ Within 15 years restore to native species approximately 250 acres of cheatgrass and about 650 acres of crested wheatgrass.
  - ◊ Continue to restore native plant species in refuge areas currently dominated by spotted knapweed in the Gros Ventre River drainage at the rate of 2 acres per year for the next 15 years.

Rationale: Producing high-quality standing forage on existing cultivated fields, using plant species that remain upright under moderate snowpack, will provide nutritional grazing habitat longer in late fall and early winter, thereby allowing supplemental feeding to be delayed and reducing concentrations of elk and bison. Increasing forage production will also provide the foundation for changing elk and bison management and will be an initial step in overall plan implementation. Invasive nonnative species are currently controlled in part because they hinder the production of preferred forage species in cultivated areas and reduce the prevalence of native forage species on native habitat.

Strategies

Irrigation and Farming:

- Use a variety of tools, including prescribed fire, irrigation, harrowing, and fertilizing, as well as blading in cultivated areas, to decrease crusting effects.

- As necessary, irrigate a minimum of 1,600 acres and increase sprinkler irrigation to 1,100 acres per year of the 1,590 acres that could be sprinkler irrigated. Enhance the flood-irrigation delivery system to irrigate an additional 500 acres.
- Use a combination of center pivot, side-roll, and hand-line sprinklers to replace flood irrigation. Use center pivots to irrigate approximately 290 acres in the McBride area, 200 acres in the Chambers area, 160 acres in the Peterson area, and 250 acres in the Nowlin area. Use supplemental side-roll and hand-line sprinklers to irrigate approximately 450 acres in the Ben Goe area and 240 acres in the Headquarters area (see the "Irrigation Project Areas of the NER" map).
- Improve delivery efficiency for flood irrigation by installing delivery pipes to the fields to replace delivery canals and ditches

Grazing Habitat:

- Restore winter and transitional grazing habitat on the refuge that has become dominated by nonnative species.

Native Winter Range:

- Fund a biological technician position to assist in establishing experimental plots to determine optimum species composition of acres to be restored. Use existing staff for restoration.
- Use native seed mixes of the intermountain west.
- Control wildland fires.

Addressing Habitat Problems Related to Unnaturally High Elk and Bison Numbers on the Refuge

Background. Woody vegetation on the refuge is adversely affected by high concentrations of animals. If a sufficient amount of woody vegetation starts to recover as the number of elk on the refuge declines, the objective number of elk may be revisited concurrent with an assessment of disease prevalence (see strategies under Goals 2 and 4). If sufficient habitat recovery does not occur after lowering elk and bison numbers on the refuge to objective levels, then numbers identified in the objectives may be further reduced.

Objectives

- Over the life of the plan protect sagebrush and grassland communities from degradation, maintain native structural and compositional characteristics, and allow degraded areas to recover, especially areas used by sage grouse and other sagebrush-dependent species. By year 5 of the plan define the desired characteristics of sagebrush and grassland communities for the development of the comprehensive conservation plan for the refuge.
- Over the life of the plan limit cultivated areas on the refuge to 2,400 acres that are already under cultivation.

Rationale. There are no objectives for balancing the needs of elk and bison with those of other wildlife. However, the National Elk Refuge has goals and objectives for perpetuating the migratory bird resource and preserving and enhancing related habitat

Side-roll sprinkler irrigation on the refuge.

Map

Irrigation Project Areas of the NER

(USFWS 1999b). Furthermore, the 1974 cooperative agreement between the U.S. Fish and Wildlife Service and the Wyoming Game and Fish Department recognizes the detrimental effects that large numbers of elk can have on habitat conditions.

- Restore 800 acres of willows to Class I or II condition (see Table 4, page 49, for a description of habitat classes).
- By year 15 of the plan allow for a sufficient level of aspen recruitment — including a minimum of 800 stems/acre that reach a height of 80 inches (2 meters) so as to be out of reach of ungulate browsers, at some point within each 100-year period. Maintain approximately 1,000 acres of aspen in Class I or II condition over the long term.

  Rationale: Because individual aspen stems generally live about 150 years and the last major stand replacement fire on the refuge occurred 120 years ago, aspen recruitment in many aspen stands will need to occur within the next 30 years. (Within-community characteristics will be specified in the upcoming comprehensive conservation plan for the refuge.)
- By year 15 of the plan allow for a sufficient level of cottonwood recruitment — including a minimum of 0.17 stem/meter that reaches a height of 80 inches (2 meters) so as to be out of reach of ungulate browsers at some point within each 100-year period — throughout each cottonwood stand in order to maintain approximately 1,000 acres of cottonwood in Class I or II condition over the long term. (Within-community characteristics will be specified in the upcoming comprehensive conservation plan for the refuge.)

  Rationale: The 100 acres of proposed cottonwood fencing will be for the upper Flat Creek riparian area. Most of the 1,000 acres in Class I or II condition will be in the Gros Ventre River bottom. The Gros Ventre receives considerably less elk use than the Flat Creek riparian area and is topographically separated from feedgrounds. Some of the Gros Ventre River bottom is already in Class II to III condition under the current management regime. With reduced elk numbers, the recovery of cottonwoods in the Gros Ventre River bottom to Class II condition will be possible. Unlike aspen, narrowleaf cottonwood is not typically a palatable plant for elk or bison. It is only eaten when elk or bison are at unusually high densities and consuming an unusual diet (pellets), as found near feedgrounds.
- By year 5 of the plan maintain at a minimum the existing proportion of the wet meadow community that remains ungrazed to lightly grazed each year (an estimated 15%–20%) and collect a sufficient amount of field data on vegetation and wildlife use within the community type, as well as published literature, to formulate a quantitative objective for the upcoming comprehensive conservation plan for the refuge.
- Limit cultivated areas on the refuge to 2,400 acres that are already under cultivation.

Strategies

Winter Supplemental Feeding:

- Provide supplemental feed away from riparian areas.

Water Management:

- Enhance the restoration of narrowleaf cottonwood communities along Flat Creek above the intake from the Gros Ventre River by reducing the amount of water that is diverted from the upper creek for irrigation on the refuge. Use sprinkler irrigation systems more frequently to increase water-use efficiency.

Woody Vegetation:

- Initially, fence approximately 500 acres of former willow habitat, 100 acres of remnant cottonwood communities along upper Flat Creek, and 1,000 acres of aspen habitat to exclude elk and bison so that these communities can recover. As grazing pressure decreases, reduce the amounts of fencing and/or rotate exclosures.

  Rationale: Stands of woody vegetation in Jackson Hole likely received some level of browsing pressure historically, but browsing pressure was low enough at times to allow successful recruitment and maintenance of willow, aspen, and cottonwood stands on the

refuge (Dobkin, Singer, and Platts 2002). Exclosures will not encompass the entire historical distribution of willows, aspen, and cottonwoods. The somewhat unnatural situation within the exclosures will compensate for heavily browsed stands and the complete loss of other stands outside the exclosures.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway

Objectives

- Restore and perpetuate a natural mosaic of climax and seral vegetation within each vegetation type used by bison and elk.
  - On grassland, meadow, sagebrush, and early seral forest communities within transitional and winter ranges in Grand Teton National Park, ensure that a natural amount and quality of forage is available for bison and elk during fall migration and wintering periods.

Rationale: Converting formerly cultivated areas to native plant communities will be the best long-term strategy to control invasive plants. Habitat restoration in the park, including invasive weed control, will continue for native wildlife communities. Elk and bison will continue to benefit from prescribed fire, invasive weed control, and research into the most effective applications of both programs to benefit elk, bison, and their native habitats.

Condition of habitat on the National Elk Refuge.

Strategies

- Begin conversion of all formerly farmed and irrigated areas in the southern portion of the park (approximately 4,500 acres) to native plant communities.
- Seek funding for a study involving experimental plots to determine the most efficient and acceptable methods of eradicating smooth brome and other agricultural plant species (needed prior to reseeding efforts), and to determine which native species would have the highest probability of successful reestablishment.

GOAL 2: SUSTAINABLE POPULATIONS

National Elk Refuge. Contribute to elk and bison populations that are healthy and able to adapt to changing conditions in the environment and that are at reduced risk from the adverse effect of non-endemic diseases.

> ***Basis and Intent for the Goal:*** The mission of the National Wildlife Refuge System requires that refuges sustain healthy populations of wildlife (16 USC 668dd(a)(2), 668dd(a) (3)(A), 668ee(4)), to the extent consistent with refuge purposes (16 USC 668dd(4)(D)). In general, a healthy population refers to a population that continues or is sustainable over the long term, with minimized risks of irreversible or long-term adverse effects to the herds and other species (50 CFR 100.4). The purpose of this goal is to contribute to sustaining a healthy population because the National Elk Refuge is only part of the area inhabited by the Jackson herds and cannot, by itself, sustain the entire bison or elk population.

Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway. Perpetuate to the greatest extent possible natural processes and the interactions of bison and elk with natural environmental fluctuations influenced by fire, vegetation succession, weather, predation, and competition. At the same time support public elk reductions in Grand Teton National Park, when necessary, to achieve elk population objectives that have been jointly developed by the Wyoming Game and Fish Department, Grand Teton National Park, and the National Elk Refuge. Support elk hunting in the John D. Rockefeller,

Elk feeding on alfalfa pellets.

Jr., Memorial Parkway that is consistent with its establishing legislation.

Basis and Intent for the Goal: NPS policies require that elk and bison be managed in such a manner that their populations will be perpetuated or sustained over the long term. Because most of the elk and bison summering in Grand Teton National Park and John D. Rockefeller, Jr., Memorial Parkway overwinter on the National Elk Refuge, the successful achievement of Goal 2 for the refuge is critical to meeting NPS mandates for the park.

Objectives and Strategies

Background

To achieve the desired conditions for this plan, it is critical to conserve a suitable habitat base and adapt to changing conditions in the environment. The following objectives and strategies are supplementary to the objectives and strategies in Goal 1, which would have to be met in order for Goal 2 to be achieved.

Objectives

- By year one, develop a structured framework, in collaboration with the Wyoming Game and Fish Department, of adaptive management criteria and actions for transitioning from intensive supplemental winter feeding of bison and elk herds to greater reliance on natural forage on the refuge. Establish objective criteria for when supplemental feeding will begin and end in years when needed on the refuge.

  Rationale: The agencies will work in collaboration with the Wyoming Game and Fish Department to develop the framework but will inform stakeholders prior to finalizing or implementing this framework. All decisions as to when to start or end feeding will be made by the refuge manager in consultation with the WGFD regional wildlife supervisor for Jackson/Pinedale and will be documented in a new memorandum of understanding between the agencies.

- Implement a phased approach to reducing the number of animals on feed while achieving the state's population objectives. The first phase objective will be to reduce the number of elk on feed on the National Elk Refuge to approximately 5,000 and achieve a target population of approximately 500 bison (see recommendation to the Wyoming Game and Fish Department below). The second phase objective will be to adaptively manage bison and elk populations to achieve desired conditions, with animals relying predominantly on available native habitat (on refuge, park, and forest lands) and cultivated forage (on the refuge).

  Rationale: The elk numbers assume that the Wyoming Game and Fish Department's elk herd objective of about 11,000 has been achieved and that higher numbers of elk would subsist on natural forage during winter. The objectives are based on current science and knowledge, but it is recognized that as conditions or knowledge change, various factors could result in different management actions. Depending on weather, success of forage cultivation on the refuge, and other factors, adaptively implementing the second phase of this plan could result in other necessary modifications of the Jackson elk herd objective. This would occur only at the state's prerogative following a comprehensive public review process, but would be encouraged by the U.S. Fish and Wildlife Service and the National Park Service if required to achieve desired conditions.

- For the park segment of the Jackson elk herd only, work cooperatively with the Wyoming Game and Fish Department to achieve desired bull-to-cow ratios that are more reflective of non-hunted populations (the initial recommendation will be 35 bulls to 100 cows in summer only).

- For the bison population, work collaboratively with the Wyoming Game and Fish Department to maintain and ensure a genetically viable population of approximately 500 animals (five-year average), with as close to an even sex ratio as possible to maximize maintenance of genetic variation over time; and work cooperatively with the department to achieve this objective.
- Within one year initiate a public education effort to build understanding of natural bison and elk behavior, population fluctuations, and ecological relationships with other species. Over the life of the plan work in collaboration with local governments to maintain opportunities for compatible wildlife observation during the winter.

Strategies

Elk Population Control:

- Work with the Wyoming Game and Fish Department to increase harvest efficiency, such as by expanding hunting areas and opportunities on the National Elk Refuge and by continuing to target cows on the refuge as well as in Grand Teton National Park. It will be the responsibility of the Wyoming Game and Fish Department to formally establish objectives and strategies after public review and approval by the Wyoming Game and Fish Commission.
- Work with private and agency partners to minimize conflicts with adjacent landowners (e.g., by providing human and/or financial resources to reduce crop depredation by elk and/or bison on private lands).
- Initiate a public education effort to build understanding of natural elk behavior, ecology, distribution, population dynamics, and expected herd fluctuations.
- Consider options on the southern end of the refuge designed to increase harvest opportunities for early migrating elk, such as implementing an early season hunt or other management options (e.g., public educational activities on the refuge).
- As population level and harvest demands allow, consider temporary or adaptive closures of the Blacktail Butte/Kelly hayfields area in the park to the elk herd reduction program, as well as the northern portion of the refuge to hunting, to increase the use of transitional and winter habitat.
- Continue hazing elk off refuge lands (on a case-by-case basis) during the growing season to prevent grazing of winter forage.

Bison Population Control:

- Working cooperatively with the Wyoming Game and Fish Department, implement a public hunt on the refuge to achieve a population objective for the bison herd of approximately 500. Manage the hunt in accordance with state licensing regulations and procedures. Determine start and end dates in collaboration with WGFD personnel. Prior to implementation, develop a refuge hunting step-down plan (see "Other USFWS Policy Constraints," page 13, on step-down plan requirements).
- In addition, potentially allow the removal of up to five bison annually on the National Elk Refuge for ceremonial purposes by Native American tribes.
- Continue hazing bison off refuge lands (on a case-by-case basis) during the growing season to prevent grazing of winter forage.

Winter Supplemental Feeding:

- Based on established objective criteria developed in collaboration with the Wyoming Game and Fish Department, implement actions to phase in a transition from intensive supplemental winter feeding to a greater reliance on free-standing forage that could include the following: delay the onset of feeding each year, decrease the average

Bison on Antelope Flats in Grand Teton National Park.

daily ration per elk or bison (adjusted for winter severity), decrease the number of days of supplemental feeding, decrease the frequency of years of providing supplemental feed, increase harvest levels, and implement mitigation measures with the Wyoming Game and Fish Department to reduce conflicts created by the redistribution of elk and bison.

- Consider factors such as the amount of forage produced on the refuge, snow conditions, and numbers of overwintering elk and bison in determining whether or not to provide supplemental food.
- In cultivated areas with high forage production that become inaccessible to elk because of crusting events, use mechanical means to increase access to forage.
- As habitat and population objectives are achieved, decrease reliance on intensive supplemental winter feeding, including complete transition to free-standing forage if and when several established criteria are met, including support from the Wyoming Game and Fish Department and the public.

Rationale: Implementing a phased transition from intensive supplemental winter feeding to greater reliance on free-standing forage will help maintain lower elk numbers on the refuge as a result of behavioral changes (fewer elk would know about supplemental feeding on the refuge and more should remain on native winter range). Reduced concentrations of wintering animals on supplemental feed would also be expected to reduce the transmission of wildlife diseases.

GOAL 3: NUMBERS OF ELK AND BISON

National Elk Refuge and Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway. Contribute to the WGFD herd objectives for the Jackson elk and bison herds to the extent compatible with Goals 1 and 2, and the legal directives governing the management of the National Elk Refuge, Grand Teton National Park, and John D. Rockefeller, Jr., Memorial Parkway.

Basis and Intent of the Goal: Both the U.S. Fish and Wildlife Service and the National Park Service are required to work with other agencies managing the same resources. The Fish and Wildlife Service is required to coordinate the development of comprehensive conservation plans with state wildlife conservation plans to the extent practicable and not inconsistent with legal directives (16 USC 668dd(e)(3)(B)). Contributing to WGFD herd objectives is consistent with the USFWS policy calling for refuges to contribute to natural population densities and natural levels of variation at larger landscape scales, especially when habitat has been lost in the surrounding landscape or ecosystem (USFWS 2001, sec. 3.7.C, 3.14.C). USFWS policy allows higher winter densities of elk and bison on the refuge in order to allow natural densities to be sustained during other seasons in the southern greater Yellowstone ecosystem, providing that the refuge is managed primarily to fulfill refuge purposes and to achieve the mission of the National Wildlife Refuge System (16 USC 668dd(a)(3)(A)).

NPS policy speaks generally to contributions that national parks make to conserving species at larger landscape scales. For example, "in addition to maintaining all native plant and animal species and their habitats inside parks, the [National Park] Service will work with other land managers to encourage the conservation of the populations and habitats of these species outside parks whenever possible" (NPS 2006, sec. 4.4.1.1). However, there are no allowances for permitting elk or bison populations to exceed natural densities in Grand Teton National Park, even when this would contribute to natural population levels for the larger landscape. Public Law 81-787 requires the National Park Service, in cooperation with the Wyoming Game and Fish Department, to implement a program for ensuring the permanent conservation of elk within Grand Teton National Park. Therefore, the park's contribution to WGFD herd objectives will be dictated by natural population densities and natural population fluctuations in the park and parkway (see Goal 2).

OBJECTIVES AND STRATEGIES

Contributions to WGFD Herd Objectives

Objectives

- Work collaboratively with the Wyoming Game and Fish Department to achieve a herd objective of about 11,000 elk for the Jackson herd.
- Work cooperatively with the Wyoming Game and Fish Department to maintain and ensure a genetically viable population of approximately 500 bison.

Rationale: Achieving the objectives and strategies outlined under Goals 1 and 2 will also enable Goal 3 to be accomplished, and additional objectives or strategies would not be necessary.

Strategies

Winter Supplemental Feeding:

- Work with the Wyoming Game and Fish Department to determine start and end dates for feeding.

GOAL 4: DISEASE MANAGEMENT

National Elk Refuge and Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway. Work cooperatively with the State of Wyoming and others to reduce the prevalence of brucellosis in the elk and bison populations in order to protect the economic interest and viability of the livestock industry, and to reduce the risk of adverse effects for other non-endemic diseases not currently found in the Jackson elk and bison populations.

Basis and Intent of the Goal: Elk and bison management on the refuge and in the park are not limited to actions taken to benefit these species. Their management also involves mitigating unintended consequences of past, present, and potential future management of elk and bison on the refuge and in the park. For example, winter feeding is responsible for a high prevalence of brucellosis in elk and bison. Brucellosis does not pose a risk to the elk and bison populations inhabiting the refuge and the park (Smith and Robbins 1994; B. L. Smith 2001; NPS and USFWS 1996), and it is widely viewed that brucellosis is primarily an issue of importance to the livestock industry (Thorne et al. 2002; Hendry 2002; Ragan 2002a and 2002b). Because of the potentially severe effects that brucellosis outbreaks in cattle could have on the Wyoming livestock industry, the *Draft* and *Final Environmental Impact Statements* examined a range of alternatives for addressing this issue.

The "economic interest and viability of the livestock industry" in the State of Wyoming is directly tied to maintaining the regional class-free designation for the state by the Animal and Plant Health Inspection Service. Class-free status could be affected by the way in which elk and bison are managed on the refuge and in the park because the potential exists for infected elk or bison to transmit the disease to susceptible livestock (those that either have no natural immunity, have not been vaccinated, or have been vaccinated but the vaccination did not impart immunity).

OBJECTIVES AND STRATEGIES

Objectives

- For the life of the plan continue efforts to lower the risk of brucellosis transmission to livestock by concentrating elk and bison on the refuge and keeping them separated from livestock during the first part of the critical period of potential transmission (February–March).
- For the life of the plan conduct winter feeding activities in ways that reduce brucellosis transmission within the elk and bison herds.
- Annually work in collaboration with WGFD personnel to inform hunters about elk and bison disease status and potential human and/or wildlife health hazards, health risks, and recommended handling practices.

Rationale: In the short term diseases will be managed in much the same way they are now. Over the long term the focus will be on implementing new disease control measures and working with partners to correct the underlying transmission rates. It is recognized that there is little that the Fish and Wildlife Service or the Park Service can do to actually prevent the introduction of new diseases.

Strategies

Disease Control and Prevention:

- Eliminate the use of all equipment that has been previously used in areas and facilities with known occurrences of non-endemic invasive diseases.
- For disease control, continue winter supplemental feeding at four areas on the refuge; change feeding sites daily in each area; spread feed along long meandering lines; and separate elk and bison to the extent possible.
- Allow WGFD personnel to use Strain 19 on elk and RB51 on calf and nonpregnant female bison along feedlines during feeding operations, but phase out if logistics prevent effective deployment or when other more effective strategies are found.

  Rationale: This program will be conducted until more efficacious vaccines are found. Despite the low efficacy of Strain 19 in elk and the lack of consensus about the efficacy of RB51 in bison, this plan assumes that (1) the benefits to the livestock industry stemming from even a small reduction in brucellosis prevalence will outweigh the expense of the program, and (2) activities associated with vaccination will not adversely impact elk or bison on the refuge. The Wyoming Game and Fish Department will provide funding, staff, and equipment for any vaccination program. The vaccination program will not influence the frequency or duration of feeding operations (i.e., the desire to vaccinate will not under any circumstances be used as a justification to begin winter feeding).
- As more effective vaccines are developed, potentially use them to reduce the prevalence of brucellosis in the elk and bison herds. Work cooperatively with the Wyoming Game and Fish Department and others to research vaccines and delivery systems for elk and bison that have efficacies greater than 50%, that will be safe, and that can be administered without hindering the accomplishment of other goals and objectives for elk and bison.

  Rationale: At present no known brucellosis vaccine approaches 50% efficacy in elk or bison, and research is continuing on vaccines and delivery systems for both species. (Some RB51 research results show potential, but other research shows little, if any, efficacy.) Furthermore, despite the availability of Strain 19 for elk, vaccinating elk on the refuge will not be a high priority for several reasons. As noted by Thorne (2001), "any brucellosis control or eradication effort would have to involve all susceptible species and populations simultaneously within a geographic area sufficiently large to assure no interchange with other exposed or affected populations in order to prevent reinfection." Bison inhabiting the refuge and the park have a considerably higher prevalence of brucellosis than do elk in this area. Even if vaccination begins to reduce brucellosis prevalence in elk, bison will be a constant source of reinfection. Therefore, without concurrently reducing brucellosis prevalence in bison, Strain 19 is not expected to reduce prevalence in elk to any large degree over the long term.

  When a vaccine that is at least 50% efficacious has been developed, animals will be vaccinated during winters when supplemental forage is provided on the refuge. They may be vaccinated in other years if a sufficiently effective oral vaccine is found, along with a safe and effective method of distributing it on a wider scale than on the feedgrounds. If the vaccine is only effective for one of the two species, research will continue until an efficacious vaccine is found for the other species. The GYIBC technical committee will be used to provide guidance on the use of brucellosis vaccines.
- In cooperation with other federal and state agencies and other partners, explore a variety of techniques (e.g., vaccination, selective fertility control, age- and sex-specific harvest) to further reduce the prevalence of brucellosis in bison.

  Rationale: Developing a structured framework for adaptive management actions may make other limited actions more appropriate for reducing brucellosis prevalence in bison.
- Increase surveillance for chronic wasting disease to a 99% confidence level of detecting prevalence at 1% in the Jackson elk herd.

Livestock Grazing Practices (Grand Teton National Park):

- Work with livestock permittees to minimize conflicts and contact between elk/bison and livestock.

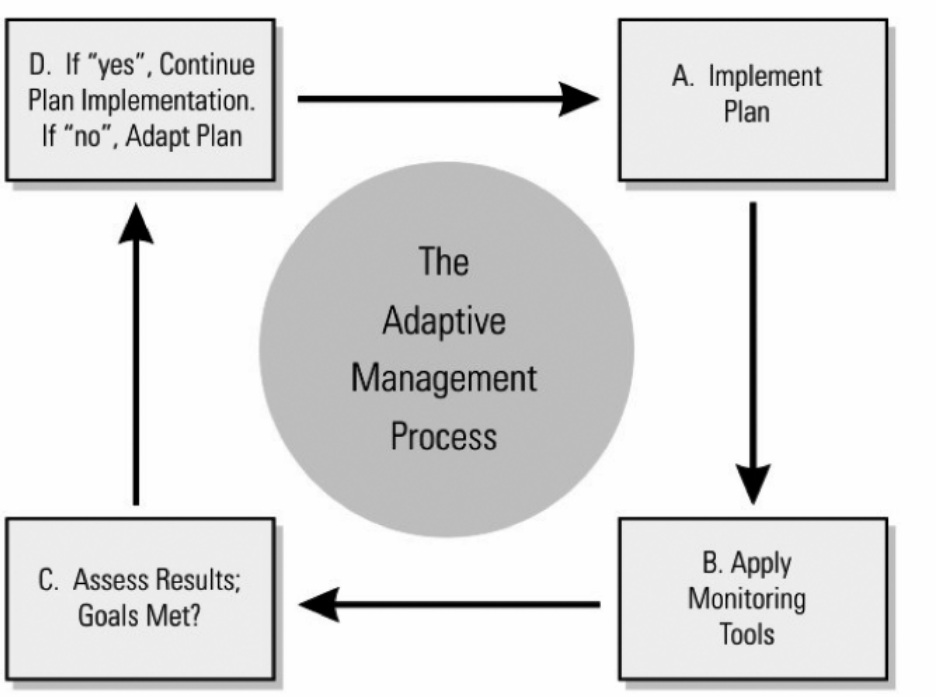
IMPLEMENTATION AND MONITORING

MONITORING AND EVALUATION

Adaptive management is a flexible approach to long-term management of biotic resources. It allows for management to be shaped and directed over time by the results of ongoing monitoring activities and other information discovered (see Figure 6). More specifically, adaptive management is a process by which projects are implemented within a framework of scientifically driven experiments to test the predictions and assumptions outlined within a plan. On-the-ground observations of responses to management by habitats and wildlife are also factored in. Analysis of results helps managers determine whether current management should continue or whether it should be modified to achieve desired conditions. Changes and adjustments to management and operations are considered utilizing the best information that is currently available.

To apply adaptive management, specific survey, inventory, and monitoring protocols will be adopted for the National Elk Refuge and Grand Teton National Park. The habitat management objectives and strategies identified in this plan will be systematically evaluated to determine management effects on wildlife populations. This information will be used to refine approaches and determine how effectively the objectives are being accomplished. If monitoring and evaluation indicate undesirable effects for target and nontarget species or communities, alterations to the management projects will be made. Specific monitoring and evaluation activities are part of the step-down management plan process for the U.S. Fish and Wildlife Service (see "Other USFWS Legal Policy Constraints," page 13), and the NPS *Management Policies 2006* guide activities in the National Park System.

FIGURE 6. ADAPTIVE MANAGEMENT SEQUENCE FOR THE BISON AND ELK MANAGEMENT PLAN



PARTNERSHIPS

In implementing the *Bison and Elk Management Plan*, ongoing partnerships such as the Jackson Interagency Habitat Initiative and the Jackson Hole Cooperative Elk Studies Group, as described under "State Plans and Agreements with Other Agencies" (page 18), and many others will continue to working in a collaborative effort to address many of the issues identified in this plan, particularly habitat conservation.

Additionally, the potential exists for the National Elk Refuge and Grand Teton National Park to establish new partnerships with individual citizens, sportsmen groups, schools, conservation agencies, Native American tribes, and community organizations at the local, regional, and state levels to identify solutions and educational opportunities for resolving elk and bison conflicts on private and public land.

FUNDING AND PERSONNEL

Table 13 identifies one-time costs for implementing the *Bison and Elk Management Plan*, and Table 14 shows annual costs, including additional staffing costs. Projects required to implement the plan will be funded through several separate systems specific to each agency. For the U.S. Fish and Wildlife Service, projects and maintenance needs will be funded through the Refuge Operations Needs System and the Maintenance Management System.

Grand Teton National Park will maintain key elements of the program, such as bison and elk monitoring and management of the elk reduction program, to the extent possible with existing base funds. The park has and will continue to seek special project dollars through programs such as the Natural Resource Preservation Program to support the restoration of former agricultural lands. A base increase request has been written into the NPS Operations Formulation System and is a high priority for Grand Teton National Park; however, limited increases in the number of park base operations are approved each year.

The projected funding levels required to implement the plan for a 15-year period are the best estimates, considering normal circumstances and they are based on assumptions outlined in Table 14. This document does not constitute a commitment for funding, and future budgets could influence implementation priorities.

TABLE 13. ONE-TIME COSTS OF BISON / ELK MANAGEMENT PLAN
(2006 dollars, not adjusted for inflation)

One-Time Costs	Total Cost
U.S. Fish and Wildlife Service	
Woody Vegetation Protection	
• Materials (14.59 ac @ $11,270/ac)	164,429
• Labor (14.59 ac @ $9,280/ac)	135,395
Subtotal	299,824
Forage Production Five-Year Setup Costs*	2,847,113
Winter Feeding Program Equipment/Supplies	
1 Challenger	140,000
1 Road grader	176,000
1 Feed wagon	50,000
2 Forklifts	46,000
1 Set challenger tracks	10,000
2 Buckets	9,000
1 Set feed trailer tires	2,000
Subtotal	433,000
Refuge Hunting Program Supplies	5,000
USFWS Total	**3,584,937**
National Park Service	
Park Habitat Restoration	
• Fencing	45,000
• Drill supplies	42,000
NPS Total	**87,000**
GRAND TOTAL	**3,671,937**

***** One-time costs for forage production on the refuge are for a five-year setup period and are due to converting to sprinkler irrigation on more of the refuge. These estimates are from the *Irrigation System Rehabilitation Plan Environmental Assessment* (USFWS 1998).

TABLE 14. ANNUAL PROGRAM COSTS
(2006 dollars, not adjusted for inflation)

Program	Annual Cost
USFWS ANNUAL COSTS	
Elk/Bison Monitoring	
•Equipment/Supplies	
Radio collars (FWS share: 25% of 20 = 5 @ $250 ea)	1,250
Immobilizing supplies/drugs (25% share)	500
Additional immobilizing supplies	1,500
Disease surveillance/blood analyses (staff est.)	1,000
Subtotal: Equipment/Supplies	4,250
•Flights	
Elk flights (FWS share: 15 hrs/yr @ $250/hr)	3,750
Spring bison hazing (possible future helicopter flights: 1 hr @ $600)	600
Subtotal: Flights	4,350
•Staffing Needs	
Biologist (GS-11/5, 0.35 FTE @ $80,475/yr)	28,166
Biological technician (GS-6/1, 0.3 FTE @ $32,038/yr)	9,611
CWD surveillance / sample analysis	7,000
Subtotal: Staffing	44,777
Subtotal — Elk/Bison Monitoring	**53,377**
Refuge Habitat Restoration	
Woody vegetation protection	
Monitoring (2 people for 2 days/yr @ $464/day)	928
Maintenance (2 people for 15 days after 10 years; $6,960/15 yrs = $464 annual cost)	464
Subtotal — Refuge Habitat Restoration	**1,392**

Program	Annual Cost
Refuge Forage Production — Enhanced with side roll and center pivot sprinkler irrigation (plan years 6 –10; annualized over 15 years)	**145,517**
Invasive Plant Species Control	**10,000**
Hunting Program on the Refuge	
•Equipment/Supplies	7,798
•Additional bison hunter mailing costs	464
•Staffing needs (2 additional LE staff (GS-9/2) for 10 years and 1 additional for 5 years)	43,428
Subtotal — Hunting Program on the Refuge	**51,690**
Refuge Winter Feeding Program	
•Equipment/Supplies	6,712
•Alfalfa Pellet Costs (mid-range pellet cost)	35,992
•Staffing Needs	
Mechanic (GS-9/5, 2 mos. during 7.5 years/15)	5,540
Other ($29/hr)	22,475
Subtotal — Refuge Winter Feeding Program	**70,719**
Elk/Bison Conflict Resolution on Adjacent Lands — $100,000/yr for 5 years (average cost per year for 15 years)	**33,333**
Subtotal — USFWS Annual Costs	**366,028**
Less Local Contributions to Refuge Programs	
Boy Scout sales contributions (a midpoint based on the expected number of elk that would winter on the refuge)	42,930
Sleigh ride program contributions	0
USFWS Total Annual Cost	**323,098**
NPS ANNUAL COSTS	
Elk Monitoring Program	
• Equipment/Supplies	
Radio collars (NPS share 25% of 20 = 5 @ $250)	1,250
Immobilizing supplies/drugs (25% share)	500
Subtotal: Equipment/Supplies	1,750
•Flights	
Summer classification flight time (6 hrs @ $1,000/hr)	6,000
Elk flights (NPS share: 15 hrs/yr @ $250/hr)	3,750
Parkwide summer census (every 5 yrs @ $7,500; 3 censuses @ $7,500 = $22,500 / 15 yrs)	1,500
Winter helicopter classification flight (6 hrs @ $1,000/hr)	6,000
Subtotal: Flights	17,250
•Staffing Needs	
Data collection, input, analysis (GS-11/5; 0.04 FTE @ $80,475/yr)	3,219
Capture, radio-tracking, data (GS-11/5; 0.04 FTE @ $80,475/yr)	3,219
Winter classification flight (GS-11/5, 0.01 FTE @ $80,475/yr)	805
Program oversight, data analysis, interagency coordination:	
– Senior wildlife biologist (GS-13/5, 0.20 FTE @ $114,643/yr)	22,929
– Ungulate biologist (GS-11/5, 0.15 FTE @ $80,475/yr)	12,071
– SRM division chief (GS-14/3, 0.10 FTE @ $135,474/yr)	13,547
Elk reduction coordination, season formulation:	
– Senior wildlife biologist (GS-13/5, 0.10 FTE @ $114,643/yr)	11,464
– Ungulate Biologist (GS-11/5, 0.15 FTE @ $80,475/yr)	12,071
– Project Bio-Tech (GS-8/5, 0.10 FTE @ $ 135,474/yr)	13,547
Subtotal: Staffing	92,872
Subtotal — Elk Monitoring Program	**118,872**
Bison Monitoring Program	
•Equipment/Supplies	
Radio collars (5/year @ $250 ea)	1,250
Telemetry equipment	250
Immobilization drugs	2,000
Subtotal: Equipment/Supplies	3,500

Program	Annual Cost
• Flights	
Flight time (60 hrs @ $250/hr)	15000
Winter helicopter classification flight (6 hrs @ $1,000/hr)	6,000
Subtotal: Flights	21,000
• Staffing Needs	
Seasonal biological technician (GS-5/5, 1.0 FTE @ $32,576/yr)	32,576
Project biological technician, wtr grd class (GS-9/5, 0.3 FTE @ $66,480/yr)	19,944
SCA intern ($2,500/season)	2,500
Winter classification flight (GS-11/5, 0.02 FTE @ $80,475/yr)	1,610
Program oversight, data analyses, interagency coordination	
– Senior wildlife biologist (GS-13/5, 0.20 FTE @ $114,643/yr)	22,929
– Ungulate biologist (GS-11/5, 0.15 FTE @ $80,475/yr)	12,071
– SRM division chief (GS-14/3, 0.10 FTE @ $135,474/yr)	13,547
Subtotal: Staffing	105,177
• Disease Surveillance and Management	
Bison blood sampling and analyses	1,000
Subtotal — Bison Monitoring Program	**130,677**
Elk Reduction Program in the Park	
• Equipment/Supplies	
Permit printing	800
Toilet rental/maintenance	4,500
Trash dumpsters (average cost per year for 15 years):	
– three 8-yd dumpsters @ $36/wk × 6 wks × 5 years = $3,240	
– two 4-yd dumpsters @ $18 /wk × 6 wks × 5 years = $1,080	
– two 8-yd dumpsters @ $36/wk × 6 wks × 10 yrs = $4,320	576
Process elk teeth (average cost per year for 15 years):	
– 650 teeth × 0.70 × 5 years = $2,275	
– 287 teeth × 0.70 × 10 years = $2,009	286
Signs and supplies	200
Permit mailing — $0.67 postage + $0.10 envelope = $0.77/permit (average cost per year for 15 years):	
– 2,200 permits × $0.77/permit × 5 yrs = $8,470	
– 957 permits × $0.77/permit × 10 yrs = $7,369	1,056
Subtotal: Equipment Costs	7,418
• Staffing Needs (Direct Labor):	
Permit mailings (average cost per year for 15 years):	
– 20 people (GS 7/4) @ $26.16/hr × 2 hrs × 5 yrs = $5,232 / 15 yrs	
– 20 people (GS 7/4) @ $18.04/hr × 1 hr × 10 yrs = $5,232 / 15 yrs	698
Maintenance refuse collection: 1 employee (WG 8/5 @ $30.55/hr × 1 hr/wk × 6 wks)	184
Permit and hunter contact	
– Primary contact:	
Weekends: 1 GS 11/4 @ $38.72/hr × 8 hrs/day × 2 days/wk × 6 wks	3,718
Weekdays: 1 GS 11/4 @ $38.72/hr × 4 hrs/day × 5 days/wk × 6 wks	4,646
– Secondary contact: 1 GS 9/4 @ $38.72/hr × 8 hrs	257
TIDC radio dispatcher: 1 GS 7/4 @ $26.16/hr × 16 hrs/day (6 a.m.–10 p.m.) × 6 wks	17,578
Law enforcement rangers	
– North District:	
1 LE 9/4 @ $33.22/hr × 16 hrs/day (6 a.m.–10 p.m.) × 6 wks	22,324
1 LE 9/4 @ $33.22/hr × 6 hrs/day (7–10 a.m.; 3–6 p.m.) × 6 wks × 5 years = $8,371/15 yrs (annualized cost for life of plan); next 10 years on furlough	2,790
– South District:	
1 LE 9/4 @ $33.22/hr × 16 hrs/day (6 a.m.–10 p.m.) × 6 wks	22,324
1 LE 9/4 @ $33.22/hr × 6 hrs/day (7–10 a.m.; 3–6 p.m.) × 6 wks × 5 years = $8,371/15 yrs (annualized cost for life of plan); next 10 years on furlough	2,790
Hunt coordinator 1 GS 11/4 @ $38.72/hr	
– Prehunt: 15 hrs/wk × 4 wks	2,323
– During hunt: 2 hrs/wk × 6 wks	465
– Posthunt: 10 hrs	387
Subtotal: Staffing	80,484
Total — Park Elk Reduction Program	**87,902**

Program	Annual Cost
Habitat Restoration in the Park	
• Equipment/Supplies	
Fencing	7,000
Vehicle (GSA rental)	3,000
Travel / collaborators	700
Subtotal: Equipment/Supplies	10,700
• Treatment	
Universal herbicide (4,500 ac × $56/ac = $252,000/15 yrs)	16,800
Forb herbicide (4,500 ac × $26/ac = $117,000/15 yrs)	7,800
Sterile cultivar (4,500 ac × $65/ac = $292,500/15 yrs)	19,500
Universal herbicide (4,500 ac × $56/ac = $252,000/15 yrs)	16,800
Prescribed burn (2,250 ac × $30/ac = $67,500/15 yrs)	4,500
Seed collection (4,500 ac × $360/ac = $1,620,000/15 yrs)	108,000
Increased seed bed preparation (4,500 ac × $60/ac = $270,000/15 yrs)	18,000
Subtotal: Treatment	191,400
• Staffing Needs	
Equipment operator (WG-9) or contractor (1,040 hrs @ $32.60/hr)	33,900
One seasonal (6 mos.) biological tech (GS-5/5, 0.5 FTE @ $32,576/yr)	16,288
Two seasonal (5 mos.) biological techs (GS-5/5, 0.84 FTE @ $32,576/yr)	27,364
One seasonal (6 mos.) ecologist (GS-9/5 @ $66,480/yr)	33,240
Subtotal: Staffing	110,792
Subtotal — Park Habitat Restoration	**312,892**
NPS Total Annual Cost	**643,343**
USFWS & NPS TOTAL ANNUAL COST	**966,441**

NOTES: Federal labor costs include a 3% per year for a cost of living adjustment.
Costs for programs that occur only for a few years during the life of the plan have been annualized over a 15-year basis.

TABLE 15. TOTAL PROJECTED PLAN COSTS
(2006 dollars, not adjusted for inflation)

One-Time Costs	
• U.S. Fish and Wildlife Service	3,584,937
• National Park Service	87,000
Total One-Time Costs	**3,671,937**
Total Annual Plan Costs (annual cost × 15 yrs)	
• U.S. Fish and Wildlife Service	4,846,470
• National Park Service	9,650,145
Total Annual Costs	**14,496,615**
TOTAL COST	**18,168,552**

APPENDIXES

APPENDIX A: LAWS AND REGULATIONS

Many procedural and substantive requirements of federal and applicable state and local laws and regulations affect refuge and park establishment, management, and development. The following list identifies the key federal laws and policies that were considered during the planning process or that could affect future refuge and park management.

American Indian Religious Freedom Act (1978): Directs agencies to consult with native traditional religious leaders to determine appropriate policy changes necessary to protect and preserve Native American religious cultural rights and practices.

Americans with Disabilities Act (1992): Prohibits discrimination in public accommodations and services.

Antiquities Act (1906): Authorizes the scientific investigation of antiquities on Federal land and provides penalties for unauthorized removal of objects taken or collected without a permit.

Archeological and Historic Preservation Act (1974): Directs the preservation of historic and archaeological data in Federal construction projects.

Archeological Resources Protection Act (1979) as amended: Protects materials of archaeological interest from unauthorized removal or destruction and requires Federal managers to develop plans and schedules to locate archaeological resources.

Architectural Barriers Act (1968): Requires federally owned, leased, or funded buildings and facilities to be accessible to persons with disabilities.

Bald and Golden Eagle Protection Act (1940): Prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions.

Clean Air Act of 1977, as amended: Establishes federal standards for various pollutants from both stationary and mobile sources and provides for the regulation of polluting emissions via state implementation plants. In addition, and of special interest for national wildlife refuges, some amendments are designed to prevent significant deterioration in certain areas where air quality exceeds national standards, and to provide for improved air quality in areas which do not meet federal standards ("non-attainment" areas). Federal facilities are required to comply with air quality standards to the same extent as nongovernmental entities (42 USC 7418).

Clean Water Act (1977): Requires consultation with the U.S. Army Corps of Engineers (404 permits) for major wetland modifications.

Emergency Wetlands Resources Act (1986): Promotes the conservation of migratory waterfowl and offsets or prevents the serious loss of wetlands by the acquisition of wetlands and other essential habitat.

Endangered Species Act (1973): Requires all federal agencies to carry out programs for the conservation of endangered and threatened species.

Executive Order No. 11593, "Protection and Enhancement of the Cultural Environment" (1971): Requires federal agencies to consult with federal and state historic preservation officers if any development activities would affect the archeological or historical sites, in compliance with section 106 of the National Historic Preservation Act of 1966, as amended.

Executive Order 11987, "Exotic Organisms" (1977): Requires federal agencies, to the extent permitted by law, to restrict the introduction of exotic species into the natural ecosystems on lands and waters owned or leased by the United States; to encourage states, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States; to restrict the importation and introduction of exotic species into any natural U.S. ecosystems as a result of activities they undertake, fund, or authorize; and to restrict the use of federal funds, programs, or authorities to export native species for introduction into ecosystems outside the U.S. where they do not occur naturally.

Executive Order 11988, "Floodplain Management" (1977): Requires each federal agency to provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by the floodplains.

Executive Order 11990, "Protection of Wetlands" (1977): Directs all federal agencies to avoid, if possible, adverse impacts to wetlands and to preserve and enhance the natural and beneficial values of wetlands. Each agency shall avoid undertaking or assisting in wetland construction projects unless the

head of the agency determines that there is no practicable alternative to such construction and that the proposed action includes measures to minimize harm. Also, agencies shall provide opportunity for early public review of proposals for construction in wetlands, including those projects not requiring an environmental impact statement.

Executive Order 12898, "Environmental Justice" (1994): Provides minority and low-income populations an opportunity to comment on the development and design of reclamation activities. Federal agencies shall make achieving environmental justice part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

Executive Order 13007, "Indian Sacred Sites" (1996): Directs federal land management agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, to avoid adversely affecting the physical integrity of such sacred sites, and where appropriate, to maintain the confidentiality of sacred sites.

Executive Order 13084, "Consultation and Coordination with Indian Tribal Governments" (1998): Requires federal agencies to work with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-government, trust resources, and Indian tribal treaty and other rights. The United States has a unique legal relationship with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, executive orders, and court decisions. Since the formation of the Union, the United States has recognized Indian tribes as domestic dependent nations under its protection. In treaties, our Nation has guaranteed the right of Indian tribes to self-government. As domestic dependent nations, Indian tribes exercise inherent sovereign powers over their members and territory.

Executive Order 13112, "Invasive Species" (1999): Directs federal agencies to prevent the introduction of invasive species, control and monitor invasive species, and restore native species and habitats that have been invaded.

Federal Aid in Wildlife Restoration Act of September 2, 1937, as amended (commonly referred to as the Pittman-Robertson Act): Provides funds to states for game and non-game wildlife restoration work. Funds from an excise tax on sporting arms and ammunition are appropriated to the Secretary of the Interior annually and apportioned to states on a formula basis for approved land acquisition, research, development and management projects, and hunter safety programs.

Federal Noxious Weed Act (1990): Requires the use of integrated management systems to control or contain undesirable plant species; and an interdisciplinary approach with the cooperation of other federal and state agencies.

Food Security Act of 1985 (Title XII, Public Law 99-198, 99 Stat. 1354; December 23, 1985), as amended: Authorizes acquisition of easements in real property for a term of not less than 50 years for conservation, recreation, and wildlife purposes.

Land and Water Conservation Fund Act (1965): Uses the receipts from the sale of surplus federal land, outer continental shelf oil and gas sales, and other sources for land acquisition under several authorities.

Migratory Bird Conservation Act (1929): Establishes procedures for acquisition by purchase, rental, or gift of areas approved by the Migratory Bird Conservation Commission.

Migratory Bird Treaty Act (1918): Designates the protection of migratory birds as a federal responsibility. This act enables the setting of seasons and other regulations, including the closing of federal or nonfederal areas to the hunting of migratory birds.

National Environmental Policy Act (1969): Requires all federal agencies to examine the impacts upon the environment that their actions might have, to incorporate the best available environmental information, and to use public participation in the planning and implementation of all actions. All federal agencies must integrate NEPA requirements with other planning requirements, and they must prepare appropriate NEPA documentation to facilitate sound environmental decision making. NEPA requires the disclosure of the environmental impacts of any major federal action that affects in a significant way the quality of the human environment.

National Historic Preservation Act (1966), as amended: Establishes as policy that the federal government is to provide leadership in the preservation of the nation's prehistoric and historic resources.

Native American Graves Protection and Repatriation Act (1990): Requires federal agencies and museums to inventory, determine ownership of, and repatriate cultural items under their control or possession.

ADDITIONAL LAWS ONLY AFFECTING THE NATIONAL ELK REFUGE

Executive Order 12996, "Management and General Public Use of the National Wildlife Refuge System" (1996): Defines the mission, purpose, and priority public uses of the National Wildlife Refuge System. It also presents four principles to guide management of the System.

Fish and Wildlife Coordination Act of March 10, 1934, as amended: Authorizes the Secretary of the Interior to assist federal, state, and other agencies in development, protection, rearing and stocking fish and wildlife on federal lands, and to study effects of pollution on fish and wildlife. The act also requires consultation with the Fish and Wildlife Service and the wildlife agency of any state wherein the waters of any stream or other water body are proposed to be impounded, diverted, channelized or otherwise controlled or modified by any federal agency, or any private agency under federal permit or license, with a view to preventing loss of, or damage to, wildlife resources in connection with such water resource projects. The act further authorizes federal water resource agencies to acquire lands or interests in connection with water use projects specifically for mitigation and enhancement of fish and wildlife.

Fish and Wildlife Act (1956): Established a comprehensive national fish and wildlife policy and broadened the authority for acquisition and development of refuges.

Fish and Wildlife Coordination Act (1958): Allows the Fish and Wildlife Service to enter into agreements with private landowners for wildlife management purposes.

National Wildlife Refuge System Administration Act of 1966: Defines the National Wildlife Refuge System and authorizes the Secretary of the Interior to permit any use of a refuge provided such use is compatible with the major purposes for which the refuge was established. This act was amended by the National Wildlife Refuge System Improvement Act of 1997 (see below).

National Wildlife Refuge System Improvement Act of 1997: Sets the mission and administrative policy for all refuges in the National Wildlife Refuge System; defines a unifying mission for the refuge system; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation and photography, or environmental education and interpretation); establishes a formal process for determining compatibility; establishes the responsibilities of the Secretary of the Interior for managing and protecting the system; and requires a comprehensive conservation plan for each refuge by the year 2012.

Native American Policy (1994): Articulates the general principles that will guide the U.S. Fish and Wildlife Service's government-to-government relationship with Native American governments in the conservation of fish and wildlife resources. The policy does not suggest recognition of tribal authority that does not exist, nor is the policy used to arbitrate differences in opinion between governmental agencies or judicial findings.

Refuge Recreation Act (1962): Allows the use of refuges for recreation when such uses are compatible with the refuge's primary purposes and when sufficient funds are available to manage the uses.

Rehabilitation Act (1973): Requires programmatic accessibility in addition to physical accessibility for all facilities and programs funded by the federal government to ensure that anybody can participate in any program.

Refuge Revenue Sharing Act of 1935, as amended: Provides for payments to counties in lieu of taxes, using revenues derived from the sale of products from refuges. Public Law 88-523 (1964) revised this act and required that all revenues received from refuge products, such as animals, timber and minerals, or from leases or other privileges, be deposited in a special Treasury account and net receipts distributed to counties for public schools and roads. Payments to counties were established as: (1) on acquired land, the greatest amount calculated on the basis of 75 cents per acre, three-fourths of 1% of the appraised value, or 25% of the net receipts produced from the land; and (2) on land withdrawn from the public domain, 25% of net receipts and basic payments under Public Law 94-565 (31 USC 1601-1607, 90 Stat. 2662), payment in lieu of taxes on public lands.

Statute 293 (1912): Establishes the National Elk Refuge as a winter game (elk) reserve.

37 Statute 847 (1913): Sets aside the National Elk Refuge for the establishment and maintenance of a winter elk refuge in the State of Wyoming.

Executive Order 3596 (1921): Establishes all lands within the boundaries of the National Elk Refuge as a refuge and breeding ground for birds.

Executive Order 3741 (1922): Sets aside the National Elk Refuge as a refuge and breeding grounds for birds.

Statute 1246 (1927): Institutes another National Elk Refuge purpose for grazing of, and as a refuge for, American elk and other big game animals.

ADDITIONAL LAWS ONLY AFFECTING GRAND TETON NATIONAL PARK

National Park Service Organic Act (39 Stat. 535, 16 USC 1 et seq., as amended, 1916): Established the National Park Service, and states its basic mission: "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."

45 Stat. 1314 (1929): Established Grand Teton National Park, creating a 96,000-acre park that included the Teton Range and eight glacial lakes at the base of the peaks.

Presidential Proclamation Number 2578, 57 Stat. 731 (1943): Established Jackson Hole National Monument, which combined Teton National Forest acreage and other federal properties, including Jackson Lake and a 35,000-acre donation by John D. Rockefeller. The Rockefeller lands continued to be privately held until December 16, 1949.

Public Law 81-787, 64 Stat. 849 (1950): Enlarged Grand Teton National Park to its present size by including the lands within Jackson Hole National Monument.

Public Law 92-404 (1972): Established John D. Rockefeller, Jr., Memorial Parkway for the purpose of commemorating the many significant contributions to the cause of conservation in the United States, which have been made by John D. Rockefeller, Jr., and to provide both a symbolic and desirable physical connection between the world's first national park, Yellowstone, and Grand Teton National Park.

General Authorities Act of 1970, as amended in 1978 by the Redwood amendment (16 USC 1a-1): States that "the promotion and regulation of the various areas of the National Park System . . . shall be consistent with and founded in the purpose established [in the Organic Act] to the common benefit of all the people of the United States. The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in 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 provided by Congress."

112 Statute 3501 (16 USC 5936, 1998): Requires the Secretary of the Interior to use the results of scientific study when making decisions about park management. Additionally, when making a decision that "may cause a significant adverse effect on a park resource," the administrative record must reflect how the manager considered the resource studies.

APPENDIX B: PLANT AND ANIMAL SPECIES FOUND IN JACKSON HOLE

PLANT SPECIES

An asterisk indicates a nonnative species.

Abies bifolia	Sub-alpine fir
Aconitum columbianum	Columbian monkshood
Agropyron cristatum	Crested wheatgrass*
Agrostis spp.	Bentgrasses
Agrostis stolonj/era	Redtop
Alnus incana	Mountain alder
Alopecurus aequalis	Meadow foxtail
Alopecurus arundinaceus	Creeping foxtail
Amelanchier alnifolia	Serviceberry
Arenaria congesta	Thread-leaved sandwort
Artemesia cana	Silver sagebrush
Artemesia frigida	Fringed sage
Artemisia tridentata	Big sagebrush
Artemisia tripartita	Three-tipped sagebrush
Betula spp.	Birch
Bromus inermis	Smooth brome*
Calamagrostis canadensis	Bluejoint reedgrass
Calamagrostis rubescens	Pinegrass
Calamagrostis species	Reedgrasses
Carex spp.	Sedges
Carex aquatilis	Water sedge
Carex microptera	Small-winged sedge
Carex utriculata	Beaked sedge
Carex vesixaria	Inflated sedge
Chrysothammus viscidiflous	Green rabbitbrush
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Douglas rabbitbrush
Claytonia lanceolata	Western Springbeauty
Cornus stolonjfera	Red-osier dogwood
Delphimiym occidentale	Tall mountain larkspur
Deschampsia cespitosa	Tufted hairgrass
Eleagnus commutata	Silverberry
Elymus cinereus	Great basin wildrye*
Elymus smithii	Western wheatgrass
Elymus spp.	Wheatgrasses
Elytrigia intermedia	Intermediate wheatgrass*
Equisetum arvense	Horsetail (common)
Equisetum spp.	Horsetails
Festuca idahoensis	Idaho fescue
Glycorrhiza lepidota	Licorice root
Gutierrezia sarothrae	Brome snakeweed
Gutierrezia sarothrae	Snakeweed
Heterotheca villosa	Golde-naster
Hordeum jubatum	Foxtail barley
Hydrophyllum capitatum	Ballhead waterleaf
Juncus species	Rushes
Kieleria macrantha	June grass
Ligusticum filicinem	Fern-leaved lovage
Lonicera involucrata	Bearberry honeysuckle
Lupinus argenteus	Silvery Lupine
Medicago sativa	Alfalfa
Mertensia ciliata	Mountain bluebells
Muhlenbergia glomerata, M. montana	Muhly
Pentaphylloides floribunda	Shrubby cinquefoil
Phalaris arundinacea	Reed canarygrass
Phleum alpinum	Mountain timothy
Picea engelmannii	Engelmann spruce
Picea pungens	Blue Spruce
Pinus albicaulis	Whitebark pine
Pinus contorta	Lodgepole pine
Pinus flexilisand	Limber pine
Poa pratensis	Kentucky bluegrass*
Poa spp.	Bluegrasses
Populus angustifolia	Narrowleaf cottonwood
Populus tremuloides	Quaking aspen
Potamogeton species	Pondweed
Prunus virginiana	Chokecherry
Pseudotsuga menziesii	Douglas fir
Pursia tridentata	Bitterbrush
Rorippa spp.	Watercress
Rosa spp.	Wild rose
Rudbeckia occidentalis	Western rayless cone- flower
Salix spp.	Willows
Salix bebbiana	Bebb's willow
Salix boothii	Booth's willow
Salix drummongii	Drummond's willow
Salix exigua	Sandbar willow
Salix geyeriana	Geyer's willow
Salix lutea	Yellow willow
Salix planifolia	Plane leaf willow
Salix wolfii	Wolf willow
Scripus acutus	Hard-stemmed bulrush
Scripus spp.	Bulrushes
Shepherdia canadensis	Buffaloberry
Solidago canadensis	Canada goldenrod
Stipa spp.	Needlegrasses
Symphoricarpos oreophilus	Snowberry
Tragopogon dubius	Yellow salsify
Typha latifolia	Cattails

ANIMAL SPECIES

Insectivora

Soricidae

Sorex cinereus	Masked shrew
Sorex merriami	Merriam's shrew
Sorex monticolus	Dusky or montane shrew
Sorex nanus	Dwarf shrew
Sorex palustris	Water shrew
Sorex vagrans	Vagrant shrew

Chiroptera

Verspertilionidae

Eptesicus fuscus	Big brown bat
Euderma maculatum	Spotted bat
Lasionycteris noctivagans	Silver-haired bat
Lasiurus cinereus	Hoary bat
Myotis ciliolabrum	Small-footed myotis
Myotis evotis	Long-eared myotis
Myotis lucifugus	Little brown myotis
Myotis volans	Long-legged myotis
Plecotus townsendii	Townsend's big-eared bat

Lagomorpha

Ochotonidae

Ochotona princeps	Pika

Leporidae

Lepus americanus	Snowshoe hare
Sylvilagus nutalli	Nuttall's cottontail

Rodentia

Sciuridae

Glaucomys sabrinus	Northern flying squirrel
Marmota flaviventris	Yellow-bellied marmot
Spermophilus armatus	Uinta ground squirrel
Spermophilus lateralis	Golden-mantled ground squirrel
Tamias amoenus	Yellow-pine chipmunk
Tamias minimus	Least chipmunk
Tamias umbrinus	Uinta chipmunk
Tamiasciurus hudsonicus	Red squirrel (pine squirrel, chickaree)

Geomyidae

Thomomys talpoides	Northern pocket gopher

Castoridae

Castor canadensis	Beaver

Cricetidae

Neotoma cinerea	Bushy tailed woodrat
Peromyscus maniculatus	Deer mouse

Arvicolinae (subfamily)

Clethrionomys gapperi	Southern red-backed vole
Lemmiscus curtatus	Sagebrush vole
Microtus longicaudus	Long-tailed vole
Microtus montanus	Montane vole
Microtus pennsylvanicus	Meadow vole
Microtus richardsoni	Water vole
Microtus richardsoni	Richardson's vole
Ondatra zibethicus	Muskrat
Phenacomys intermedius	Heather vole

Murinae (subfamily)

Mus musculus	House mouse
Rattus norvegicus	Norway rat

Dipodidae

Zapus princeps	Western jumping mouse

Erethizontidae

Erethizon dorsatum	Porcupine

Carnivora

Canidae

Canis latrans	Coyote
Canis lupus	Gray wolf
Vulpes vulpes	Red fox

Ursidae

Ursus americanus	Black bear
Ursus arctos	Grizzly bear

Procyonidae

Procyon lotor	Raccoon

Mustelidae

Gulo gulo	Wolverine
Lutra canadensis	Northern river otter
Martes americana	American marten
Martes pennanti	Fisher
Mephitis mephitis	Striped skunk
Mustela erminea	Ermine (short-tailed weasel)
Mustela frenata	Long-tailed weasel
Mustela nivulis	Least weasel
Mustela vison	Mink
Spilogale gracilis	Western spotted skunk
Taxidea taxus	Badger

Felidae

Lynx lynx	Lynx
Lynx rufus	Bobcat
Puma concolor	Mountain lion

Artiodactyla

Cervidae

Alces alces	Moose
Antilocarpa americana	Pronghorn
Cervus elaphus	Elk (Wapiti)
Odocoileus hemionus	Mule deer
Odocoileus virgianus	White-tailed deer

Bovidae

Bison bison	Bison (American buffalo)
Oreamnos americanus	Mountain goat
Ovis canadensis	Mountain sheep (bighorn sheep)

REPRESENTATIVE BIRD SPECIES OF JACKSON HOLE

Hummingbirds

Selasphorus platycercus	Broad-tailed hummingbird
Selasphorus platycercus	Rufous hummingbird
Stellula calliope	Calliope hummingbird

Perching Birds

Agelaius phoeniceus	Red-winged blackbird
Bombycilla cedrorum	Cedar waxwing
Carduelis tristis	American goldfinch
Catharus fuscescens	Veery
Catharus guttatu	Hermit thrush
Catharus ustulatus	Swainson's thrush
Contopus sordidulus	Western wood-pewee
Corvus brachyrhynchos	Common crow
Corvus corax	Common raven
Dendroica petechia	Yellow warbler
Dumetella carolinensis	Gray catbird
Empidonax minimus	Least flycatcher
Empidonax oberholseri	Dusky flycatcher
Empidonax occidentalis	Cordilleran flycatcher
Empidonax trailii	Willow flycatcher
Euphagus cyanocephalus	Brewer's blackbird
Geothlypis trichas	Common yellowthroat
Icteria virens	Yellow-breasted chat
Icterus bullockii	Bullock's oriole
Junco hyemalis	Dark-eyed junco
Melospiza lincolnii	Lincoln's sparrow
Melospiza melodia	Song sparrow
Molothrus ater	Brown-headed cowbird
Oporornis tolmiei	MacGillivray's warbler
Passerculus sandwichensis	Savannah sparrow
Passerella iliaca	Fox sparrow
Passerina amoena	Lazuli bunting
Pheucticus melanocephalus	Black-headed grosbeak
Pica hudsonia	Black-billed magpie
Piranga ludoviciana	Western tanager
Poecile atricapilla	Black-capped chickadee
Poecile gambile	Mountain chickadee
Pooecetes gramineus	Vesper sparrow
Seiurus noveboracensis	Northern waterthrush
Setophaga ruticilla	American redstart
Sialia currucoides	Mountain bluebird
Sialia mexicana	Western bluebird
Spizella breweri	Brewer's sparrow
Spizella passerina	Chipping sparrow
Sturnella neglecta	Western meadowlark
Sturnus vulgaris	European starling
Tachycineta thalassina	Tree swallow
Tachycineta thalassina	Violet-green swallow
Troglodytes aedon	House wren
Turdus migratorius	American robin
Tyrannus tyrannus	Eastern kingbird
Tyrannus verticalis	Western kingbird
Vermivora celat	Orange-crowned warbler
Vireo gilvus	Warbling vireo
Wilsonia pusilla	Wilson's warbler
Xanthocephalus xanthocephalus	Yellow-headed blackbird
Zonotrichia leucophrys	White-crowned sparrow

Woodpeckers

Colaptes auratus	Northern flicker
Melanerpes lewis	Lewis' woodpecker
Picoides pubescens	Downy woodpecker
Picoides villosus	Hairy woodpecker
Sphyrapicus nuchalis	Red-naped sapsucker
Sphyrapicus thyroideus	Williamson's sapsucker

Gallinaceous Birds

Bonasa umbellus	Ruffed grouse
Centrocercus urophasianus	Sage grouse
Dendragapus obscurus	Blue grouse

Waterfowl

Anas americana	American widgeon
Anas crecca	Green-winged teal
Anas cyanoptera	Cinnamon teal
Anas platyrhynchos	Mallard
Anas strepera	Gadwall
Aythya collaris	Ringed-neck duck
Branta canadensis	Canada goose
Bucephala clangula	Common Golden-eye
Bucephala islandica	Barrow's golden-eye
Cygnus buccinator	Trumpeter swan
Cygnus columbianus	Tundra swan
Mergus merganser	Common merganser

Shorebirds

Capella gallinago	Common snipe
Catoptrophorus semipalmatus	Willet
Charadrius semipalmatus	Semipalmated plover
Charadrius vociferus	Killdeer
Ereubetes mauri	Western sandpiper
Eupoda montana	Mountain plover
Himantopus mexicanus	Black-necked stilt
Numenius americanus	Long-billed curlew
Recurvirostra americana	American avocet

Rails and Coots

Coturnicops noveboracensis	Yellow rail
Fulica americana	American coot
Porzana carolina	Sora
Rallus limicola	Virginia rail

Cranes

Grus canadensis	Sandhill crane

Bitterns and Herons

Ardea herodias	Great blue heron
Botaurus lentiginosus	American bittern
Bubulcus ibis	Cattle egret
Leucophoyx thula	Snowy egret
Nycticorax nycticorax	Black-crowned night heron

Raptors

Aquila chrysaetos	Golden eagle
Buteo jamaicensis	Red-tailed hawk
Circus cyaneus	Northern harrier
Falco peregrinus	Peregrine falcon
Falco sparverius	American kestral
Haliaeetus leucocephalus	Bald eagle
Pandion haliaetus	Osprey

Owls

Athene cunicularia	Burrowing owl
Bubo virginianus	Great-horned owl
Otus kennicottii	Western screech owl
Strix nebulosa	Great grey owl
Tyto alba	Barn owl

Seabirds

Pelecanus erythrorhynchos	White pelican
Phalacrocorax auritus	Double-crested cormorant
Podiceps caspicus	Eared grebe

Gulls and Terns

Chlidonias niger	Black tern
Larus philadelphia	Bonaparte's gull
Larus pipixcan	Franklin's gull
Sterna caspia	Caspian tern

APPENDIX C: COMPATIBILITY DETERMINATION FOR BISON HUNTING

Use: Bison Hunting

Refuge Name: National Elk Refuge, Teton County, Wyoming

Refuge Purposes and Establishing Authority:

> ". . . the establishment of a winter game (elk) reserve..." Stat. 293, dated Aug. 10, 1912.
>
> "For the establishment and maintenance of a winter elk refuge in the State of Wyoming. . . ." 37 Stat. 847, dated March 4, 1913.
>
> ". . . all lands that now are or may hereafter be included within the boundaries of . . . the Elk Refuge, Wyoming,...are hereby further reserved and set apart for the use of the Department of [Interior] as refuges and breeding grounds for birds." Executive Order 3596, dated Dec. 22, 1921.
>
> ". . . for the use of the Secretary of [the Interior] as a refuge and breeding grounds for birds. . . ." Executive Order 3741, dated September 20, 1922.
>
> ". . . for grazing of, and as a refuge for, American elk and other big game animals. . . ." Stat. 1246, dated Feb. 25, 1927.
>
> ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources. . . ." Fish and Wildlife Act of 1956.
>
> ". . . suitable for – (1) incidental fish and wildlife-oriented recreational development. (2) the protection of natural resources. (3) the conservation of endangered species or threatened species. . . ." 16 USC 460k-1 (Refuge Recreation Act of 1962).

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats, of the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended [16 USC 668dd–668ee]).

Additionally, the National Wildlife Refuge System Act specifically addresses wildlife-dependent recreation:

> "compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System and the purposes of many refuges, and which generally fosters refuge management and through which the American public can develop an appreciation for fish and wildlife." 16 USC 668dd(a)(3)(B).
>
> "when the Secretary determines that a proposed wildlife-dependent recreational use is a compatible use within a refuge, that activity should be facilitated, subject to such restriction or regulations as may be necessary, reasonable, and appropriate." 16 USC 668dd(a)(3)(D).
>
> "the terms 'wildlife-dependent recreation' and 'wildlife-dependent recreational use' mean a use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation." 16 USC 668ee (2).

Description of Use:

The National Elk Refuge will administer a bison hunting program for the general public licensed by the Wyoming Game and Fish Department (WGFD) and could potentially allow for a small ceremonial event for Native American tribes historically associated with the Jackson Hole area. Both the hunt and the ceremonial

event are being instituted for the purpose of removing surplus bison as determined in the *Final Bison and Elk Management Plan and Environmental Impact Statement* (Final Plan/EIS). Under the Preferred Alternative in the Final Plan/EIS the bison herd will be adaptively managed based on habitat and population monitoring, and the U.S. Fish and Wildlife Service (USFWS) and the National Park Service (NPS) will recommend a population objective of approximately 500 animals for the Jackson bison herd. WGFD sets the objective levels for the herd through a public review process that requires approval by the Wyoming Game and Fish Commission.

General Public Hunt. Hunters will be required to meet all State of Wyoming requirements for the hunting of bison, including rifle caliber, wearing of hunter orange clothing, reporting of kills, and providing biological samples for disease testing and genetic analyses. Hunters must show evidence of having passed a state sponsored and approved hunter safety course. Hunters will be provided instructional materials on identification of sex and age of bison in the field to enhance selection of the type of animal that their permit specifies.

Bison hunting for the general public will occur on the refuge at approximately the same time that elk hunting for the general public is occurring. The National Elk Refuge program will be highly managed. Members of the general public wishing to hunt on the refuge must have a valid State of Wyoming Bison Hunting License, and a valid Hunter Safety Card (or certification) or a current Hunter Safety Instructor Card issued by a state. While hunting on the refuge, individuals must also possess a Wyoming Conservation Stamp. Hunt dates, bag limits, hunter quotas, and any adjustments to Refuge Hunt Zones will be determined on an annual basis, in consultation with WGFD.

Ceremonial Event by Tribes. The refuge manager would potentially allow for the removal of up to five bison annually on the National Elk Refuge by Native American tribes for ceremonial purposes.

All special National Elk Refuge regulations governing personal conduct during elk hunting shall also apply to tribal members. The National Elk Refuge manager has the authority to close hunting seasons to prevent resource (soil and vegetation) damage during inclement weather or to insure public safety.

Availability of Resources:

It is anticipated that annual planning and execution of the proposed bison hunting and reduction programs will require approximately 95 staff-days of work, spread among the Refuge Manager, Biological, Visitor Services and Law Enforcement staff and cost approximately $26,000 to operate. Refuge resources are expected to be augmented by the services and volunteers and partnership with WGFD personnel.

Anticipated Impacts:

Impacts on National Elk Refuge lands, waters or interests will be limited to permitting hunters to access closed areas of the refuge to pursue, harvest and remove bison based on fair-chase principles. An annual elk hunting program has been conducted on the National Elk Refuge for over 50 years. The general public bison hunt is anticipated to occur concurrently with elk hunting to limit disturbance to other wildlife to the same period of time. The program will require no facility development or conversion of habitat areas to administrative use.

The bison hunt will likely have minimal impacts to other refuge wildlife and significant beneficial impacts on the soil and flora of the refuge (Final Plan/EIS). Hunting can benefit habitats by reducing the number of bison that forage on the refuge in the winter, thus controlling ungulate grazing and browsing pressure.

Direct negative impacts of the hunting program on most wildlife will be minimal because hunting occurs in the fall when breeding and nesting seasons are over. Most Neotropical birds have migrated to their wintering grounds. Any disturbance impacts on most predators and scavengers, including threatened or endangered species, will be far outweighed by the increase in food in the form of gut piles and carcass remains. Migrating bald eagles and other raptors, in particular, benefit from this food source (Griffin, pers. comm. 2002). Grizzly bears and wolves could benefit from this food source in the future if these species begin to occur on the refuge with greater frequency.

Implementing a public hunt on the refuge will likely affect bison movements, distribution, and behavior once bison understand that traditionally safe areas are no longer safe. Bison will likely move away from hunt areas to non-hunt areas on the refuge and in the park. Bison hunting in the northern end of the refuge may encourage bison to move south, possibly into the town of Jackson although this is unlikely. If they move to private lands, WGFD will have the prerogative to haze or destroy them because of safety or damage concerns. Hunting may also increase agitation, nervousness, and energetic expenditures associated with fleeing from hunters and the sounds of weapons firing, possibly lowering nutrition because bison will stop foraging while being displaced from these areas (Smith, pers. comm. 2003).

The National Elk Refuge is bordered by public lands to the north and east, i. e. Grand Teton National Park and Bridger Teton National Forest. Fencing on the western and southern boundaries of the refuge is designed to prevent ungulates from moving onto private lands and crossing Highway 89. Bison will continue to be able to move freely between their winter range on the National Elk Refuge and their summer range on Grand Teton National Park and their limited use of private lands and adjacent forest land.

Public Review and Comment:

The draft compatibility determination for bison hunting was presented for public review and comment in conjunction with the public comment period for the Draft Plan/EIS, beginning on July 21, 2005. The comment period closed on November 7, 2005.

At three public hearings, and throughout the comment period for the Draft Plan/EIS, substantial public input was received regarding the provisions in the Proposed Action to provide a hunting program and ceremonial event for bison at the National Elk Refuge.

Only one comment specifically addressed the draft compatibility determinations, and the commenter expressed the view that the compatibility determinations were inadequate, premature and suggested a predetermined outcome of the EIS process.

With respect to public comments, a large number of individuals and some conservation groups expressed concern that the population objective of 450–500 (Draft Plan/EIS) is at the low end of what is considered to be a genetically viable population. The public overwhelmingly desires that the bison herd be managed like other big game species and not be reduced to the lowest genetically viable population. Several studies indicate this number to be about 400 (Berger 1996; Gross and Wang 2005). The Preferred Alternative in the Final Plan/EIS was modified to state that the bison herd would be adaptively managed based on habitat monitoring, and that the lead agencies will recommend a population objective of approximately 500 animals. WGFD sets the objective levels for the herd through a public review process, and the Wyoming Game and Fish Commission must approve.

Overall, most agencies, conservation groups, and Native American tribes that submitted comments support the reduction of the bison herd through hunting. Letters were received from WGFD, the Shoshone-Bannock Tribes, the Town of Jackson, and numerous conservation and sportsmen groups. The Shoshone-Bannock Tribes oppose limiting the small ceremonial event to five animals annually, while WGFD opposes the ceremonial event by Native Americans. As stated above, most people support reducing the herd as long as the herd is not reduced to the minimum for a genetically viable population. Two animal rights stakeholder groups and a few individuals voiced their opposition to the bison hunt. In addition to issues of whether a hunt based on "fair-chase" principles can be implemented, they raised concerns about whether visitors to Grand Teton National Park would have fewer opportunities to view bison, and they were generally opposed to hunting and how that affects a person's overall experience.

A 2004 study by Loomis and Koontz and a 2005 study by Koontz and Hoag analyzed visitor preferences for different management alternatives and actions, including bison hunting, across three geographic areas — Teton County, the State of Wyoming, and the rest of the United States. The study found a strong correlation between stakeholder viewpoints and preferred management actions. Assessment about the dynamic of hunting on an individual bison or the bison herd found it would unlikely change the impact of summer visitor experiences in Grand Teton National Park. Loomis and Koontz (2004) found that having a hunting program on the National Elk Refuge would not lead to a change in visitors coming to Grand Teton National Park unless there were major changes in numbers of animals.

In the professional judgment of the undersigned, none of the issues received during the comment period warrants changing the proposal for allowing a public bison hunt on the National Elk Refuge. The proposal to allow for a small ceremonial event by Native Americans was modified as potentially allowing for the removal of five bison for ceremonial purposes. Hunting is clearly an appropriate use of the National Wildlife Refuge System by law and policy. The costs of the program are mostly salaries of personnel expended over the course of a fiscal year and are not excessive compared to many refuge programs. Hunting is an effective tool for ungulate population management that provides a wholesome outdoor recreational experience. In accordance with the U.S. Fish and Wildlife Service's Compatibility Policy (2000), seeking public comment during the comment period on the Draft Plan/EIS is appropriate and recommended.

Compatibility Determination:

Using sound professional judgment (603 FW 2.6U., and 2.11A), place an "X" in the appropriate space to indicate whether the use would or would not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes of the National Elk Refuge.

Use is Not Compatible

X Use is Compatible

Stipulations Necessary to Ensure Compatibility:

The following stipulations would allow the bison hunting program to be compatible from the standpoint of direct and short-term effects on the ability of the USFWS to fulfill the mission of the National Wildlife Refuge System and the purposes of the refuge:

- Weapons will be limited to rifles. No archery or handguns will be allowed.
- The bison hunt must be detailed in an approved hunting plan prior to implementation.

Justification:

Jackson Hole has the second largest free-ranging bison herd in the United States and the largest herd within the National Wildlife Refuge System. The current Jackson bison herd numbers over 1,000 animals, more than 500 animals above the recommended population objective of 500 animals. WGFD conducts a sport hunt for bison in Bridger-Teton National Forest in an effort to reduce herd numbers. Because few bison move outside the boundaries of the refuge and the park, the Wyoming Game and Fish Department has had difficulty in achieving its bison herd objective. The bison hunt and reduction programs on the refuge would assist the state in achieving this objective.

The USFWS, NPS, and WGFD jointly manage the Jackson bison herd. The herd increases at a rate of 10%–14% annually, largely because of low winter mortality. The herd winters on the refuge and consumes pelleted alfalfa hay. Winter range for bison is limited due to human occupation of winter range that is now cattle ranchlands and subdivisions. Therefore, the size of the bison herd must be controlled to prevent habitat damage and to reduce the potential for disease transmission.

Annual censuses of the bison herd are conducted each summer to determine calf production, and each winter to determine population size, age and sex composition, and recruitment. Several evaluations of the bison herd's population genetics have established that a herd of 400 bison is likely large enough to ensure that the herd's genetic diversity will be protected (Shellley and Anderson 1989; Berger 1996; Gross and Wang 2005). The recommended herd objective would be approximately 500 bison.

Annual censuses of bison and elk are conducted on the National Elk Refuge each winter. Almost every winter that 7,000 or more elk (plus varying numbers of bison, mule deer and moose) have wintered on the refuge, forage supplies have been depleted and supplemental feeding has been necessary (USFWS 1990–2004). The refuge capacity to support large ungulates is being exceeded, and considerable degradation is occurring to woody vegetation on the refuge from bison and elk. This jeopardizes the long-term health of plant communities and their ability to support a diverse fauna. It also places elk and bison at risk of increased susceptibility to disease.

Forage utilization surveys conducted each spring on the refuge indicate that the use of herbaceous forage on the southern half of the refuge has consistently exceeded 50% in recent years. In the McBride management unit, where the bison spend much of their six months on the refuge, forage utilization rates have averaged more than 70% during the past 15 years (USFWS 1990–2004). Changes in plant communities have also occurred, particularly in the cottonwood habitats along upper Flat Creek and in the sagebrush community in Long Hollow. Excessive browsing by elk and bison has prevented regeneration in aspen and cottonwood habitats. Willow, serviceberry, chokecherry, currant, and other shrubs are also heavily browsed and declining in vigor, particularly on the southern half of the refuge (Smith, Cole, and Dobkin 2004). In addition, nonnative invasive plant species are increasing in National Elk Refuge grassland habitats and reducing the carrying capacity for herbivores. As a result, a concerted effort has been made in recent years to reduce the size of the wintering elk herd. Likewise, the size of the bison herd must be controlled to reduce negative effects on refuge plant communities and other wildlife species that use these habitats.

The Jackson bison herd is infected with brucellosis and may pose some level of risk of infection to livestock. As a result, surplus bison cannot be trapped and relocated to other areas outside Jackson Hole. Brucellosis and other contagious bovine diseases are far more likely to spread and be maintained in a herd under the crowded conditions experienced on the National Elk Refuge in the winter. Bovine tuberculosis, in particular, could cause extensive losses in Jackson bison, threaten the health and welfare of area cattle, elk and other wildlife, and pose a significant human health risk, should this disease infect the bison herd. Lower numbers of bison, combined with fewer years of feeding, may reduce the risk of disease transmission among bison and from bison to cattle, other wildlife, and humans.

The use of fertility control was considered in the Draft Plan/EIS but was not selected as the Preferred Alternative in the Final Plan/EIS. Hunting is a form of wildlife-dependent recreation and is considered to be a priority use of the National Wildlife Refuge System (Refuge Improvement Act 1997). As stated above, hunting helps control ungulate populations, and provides scientific data for surveillance of the bison populations for brucellosis and other diseases.

Mandatory Re-Evaluation Date: (provide month and year for "allowed" uses only)

__X__ Mandatory 15-year Re-Evaluation Date (for priority public uses)

____ Mandatory 10-year Re-Evaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision: (check one below)

____ Categorical Exclusion without Environmental Action Statement

____ Categorical Exclusion and Environmental Action Statement

____ Environmental Assessment and Finding of No Significant Impact

__X__ Environmental Impact Statement and Record of Decision

Determination

Prepared by Refuge Manager: (Signature) (Date) 11-3-06

Concurrence

Regional Chief, National Wildlife Refuge System: (Signature) (Date) 11/9/06

Literature Cited and Personal Communications

Berger, J.
1996 "Scenarios Involving Genetics and Population Size of Bison in Jackson Hole." On file at Grand Teton National Park, Moose, WY.

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2000 "603 FW2, Compatibility," In *U.S. Fish and Wildlife Service Policy Manual*. Washington DC.

APPENDIX D: COMPATIBILITY DETERMINATION FOR ELK HUNTING

Use: Elk Hunting Program

Refuge Name: National Elk Refuge, Teton County, Wyoming

Refuge Purposes and Establishing Authority:

> ". . . the establishment of a winter game (elk) reserve. . . ." Stat. 293, dated Aug. 10, 1912.
>
> "For the establishment and maintenance of a winter elk refuge in the State of Wyoming. . . ." 37 Stat. 847, dated March 4, 1913.
>
> ". . . all lands that now are or may hereafter be included within the boundaries of...the Elk Refuge, Wyoming,...are hereby further reserved and set apart for the use of the Department of [Interior] as refuges and breeding grounds for birds." Executive Order 3596, dated Dec. 22, 1921.
>
> ". . . for the use of the Secretary of [the Interior] as a refuge and breeding grounds for birds. . . ." Executive Order 3741, dated September 20, 1922.
>
> ". . . for grazing of, and as a refuge for, American elk and other big game animals. . . ." Stat. 1246, dated Feb. 25, 1927.
>
> ". . . for the development, advancement, management, conservation, and protection of fish and wildlife resources. . . ." Fish and Wildlife Act of 1956.
>
> ". . . suitable for — (1) incidental fish and wildlife-oriented recreational development. (2) the protection of natural resources. (3) the conservation of endangered species or threatened species. . . ." Refuge Recreation Act of 1962 (16 USC 460k-1).

National Wildlife Refuge System Mission:

The mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats, of the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended [16 USC 668dd–668ee]).

Additionally, the National Wildlife Refuge System Act specifically addresses wildlife-dependent recreation:

> "compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System and the purposes of many refuges, and which generally fosters refuge management and through which the American public can develop an appreciation for fish and wildlife." 16 USC 668dd(a)(3)(B)
>
> "when the Secretary determines that a proposed wildlife-dependent recreational use is a compatible use within a refuge, that activity should be facilitated, subject to such restriction or regulations as may be necessary, reasonable, and appropriate." 16 USC 668dd(a)(3)(D)
>
> "the terms 'wildlife-dependent recreation' and 'wildlife-dependent recreational use' mean a use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation." 16 USC 668ee(2).

Description of Use:

The National Elk Refuge will administer an elk hunting program for youth and members of the general public.

A maximum of 70 hunters/participants will be allowed on the refuge at one time. There will be two hunts per year (one for youth and one for the general public). The youth hunt will last for 1 weekend, including a Saturday and Sunday. Youth hunters will be accompanied by an experienced non-hunting adult. General public hunts will be scheduled in accordance with Wyoming Game and Fish regulations.

Hunters will be required to meet all State of Wyoming requirements for the hunting of elk, such as rifle caliber, wearing of hunter orange clothing, reporting of kills, or other stipulations.

The National Elk Refuge hunt program will be highly managed. A Refuge Hunting Permit is required, which is obtained by participation in a weekly public drawing. Individuals wishing to draw for a Refuge Hunting Permit must be present at the drawing, possess a valid State of Wyoming Elk Hunting License, and a valid Hunter Safety Card (or certification) or a current Hunter Safety Instructor Card issued by a state. While hunting on the refuge, individuals must also possess a Wyoming Conservation Stamp and a Wyoming Elk Feedground Special Management Permit.

Hunt dates, bag limits, hunter quotas, and any adjustments to Refuge Hunt Zones will be determined on an annual basis, in consultation with the Wyoming Game and Fish Department (WGFD). Some changes to the existing hunt zones may occur in an effort to move elk out of traditional safe zones in the southern portion of the refuge and increase harvest efficiency.

Availability of Resources:

It is anticipated that annual planning and execution of the proposed hunting program will require approximately 105 staff-days of work, spread among the National Elk Refuge Manager, Biological, Visitor Services and Law Enforcement staff and cost approximately $26,000 to operate. Refuge resources are expected to be augmented by the services and volunteers and partnership with WGFD personnel.

Anticipated Impacts:

Impacts on National Elk Refuge lands, waters, or interests will be limited to permitting hunters to access closed areas of the refuge to pursue, harvest and remove elk. An annual elk hunting program has been conducted on the National Elk Refuge for over 50 years.

Hunting on the refuge does affect elk movements, distribution and behavior. Elk would likely spend more time during the fall utilizing available habitat on the northern portion of the refuge. Many elk move quickly through hunt areas in the northern zone to non-hunt areas on the refuge and in the park, sometimes traveling through the hunt areas during the night. Hunting also increases agitation, nervousness and energetic expenditures associated with running from hunters and the sounds of weapons firing and possibly lowers nutrition because elk will stop foraging while running from these areas (Smith, pers. comm. 2003). Changing the areas where hunting is allowed from one year to the next may increase these impacts, as elk have to learn where the safe zones are every year. A beneficial effect to this would be increasing harvest efficiency of certain segments of the Jackson elk herd that arrive on the refuge earlier in the fall and thus reducing the number of elk wintering on the refuge.

Woody riparian vegetation in the northern half of the refuge benefits from hunting because elk quickly move through that area in the fall and therefore do not heavily browse aspen, willow and cottonwood habitats. However, it is browsed heavily later in the year after hunting ends and when snow depth does not prevent foraging in that area (Cole, pers. comm. 2004).

The hunt zone in the northern section of the refuge represents approximately 15,000 acres of transitional range that is lightly used because elk move quickly through to the safe zones on the southern section of the refuge, compounding already heavy grazing pressure on approximately 10,000 acres of native grasslands, wet meadows, and cultivated fields. In most years, by the time hunting season is over, snow prevents elk from returning to the northern section of the refuge to forage. Therefore grasses on the northern section of the National Elk Refuge get little use except in the spring when the elk are moving back into the park and the national forest, or in winters with below average snow accumulation.

Direct negative impacts of the hunting program on other wildlife will be minimal because hunting occurs in the fall when breeding and nesting seasons are over. Most Neotropical birds have migrated to their wintering grounds. Any disturbance impacts on most predators and scavengers will be far outweighed by the increase in food in the form of gut piles and carcass remains. Migrating bald eagles and other raptors, in particular, benefit from this food source (Griffin, pers. comm. 2002). Grizzly bears and wolves could benefit from this food source in the future if these species begin to occur on the refuge with greater frequency.

The refuge is bordered by public lands to the north and east, i. e. Grand Teton National Park and Bridger-Teton National Forest. Fencing on the western and southern boundaries of the refuge is designed to prevent elk from moving onto private lands and crossing Highway 89. Elk will continue to be able to move freely between the refuge and adjacent public lands.

To date all harvested elk that have been tested on the National Elk Refuge have tested negative for chronic wasting disease. The percentage of hunter-killed elk that have been tested is unknown due to many hunters choosing not to participate in the testing program. Under the Region 6 "Chronic Wasting Disease Policy," it will be necessary to continue surveillance of the refuge herds for occurrence and prevalence of chronic wasting disease. Hunter-harvested deer and elk will provide data for this surveillance requirement.

Jackson Hole has the largest wintering elk herd in North America. The current Jackson elk herd is approximately 2,000 animals above the WGFD's objective, and WGFD has taken aggressive action in recent years to reduce the herd through sport hunting. The hunt program on the refuge is helping the state achieve its elk herd objective goals.

Public Review and Comment:

The draft compatibility determination for elk hunting was presented for public review and comment in conjunction with the public comment period for the *Draft Bison and Elk Management Plan / Environmental Impact Statement* (Draft Plan/EIS), beginning on July 21, 2005. The comment period closed on November 7, 2005.

At three public hearings, and throughout the comment period for the Draft Plan/EIS, substantial public input was received regarding the provisions in the Proposed Action to continue the elk hunting program at the National Elk Refuge.

Only one comment specifically addressed the draft compatibility determinations, and the commenter expressed the view that the compatibility determinations were inadequate, premature and suggested a predetermined outcome of the EIS process.

Many comments were received by conservation groups, other agencies, and the general public in support of continuation of the elk hunt on the National Elk Refuge. Two stakeholder groups plus a few members of the general public voiced their opposition to elk hunting. Many commenters expressed a desire for more access for hunting and maximum opportunity for hunting.

In the professional judgment of the undersigned, none of the issues received during the comment period warrants changing the proposal for continuation of the elk hunting program on the National Elk Refuge. Hunting is clearly an appropriate use of the National Wildlife Refuge System by law and policy. The costs of the program are mostly salaries of personnel expended over the course of a fiscal year and are not excessive compared to many refuge programs. Hunting is an effective tool for ungulate population management that provides a wholesome outdoor recreational experience. In accordance with the USFWS "Compatibility Policy" (2000), seeking public comment during the comment period on the Draft Plan/EIS is appropriate and recommended.

Compatibility Determination:

Using sound professional judgment (603 FW 2.6U., and 2.11A), place an "X" in the appropriate space to indicate whether the use would or would not materially interfere with or detract from the mission of the National Wildlife Refuge System or the purposes of the National Elk Refuge.

___ Use is Not Compatible

_X_ Use is Compatible

Stipulations Necessary to Ensure Compatibility:

The following stipulations would allow the elk hunting program to be compatible from the standpoint of direct and short-term effects on the ability of the USFWS to fulfill the mission of the National Wildlife Refuge system and the purposes of the refuge:

- Weapons will be limited to rifles. No archery or handguns will be allowed.

Justification:

Hunting is a form of wildlife-dependent recreation and is considered to be a priority use of the National Wildlife Refuge System (Refuge Improvement Act 1997). Hunting has been a successful program for over 50 years on the National Elk Refuge as part of the overall management of the entire Jackson elk herd. It helps control ungulate populations, reduces mortality by starvation, and provides scientific data for surveillance of refuge elk populations for chronic wasting disease.

Mandatory Re-Evaluation Date: (provide month and year for "allowed" uses only)

_X_ Mandatory 15-year Re-Evaluation Date (for priority public uses)

____ Mandatory 10-year Re-Evaluation Date (for all uses other than priority public uses)

NEPA Compliance for Refuge Use Decision (check one below):

____ Categorical Exclusion without Environmental Action Statement

____ Categorical Exclusion and Environmental Action Statement

____ Environmental Assessment and Finding of No Significant Impact

_X_ Environmental Impact Statement and Record of Decision

Determination

Prepared by Refuge Manager

(Signature) 11-3-06 (Date)

Concurrence

Regional Chief, National Wildlife Refuge System:

(Signature) 11/9/06 (Date)

Literature Cited and Personal Communications

Cole, E. K., Wildlife Biologist, U.S. Fish and Wildlife Service, Jackson, WY
2004 Personal communication regarding elk and habitat on the National Elk Refuge.

Griffin, J., Refuge Operations Specialist, U. S. Fish and Wildlife Service, Jackson, WY
2002 Personal communication regarding bald eagles on the National Elk Refuge.

Smith B. S., Wildlife Biologist, U. S. Fish and Wildlife Service, Jackson, WY
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APPENDIX E: BIOLOGICAL OPINION

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
5353 Yellowstone Road, Suite 308A
Cheyenne, Wyoming 82009

In Reply Refer To:
ES-61411/W.25/WY07FA0209
ES-6-WY-07-F014

Memorandum

To: Barry Reiswig, Refuge Manager, U.S. Fish and Wildlife Service, National Elk Refuge, Jackson, Wyoming

From: Brian T. Kelly, Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Field Office, Cheyenne, Wyoming

Subject: Final Biological Opinion for the Bison and Elk Management Plan (Formal Consultation No. ES-6-WY-07-F014)

This memorandum transmits the U.S. Fish and Wildlife Service's (Service) final biological opinion based on our review of the January 2007 Bison and Elk Management Plan (Plan or Project) and Final Environmental Impact Statement (FEIS) and the Project's effects on endangered, threatened, proposed and experimental non-essential species.

This final biological opinion addresses the effects of the Project on the threatened grizzly bear (*Ursus arctos horribilis*) in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act; 50 CFR § 402.14). Your February 07, 2007 letter requesting formal consultation, and including the Intra-Service Section 7 Biological Evaluation (BE) form, was received on February 7, 2007.

The National Elk Refuge (NER or Refuge) and Grand Teton National Park (GTNP or Park)/John D. Rockefeller, Jr., (JDR) Memorial Parkway are proposing to implement a bison and elk management plan that will address adaptive management of the Jackson bison and elk herds and their habitat on the Refuge and in the Park with an emphasis on improving range quality, and insuring long term sustainability of biotic integrity and environmental health. The Plan includes development and implementation of a dynamic framework for decreasing the need for supplemental feeding on the Refuge based on existing conditions, trends, new research findings, and other changing circumstances. The Park and NER will work in close cooperation with the Wyoming Game and Fish Department (WGFD) during both development and implementation of

this framework which will include population management through methods including implementation of special, organized elk and bison hunts, vegetation restoration, ongoing monitoring, and public education as integral components.

The Service concurs with the Refuge's assessment that the Project is likely to have "no affect/no adverse modification" for Canada lynx (*Lynx canadensis*), "may affect, not likely to adversely affect species/adversely modify critical habitat" for the gray wolf (*Canis lupus)* and bald eagle (*Haliaeetus leucocephalus*), and "no effect" for the yellow-billed cuckoo (*Coccyzus americanus*).

This final biological opinion is based on information provided in the FEIS, BE, telephone conversations with Laurie Shannon, Project Manager, of the Service's Mountain-Prairie Region Lakewood, Colorado office, Steve Cain, Senior Wildlife Biologist for GTNP, and other sources of information. A complete administrative record of this consultation is on file in the Cheyenne Field Office.

CONSULTATION HISTORY

Initial discussions regarding the Bison and Elk Management Plan/EIS began several years ago. A summary of pertinent sections of the draft EIS dealing with threatened and endangered species was received by the Service's Wyoming Field Office on July 14, 2004. A full copy of the Draft Bison and Elk Management Plan/EIS was received on July 20, 2005; however, consultation was delayed pending completion of a BE for the Project. The Final Bison and Elk Management Plan/EIS was received on February 2, 2007, and both the BE and the request for initiation of formal consultation were received on February 7, 2007. The consultation was assigned log number ES-6-WY-07-F014. Since January 2007, numerous telephone conversations regarding the Project have taken place between all involved parties.

BIOLOGICAL OPINION
Grizzly Bear and Gray Wolf

DESCRIPTION OF THE PROPOSED ACTION

The Final Bison and Elk Management Plan and EIS for the NER and GTNP addresses adaptive management of the Jackson bison and elk herds and their habitat on the Refuge and in the Park with an emphasis on improving range quality and insuring long term sustainability of biotic integrity and environmental health. It includes development and implementation of a dynamic framework for decreasing the need for supplemental feeding on the refuge based on existing conditions, trends, new research findings, and other changing circumstances. The Park and NER will work in close cooperation with the WGFD during both development and implementation of this framework which will include population management through methods including implementation of special, organized elk and bison hunts, vegetation restoration, ongoing monitoring, and public education as integral components.

Chronic Wasting Disease/Brucellosis

Efforts would be made to coordinate with the WGFD to increase surveillance in elk for chronic wasting disease (CWD), a fatal transmissible disease of white-tailed deer, mule deer, and elk. The objective of surveillance would be to provide a 95 percent confidence level of discovering infection at 1 percent prevalence in the Jackson elk herd. If infection was found, strategies from the state's *Chronic Wasting Disease Management Plan* (WGFD 2006) would be implemented to reduce transmission. These strategies include removing clinically consistent elk, removing 50 animals within 5 miles of the index case, and another 50 within 10 miles if an additional positive animal is found during collection of the first 50; enforcing carcass movement and disposal restrictions; decreasing duration of feeding and expanding the distribution of feeding to the extent possible; and potentially decreasing elk densities through hunting or other management strategies. Any difference from this general approach is detailed under the alternative strategies. Plans to follow the state's *Chronic Wasting Disease Management Plan* have been made in deference to the State and could change if the National Park Service and/or the Service adopted management requirements that differed from what is currently being done. Potential changes would be communicated to the State.

The NER and GTNP/ John D. Rockefeller, Jr., Memorial Parkway will work cooperatively with the state of Wyoming and others to reduce the prevalence of brucellosis in the elk and bison populations in order to protect the economic interests and viability of the livestock industry, and reduce the risk of adverse effects for other non-endemic diseases not currently present in the Jackson elk and bison populations.

Strategies for Hunting/Reduction Programs

The Service and the NPS would work cooperatively with the WGFD to achieve population objectives (including herd ratios and elk herd segment sizes), to develop hunting seasons, and to evaluate hunting or elk reduction areas. The WGFD would formally establish objectives and strategies after public review and approval by the Wyoming Game and Fish Commission.

In the long term, elk hunting opportunities on the Refuge would decline from an average of 733 hunters per year to 420–487. In the Park it is estimated that the number of deputized hunters would decline from an average of 1,600 hunters per year to 773–957. The number of elk hunters in the Bridger-Teton National Forest (B-TNF) and other areas outside the Refuge and Park would increase to an estimated 5,600–5,870 hunters per year, an increase of 29–35 percent. For the herd unit as a whole, the number of elk hunters could range from an estimated 6,793 to 7,314 per year, which is an increase of 2–10 percent compared to average baseline conditions.

In the short term an estimated 140–150 bison would be harvested each year to reduce bison numbers to a herd of approximately 500 animals. An average of about 50 bison would continue to be harvested in the national forest and the remaining 90–100 bison on the Refuge. This would allow an average of about 175–190 bison hunters in Jackson Hole each year.

In the long term the number of bison harvested each year would decline to about 70 bison. The number of bison harvested on the Refuge and the national forest could be equally split, or up to 50 bison could be harvested in the national forest. This would allow an average of about 90 bison hunters in Jackson Hole each year.

Adaptive Management of Habitat and Populations

Under the proposed action, the NER will provide secure, sustainable ungulate grazing habitat characterized primarily by native composition that is healthy, productive and sustained for the benefit of elk, bison and other native species. Actions included under the proposed plan would be implemented in concert with restoring and perpetuating natural ecosystem functions of native habitats used by bison and elk in GTNP and the JDR. The proposed action would contribute to maintaining sustainable population of elk and bison that are healthy, at a reduced risk of contracting non-endemic diseases, and able to adapt to changing environmental conditions.

Four goals outlined in the Plan and developed based upon the desired conditions and purposes of the NER and GTNP, the missions of the National Wildlife Refuge System and the National Park System, and other legal and policy directives include:

i. Habitat Conservation
ii. Maintaining Sustainable Populations
iii. Managing Numbers of Elk and Bison
iv. Disease Management

The aforementioned goals laid out under the proposed action would be accomplished through the following objectives:

- Initiate habitat restoration projects to improve native and cultivated forage and achieve desired conditions and goals.
- Protect woody vegetation on the refuge by rotating small exclosures until habitats have recovered. Prescribed fire could be used and logging allowed on the refuge inside exclosures.
- Initiate restoration of about 4,500 acres (1,821 ha) of previously cultivated areas in the Park to native plant communities.
- Work with private and agency partners to minimize bison/elk conflicts with adjacent landowners (e.g., by providing human and/or financial resources to manage co-mingling and reduce crop depredation by elk and bison on private lands).
- Initiate a public education effort to build understanding of natural elk and bison behavior, ecology, distribution, disease implications, and effects to other species.
- Identify criteria for beginning and ending feeding each year in consultation with the WGFD.
- In collaboration with the WGFD, develop a structured framework of adaptive management actions that include established criteria for progressively transitioning from intensive supplemental winter feeding to greater reliance on free-standing forage, based on some or all of the following considerations:
    1. level of forage production and availability on the NER
    2. desired herd sizes and sex and age ratios
    3. effective mitigation of bison and elk co-mingling with livestock on private lands
    4. winter distribution patterns of elk and bison
    5. prevalence of brucellosis, chronic wasting disease, and other wildlife diseases
    6. public support
- Work in collaboration with the WGFD to maintain the Jackson elk herd objective of 11,000 (after the initial phased approach, approximately 5,000 elk would be expected to winter on the refuge). As herd sizes and habitat objectives are achieved, further reduce feeding or elk numbers, based on established criteria and changing social, political, or biological conditions. Use hunting on the Refuge, and when necessary, the elk herd reduction program in the Park, to assist the State in managing herd sizes, sex and age ratios, and summer distributions.
- Recommend that the WGFD establish a genetically viable bison herd of approximately 500 animals, with as close to an even sex ratio as possible to maximize maintenance of genetic variation over time. Initiate a WGFD-administered bison hunt on the Refuge.
- Allow the WGFD to vaccinate elk and bison for brucellosis on the Refuge as long as logistically feasible.

Other Wildlife-dependent Recreation

- Over time wildlife viewing opportunities would be concentrated during some winters and would be more natural and sporadic during milder winters.
- Build public understanding and support for bison and elk management actions.

STATUS OF THE SPECIES

Grizzly Bear

Life History

Home range and dispersal. Much of the following information is summarized from the Grizzly Bear Recovery Plan (U.S. Fish and Wildlife Service 1993); additional information including species description can be obtained in that document. Grizzly bears require large areas to fulfill all their basic biological needs, as well as dense forest cover for hiding and security. In the Greater Yellowstone Ecosystem (GYE), defined as an area of relative ecological intactness covering some 19 million acres (7,689,027 ha), lodgepole pine (*Pinus contorta*) forests are a large and dynamic part of grizzly bear habitat. Grizzly bears generally do not use areas with human-caused habitat disturbances, and often, the lack of security cover and overstory cover are believed to be major causes of this (Gillian et al. 1994). Grizzly bear home range size averages 50 to 500 mi^2 (130 to 1,300 km^2). Within these home ranges the grizzly bear uses a diverse mixture of forests, moist meadows, grasslands, and riparian habitats to complete its life cycle. Grizzly bears generally prefer large, remote areas of habitat that are isolated from human development for feeding, denning, and reproduction (USFWS 1993). Long distance travel habits of some grizzly bears increase the risk of contact with highway crossings, hunters, recreationists, and a variety of other human congregations. Isolation from human activities is extremely important for bear survival, as grizzly bears habituate to human foods quickly. Food-conditioned bears often must be eliminated or removed from developed areas. Avoiding human-caused bear mortality is a goal of the Grizzly Bear Recovery Plan (USFWS 1993) and is essential to maintaining a viable grizzly bear population.

Diet. The grizzly bear is an opportunistic omnivore that uses a wide variety of plant and animal food sources. Grizzly bears in the Yellowstone Grizzly Bear Ecosystem (YGBE), a 9,500 sq. mi. (23,300 km^2) area consisting of Yellowstone National Park (YNP), GTNP, JDR Memorial Parkway, the Gallatin, Shoshone, Bridger-Teton, Targhee, Beaverhead, and Custer national forests, as well as state, private and Bureau of Land Management (BLM) lands, have the highest percentage of meat consumption in their diet of any inland grizzly bear population (Hilderbrand *et al.* 1999). Meat constitutes as much as 79 percent of the diet of male, and 45 percent of the diet of female grizzly bears in the YGBE (Jacoby et al. 1999). Ungulates, both adult and neonate, are an especially important food source for bears in the spring and fall (Zager and Beecham, 2006), and use of these carcasses in the YGBE is well documented (Podruzny and

Gunther 2001). Grizzly bears also eat small mammals such as pika and marmots; however, these mammals form a relatively minor portion of the bear's diet. Spawning cutthroat trout in streams surrounding Yellowstone Lake in YNP have been documented as an important food source for grizzly bears there (Mattson and Reinhart 1995). Army cutworm moths (*Euxoa auxiliaries*, ACMs) are also an important food source for bears in the YGBE (Mattson *et al.* 1991a). ACMs congregate in remote, high altitude alpine talus areas and feed on alpine flowers. These moths provide important dietary fat in the fall, when grizzly bears are preparing for hibernation, and are also positively correlated with bear reproductive success (Bjornlie and Haroldson 2001). During times of great moth abundance, grizzly bears may eat up to 40,000 moths per day totaling 20,000 kcal/day (USGS 2005). Surviving moths migrate back to lower elevations to deposit their eggs, leaving the alpine areas between August and October. ACM congregation sites are in remote areas, and therefore potentially reduce human-bear conflicts by isolating the bears. Grizzly bears will also eat ants (Mattson 2001) and earthworms (Mattson *et al.* 2002).

The grizzly bear also makes use of a variety of vegetative food sources. Whitebark pine (*Pinus albicaulis*) seeds are an important fall source of food for grizzly bears in the YGBE (Mattson and Reinhard 1997), and bears are known to consume whitebark pine seeds contained in red squirrel cone caches (Mattson and Reinhard 1997). In addition to supplying a food source high in fat, whitebark pine seed crops also serve grizzly bears by keeping them occupied at high elevations far from intense human use. Studies show that in years when high quality bear foods are low, there is an increase in human-bear conflicts (Gunther et al. 2004) as well as human-caused grizzly bear mortality (Mattson et al. 1992). Other vegetative food sources such as exotic clover species, yampa (*Perideridiea gairdneri*), biscuit root (*Lomatium cous*), and sweet cicily (*Osmorhiza chilensis*) are eaten almost exclusively in some years and seasons (Mattson et al. 1991). Other grizzly bear seasonal forage may include graminoids, horsetail, forbs, and fruits (whortleberry and huckleberry) and fungi (Mattson and Knight 1991).

Den site selection. Grizzly bears generally construct dens in areas far from human disturbance at an elevation of about 6,500 to 10,000 ft. (2,000 to 3,050 m). Grizzly bears in the GYE den from the end of September to the last week in April or early May, with entrance and emergence dates affected by the gender and reproductive status of the bears. Denning bears can be disturbed by winter sport activities such as snowmobiling as well as by human den encroachment, and late season hunting, and current studies are focused on minimizing disturbance by controlling access to important denning areas (Haroldson *et al.* 2002, Podruzny *et al.* 2002). If pregnant female bears are disturbed in their dens and this disturbance causes them to relocate to a new den prior to parturition, negative consequences can occur in the form of reduced cub fitness and survival (Linnell *et al.* 2000, Swenson *et al.* 1997).

Population Dynamic/Status and Distribution

Grizzly bear numbers have greatly declined during the past two centuries. It is believed that the grizzly bear population numbered over 50,000 individuals prior to the 18th century (USFWS 1993). More recently, the estimated total population of grizzly bears as of 1993 stood at 800 to

1,000 individuals (USFWS 1993). The exact size of the grizzly bear population in the YGBE is currently unknown, as the very nature of the grizzly bear and the rugged terrain it inhabits makes any census efforts extremely difficult. Eberhardt and Knight (1996) used several different estimates of population parameters to determine a minimum total population size of 245 grizzly bears, an estimated population size of 390 grizzly bears using marked females, and an estimated population size of 344 grizzly bears using distinct family groups. In 2003, the Interagency Conservation Strategy team identified the minimum population estimate for the grizzly bear population in the YGBE as of 2001 as 365 grizzly bears with a total population estimate of 531. Haroldson and Frey (2004) determined a minimum population estimate of 416 in both 2002 and 2003. The Interagency Grizzly Bear Study Team more recently estimated the population at 580 bears (USFWS 2005).

The grizzly bear was listed as a threatened species on July 28, 1975 (USFWS 1975). Historically, the grizzly bear ranged from the Great Plains to the Pacific Coast, and from the northern U.S. border with Canada to the southern border with Mexico. Currently in the contiguous United States, the grizzly population has been reduced to roughly two percent of its former range. It presently occupies portions of Canadian British Columbia and Alberta, and portions of Montana, Idaho, Wyoming, Washington, and Alaska in the United States. The grizzly bear population in the YGBE and surrounding area was proposed for delisting from the list of endangered and threatened species in November 2005 (USFWS 2005).

Conservation

In an effort to facilitate consistency in the management of grizzly bear habitat within and across ecosystems, the Interagency Grizzly Bear Guidelines were developed by the Interagency Grizzly Bear Committee (IGBC)(51 FR 42863; November 26, 1986) for use by land managers. The IGBC developed specific land management guidelines for use in each of the five ecosystems including the YGBE.

Recovery zones also have been established for the grizzly bear and include areas large enough and of sufficient habitat quality to support a recovered bear population. According to the Grizzly Bear Recovery Plan (USFWS 1993), a recovery zone is defined as that area in each grizzly bear ecosystem within which the population and habitat criteria for achievement of recovery will be measured. Areas outside of recovery zones may provide habitat that grizzly bears will use, but are not considered necessary for the survival and recovery of this species. The area outside the recovery zone but within the 10-mile buffer area is managed to consider and protect grizzlies and their habitat whenever possible, recognizing that population and mortality data within this zone are collected and pertinent to recovery criteria. Beyond the 10-mile buffer, grizzly bear mortalities or populations are not considered when determining whether recovery goals have been met, although protection is still accorded to the grizzly bear under the Act.

The Yellowstone Grizzly Bear Recovery Zone (Recovery Zone) covers approximately 5,438,000 acres (2,200,729 ha) of primarily NPS and National Forest Service (NFS) lands, roughly 89

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percent of the currently known distribution of the grizzly bears in the YGBE. Yellowstone and Grand Teton National Parks make up 39.4 percent of the YGBE recovery zone. Private holdings and other ownership make up 2.1 percent of the recovery zone and the remaining 58.5 percent occurs on lands managed by the NFS (ICST 2003).

Areas within the Recovery Zone are stratified into Management Situation Zones 1, 2, or 3; each having a specific management direction according to the Interagency Grizzly Bear Guidelines (IGBC 1986).

> **Management Situation 1** (MS1): lands contain population centers of grizzlies, are key to the survival of the species, and are where management decisions will favor the needs of the bear even when other land use values compete.
>
> **Management Situation 2** (MS2): lands are those areas that lack distinct population centers and the need for this habitat for survival of the grizzly bear is more uncertain. The status of such lands is subject to review. Here, management will at least maintain those habitat conditions that resulted in the area being classified as MS2.
>
> **Management Situation 3** (MS3): designation is intended for lands where grizzly bears may occur infrequently. There is high probability that Federal activities here may affect the species survival and recovery. Management focus is on human-bear conflict minimization, rather than habitat maintenance and protection.

Recovery zones are divided into smaller areas called Bear Management Units (BMUs) for the purpose of habitat evaluation and monitoring. BMUs were designed to:

(1) assess the effects of existing and proposed activities on grizzly bear habitat without having the effects diluted by consideration of too large an area;

(2) address unique habitat characteristics and bear activity and use patterns;

(3) identify contiguous complexes of habitat which meet year-long needs of the grizzly bear; and,

(4) establish priorities for areas where land use management needs would require cumulative effects assessments.

The low survival of adult females was identified as the single most important factor in causing the decline in the Yellowstone population prior to the mid-1980s (Knight and Eberhardt 1985). The current Grizzly Bear Recovery Plan (USFWS 1993) outlines demographic goals to objectively measure and monitor the recovery of the Yellowstone grizzly bear population. That plan defines a recovered population as one that can sustain the existing level of known and

unknown human-caused mortality that exists in the ecosystem and is well-distributed throughout the recovery zone. Demographic recovery criteria outlined for the Yellowstone recovery zone include:

(1) observation of 15 females with cubs of the year annually (unduplicated sightings) over a 6-year running average;

(2) occupation of 16 of the 18 BMUs by females with young from a running 6-year sum of verified observations, and no 2 adjacent BMUs unoccupied with a study to be initiated in the Plateau and Henry's Lake BMUs to determine the capability of these units to support females with cubs;

(3) known, human-caused mortality not to exceed 4 percent of the current population estimate (based on most recent 3-year sum of females with young); with no more than 30 percent of this total mortality limit incurred by females; and,

(4) these mortality limits cannot be exceeded during any 2 consecutive years.

In addition, the existence of adequate regulatory mechanisms for population and habitat management through the development of a conservation strategy must be demonstrated.

In 1994, all population recovery parameters were achieved for the first time, and since 1997 these recovery criteria have not been exceeded in 2 consecutive years. In 2005, a revised method for calculating total population size and sustainable mortality levels for the YGBE was established (IGBST 2005). The revised method was appended to the Recovery Plan and included in the Conservation Strategy. By the end of 2005, the number of unduplicated females with cubs-of-the-year stood at 31 within the recovery zone and 10-mile perimeter (Haroldson 2006), resulting in a 6-year running average of 40 unduplicated females with cubs – more than double the recovery target of 15 females identified in the Recovery Plan (USFWS 1993). Sixteen of 18 BMUs had verified observations of female grizzly bears with young during 2003, 17 of 18 BMUs during 2004 (Podruzny 2005) and 18 of 18 BMUs in 2005 (Schwartz et al. 2006).

Threats

Isolation from human activities is extremely important for bear survival, due to the tendency of grizzly bears to rapidly habituate to human foods. Food-conditioned bears often must be eliminated or removed from developed areas. Avoiding human-caused bear mortality is a goal of the Recovery Plan and is essential to maintaining a viable grizzly bear population (USFWS 1993).

Primary threats to grizzly bears are associated with motorized and dispersed recreational use and forest management activities, including timber harvest. Recreation use includes hunting, fishing, camping, horseback riding, hiking, biking, off-road vehicle (ORV) use, and snowmobiling. Direct human-caused mortality is the most obvious threat to the grizzly bear. This kind of mortality can occur in several ways: (1) defense of human life or property, (2) management removals, (3) mistaken identification by big game hunters, or (4) malicious killing. Nuisance bears are removed to defend human life or property, usually because they have become dangerously bold as a result of food conditioning and habituation at campsites, lodges, resorts, and private residences or they become habituated predators of livestock (Knight and Judd 1983).

Human-grizzly bear interactions have been increasing in the YGBE due, in part, to increasing human use and development, increasing bear numbers, and bears and people both expanding their range of occupancy, increasing the chances of adverse encounters. The frequency of grizzly bear-human conflicts is inversely associated with the abundance of natural bear foods (Gunther *et al.* 2004). Most grizzly bear mortalities are directly related to grizzly bear-human conflicts. The Interagency Conservation Strategy Team (2000, pp. 1-2) reported known human-caused mortalities from 1992-98. Of 58 human-caused mortalities, 43 percent were hunting-related, 10 percent were poaching, 28 percent were food-conditioned bears, 7 percent were related to livestock and 12 percent were accidental deaths. The greatest increase in recent years is self-defense in fall by big game hunters. According to a study by Gunther *et al.* (2004a), three areas were identified as having 71 percent of the 136 conflicts in the GYE in 2003. These were (1) the headwaters region of the Green, Snake, and Wind Rivers, (2) the Crandall Creek/Sunlight Basin area, and (3) the north and south forks of the Shoshone River.

There are a number of naturally or semi-naturally occurring factors that also may influence Yellowstone grizzly bear population levels. Whitebark pine provides an important food source for grizzly bears. Blister rust, which has severe consequences on whitebark pine in the Northern Continental Divide Ecosystem, has been observed in the Yellowstone area. The Yellowstone cutthroat trout, which is an important food source for grizzly bears in the area, has been negatively influenced by introduced lake trout, which are less available to bears due to their deeper water habits (Reinhart *et al.* 2001). Winter-killed ungulates are an important food supply, but ungulate populations vary widely in numbers and are influenced by weather conditions. The reintroduction of wolves has increased competition for ungulate prey and winter-killed carrion. Recent fires may have impacts on available food and cover over the short term, particularly to individual bears with heavily burned home ranges. Fire, in general, over time stimulates many forage species and berries preferred by bears, provided alternate food supplies and cover is available to maintain bears through the immediate aftermath of the fire.

Army cutworm moths in some areas could be affected by agricultural pesticide use, and due to their reliance on this food resource, there has been concern that certain pesticides may bioaccumulate in bears. Recent investigation into this possibility indicates that, while pesticides are present in ACMs in trace quantities, they are most likely not sufficient to cause direct adverse effects on, or biomagnify in bears (Robinson et al. 2006). This study cautions, however, that

pesticide use is a relevant concern when addressing bear conservation issues. Due to their unique physiology including hyperphagia, brown fat accumulation and torpor, bears may assimilate and excrete certain chemicals in unique ways. Further research is recommended including sampling and analysis of blood, hair and fat samples in order to monitor this potential threat as available pesticides and their listed uses change.

Grizzly bears have also experienced displacement from available habitat (loss of habitat effectiveness due to human disturbance) due to increased human uses from (1) expanding road access in wilderness areas (Kasworm and Manley 1989), (2) ORV use and (3) recreation use. They have also experienced loss of existing available habitat due to (1) increased development on private land related primarily to residential housing, and (2) potential for increased development on public land related primarily to oil/gas and recreation development. The grizzly bear also faces a decrease in value of available habitat due to (1) a loss of biodiversity (especially early-succession related vegetative types), and (2) sub-optimal composition, structure, and juxtaposition of vegetation as a result of fire suppression, management strategies, and advancing succession. Finally the bear faces isolation due to fragmentation of available habitat due to (1) major development of private land, (2) construction of major highways that block or restrict movement, (3) inadequate provision for linkage on minor roads and highways, and (4) large blocks of clearcuts.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed State or Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation process.

The action area is defined at 50 CFR 402 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." While the proposed action directly affects the areas located within the NER, GTNP and JDR Memorial Parkway, it will indirectly affect other areas outside of the Refuge and within the B-TNF.

The action area/decision area defined in the EIS includes the NER, GTNP, and the JDR Memorial Parkway.

- The NER is a 24,700 acre (9,996 hectare) unit of the National Wildlife Refuge System administered by the Service. The GTNP is 309,995 acres (125,453 ha), and JDR Memorial Parkway is an additional 23,777 acres (9,622 ha), for a total of 333,772 (135,076 ha) acres administered by them NPS.

- The GTNP is 22.5 miles (36 kilometers) wide and 41 miles (66 km) long from north to south. Elevations range from 6,420 feet (1,957 m) on the valley floor to 13,766 ft. (4,196 m) (the summit of Grand Teton). The Park is bordered to the northwest, west, and southwest by Targhee National Forest. On the south the Park surrounds a wedge of private land and a small section of Bridger-Teton National Forest (B-TNF). The Teton Wilderness in the B-TNF borders the Park to the northeast.

- The JDR Memorial Parkway extends for 82 miles (132 km) from West Thumb in YNP to the north entrance of GTNP. The management area between the two parks includes 7.5 miles (12 km) of parkway and 23,778 acres (9,623 ha).

Ecologically, the NER, GTNP, JDR Memorial Parkway, and YNP are part of a larger area referred to as the GYE.

For the purposes of this biological opinion, we will also consider portions of surrounding lands in the B-TNF and other areas outside of the Refuge as part of the action area due to the projected long-term increase in the number of hunters as a result of the proposed action. The action area will be discussed in terms of Game Management Units (GMU) or Existing Elk Hunting Areas (Area). The following is a brief description of their general locations within the action area:

NER GMUs

Area 77. National Elk Refuge. Beginning where U.S. Highway 26 crosses the Gros Ventre River; easterly up said river to the B-TNF boundary; southerly along said boundary to Flat Creek; westerly along said creek approximately 3.5 miles to the second road crossing; southerly along said road .8 mile to a trail junction; westerly along a marked boundary to the NER fence; northerly along said fence to the Gros Ventre River.

GTNP GMUs

Area 72. Webb Canyon/Moose Creek. All of the drainages of Berry Creek, Owl Creek and Webb Canyon Creek and that area north of Berry Creek to the GTNP boundary.
Area 75. Snake River. Beginning at the junction of the Gros Ventre-Kelly Road and U.S. Highway 26-89-191; northerly along said highway to Ditch Creek; westerly along said creek to the Snake River proper; northerly along the easternmost bank of the main channel of the Snake river to the northernmost channel of Spread Creek; easterly along said creek to U.S. Highway 26-89-191; southwesterly along said highway to U.S.F.S. Road 30310 at the Cunningham Cabin; southerly along said road to the GTNP boundary; southerly along said boundary to the intersection with the Shadow Mountain-Kelly Road (U.S.F.S. Road 30340); southwesterly along said road to the junction of the Teton Science School road; northeasterly along said road one and one-quarter (1¼) miles to a marked boundary; easterly one (1) mile to the GTNP boundary; southerly along the GTNP boundary to the Gros Ventre-Kelly Road; southwesterly along said road to U.S. Highway 26-89-191.

Area 79. Teton Park. Beginning where the U.S. Forest Service access road (U.S.F.S. Road 30310) near Cunningham Cabin intersects U.S. Highway 26-89-191; northerly along said highway to the junction of U.S. Highway 89-287 at Moran; northwesterly along said highway to the Grand Teton National Park boundary easterly and southerly along said boundary to the U.S. Forest Service access road (U.S. F.S. Road 30310) near Cunningham Cabin; westerly along said road to U.S. Highway 26-89-191.

B-TNF GMUs

Area 70. Buffalo Fork. Beginning where U.S. Highway 26-287 intersects the GTNP boundary; northerly along said boundary to Pacific Creek; northeasterly up said creek to Gravel Creek; northerly up said creek to the Snake River Trail; northerly along said trail to the south boundary of YNP; easterly along said boundary to the Continental Divide; southerly and easterly along said divide to U.S. Highway 26-287 at Togwotee Pass; westerly along said highway to the east boundary of GTNP.

Area 71. Pacific Creek. Beginning where Pacific Creek crosses the GTNP boundary; northerly along said boundary to the Targhee National Forest boundary; northerly along said boundary to the southern boundary of YNP; easterly along said boundary to the Snake River Trail at Fox Park; southwesterly along said trail over Big Game Ridge to Gravel Creek; southerly along said creek to Pacific Creek; southerly down said creek to the GTNP boundary.

Area 74. Ditch Creek. Beginning where Ditch Creek crosses the GTNP boundary; northeasterly along said boundary to Brush Creek; southerly up said creek to the divide between Brush Creek and Ditch Creek; southerly along a posted boundary to Ditch Creek; southerly down said creek to the GTNP boundary.

Area 78. Wilson. Beginning at the junction of Wyoming Highway 22 and Wyoming Highway 390; northerly along Wyoming Highway 390 to the GTNP boundary; northerly and southerly along said boundary to U.S. Highway 26-89-191; southerly along said highway to its junction with Wyoming Highway 22; westerly along said highway to its junction with Wyoming Highway 390.

Area 80. Sheep Creek. All of the drainages of Flat Creek, Sheep Creek and Nowlin Creek east of the NER.

Area 81. Spread Creek. Beginning where the GTNP boundary crosses the Gros Ventre River; northerly along said boundary to Ditch Creek; up said creek to a posted boundary; straight north along the posted boundary to the divide between Brush Creek and Ditch Creek; northerly down Brush Creek to the GTNP boundary; northerly along said boundary to U.S. Highway 26-287; easterly along said highway to Togwotee Pass and the Continental Divide; southerly along said divide to the Moccasin Basin Road (U.S.F.S. Road 30750); southerly down said road to the North Fork of Fish Creek at Calf Creek; southerly down said creek to Fish Creek; southeasterly down said creek to the Gros Ventre River; westerly down said river to the GTNP Park boundary.

Area 82. Crystal Peak. Beginning where the Gros Ventre River crosses the NER boundary near the town of Kelly; easterly up said river to Kinky Creek; easterly up said creek to the Darwin Ranch Road (U.S.F.S. Road 620); easterly along said road to the divide between the Green River and Gros Ventre River; southwesterly along said divide to the divide between the Green River

and Hoback River at Hodges Peak; westerly along the divide between Flat Creek and the Gros Ventre River; northerly along said divide to the NER boundary; northerly along said boundary to the Gros Ventre River.

Area 84. Lower Hoback. Beginning where U.S. Highway 191 crosses Flat Creek at the north edge of the town of Jackson; due east to the NER boundary; easterly along said boundary to the B-TNF boundary and the ridge between Twin Creeks and Cache Creek; easterly along said ridge to Jackson Peak; southerly along the divide between Flat Creek and Cache Creek to Cache Peak; easterly along the divide between Flat Creek and Granite Creek to Pyramid Peak; southerly along the divide between the Gros Ventre River and the Hoback River to Steamboat Peak; southerly and westerly along the divide between Shoal Creek and Dell Creek; westerly along said divide to the Riling Draw Road; southerly along said road to the Dell Creek Road; westerly along said road to the Hoback River; westerly down said river to Cliff Creek; southerly up Cliff Creek to the divide between the Greys River and the Hoback River; northwesterly along said divide to the divide between the Greys River and Willow Creek; northerly along said divide to the divide between the Bailey Creek and Willow Creek (Greyback Ridge); northerly along said divide to Dry Wash Draw; westerly down said draw to Bailey Creek; northwesterly down said creek to the Snake River; northerly up said river to Wyoming Highway 22; easterly along said highway to U.S. Highway 191; easterly along said highway to Flat Creek at the north edge of the town of Jackson.

Past projects, their effects on grizzly bears, and the level of incidental take have also been considered in the environmental baseline. Previous formal consultation in the vicinity of the action area addressed transportation projects and grazing permits. The projects are: (1) the Grand Teton National Park Transportation Plan (WY003, February 9, 2007); (2) domestic livestock grazing in Grand Teton National Park (WY9351, May 2, 2006); (3) the Federal Highway Administration's Highway 287/26 Reconstruction project, a.k.a. Togwotee Pass Highway (WY5998, August 22, 2003); and (4) the Forest Services' issuance of commercial grazing permits on the Bridger-Teton National Forest (WY4715, December 3, 2002). These projects, their effects to the grizzly bears, and the level of incidental take have been considered in the environmental baseline for this biological opinion.

Status of the Species within the Action Area

Portions of the action area are within the Yellowstone Recovery Zone and Primary Conservation Area (PCA) for grizzly bears identified in the Conservation Strategy for the Grizzly Bears in the GYE (USFWS 2003). The PCA, or grizzly bear recovery zone as it was initially described (USFWS 1982), was delineated to define an area within which to focus grizzly bear recovery efforts after the species was listed in 1975. At the time the boundary was delineated, grizzly bears were uncommon in GTNP and surrounding areas. Currently, however, grizzly bears are established in large areas outside of the PCA in GTNP (Schwartz et al. 2002), and the line does not represent grizzly bear distribution in the GTNP area.

Grizzly bears are relatively common in the southern GYE, including the Gros Ventre Mountains southeast of GTNP, and are regularly observed in the Teton Mountain Range north of Paintbrush Canyon and the Badger Creek drainage. Grizzly bears have been observed on the valley floor south of Triangle X Ranch, at Jackson Lake, in Death Canyon, and south of GTNP in the vicinity of Teton Village and along the Snake River south of Jackson (Schwartz et al. 2002). In addition, a young male radio-collared grizzly bear used the Bradley-Taggart Lakes and White Grass areas for several weeks in 2005, providing empirical evidence for the continued southward movement of grizzly bears in the Teton Range.

There have been no grizzly bears sighted on the NER since 1994; however, bears occupy areas immediately north and east of the Refuge. As the GYE bear population continues to expand southward into presently unoccupied areas, and with continued habituation of bears to human presence and activity, the potential for the occurrence of bears on the Refuge will likely increase.

Management of grizzly bears and their habitat in the Park follows IGBC guidelines (1986) and the Park's Human-Bear Management Plan (NPS 1989). These guidelines were developed to provide effective direction for the conservation of grizzly bears and their habitat to Federal agencies responsible for managing land within the recovery zone. The objectives for managing grizzly bears in the Park under the 1989 NPS plan are to: (1) restore and maintain the natural integrity, distribution, and behavior of grizzly bears, (2) provide opportunities for visitors to understand, observe, and appreciate grizzly bears, and (3) provide for visitor safety by minimizing bear/human conflicts, by reducing human-generated food sources, and by regulating visitor distribution.

The Park has been highly successful in promoting grizzly bear recovery and reducing bear-human conflicts (e.g., property damages, incidents of bears obtaining human food, bear-inflicted human injuries) and human-caused bear mortalities in the Park. Recreational and administrative facilities, human activities, and human waste (garbage and sewage) in GTNP are managed in a manner that minimizes the potential for human-caused grizzly bear mortalities. Management actions also include implementation of backcountry food storage requirements. Bears that are typically wary of humans will often tolerate people at close distances when carcasses or other high quality foods are available.

Shifts in grizzly bear seasonal distribution within the GYE appear to be directly related to resource availability. Recent research indicates that bears in YNP are 2 times more likely to be found outside of the park during the early hunting season. This movement occurred regardless of the relative yearly production and abundance of whitebark pine seed production (Haroldson et al. 2004). Elk hunting seasons in the GYE begin as early as September 10 and run through December 3. This period coincides with late hyperphagia in GYE grizzly bears, as well as the time period (September-October) during which the majority of hunting-related grizzly bear mortalities have occurred (Haroldson et al. 2004)

Hunting-related deaths resulting from human-grizzly conflict remain the most significant source of known grizzly bear mortality in the GYE (Haroldson et al. 2004; USFWS 2003). In the PCA itself, analysis of the potential correlation between hunter numbers and levels of known and probable grizzly bear mortality from 1987 to 1997 indicated little relationship (USFWS 2003). This analysis did not consider the relationship between hunter numbers and grizzly bear mortality in areas outside of the PCA. While the high level of hunting-related grizzly mortality has not been directly linked to hunter numbers in the PCA, it is nonetheless primarily the result of chance encounters between bears and hunters in the field, conflicts over ungulate carcasses and conflicts in hunter camps often as a result of game meat being kept in campsites (USFWS 2003; Haroldson et al. 2004).

Status of Species Habitat within the Action Area

The following is a brief description of habitat and cover types within existing elk hunting areas/GMUs:

Within the NER, elk hunting area (77) is dominated by mixed shrub and sagebrush shrubland interspersed with grassland. Riparian woodland habitat consists primarily of narrowleaf cottonwood (*Populus angustifolia*) and willow (*Salix* spp.) stands. Aspen woodlands occur on many hillsides, often some distance from water sources. Small patches of conifer forest occur within the hunt area and consist of Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*) and junipers. Agricultural areas and cultivated fields occur throughout the hunt area. The relatively even and open nature of terrain within the hunt area provides excellent foraging habitat for ungulates, but largely precludes grizzly-bear use and occupancy.

Within the GTNP, elk hunting areas (72, 75, 79) have quite different topographical and vegetational characteristics. Area 72 ranges from valley floor to alpine, with coniferous woodlands of lodgepole pine as well as whitebark pine, Englemann spruce (*Picea engelmannii*), sub-alpine fir (*Abies bifolia*), and Douglas-fir. Area 75 is predominately covered in sagebrush, with rolling terrain punctuated by areas of steeper relief. Small patches of grassland are located along the eastern border, with cultivated fields to the south. Patches of coniferous woodlands are located south of Ditch Creek and in the Snake River bottom. The relative lack of tree cover across most of the hunt area makes it less suitable for grizzly bears, with the exception of areas within the Snake River bottom, Blacktail Butte, and other small forested patches. Area 79 is composed of highly variable terrain predominately covered in dense coniferous woodlands composed of lodgepole pine, whitebark pine, Douglas and subalpine fir, and spruce; but it also includes some large expanses of sagebrush grasslands and willow habitats. The extensive areas of tree cover throughout the hunt area provide a large amount of suitable habitat for both elk and grizzly bear.

Within the B-TNF, elk hunting areas (70, 71, 74, 78, 80, 81, 82, 84) are highly variable in terms of terrain and are predominately forested with dense stands of conifers dominated by lodgepole pine, as well as whitebark pine, Englemann spruce, sub-alpine fir, and Douglas-fir.

Willow and quaking aspen (*Populus tremuloides*) occur in valley bottoms in association with streams, and sagebrush shrubland and grassland habitat grow in the lower elevations. The varied topography, dense woodland cover and general lack of human development offer extensive suitable habitat for grizzly bear north the Gros Ventre River and provide important transitional, and migration habitat for elk.

Factors Affecting Species Environment within the Action Area

General Factors

Past and ongoing actions within the action area and within the grizzly bear Recovery Zone are likely to affect GYE grizzly bears moving through the action area whether their home range is within or adjacent to the action area. These actions include:

- livestock grazing (which would impact grizzly bears through management actions),
- private land development,
- firewood cutting,
- road use/management/improvements,
- timber harvest,
- recreation activities that lead to human-bear conflicts,
- vegetation management,
- wild and prescribed fire, and
- loss or decline of important food sources (e.g., whitebark pine seeds due to fire suppression).

EFFECTS OF THE ACTION

Under section 7(a)(2) of the Act, "effects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, with the effects of other activities interrelated or interdependent with that action. Direct effects are immediate effects of the proposed action on the species or its habitat. Indirect effects are those caused by the proposed action and are later in time, but still are reasonably certain to occur (50 CFR 402.02). The effects of the action are added to the environmental baseline to determine the future baseline and to form the basis for the determination in this opinion. Should the Federal action result in a jeopardy situation and/or adverse modification conclusion, the Service may propose reasonable and prudent alternatives that the Federal agency can take to avoid violation of section 7(a)(2). The effects discussed below are the result of direct and indirect impacts of implementing the proposed project and are addressed according to the four management goals outlined in the Plan. They are broken down and discussed further according to key actions occurring under each goal.

Habitat conservation

Under the proposed action 800-2,000 acres/year (324-809 ha/yr) of cultivated land would continue to be flood irrigated, while up to 1,100 acres (445 ha) would be converted from flood to sprinkler irrigation. Restoration of native species to 4,500 acres (1,821 ha) of existing agriculture fields would occur in GTNP and exclosures would be used on the Refuge to allow recovery of willow, aspen and cottonwood stands. These actions would likely result in an overall minor decrease in total herbaceous forage available for elk and bison, but would improve the overall quality of available forage. While these actions may alter ungulate distributions and densities, and cause elk in the Jackson herd to alter their movements within and outside of the Refuge in response to the changes, it is unlikely that these factors would have any significant impact on the GYE grizzly bear population.

Sustainable populations/ Elk and bison numbers

Supplemental feeding

Under the proposed action, supplemental feeding would be reduced from current levels and replaced by greater ungulate reliance on standing forage. The reduction in food supplementation may lead to changes in ungulate distribution and mortality and would likely cause elk and bison to return to a more natural pattern of existence influenced to a greater degree by factors such as climate and availability of native forage. Supplemental feeding likely reduces the effects of density in the Jackson elk herd (Lubow and Smith 2004); therefore, density-dependent effects on seasonal juvenile survival and dispersal may become more apparent as supplemental feeding is reduced. These effects, however, along with any associated decrease in adult and juvenile elk survival rates, are likely to be negligible since the Jackson elk herd is maintained below carrying capacity (Lubow and Smith 2004). While minor increases in elk mortality as a result of reduced supplemental feeding may be beneficial to grizzly bears in the GYE due to increased availability of carcasses, the effect would not likely be significant.

Elk hunt

The Jackson elk herd comprises one of the largest concentrations of elk in North America, with an estimated 13,000 individuals whose seasonal distributions allow them to be considered as being divided into four herd segments (Grand Teton, Yellowstone, Teton Wilderness, and Gros Ventre). The elk migrate across several jurisdictional boundaries, including the NER, GTNP, JDR Memorial Parkway, YNP, B-TNF, BLM resource areas, and state and private lands. Because of its large size, wide distribution, effects on vegetation, and importance to the area's predators and scavengers, the Jackson elk herd contributes significantly to the ecology of the southern GYE.

Elk hunting has been an annual event on the NER since 1955 and is the primary management tool used to control the Jackson elk herd population both on the Refuge and throughout the

Jackson elk herd units. As part of the proposed action, there will be a short-term increase in hunter numbers on the Refuge from 733 to 1,000 and an increase from 220 to 300 elk harvested annually. In the long term, overall hunter numbers on the Refuge will likely decrease to 470-487, as will the number of elk harvested (126-146). Hunting on the Refuge currently occurs in Area 77; however, a small hunt area may potentially be added in the southern portion of the Refuge in order to force elk back into other hunt areas. Hunting will be strictly managed and the areas available to hunting frequently patrolled. Hunting permits issued for the Refuge are day-use only and do not allow hunters to camp overnight. Due to these aforementioned factors, and the fact that habitat on the Refuge is relatively open and generally lacks densely forested areas, it is unlikely that the risk of elk hunters killing grizzly bears will be greater in either the short or long term as a result of the proposed action.

Elk hunting as part of the Park's annual elk reduction, occurs on approximately 66,600 acres (26,952 ha) of the Park's backcountry, 29,100 acres (11,776.4 ha) of which is in the recovery zone. Under the proposed action, there will be a short-term increase in the number of hunters permitted and deputized to hunt in the Park from 1,600 currently, to 2,200, and an increase in the number of elk harvested from 480 to 650. In the long term, the overall number of hunters in the Park will decrease to 773-957 per year, and the number of elk harvested will decrease to 232-287. Unlike the Refuge, overnight camping is permitted in certain areas.

There are 3 elk hunting areas (Areas 72, 79, 75) located within the boundaries of the GTNP. The terrain of Area 75 is largely open and lacking densely forested areas. This open, shrubland characteristic and general absence of dense woodland cover would tend to reduce the risk of surprise encounters between elk hunters and grizzly bears in these areas that might potentially result in human-caused grizzly mortality. Exceptions include the Snake River bottom where thicker cover exists and grizzly bears are known to frequent, and Blacktail Butte where grizzly bears might be expected to occur (Steve Cain, National Park Service, person. comm. 2007). Hunters in this area may face a higher risk of grizzly conflict than in other portions of Area 75. Portions of Area 71 are located within the 23,778 acres (9,623 ha) of the JDR Memorial Parkway managed by the Park; however, hunting for elk and other wildlife is largely managed by the WGFD. Area 72 has been closed to hunting since 1967. It is the only area in the Park west of the Snake River where hunting was authorized in the Park's 1950 enabling legislation and, although the potential for it to be reopened exists, this is not expected to occur within the foreseeable future. Compared with Area 75, Area 79 contains large expanses of dense woodland that provide ideal grizzly bear cover. Portions of the hunting area are located within the Buffalo Spread Creek BMU and represent a region where human-bear conflicts have occurred in the past (Haroldson et al. 2004; Gunther et al. 2004). The short-term risk for future human-bear conflicts resulting in potential grizzly bear mortality as a result of the proposed action is considered high for this hunting area both south of Elk Ranch and north of Moran and highway 26/287. However, a later start date of the elk hunting season relative to surrounding areas, a 30 to 40 percent yearly hunter-ranger contact rate, restricted backcountry camping, required use of bear-deterrence spray and supplemental educational materials addressing hunter-grizzly conflict

provided to deputized hunters (Steve Cain, National Park Service, person. comm. 2007) may limit this potential risk. The long term risk is considered to be equivalent to current levels.

Most of the remainder of the Jackson elk herd unit is comprised of the Buffalo and Jackson ranger districts of B-TNF. Elevation ranges from about 6,300 ft. (1,920 m) to nearly 12,200 ft. (3,719 m) at the headwaters of the Yellowstone River. There is not expected to be a substantial short-term increase in the short term in either the number of elk hunters using the forest or the number of elk harvested unless hunts on the Refuge cause more elk to move into these areas. As a result of the proposed action, in the long-term it is expected that herd reductions in the Grand Teton segment will cause individuals to radiate into and be sustained in other herd segments, allowing proportionately more elk to be harvested. In the long-term, it is estimated that there will be a 29-35 percent increase in hunter numbers in the B-TNF (from 4,227 currently to 5,600-5,870) as a result of the proposed action. The number of elk harvested per year in the B-TNF is predicted to increase from 1,268 to between 1,680 and 1,761.

There are 6 hunting areas (Area 70, 71, 74, 80, 81, 82) located in the B-TNF and surrounding the Park. These areas are dotted with dense coniferous woodlands interspersed with more open woods, and sagebrush and mixed grasslands at lower elevations and in the valleys. The terrain is highly variable with elevations ranging from 6,396 to 9,676 ft. (1,950 to 2,950 m). Multiple human-bear conflicts have been recorded throughout these areas in the past including hunting-related grizzly bear mortalities (Haroldson et al. 2004; Gunther et al. 2004, USFWS 2003). Elk season start dates in these areas range from September 10 to September 26, which corresponds both with the period when bears are actively foraging and preparing for hibernation and with the time during which most known and probable hunting-related grizzly bear mortalities occur (Haroldson et al. 2004; Gunther et al. 2004). Traditional early fall elk hunts in these areas have created a reliable food source for hyperphagous bears which take advantage of ungulate remains left by hunters, and this brings them into close proximity to hunters themselves (Haroldson et al. 2004). As a result of these factors, the risk of human-bear conflict resulting in potential hunting-related grizzly bear mortality is considered high in Areas 70, 71, and 81. Hunting Areas 73, 78, 84, and 85 are considered to represent regions with low risk of human-bear conflict due to the relatively high level of human occupation and their location outside of the main fall migration routes of the Jackson herd.

Bison hunt

A bison hunt would occur under the proposed action in order to reduce the herd size on the Refuge, increase bison distribution, limit bison-elk conflict along feed lines and reduce the potential for disease transmission. A reduction in herd size would also contribute to enhancement of habitat through a decrease in the damage caused by excessive grazing and browsing of willow, aspen and cottonwood stands. Initially, the bison hunt would reduce herd size by 140-150 bison/year, of which, 90-100 would be removed on the Refuge and 50 would be removed from the B-TNF. This would involve an average of 175-190 bison hunters each year. In the long term, the Plan estimates that an average of 70 bison will be killed annually, with an

average of 90 hunters participating in the hunt. This nevertheless represents a substantial increase over recent numbers of bison being harvested and bison hunters on the Refuge. Despite the increase in the number of hunters on the NER, due to the aforementioned factors and conditions associated with hunts on Refuge, the risk of human-grizzly conflict resulting in hunting-caused grizzly bear mortality is considered to be low, both in the short and the long term. The risk of hunter-caused grizzly mortality associated with bison hunts in the B-TNF is considered to be higher than on the Refuge, especially in the northern portions of Area 81 east of Elk Ranch and between Buffalo Fork and Spread Creek.

Disease management

In order to maintain the health of elk and bison populations while continuing supplemental feeding at reduced levels, a variety of disease management techniques will be explored (e.g., vaccination, selective fertility control, age- and sex-specific harvest). Under the proposed action, WGFD personnel will be allowed to use brucellosis vaccine Strain 19 on elk and RB51 on calf and nonpregnant female bison along feedlines during feedline operations. Grizzly bears may consume elk or bison exposed to these brucellosis vaccines; however, research indicates that there are no significant adverse effects of the RB51 vaccine on nontarget species (Januszewski et al. 2001). No clinical trials have been conducted to determine if vaccine Strain 19 is safe for nontarget species; however, the vaccine has been used on WGFD feedgrounds for 17 years without any noticeable adverse clinical, histological or reproductive effects on nontarget species. Since vaccination activities will occur within the Refuge along feedlines, it is not expected that there would be a risk of disturbance to grizzly bear associated with the action.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Cumulative Effects within the Action Area

Several privately owned and State of Wyoming-owned in-holdings are present in GTNP; depending upon future human activities occurring on these properties, grizzly bears could be negatively affected. For many years, GTNP has attempted to secure these in-holdings with lifetime leases and out-right purchases and has been very successful in doing so. No large-scale developments or land-based projects have been proposed for these in-holdings.

There are plans to convey the Laurance S. Rockefeller (LSR) Preserve (approximately 1,100 acres [445 ha]) in southern GTNP to the Federal government in 2007. However, the LSR Preserve is presently a private in-holding in the Park. Although the future plans include removal

of most of the development that has been present on the ranch, the current owners will develop an interpretive facility and trail system prior to the conveyance of the property.

Cumulative Effects Adjacent to the Action Area and Grizzly Bear Recovery Zone

Cumulative effects of actions outside the action area and within the grizzly bear Recovery Zone are likely to affect resident grizzly bears moving through the action area whether their home range is within or adjacent to the action area. These actions include:

- livestock grazing (which would impact grizzly bears through management actions),
- private land development,
- firewood cutting,
- road use/management/improvement,
- timber harvest,
- recreation activities that lead to human-bear conflicts,
- vegetation management,
- wild and prescribed fire, and
- loss or decline of important food sources (e.g., whitebark pine seeds due to fire suppression),

The recent Teton County, Wyoming, approval of the Snake River Associates development plan for Teton Village on private land adjacent to the Park's southern boundary could have additional cumulative, long-term impacts on grizzly bears. This development will likely result in a higher number of visitors to the Park and an increase in associated dispersed recreational use. This may be particularly true in the southwest corner of the Park, where excellent bear habitat exists. Grizzly bears will likely colonize this area, even though it is several miles outside of the PCA.

These activities would cumulatively contribute to increased mortality risks, reduce availability of secure habitat, and diminish habitat effectiveness for grizzly bears. However, the total cumulative impact of the above-listed activities, as well as other unidentified actions occurring within the grizzly bear recovery zone, do not appear to be adversely affecting population recovery, as evidenced by the expanding grizzly bear population in the GYA (Eberhardt and Knight 1996; Schwartz et al. 2002; Pyare et al. 2004).

CONCLUSION

After reviewing the current status of the threatened grizzly bear, the environmental baseline for the species in the action area, the effects of the action and the cumulative effects, it is the Service's opinion that the Final Bison and Elk Management Plan, as proposed, is not likely to jeopardize the continued existence of the grizzly bear. No critical habitat has been designated for grizzly bears, therefore, none will be affected. Implementing regulations for section 7 (50 CFR

402) define "jeopardize the continued existence of" as to "engage in an action that reasonably 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." Our conclusion that the proposed action is not likely to jeopardize the continued existence of grizzly bears is based primarily on the information presented in the FEIS and BE prepared for the proposed Bison and Elk Management Plan, information in our files, and informal discussions between the Service, the Park and other personnel from other agencies and groups.

Grizzly bears in the GYE have increased in numbers and expanded in range during the past two decades (Schwartz et al. 2006). Female grizzly bears with young have been observed out side of the recovery zone, leading to the assumption that females are able to establish home ranges and find the resources needed to survive and reproduce in these areas.

The Service concludes that some adverse affects may occur to grizzly bears as a result of the proposed bison and elk management plan. The existing level of hunting on the Refuge has not presented a problem of grizzly-human conflict and, though the best available information suggests the GYE grizzly bear population is stable to increasing and is expanding its range to the south, the open nature of terrain on the Refuge and high levels of human activity and visibility will limit the risk of conflicts in both the short and long terms. As on the Refuge, existing hunting within the Park has not presented a substantial problem of hunting-caused grizzly bear mortality; however, unlike on the Refuge, the variability of terrain and densely wooded areas in the Park contribute to an elevated risk of hunting-related conflicts occurring. This increased risk would be minimal in the long term as a result of the proposed action, but would be higher in the short-term, especially within Area 79. Within the B-TNF, the short term risk of increased hunting-related grizzly bear mortality would be relatively unchanged as a result of the proposed plan under current conditions. The long-term risk, however, would be considerably higher in all areas where grizzly bear occur.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation when it actually kills or injures listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent act or omission which creates the likelihood of injury to listed species by annoying it such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to

and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary and must be implemented by the Park and Refuge so that they become binding conditions of any permit issued by the Park or Refuge, as appropriate, in order for the exemption from prohibited taking of the species concerned, as described in section 7(o)(2), to apply. The Park and Refuge have a continuing duty to regulate the activity covered by this incidental take statement. If the Park or Refuge (1) fails to assume and implement the terms and conditions or (2) fails to require permittees to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or other documents, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Park and Refuge must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR §402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

Considering the history of hunting-related conflicts in the GYE, differing strategies for management of hunters by the Park and the B-TNF, and differences in landscape and habitat characteristics, the risk of hunting-related grizzly bear mortality and associated incidental take are addressed separately for the Park and the B-TNF. The Service anticipates that the proposed action will exacerbate the short-term risk for hunting-related grizzly bear mortality within the Park and the long-term risk for hunting-related grizzly bear mortality in the B-TNF and JDR Memorial Parkway as a result of the Plan.

The Service anticipates 1 grizzly bear (adult or juvenile) over the 15-year implementation period of the Plan could be incidentally taken as a result of the proposed action in GTNP and 2 grizzly bears (adult or juvenile) in a 15-year period could be incidentally taken as a result of the proposed action in the B-TNF. It is expected that all grizzly bears would be lethally taken through hunting-related conflicts. In the period 1987-2001, an average of 2 human-caused grizzly bear mortalities occurred per year in the B-TNF. During the same time period the average human-caused grizzly bear mortality was less than 1 per year in the Park (USFWS 2003). The incidental take of 2 grizzly bears in the B-TNF and 1 in GTNP as a result of the proposed action is considered to be in addition to this baseline level of mortality.

EFFECT OF THE TAKE

As analyzed in this biological opinion, the Service concludes that this level of anticipated incidental take is not likely to result in jeopardy to the species. Critical habitat has not been designated for the grizzly bear; therefore none would be affected.

REASONABLE AND PRUDENT MEASURES

The Service believes the following Reasonable and Prudent Measures (RPM) are necessary and appropriate to minimize impacts of incidental take of grizzly bears:

RPM 1 Minimize the likelihood of hunting-related human/grizzly bear conflict associated with the Project through education of hunters

TERMS AND CONDITIONS

The Service believes no more than 3 grizzly bears will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is reached, such incidental take represents new information requiring re-initiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

1. The Park and Refuge shall continue ongoing educational measures related to limiting the risk of hunter-grizzly conflict and hunting-caused grizzly bear mortality and shall adapt or modify these measures as changing circumstances and information warrant.

2. If incidental take of grizzly bears in the B-TNF above the baseline level reaches 1 grizzly bear, Service and Park representatives shall meet with representatives from the WGFD and B-TNF to discuss whether additional educational and/or preventative measures or other changes could be implemented within the action area to minimize additional take of grizzly bears within the B-TNF.

3. In the event that a grizzly bear is killed within the action area as a result of hunting-related conflict, the Park, Refuge or B-TNF shall notify the Service's Wyoming Field Office (307-772-2374) and the Service's Law Enforcement Office (307-261-6365) within 24 hours.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation Recommendations (CR) are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

CR1. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

CR2. The Refuge and Park should participate in ongoing interagency efforts to identify, map and manage linkage habitats essential to grizzly bear movement. Please contact the Service's grizzly bear recovery coordinator at (406) 243-4903 for information.

CR3. If grizzly bears are sighted on the NER during the implementation period of the project, all hunting activities on the NER should be reassessed in order to determine the potential risk of hunter-grizzly conflict.

CR4. The Park should encourage hunters to move their kills out from underneath thick tree cover or undergrowth into more open areas as quickly as possible in order to reduce the risk of surprise encounters with grizzly bears.

CR5. The Park should encourage hunters to retrieve and remove or hang their kills as quickly as possible after making a kill in order to reduce the risk of hunter-grizzly conflict over ungulate carcasses.

CR6. The Park should recommend that after making a kill or tagging a kill, any hunter that finds a grizzly bear is already on the carcass will forfeit that kill and/or tag.

CR7. The Park should place educational signs/information addressing the risks of hunter-grizzly conflict, including information on daily and seasonal periods that represent the highest risk for hunter-grizzly conflict and how to diffuse grizzly bear confrontations, in any parking area, maintained camp site and high use trail head where such signs/information are not already in place.

CR8. The Park should continue encouraging hunters to maintain at least 100m distance between any campsite and any carcass or meat that is hung in order to elevate it beyond the reach of scavenging grizzly bears.

CR9. As a non-action agency indirectly affected by the proposed project, the B-TNF should implement the abovementioned conservation measures whenever possible and appropriate.

REINITIATION REQUIREMENT

This concludes formal consultation on the action outlined in your February 7, 2007, request for formal consultation on the Final Bison and Elk Management Plan and Environmental Impact

Statement. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Thank you for your assistance in the conservation of endangered, threatened, and proposed species. If you have any questions or comments on this final biological opinion or your responsibilities under the Act, please contact Tyler Fox of our staff at the letterhead address or by phone at (307) 772-2374, extension 237.

cc: B-TNF, Forest Supervisor, Jackson, WY (K. Hamilton)
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FWS, Planning Team Leader, Lakewood, CO (L. Shannon)
GTNP, Superintendent, Jackson, WY (M. Gibson-Scott)
GTNP, Management Assistant, Moose, WY (G. Pollock)
GTNP, Senior Wildlife Biologist, Moose, WY (S. Cain)
WGFD, Statewide Habitat Protection Coordinator, Cheyenne, WY (V. Stelter)
WGFD, Non-Game Coordinator, Lander, WY (B. Oakleaf)

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APPENDIX F: RECORD OF DECISION FOR THE BISON AND ELK MANAGEMENT PLAN

Record of Decision

National Elk Refuge
Grand Teton National Park

Final Bison and Elk Management Plan and Environmental Impact Statement

April 2007

Prepared by

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Introduction

This Record of Decision (ROD) for the Final Bison and Elk Management Plan (Plan) for the National Elk Refuge and Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway provides the basis for management decisions made by the U.S. Fish and Wildlife Service and the National Park Service (FWS and NPS). The plan was prepared along with an Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA), and relevant planning policies. We (FWS and NPS) propose to adopt and implement the plan which provides guidance on managing the Jackson bison and elk herds within our jurisdictions for a 15-year period.

The Final Plan/EIS described our proposal for management of the Jackson bison and elk populations within their respective jurisdictions and disclosed the effects of six management alternatives. The significant issues addressed in the Final Plan/EIS include: bison and elk populations and their ecology, restoration of habitat and management of other species of wildlife, supplemental winter feeding operations of bison and elk, disease prevalence and transmission, recreational opportunities, cultural opportunities and western traditions and lifestyles, commercial operations, and the local and regional economy.

In preparing the Final Plan/EIS, we worked closely with several cooperative agencies and partners including the Wyoming Game and Fish Department (WGFD), the U.S. Forest Service which administers the Bridger-Teton National Forest, the Bureau of Land Management (BLM) which administers BLM resource areas in Jackson Hole, and the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service, which is in part responsible for preventing the introduction and spread of significant livestock diseases.

Background

The planning area is located in Teton County, Wyoming near the town of Jackson and in the valley commonly known as Jackson Hole. The National Elk Refuge is a 24,700-acre unit of the National Wildlife Refuge System administered by the U.S. Fish and Wildlife Service. Grand Teton National Park is 309,995 acres, and John D. Rockefeller, Jr., Memorial Parkway is 23,777 acres, for a total of 333,772 acres administered by the National Park Service.

The Jackson elk and bison herds comprise one of the largest concentrations of elk and bison in North America, with an estimated 13,000 elk and over 1,000 bison. The elk migrate across several jurisdictional boundaries in northwestern Wyoming, including the National Elk Refuge and Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway. The bison range largely within Grand Teton National Park and the National Elk Refuge, with some crossing into Bridger-Teton National Forest and onto state and private lands in the Jackson Hole area.

Before Euro-American settlement of the Jackson Hole area, the elk generally wintered in the southern portion of Jackson Hole and are believed by some to have migrated to the Green River, Wind River, and Snake River basins. Due to changes in land use and development in the late 1800s, the winter range area became less accessible resulting in an increasing number of elk wintering in Jackson Hole.

After substantial numbers of elk died during severe winters, local citizens,

along with state and federal officials, began feeding in the winter of 1910-1911. In 1912, Congress set aside land that would become the National Elk Refuge as a "winter game (elk) reserve" (37Stat. 293, 16 USC 673). Supplemental feeding has continued during most winters since then although this was not legislatively mandated.

While there have been many benefits associated with wintering large numbers of elk (and bison) on the refuge, high animal concentrations have created an unnatural situation that has contributed to the following problems: an increased risk for potentially major outbreaks of exotic diseases; damage to and loss of habitat due to browsing of willow, cottonwood, and aspen stands, thereby reducing other wildlife associated with woody vegetation; unusually low winter mortality which affects predators and other species and requires intensive hunting programs; and a high level of brucellosis in the elk and bison herds.

After having been extirpated from Jackson Hole in the 1880s, a small herd of bison was re-introduced to the Jackson Hole Wildlife Park near Moran in 1948 (approximately 20). Twenty years later, the herd escaped the park and began to range freely. In 1975, the small bison herd began wintering on the National Elk Refuge, and by 1980, began eating supplemental feed that was being provided for elk. Since discovering this supplemental food source, the Jackson bison herd has grown at a rate of about 13% each year to its 2007 level of about 1,100 animals. Concerns about the rapidly increasing bison herd include escalating damage to habitats, competition with elk, high prevalence of brucellosis, human safety concerns, damage to private property, and additional costs of providing supplemental feed for bison.

Many of the management issues surrounding the bison and elk herds are controversial. In 1996, a bison management plan (Jackson Bison Herd Long Term Management Plan and Environmental Assessment) was finalized by the NPS and the FWS, in cooperation with the WGFD and the Bridger-Teton National Forest. In 1998, a lawsuit was brought by the Fund for Animals enjoining most federal management actions proposed in the 1996 plan. The court ruled that the destruction of bison on federal lands for population control purposes could not be carried out until additional NEPA compliance was completed that considered the effects of supplemental winter feeding of elk on the National Elk Refuge on the Jackson bison population.

Purpose and Need for the Plan

The purpose of the Bison and Elk Management Plan is to provide managers with goals, objectives, and strategies for managing bison and elk on the National Elk Refuge and in Grand Teton National Park. The plan will contribute to the missions and management policies of the FWS and the NPS. Given the substantial role that the refuge and the park play in the overall habitat of the Jackson bison and elk herds and the effects that the herds can have on surrounding habitats, the plan will also contribute to the herd objectives set by the WGFD, as well as to several goals and objectives established by the U.S. Forest Service related to elk, bison, and their habitat in the Bridger-Teton National Forest.

This planning effort considered changes in how the bison and elk herds could be managed on the National Elk Refuge and in Grand Teton National Park in order to meet legal obligations and to address problems related to high animal concentrations in winter and effects on

habitat. Other factors that were considered in developing the plan included FWS and NPS policies, wildlife management principles, scientific information, and stakeholder issues and concerns.

Desired Conditions

By the end of the 15-year implementation period, the National Elk Refuge and Grand Teton National Park will provide winter, summer, and transitional range for large portions of the Jackson bison and elk herds. The environment will support a full complement of native plant, wildlife, and breeding bird species. Refuge and park staffs, working with others, will adaptively manage bison and elk in a manner that contributes to the state's herd objectives yet allows for the biotic integrity and environmental health of the resources to be sustained. As a result, the public enjoys a variety of compatible, wildlife-dependent recreational opportunities.

Management Goals

Four goals for the plan were developed based on the purposes of the National Elk Refuge and Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway, the missions of the National Wildlife Refuge System and the National Park System, and other legal and policy directives. The goals also considered input from stakeholders. The alternatives developed and considered in the Final EIS respond to these four goals.

Goal 1. Habitat Conservation

National Elk Refuge – Provide secure, sustainable ungulate grazing habitat that is characterized primarily by native composition and structure within and among plant communities and that also provides for the needs of other native species.

Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway – In concert with restoring and perpetuating the natural ecosystem functioning in the park, restore and maintain the full range of natural, structural, and compositional characteristics of native habitats used by bison and elk, emphasizing the plant species diversity that native habitats would support.

Goal 2. Sustainable Populations

National Elk Refuge – Contribute to elk and bison populations that are healthy and able to adapt to changing conditions in the environment and that are at reduced risk from the adverse effect of non-endemic diseases.

Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway – Perpetuate to the greatest extent possible, natural processes and the interactions of bison and elk with natural environmental fluctuations influenced by fire, vegetation succession, weather, predation, and competition. At the same time support public elk reductions in Grand Teton National Park, when necessary, to achieve elk population objectives that have been jointly developed by the WGFD, the park, and the refuge. Support elk hunting in the John D. Rockefeller, Jr., Memorial Parkway that is consistent with its establishing legislation.

Goal 3. Numbers of Elk and Bison

Contribute to the WGFD herd objectives for the Jackson elk and bison herds to the extent compatible with Goals 1 and 2, and to the legal directives governing the management of the National Elk Refuge and Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway.

Goal 4. Disease Management

Work cooperatively with the state of Wyoming and others to reduce the prevalence of brucellosis in the bison and elk populations in order to protect the economic interest and viability of the livestock industry, and reduce the risk of adverse effects of or from other non-endemic diseases not currently found in the Jackson bison and elk populations.

Stakeholder Issues

Seven significant stakeholder issues were identified during the planning process. These issues were considered in the formulation of alternative sets of objectives and strategies. The significant stakeholder issues are:

1. ***Bison and Elk Populations and their Ecology*** - Most members of the public generally want healthy bison and elk herds, whether for the abundance of recreational opportunities or for the benefit of the animals themselves and the ecosystem. There was no agreement about how many animals should be in each herd, or how to reach those numbers.

2. ***Restoration of Habitat and Management of Other Species of Wildlife*** - Some people want to see habitat restored and improved, but opinions differ on the specifics of this goal.

3. ***Winter Feeding Operations for Bison and Elk*** - Some stakeholders disagree with the concept of providing supplemental feed to elk and bison, while others believe supplemental feed should be provided every year.

4. ***Disease Prevalence and Transmission*** -Brucellosis and the high rates of infection in both the bison and elk herds is of concern because of the economic effect it could have on livestock producers if cattle contract the disease. Some stakeholders are concerned about the potential of more serious non-endemic diseases, such as bovine tuberculosis or chronic wasting disease, getting into the herds.

5. ***Recreational Opportunities*** - Many people are concerned that changes in the management of elk and bison on the National Elk Refuge and in Grand Teton National Park would impact hunting and wildlife viewing opportunities.

6. ***Cultural Opportunities and Western Traditions and Lifestyles*** - Tribal representatives and other members of the public have stated that American Indian tribes should be actively involved in decisions regarding bison. Some Native Americans have traditions and spiritual values that are closely associated with both elk and bison and would like the plan to include ceremonial take or hunting of bison by tribal members. Local residents are also concerned about how changes in elk and bison management would affect their own traditions and lifestyles, which are in part dependent on wide-open spaces and plentiful wildlife.

7. ***Commercial Operations and the Local and Regional Economy*** - Wildlife viewing and hunting opportunities contribute to the local economy, and many businesses, including outfitters and dude ranchers, depend on abundant wildlife.

Decision (Alternative 4)

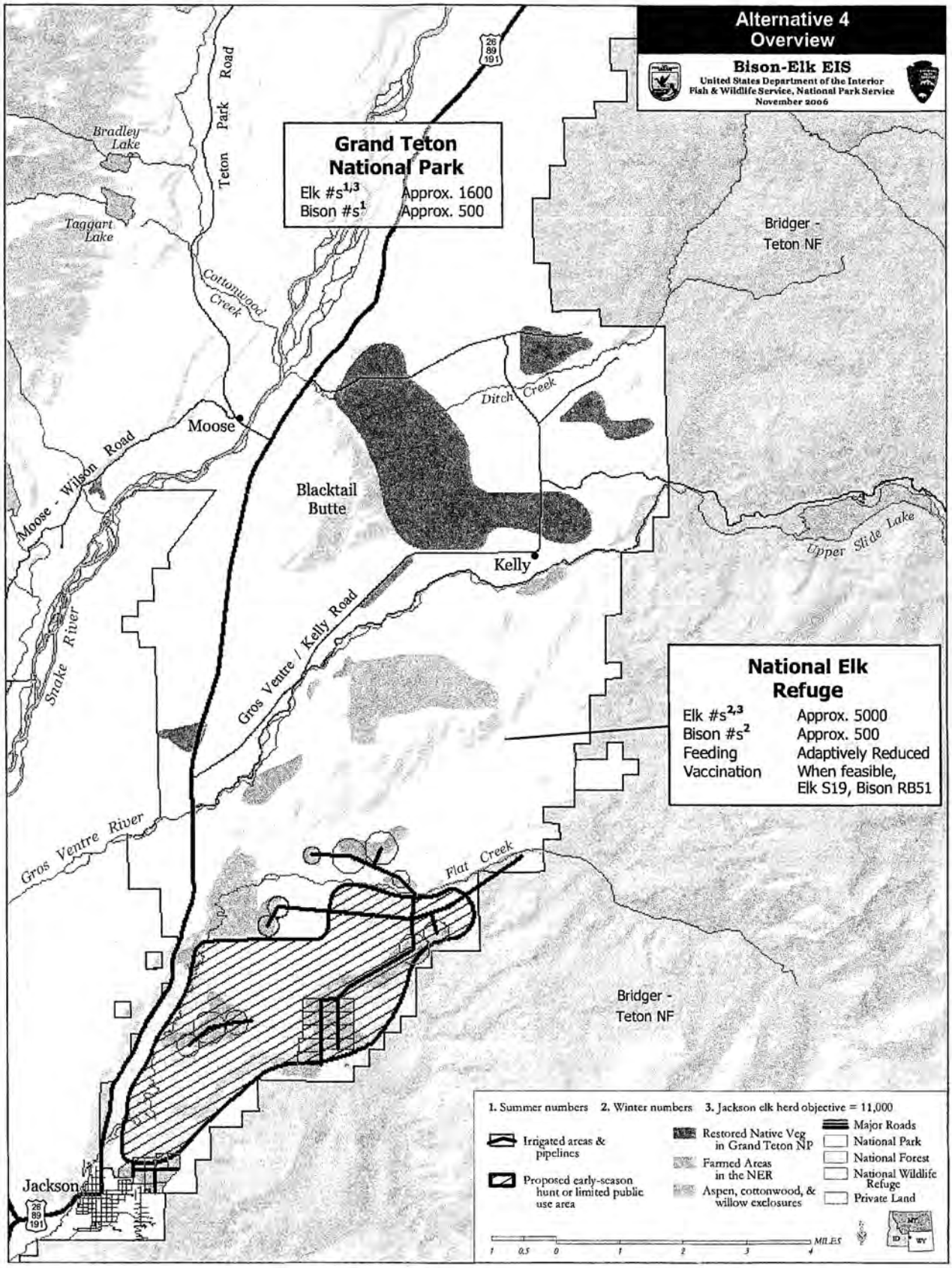
We select to implement Alternative 4 – Adaptively Manage Habitat and Populations as described in the Final Plan/EIS. Alternative 4 is selected for bison and elk management because it will adaptively manage habitat and populations to achieve desired conditions over 15 years. This alternative will balance the significant management

issues with the purposes, missions, and management policies of the FWS and NPS, as well as with the interests and perspectives of other agencies and stakeholders.

Under the proposed plan, the Jackson bison and elk herds and their habitat will be managed with an emphasis on improving winter, summer, and transitional range on the park and refuge and ensuring that the biotic integrity and environmental health of the resources are sustained over the long term. Working in close cooperation with WGFD, existing conditions, trends, new research findings, and other changing circumstances will provide the basis for developing and implementing a dynamic framework for decreasing the need for supplemental food on the refuge. Population management, vegetation restoration, on-going monitoring, and public education will be integral components of this framework (See Alternative 4 map below and FEIS pages 48-49 and 54-74 for complete description and objectives and strategies).

Key habitat conservation and population management elements of Alternative 4 are:

- Initiate habitat restoration projects to improve native and cultivated forage on the refuge and achieve desired conditions and goals.
- Initiate restoration of previously cultivated areas in the park to native plant communities.
- Work with private and agency partners to minimize bison and elk conflicts with adjacent land owners (e.g., by providing human and/or financial resources to manage co-mingling and reduce crop depredation by elk and/or bison on private lands).
- Initiate a public education effort to build understanding of natural elk and bison behavior, ecology, distribution, disease implications, and effects to other species.
- Identify criteria for beginning and ending feeding each year in consultation with WGFD.
- Develop a structured framework, in collaboration with WGFD, of adaptive management actions that include triggers for progressively transitioning from intensive supplemental winter feeding to greater reliance on free-standing forage, based on these considerations:
  1. Level of forage production and availability on the National Elk Refuge
  2. Desired herd size and ratios
  3. Effective mitigation of bison-elk-cattle mingling on private lands
  4. Winter distribution patterns of elk and bison
  5. Prevalence of brucellosis, chronic wasting disease, and other wildlife diseases
  6. Public support
- Working in collaboration with WGFD to maintain the Jackson elk herd objective of 11,000, following the initial implementation of a phased approach, about 5,000 elk will be expected to winter on the refuge. As herd sizes and habitat objectives are achieved, further reductions in feeding or elk numbers could occur based on established triggers and changing social, political, or biological conditions. Hunting (bison and elk on the refuge) and, when necessary, a herd reduction program in the park will be used to assist the state in managing herd sizes, sex and age ratios, and summer distributions.


Alternative 4
Overview
Bison-Elk EIS
United States Department of the Interior
Fish & Wildlife Service, National Park Service
November 2006
Grand Teton
National Park
Elk #s[1,3] Approx. 1600
Bison #s[1] Approx. 500
National Elk
Refuge
Elk #s[2,3] Approx. 5000
Bison #s[2] Approx. 500
Feeding Adaptively Reduced
Vaccination When feasible,
Elk S19, Bison RB51
Teton Park Road
Bradley Lake
Taggart Lake
Cottonwood Creek
Ditch Creek
Moose
Moose - Wilson Road
Blacktail Butte
Kelly
Upper Slide Lake
Gros Ventre / Kelly Road
Snake River
Gros Ventre River
Flat Creek
Bridger - Teton NF
Bridger - Teton NF
Jackson
26 89 191
1. Summer numbers 2. Winter numbers 3. Jackson elk herd objective = 11,000
Irrigated areas & pipelines
Proposed early-season hunt or limited public use area
Restored Native Veg in Grand Teton NP
Farmed Areas in the NER
Aspen, cottonwood, & willow exclosures
Major Roads
National Park
National Forest
National Wildlife Refuge
Private Land
MILES
1 0.5 0 1 2 3 4
MT
ID
WY

- Work collaboratively with WGFD to maintain and ensure a genetically viable population of about 500 bison (currently bison number about 1,100). A public bison hunt will be initiated on the refuge and managed in accordance with the State of Wyoming's licensing regulations and an approved refuge hunting plan.
- Potentially allow for a small ceremonial taking of bison (approximately 5 each year) by the tribes traditionally associated with Jackson Hole. If implemented, this would be administered and managed by FWS.
- Permit WGFD to vaccinate elk and bison for brucellosis on the refuge as long as it is logistically feasible and vaccines are determined to be safe.

Alternative 4 was revised from the proposed action in the Draft Plan/EIS after consideration of many comments received from agencies, tribes, other organizations, and the public during the comment period.

Other Alternatives Considered

The Final Plan/EIS evaluated five other alternatives for the management of bison and elk in the refuge and park. These alternatives are summarized below, along with an explanation of why the alternative was not selected.

Alternative 1: No Action

In the No Action Alternative, few changes would occur in managing the elk and bison herds and their habitat on the National Elk Refuge and in Grand Teton National Park / John D. Rockefeller, Jr., Memorial Parkway. About half of the Jackson elk herd (5,600–7,500), and the entire bison herd (1,000+) would continue to winter on the refuge. Cultivated fields would continue to provide additional forage to existing native habitat, but a primary source of winter food would be imported feed. A limited elk hunt on the refuge and, when necessary, the elk reduction program in the park would continue. No bison hunting would be allowed on refuge or park lands.

The high prevalence of brucellosis in the elk and bison herds would continue because no new strategies would be used to reduce transmission between animals. No further measures would be taken to protect woody riparian habitat for the benefit of other species.

Alternative 1 was not selected for implementation. High numbers of elk and bison concentrated on the refuge during nearly annual winter supplemental feeding would continue to contribute to high brucellosis levels, cause the highest risk of potentially serious impacts from non-endemic diseases among all alternatives, and result in continued decline of woody vegetation. The lack of an established population objective for bison and limited population control outside the refuge and the park would allow essentially uncontrolled growth in bison numbers and exacerbate these negative effects. Habitat damage would also negatively impact other wildlife species, ranging from Neotropical birds to mule deer, moose, and bighorn sheep in localized areas. Efforts to cultivate additional refuge forage for ungulates would continue although less efficiently than under other alternatives, and former agricultural lands in the park would not be restored to native plant communities (native grasslands and sagebrush shrubland) which would likely surpass non-native species in palatability.

Finally, there was almost no public support expressed for Alternative 1

during the public comment period on the Draft Plan/EIS.

Alternative 2: Minimal Management of Habitat and Populations, with Support for Migrations

Efforts to actively manage the elk and bison herds and their habitat would be greatly reduced over time on the refuge and in the park. The Jackson elk and bison populations would fluctuate more naturally, with 1,200–6,000 elk and 250–500 bison estimated to winter on the refuge and 600–3,000 elk summering in the park at levels that could be supported by available habitat. Additionally, the FWS and NPS would support stakeholder efforts to establish elk migration out of Jackson Hole to other wintering areas. Cultivated areas would be restored with native grasses, and irrigation practices would be phased out. The use of imported supplemental feed during winter months would be phased out over 10–15 years. Eliminating hunting on the refuge and the elk reduction program in the park would allow elk to increase their use of transitional winter habitats. Over time, natural densities and concentrations would reduce the prevalence of brucellosis found in the elk and bison herds.

Alternative 2 was not selected for implementation. It would likely generate negative public reaction to increased elk and bison winter mortality and lower herd numbers in some years, increase competition for forage with other ungulates in some areas, increase the likelihood of higher depredation on stored hay and damage to crops and landscaping, and result in the immediate elimination of hunting opportunities on the refuge and the herd reduction in the park. Because Alternative 2's minimal management foundation would cause Jackson elk and bison numbers to fluctuate widely and mortality to rise in severe winters without supplemental feeding on the refuge, total Jackson elk and bison numbers could fall below established WGFD objectives in some years. There could also be impacts on grizzly bears due to lower elk numbers, especially in the park, and higher competition for forage in the Green River basin due to increased distribution. Fewer refuge elk could reduce sleigh ride viewing opportunities along with associated personal income and jobs.

While some stakeholders are opposed to hunting of any kind, overall most stakeholder groups and local, state and federal agencies did not support this alternative.

Alternative 3: Restore Habitat, Support Migrations, and Phase Back Supplemental Feeding

The Jackson elk and bison herds and their habitat would be actively managed on the refuge, with an emphasis on restoring habitat by reducing elk numbers. An estimated 1,000–2,000 elk would winter on the refuge, and 500–1,000 would summer on park lands. Bison numbers would be maintained at current levels (about 1,100) on the refuge and in the park.

Supplemental feeding would be reduced over 10 years on the refuge, in coordination with an increased elk harvest program, and eventually feed would only be provided during the severest winters (estimated in roughly 2 of 10 winters and depending on snow conditions). Additionally, the FWS and NPS would support stakeholder efforts to establish elk migration out of Jackson Hole to other wintering areas. Elk hunting on the refuge and, when necessary, the elk herd reduction program in the park would continue, but

some hunt areas would be closed after elk objectives were reached. Also, a bison hunt would be initiated on the refuge. The prevalence of brucellosis in the elk and bison herds could decrease over time as a result of fewer concentrated animals, and vaccines with higher efficacies or other techniques would be used when developed. Willow and cottonwood habitat would be sustained for the benefit of other species.

Alternative 3 was not selected for implementation. It would likely generate negative public reaction due to major decreases in elk numbers on the National Elk Refuge without decreases in bison numbers. The alternative would decrease elk hunting and viewing opportunities, slightly increase elk and bison winter mortality, and would likely lower Jackson elk herd numbers below the Wyoming Game and Fish objective in some years. In the short term, it would likely increase competition for forage with other ungulates in some areas and increase the likelihood of higher depredation on stored hay and damage to crops and landscaping (similar to Alternative 2 effects). There could also be impacts on grizzly bears due to lower elk numbers, especially in the park, and higher competition for forage in the Green River basin due to increased distribution. Fewer refuge elk could reduce contributions from the antler auction and sleigh ride elk viewing opportunities along with associated sleigh ride personal income and jobs.

Finally, there was no public support for Alternative 3.

Alternative 5: Restore Habitat, Improve Forage, and Continue Supplemental Feeding

The Jackson elk and bison herds and their habitat would be heavily managed on the refuge, with an emphasis on improving forage quality on cultivated lands through improved irrigation methods. About 5,000–7,500 elk and 400 bison would winter on the refuge. During the summer up to 2,500 elk would use habitat in the park. Imported supplemental feed would be used in average and above average winters (estimated to occur roughly 9 of 10 years). The elk hunt on the refuge and, when necessary, the elk reduction program in the park would continue. Also, a bison hunt would be initiated on the refuge. Efforts to minimize disease outbreaks would include spreading out feed and moving feed locations. To reduce the prevalence of brucellosis in the elk and bison herds, WGFD personnel would be permitted to use Strain 19 to vaccinate elk and RB51 to vaccinate bison. Woody vegetation would be restored for the benefit of other species.

Alternative 5 was not selected for implementation. Despite improved refuge forage production and protection of some woody vegetation areas, it remains similar to current management in that high numbers of elk and bison remain concentrated on the refuge during nearly annual winter supplemental feeding. These concentrations would continue to contribute to high brucellosis levels, high risk of potentially serious impacts from non-endemic diseases, and woody vegetation damage and destruction. Habitat damage would also negatively impact other wildlife species, ranging from Neotropical birds to mule deer, moose, and bighorn sheep. Large concentrations of elk and bison on refuge feedlines would continue the potential for mule deer and moose populations to be infected by a non-endemic infectious disease transmitted from elk or bison.

Many stakeholder groups, general public, and other agencies oppose this alternative while some stakeholder groups, general

public, and other agencies supported this alternative.

Alternative 6: Restore Habitat, Adaptively Manage Populations, and Phase Out Supplemental Feeding

The Jackson elk and bison herds and their habitat would be adaptively managed on the refuge to improve available winter grazing habitat and to respond to changing conditions. In the short term, about 2,400–2,700 elk would winter on the refuge, but over time could increase to 2,800–3,200. An estimated 1,200–1,600 elk would summer in the park. Native habitat and cultivated fields on the refuge would provide substantial standing winter forage, and winter feeding would be phased out within five years. Elk hunting would continue on the refuge and, when necessary, the herd reduction program in the park. Also, the FWS would implement a bison hunt on the refuge and eventually the herd would be reduced to about 500 animals. The prevalence of brucellosis in the elk and bison herds as a result of concentrated animals would decrease over time, and vaccines with higher efficacies or other techniques to reduce transmission would be used when developed. Woody vegetation would be initially protected and restored for the benefit of other species.

Alternative 6 was not selected for implementation. Its goal to eliminate refuge supplemental feeding and reduce elk and bison numbers on the refuge within 5 years could be difficult to achieve within the time frame, and it would not be acceptable for some stakeholder groups, many local residents, and the State of Wyoming including WGFD.

Implementation of Alternative 6 would require a substantial expanded harvest where large numbers of elk and bison would be killed annually. Further adverse winter conditions could prevent or delay eliminating refuge supplemental feeding during such a short time frame. If supplemental feeding was discontinued before herd size objectives were reached, the risk for depredation and disease associated with potentially large numbers of elk and bison would be greater. In the long term, Alternative 6 could decrease elk hunting and viewing opportunities, slightly increase elk and bison annual winter mortality, and would likely lower Jackson elk herd numbers below the WGFD's objective in some years. In the short term, competition for forage with other ungulates in some areas and the likelihood of higher depredation on stored hay and damage to crops and landscaping (similar to Alternative 2 effects) would increase.

Fewer refuge elk could reduce contributions from the antler auction and sleigh ride elk viewing opportunities along with associated sleigh ride personal income.

Many stakeholder groups, general public, and other agencies oppose this alternative while other stakeholder groups, general public, and other agencies supported this alternative.

Public Involvement

Project Scoping

The scoping process began with eight prescoping meetings between February 10 and May 5, 2001 in Jackson, Riverton, Casper, Cheyenne, and Rock Springs, Wyoming. The formal scoping period began on July 18, 2001, with the publication of a Notice of Intent in the Federal Register (66 FR 37489). The Notice of Intent notified the public of the agencies intent to begin the Plan/EIS process, announce the dates for public scoping meetings, and solicit public

comments. Ten scoping meetings were held throughout the country from July 20 to August 3, 2001; six meetings were held in Wyoming, and meetings were also held in Idaho, Montana, Colorado, and Virginia. The scoping period ended on August 24, 2001.

Interagency Working Group Meetings

Interagency working group meetings have been held as needed since October 2000. Agencies represented have included the U.S. Fish and Wildlife Service, National Park Service, U.S. Forest Service (Bridger-Teton National Forest), USDA-Animal and Plant Health Inspection Service, BLM, and the WGFD.

Tribal Involvement and Consultation

The FWS and NPS consulted with tribes with known traditional association to the project area. Those tribes included the Northern Arapaho, Blackfeet, Crow, Chippewa-Cree, Gros Ventre, Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Nez Perce, Northern Cheyenne, Confederated Salish and Kootenai Tribes, Shoshone-Bannock Tribes, and Eastern Shoshone. Briefings were also provided at meetings of the Montana-Wyoming Tribal Fish and Game Commissioners, Montana-Wyoming Tribal Leaders Council, Intertribal Bison Cooperative, Northern Arapaho Business Council, Shoshone-Bannock Business Council, the Eastern Shoshone Business Council, and the Yellowstone National Park government-to-government consultation and/or information exchange meetings.

Other Meetings and Discussions

Agency representatives have given briefings and status updates to several interest group meetings, including county commissioners, Jackson Chamber of Commerce, and other organizations. Agency representatives have also met with numerous individuals during the planning process.

Alternative Development Meetings

Two alternative development meetings were held on November 28 and 29, 2001, in Riverton and Jackson, Wyoming. Public input represented a wide variety of opinions on all management issues.

Comments on the Draft Plan/EIS

A Notice of Availability for the Draft Plan/EIS was published in the Federal Register on July 21, 2005 (70 FR 42089). During the Draft Plan/EIS comment period that occurred from July 21, 2005 to November 7, 2005, we received over 11,900 written comments and public testimony from 241 individuals, 37 agencies or organizations, and 1,751 form letters or petitions. Public hearings were held in Bozeman, Montana, Jackson, Wyoming, and Riverton, Wyoming in late August 2005. All substantive issues raised in the comments were addressed in the Final Plan/EIS. Public comments, public hearing testimony, and responses will be available for review at the National Elk Refuge, 675 East Broadway, Jackson, Wyoming 83001 during normal business hours. Responses to comments are included as a companion document to the Final Plan/EIS.

Comments on the Final Plan/EIS

The Final Plan/EIS was published on February 2, 2007 (72 FR 5078) and the 30-day waiting period ended on March 12, 2007 (72 FR 6238). We received 938 emails from individuals and 5 letters from

organizations. The majority of the emails were form petitions in support of Alternative 6 with changes, while two individuals opposed hunting. A total of about 4,738 comments were recorded. In addition, we consulted with the Shoshone-Bannock Tribes on March 9, 2007 at Fort Hall, Idaho to discuss their concerns on the Final Plan/EIS. None of the comments that we received either raised new substantive issues or presented reasonable alternatives other than those presented in the Final Plan/EIS, or provided significant additional information relevant to the analysis.

Summary of FEIS Comments

Supplemental Feeding - While the Final Plan/EIS acknowledges that many biological issues on the refuge are related to supplemental feeding, Alternative 4 makes no commitment to phase out supplemental feeding.

Adaptive Management Framework - The proposed adaptive management framework to reduce reliance on supplemental feeding is not adequately described and analyzed, and presents no observable benchmarks or standards by which the public can gauge progress.

Legal Mandates – Alternative 4 does not conform to the existing laws and policies that govern management of the National Elk Refuge.

Fencing – The preferred alternative should include additional fencing and/or partnerships to reduce property damage and commingling of elk and bison with livestock.

Bison – Population targets for bison should be higher, and bison should be allowed to distribute over a larger geographic area than what is proposed in Alternative 4. The agencies should consider other habitat modeling data in determining the carrying capacity for bison.

Vaccination – Opposition to the use of vaccines (Strain 19 or RB51) in elk or bison

Tribal Concerns – A process has not been identified for how the tribes would participate in a ceremonial hunt. Alternative 4 only provides the potential that tribal ceremonial take could occur, and the numbers of bison that could be taken by the tribes (5 or possibly more depending on need) is too low. The importance of traditions and cultural values has not been adequately addressed in the Final Plan/EIS, and the agencies' trust responsibilities including treaty and subsistence rights were not addressed.

Other - Opposition to hunting

Discussion of FEIS Comments

Comments raised about opposing supplemental feeding, legal mandates, bison population objectives, habitat modeling assumptions, vaccination and hunting were addressed in Volume 2, Responses to Comments on the Final Plan/EIS and changes made in the Final Plan/EIS. These issues are not discussed further. We believe several topics warrant further clarification.

Adaptive Management Framework – The preferred alternative identified in the Final Plan/EIS was modified from the proposed action identified in Draft Plan/EIS as a result of the public comments received. The preferred alternative provides substantial guidance and direction for managing the Jackson bison and elk herds for the next 15 years. Even though this plan does not constitute a commitment for future funding, any significant deviation from implementing Alternative 4 will require further public review and analysis.

Throughout the planning process, the most significant issue identified is that there is not enough winter forage to

support the Jackson bison and elk herd sizes that are desired by many stakeholders groups, the public, and the State of Wyoming. Further complicating this issue is that these populations migrate across several jurisdictional boundaries, necessitating cooperation and coordination among several agencies and jurisdictions with differing legal mandates and constituents.

The preferred alternative clearly states that the FWS intends to progressively reduce the use of supplemental feeding on the National Elk Refuge, and specific objectives and strategies were outlined to address habitat conservation and wildlife management in order to achieve a greater reliance on free-standing forage. We understand that many commenters on the Final Plan/EIS desire a definitive answer about eliminating the use of supplemental feeding. We also recognize that many agencies, stakeholder groups, and the public have divergent opinions about phasing out supplemental feeding. The plan does not identify whether or not feeding will be phased out within 15 years; instead it focuses on achieving the desired conditions (described on page 2) through an adaptive, progressive, and collaborative approach that incorporates different objectives and tools (strategies) for managing these populations. We will not preclude the use of supplemental feeding or other management tool as we work to resolve the bison and elk management issues that have been at play for 100 years, nor will we make predictions about how fast we can implement the phased approach for improving forage, reducing the elk populations to about 5,000, reducing the bison herd to about 500, and reducing the need for supplemental feed as described on pages 4-5. When the biological, social, and political conditions enable us to consider a phase-out of feeding, this adaptive framework provides us with that flexibility. At the same time, we are committed to working collaboratively with other federal agencies and the State of Wyoming.

The integral components of the management framework described in the Final Plan/EIS— population management, habitat restoration, public education and monitoring— are not linear, separate components. They are dynamic and interwoven and require adaptable and workable solutions to changing biological, social, and political conditions. The primary elements in developing a structured framework are identified on pages 4-5 and in greater detail in the Final Plan/EIS.

Successful implementation of the preferred alternative will require flexibility and additional discussions between the agencies, particularly between the WGFD and the FWS, to address issues such as criteria for feeding, vaccination procedures, management of the bison and elk hunts, and continued coordination and cooperation. The outcome of these discussions will be documented in a new memorandum of understanding or other appropriate agreement document and will be made available to all stakeholders.

Fencing – We do not anticipate any need for additional fencing on the refuge other than what was identified in the preferred alternative as suggested by some commenters, and we believe there is flexibility and funding identified within the alternative to work with adjacent landowners, the WGFD and others to identify strategies (including fencing) for reducing conflicts on private lands.

Tribal Concerns – The option of potentially allowing the tribes to take a small number of bison for the purposes of a ceremonial

event was included in the preferred alternative. The population objectives for bison and the subsequent analysis presented in the Final Plan/EIS would remain unchanged irrespective of whether a small taking for ceremonial purposes was eventually allowed. We believe this issue can be resolved outside of this decision document, and consultation with the tribes and discussion with the State of Wyoming is ongoing. Other tribal concerns were addressed in the Responses to Comments, Volume 2 in the Final Plan/EIS.

Environmentally Preferable Alternative

The environmentally preferable alternative is defined as the "alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Typically, this means the alternative that causes the least damage to the biological and physical environment. It also means the alternative that best protects, preserves and enhances historic, cultural and natural resources" (Forty Most Asked Questions Concerning Council of Environmental Quality's National Environmental Policy Act Regulations, 1981). Alternative 6, Restore Habitat, Adaptively Manage Populations, and Phase Out Supplemental Feeding, is the environmentally preferable alternative.

Alternative 6 would emphasize a more aggressive reduction in elk numbers on the refuge with additional measures to restore and enhance riparian and aspen woodlands. Compared to Alternative 4 (the preferred alternative), Alternative 6 would phase out supplemental feeding within 5 years rather than reduce feeding in an adaptive manner over 15 years. This would result in up to about 3,200 elk on the refuge, compared to 5,000 in the initial implementation under Alternative 4. With a smaller herd size under Alternative 6, habitat enhancements would be expected to have increased success. Alternative 6 would restore up to 4,540 acres of riparian and aspen woodlands on the refuge compared to 2,710 acres in Alternative 4. These habitat benefits would also benefit other wildlife species. Reduced herd sizes and other measures on the refuge would also be expected to result in greatly reduced risk of brucellosis in Alternative 6, compared to Alternative 4. In some habitat areas, including native grasslands and wet meadow habitat, Alternative 4 results in greater environmental benefits than Alternative 6. The environmental effects of Alternative 4 would be similar to Alternative 6 within Grand Teton National Park and in other areas.

Although Alternative 6 would result in the greatest overall benefit to the biological and physical environment, all of the action alternatives would promote the national environmental policy as expressed in NEPA's Section 101, and would be preferable to no action. Most of the habitat restoration and conservation objectives of Alternative 6 are also found in Alternative 4 (the preferred alternative), though the specific strategies for their implementation are different. While it is not the environmentally preferable alternative, Alternative 4 has been selected for implementation because it will contribute to significant environmental benefits in a manner that is consistent with regional herd management objectives; it better balances the divergent views and interests and perspectives of other agencies, stakeholders groups and the public; it builds upon success implemented on the ground; and it enables managers to adapt to new information and changing conditions.

Measures to Minimize Environmental Harm

Throughout the planning process, we took into account all practicable measures to avoid or minimize environmental impacts that could result from the implementation of Alternative 4. These measures include the following:

Grizzly Bear - Implementation of Alternative 4 could adversely affect individual grizzly bears in Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway due to potential conflicts with hunters. As documented in the Biological Opinion, the NPS will continue to implement measures to reduce bear-human conflicts during elk reduction activities within Grand Teton National Park and hunting on the John D. Rockefeller Memorial Parkway as follows.

The NPS will provide "Bearwise" education programs and information for all hunters and personnel involved in hunting and elk management programs.

The NPS will instruct all hunters and personnel to properly store all food and other attractants at all times, and pack out all food materials, garbage, and other attractants on a daily basis if they cannot be stored in bear-resistant containers.

The NPS will train its staff, as well as hunters, in bear safety and standards for sanitation, attractant storage, and encourage them to carry bear pepper spray. In the park, hunters would continue to be required to carry bear spray while hunting.

Riparian and Aspen Woodlands - Habitat enhancements, including fencing exclosures and native winter range enhancement on the refuge, would be used to reduce the adverse impacts of excessive elk browsing on woody vegetation. Those enhancements will be coordinated with the reduction of supplemental feeding on the refuge.

Prescribed Fire – Prescribed fire may be used in restored vegetation communities to reduce the effects of excessive sagebrush establishment in formerly cultivated areas where herbaceous vegetation is preferred.

Other Resources – Measures to mitigate the potential impacts to other resources, including soils, water quantity/quality, views and marshlands are described individually in the Final Plan/EIS.

Consultation Requirements

Section 7 of the Endangered Species Act

All potential effects of Alternative 4 on species listed as threatened or endangered under the Endangered Species Act, along with specific measures to minimize or mitigate those impacts, were documented in an Intra-Service Section 7 Consultation. This consultation concluded that the preferred alternative may adversely affect grizzly bear in Grand Teton National Park/ John D. Rockefeller, Jr., Memorial Parkway due to potential hunter conflicts, and that it may affect but is not likely to adversely affect bald eagles and wolves on either Grand Teton National Park/ John D. Rockefeller, Jr., Memorial Parkway or the National Elk Refuge due to increased availability of elk carcasses. (Alternative 4 will have no effect on Canada lynx and yellow-billed cuckoo).

On April 10, 2007, the U.S. Fish and Wildlife Service (Ecological Services) issued a Biological Opinion stating that the proposed action is not likely to result in jeopardy to the continued existence of the grizzly bear or destruction or adverse

modification of critical habitat. In the Biological Opinion, the U.S. Fish and Wildlife Service (Ecological Services) concluded that the preferred alternative will increase the short-term risk for hunting-related grizzly bear mortality within Grand Teton National Park and the long-term risk for hunting-related grizzly bear mortality in the John D. Rockefeller Jr., Memorial Parkway and the Bridger-Teton National Forest as a result of implementing the plan. Habitat on the National Elk Refuge is relatively open and generally lacks densely forested areas, and it is unlikely that the risk of elk hunters killing grizzly bears will be greater in either the short or long term as a result of the proposed action.

The U.S. Fish and Wildlife Service (Ecological Services) concluded one grizzly bear (adult or juvenile) over the 15-year implementation plan could be incidentally taken as a result of the proposed action in Grand Teton National Park/John D. Rockefeller Jr., Memorial Parkway and two grizzly bears (adult or juvenile) could be incidentally taken as a result of the proposed action in the Bridger-Teton National Forest.

The U.S. Fish and Wildlife Service (Ecological Services) recommended the best reasonable and prudent measure is to minimize the likelihood of hunting-related human/grizzly bear conflicts through education. The NPS will continue its ongoing educational measures related to limiting the risk of human/grizzly conflicts and hunter-caused grizzly bear mortality and will modify measures as changing circumstances and information warrant. Further, if the level of incidental take is reached, such incidental take represents new information requiring re-initiation of consultation and review of the reasonable and prudent measures provided. If incidental take of grizzly bears in the Bridger-Teton National Forest reaches one grizzly bear, NPS and FWS representatives will meet with representatives from the WGFD and Bridger-Teton National Forest to discuss whether additional education and/or preventative measures or other changes could be implemented within the action area to minimize additional risks within the Bridger-Teton National Forest.

Section 106 of the National Historic Preservation Act

Alternative 4 will have no adverse effects to archaeological or historic resources on the refuge, and would not impair archaeological or historic resources in the park, and does not require consultation under Section 106 of the National Historic Preservation Act. Prior to any soil disturbance from new projects, archaeological resources within the proposed project area will be assessed for potential effects as well as their significance in accordance with Section 106 of the National Historic Preservation Act. Any unavoidable adverse effects will be mitigated in coordination with the Wyoming State Historic Preservation Office.

Impairment

The preferred alternative will not impair resources within Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway and will not violate the National Park Service Organic Act.

Finding and Basis for Decision

We have considered the environmental and relevant concerns presented by agencies, tribes, organizations and individuals on the proposed action to develop and implement a Bison and Elk Management Plan for the National Elk Refuge and Grand Teton National Park/John D. Rockefeller, Jr., Memorial Parkway. Alternative 4 was selected for

implementation because it achieves a reasonable balance between significant resource management issues, the purposes, missions, and management policies of the FWS and NPS, and the interests and perspectives of all stakeholders.

All public, tribal, and agency comments received during the environmental process were reviewed. The issues and comments raised have been addressed in the Final Plan/EIS. Comments and responses on the Final Plan/EIS are addressed in this Record of Decision. Based on the above information, the FWS and NPS have selected Alternative 4 for implementation.

4/26/07

Mitch King **Date**
Regional Director, Region 6
U.S. Fish and Wildlife Service
Lakewood, Colorado

4/26/07

Michael D. Snyder **Date**
Regional Director,
Intermountain Region
National Park Service
Lakewood, Colorado

GLOSSARY

Above-average Winter – In above-average winters snow depths would make it more difficult for elk to acquire sufficient food resources to survive on their own. Suitable habitat in years when snows were above average would decline to an estimated 20,000 acres, most of which would be in the Gros Ventre River basin and an estimated 2,600 acres on the refuge. The winter of 1982 was designated as above average (Hobbs et al. 2003). See glossary definition of an average winter.

Adaptive Management – The rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities. A process that uses feedback from research and the period evaluation of management actions and the conditions they produce to either reinforce the viability of objectives, strategies, and actions prescribed in a plan or to modify strategies and actions in order to more effectively accomplish management objectives.

Allele – Either of a pair of genes located at the same position on both members of a pair of chromosomes and conveying characters that are inherited in accordance with Mendelian law. (*Webster's New World Dictionary of American English*, 3rd College ed., 1988).

Alluvial – Of and/or relating to clay, sand, or other sediment that is gradually deposited by moving water.

Animal unit month (AUM) – The forage base required to sustain a cow and her calf for one month.

Anthropogenic – Pertaining to humans.

Antibody – An immunoprotein that is produced by lymphoid cells, in response to a foreign substance (antigen), with which it specifically reacts.

Antigen – A foreign substance, usually a protein or polysaccharide, that upon introduction into a vertebrate animal, stimulates an immune response.

Average Winter – In average years snow depths would not prevent elk from acquiring sufficient food resources to survive on their own. During an average winter, an estimated 51,000 acres in the Jackson elk herd unit area would likely be suitable as elk winter habitat (Wockner, pers. comm. 2002). Most of this acreage would be in the Gros Ventre River basin, with about 8,500 acres on the refuge, as well as in the Buffalo Valley area. The winter of 1996 was designated as average, based on rankings of snow-water equivalent measurements taken over a 50-year period at the Hunter-Talbot hayfields in Grand Teton National Park (Farnes, Heydon, and Hansen 1999; Hobbs et al. 2003). Snow crusting that decreases access to forage would make model predictions about winter conditions more similar to predictions for severe winters.

Baseline Conditions – Conditions that have resulted from the current management program up through the signing of a record of decision. These conditions assume (1) the elk herd is being maintained at 11,000, (2) the number of elk that winter on the NER fluctuates between 5,000 and 7,500, (3) the bison herd numbers 800-1,000, (4) information on wildlife populations, habitats and socio-economic factors are averaged from the past 5-20 years.

Biobullet – A single dose, biodegradable projectile comprised of an outer methylcellulose casing containing a solid, semi-solid, or liquid product (usually a vaccine or chemical contraceptive), propelled by a compressed-air gun.

Biological Diversity – The variety of living organisms, including the genetic differences among them, and communities and ecosystems in which they occur (USFWS 2001: 601 FW 3).

Biological Integrity – For the National Wildlife Refuge System, biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities (USFWS 2001: 601 FW 3).

Biological Opinion – Document stating the opinion of the Fish and Wildlife Service or the National Park Service on whether or not a Federal action is likely to jeopardize the continued existence of listed species, or result in the destruction or adverse modification of critical habitat.

Brucellosis – Infection with or disease caused by the *Brucella abortus* bacteria. Also known as Bangs disease, undulant fever, and contagious abortion.

Carrying Capacity – The maximum number of organisms that can be supported in a given area or habitat.

Chytrid Disease – *Batrachochytrium dendrobatidis* is a pathogenic fungus that infects amphibians. Chytrid

fungi are typically found in the water or soil and several types are known to parasitize plants and insects. Recent outbreaks (since 1993) of chytridiomycosis among amphibians are the first known outbreaks in vertebrates. The exact mechanism of the disease is unknown but it appears to attack keratin, a fibrous protein that forms a protective layer in animal skin. This disease could be at least partially responsible for worldwide declines in amphibians.

Climax Community – A final stage of a plant succession, in which vegetation reaches a state of equilibrium with the environment. The community is self-perpetuating, except that changes may occur very slowly and over a time-scale that is extensive compared with the rapid and dramatic changes during the early stages of succession.

Coliform – Of, pertaining to, or resembling the colon bacillus (*Escherichia coli*), which are found normally in all vertebrate intestinal tracts and are occasionally virulent, causing infantile diarrhea.

Compatible Use – A wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge (USFWS Manual 603 FW 3.6).

Conservation Easement – A legal document that provides specific land-use rights to a secondary party. A perpetual conservation easement usually grants conservation and management rights to a party in perpetuity.

Cultural Resource Inventory – A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register follows the criteria found in 36 CFR 60.4.

Cumulative Effects – Those effects on the environment that result from the incremental effect of the action when added to the past, present, and reasonable foreseeable future actions regardless of what agency (Federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Disease Reservoir – A place in nature where a disease normally lives or is always found in significant numbers.

Ecosystem – An ecological system; the interaction of living organisms and the nonliving environment producing an exchange of materials between the living and nonliving.

Ecosystem Management – Management of an ecosystem that includes all ecological, social, and economic components which make up the whole of the system.

Effective Population Size – A measure of population size based on members that effectively contribute genes to subsequent generations (Berger 1996).

Emergent Wetland – Wetlands with rooted plants that have most of their vegetative (non-root) parts above water.

Endangered Species – Any species of plant or animal defined through the Endangered Species Act (16 USC 1532(6)) as being in danger of extinction throughout all or a significant portion of its range, and published in the *Federal Register*.

Endemic Species – A species only found in a particular area or region.

Environment – The sum total of all biological, chemical, and physical factors to which organisms are exposed; the surroundings of a plant or animal.

Environmental Health – Abiotic composition, structure, and functioning of the environment consistent with natural conditions, including the natural abiotic processes that shape the environment. Specifically for the National Wildlife Refuge System, composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions (USFWS 2001: 601 FW 3).

Exotic Species – Any introduced plant, animal or protist species that is not native to the area and may be considered a nuisance.

Feedground – An area where a herd of elk are given feed during the winter months.

Forage Production – The amount of forage produced in a given year by a particular species of plant or by vegetation in an area as a whole.

Forage Utilization – The proportion of the current year's forage production that is consumed or destroyed by grazing animals. May refer to a single species of forage or to the vegetation as a whole.

Genetic Variability – The amount of genetic difference among individuals in a population, measured by the number of genes in the population that are polymorphic (having more than one allele), the number of alleles for each polymorphic gene, and the number of genes per individual that are polymorphic.

Genetic Viability – Retention of genetic differences among individuals in a population at a level that allows the populations to persist with limited inbreeding and associated deleterious effects.

Genotype – The genetic constitution, latent or expressed, of an organism, as distinguished from its physical appearance (its phenotype). The sum total of all the genes present in an individual.

Goal – Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (USFWS 2000b, 602 FW 1.5).

Habitat – The environment in which a plant or animal lives (includes vegetation, soil, water, and other factors).

Habitat Effectiveness – The extent to which suitable habitat provides is usable by a given species of wildlife or wildlife community with respect to human activity. Habitat effectiveness can be reduced by human activity and disturbance (e.g., resulting from hiking, driving, hunting, and other forms of recreation).

Healthy Habitat – The composition and structure of habitat approximating historical conditions (e.g., conditions that were present prior to substantial human related changes to the landscape), based on the definition of environmental health and biotic integrity (USFWS 2001:601 FW 3.6.B-D).

Healthy Population – Conservation of healthy populations of fish and wildlife means the maintenance of fish and wildlife resources and their habitats in a condition that ensures stable and continuing natural populations and species mix of plants and animals in relation to their ecosystem; minimizes the likelihood of irreversible or long-term adverse effects upon such populations and species; and ensures the maximum practicable diversity of options for the future (50 CFR 100.4).

Herbaceous Forage – Non-woody plants; includes grasses, wildflowers, and sedges and rushes (grass-like plants).

Herd Integrity – The genetic integrity of the herd or population; i.e., the state in which heterozygosity, fitness, and viability are maintained.

Heterozygosity – The proportion of individuals with more than one version of the same gene on a chromosome locus. Also, the tendency to possess two versions of the same gene on a locus, as opposed to the same version (homozygosity).

Heterozygote – A plant or animal having two different alleles at a single locus on a chromosome, and hence not breeding true to type for a particular genetic characteristic.

Historic Conditions – For the National Wildlife Refuge System, the composition, structure, and functioning of ecosystems resulting from natural processes that were present prior to substantial human-related changes to the landscape (USFWS 2001: 601 FW 3).

Hydrology – The science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere. The distribution and cycling of water in an area.

Immunocontraception – The induction of contraception by injecting an animal with a compound that produces an immune response that precludes pregnancy.

Immunocontraceptive – A contraceptive agent that causes an animal to produce antibodies against some protein or peptide involved in reproduction. The antibodies hinder or prevent some aspect of the reproductive process.

Jackson Hole Area – The approximate geographic area south of Yellowstone National Park that includes Jackson Hole; the east side of the Teton Range; the stream and river drainages that flow into Jackson Hole, including the Pacific Creek, Buffalo Fork, Spread Creek, Hoback River, Flat Creek, and Mosquito Creek drainages; and the lower Hoback River drainage west of Granite Creek.

Listed Species – Any species of fish, wildlife or plant, which has been determined to be endangered or threatened under section 4 of the Endangered Species Act.

Loam – Loose-textured soil consisting of a mixture of sand, clay, and organic matter.

Loess – A pale, yellowish silt or clay forming finely powered, usually wind-borne deposits.

Management Plan – A document that provides direction and guidance for accomplishing management goals and establishing purposes, and for contributing to the fulfillment of agency missions. The heart of a management is comprised of goals, objectives, and strategies.

Mesic – Applied to an environment that is neither extremely wet (hydric) or extremely dry (xeric).

Monitoring – A process of collecting information to evaluate if an objective and/or anticipated or assumed results of a management plan are being realized (effectiveness monitoring) or if implementation is proceeding as planned (implementation monitoring).

National Wildlife Refuge System Mission – The mission of the system is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Native – With respect to a particular ecosystem, a species that occurred historically in that ecosystem (USFWS 2001: 601 FW 3).

Natural Diversity – For the U.S. Fish and Wildlife Service, the number and relative abundance of indigenous species that would occur without human interference (USFWS 1992: 701 FW 1).

Non-endemic Infectious Disease – A disease that is not native to a particular area and that is caused by a microbial agent capable of invasion, growth, and replication within a host animal.

Objective – A concise statement of what will be achieved, how much will be achieved, when and where it will be achieved, and who is responsible for the work. Objectives are derived from goals and provide the basis for determining management strategies, monitoring refuge and park accomplishments, and evaluating the success of the strategies. Objectives should be attainable and time-specific and should be stated quantitatively to the extent possible. If objectives cannot be stated quantitatively, they may be stated qualitatively (USFWS 2000b, 602 FW 1.5).

Pathogen – A disease-producing microorganism.

Pathogenic – Capable of producing disease.

Preferred Alternative – The preferred alternative can be the proposed action as found in the draft NEPA document, the no-action alternative, another alternative, or a combination of actions or alternatives discussed in the draft NEPA document.

Prevalence (of a disease) – The number of cases of a disease that are present in a population at one point in time, usually expressed as a percentage of the total population of animals.

Record of Decision (ROD) – A concise public record of decision prepared by a federal agency, pursuant to NEPA, that contains a statement of the decision, identification of all alternatives, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).

Recruitment – Number of animals surviving and being added to a breeding population at a certain point in time.

Refuge – A designated area of land or water, or an interest in land or water, within the National Wildlife Refuge System.

Residual Forage – Grasses, forbs, and other herbs that remain standing from one growing season to the next, and sometimes beyond. Generally, the above ground portion of herbaceous vegetation dies after the growing season, and if left undisturbed can remain upright for a period of time. Strong wind, heavy cover, and grazing can reduce the amount of residual vegetation remaining from one season to the next.

Riparian Area – A geographic area containing an aquatic ecosystem and the adjacent upland areas that directly affects it. This includes floodplain, and associated woodland, rangeland, or other related upland areas. Pertaining to the banks of streams, lakes, wetlands, or tidewater.

Riparian Zone – Terrestrial areas where the vegetation complex and micro-climate conditions are products of the combined presence and influence of perennial and/or intermittent water, associated high water tables, and soils that exhibit some wetness characteristics. Normally used to refer to the zone within which plants grow rooted in the water table of rivers, streams, lakes, ponds, reservoirs, springs, marshes, seeps, bogs, and wet meadows.

Scope – The range of actions, alternatives, and impacts to be considered in an environmental impact statement (40 CFR 1508.2.5).

Scoping – An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

Sensitive Species – Those plant or animal species for which population viability is a concern as evidenced by a significant current or potential downward trend in population numbers, distribution, density, or habitat capability.

Seral – A phase in the sequential development of a climax community.

Seroprevalence – The proportion of individuals in a population that show positive results on serological examination.

Severe Winter – For modeling purposes, a severe winter is defined as one in which the snow-water equivalent over a large part of the analysis area would be 6 inches or, the threshold at which elk would be unable to acquire sufficient food resources to survive on their own (Hobbs et al. 2003). In a severe winter suitable habitat would decline to an estimated 12,000 acres, with less than 700 acres on the refuge. For reference purposes, the winter of 1997 was designated as severe, based on rankings of snow-water equivalent measurements at the Hunter-Talbot hayfields in Grand Teton National Park (Farnes, Heydon, and Hansen 1999; Hobbs et al. 2003). Because some portions of the snow data set only went back to 1980, 1997 was used as "the most severe on record" (Hobbs et al. 2003). Snow crusting that decreases access to forage would likely intensify winter severity.

Shoulder Season – Period of time between two busy tourist seasons. In Jackson Hole, fall and spring are shoulder seasons between the busy summer season, when many tourists come to the area to view wildlife and scenery, hike, and raft rivers and the busy winter season when tourists come to downhill ski.

Snow-water Equivalents – Refers to the water content of snow, per unit volume of snow.

Stakeholder – Individuals, organizations, and groups; officials of Federal, State, and local government agencies; Native American tribes; and foreign nations. It may include anyone outside the core planning team. It includes those who may or may not have indicated an interest in planning issues and those who do or do not realize that the agencies' decisions may affect them.

Strain – An intraspecific group of organisms, possessing only one or a few distinctive traits, usually genetically homozygous for those traits, and maintained as an artificial breeding group by humans.

Strain 19 – The strain of *Brucella abortus* bacteria currently used to vaccinate cattle against brucellosis.

Strategy – A specific action, tool, or technique or combination of actions, tools, and techniques used to meet unit objectives (USFWS 2000b, 602 FW 1.5).

Subirrigated – Irrigated from beneath.

Succession – A gradual change from one community to another, characterized by a progressive change in species structure, an increase in biomass and organic matter, and a gradual balance between community production and community respiration.

Test and Cull – A procedure that involves capture, handling, and testing a group of cattle or bison for brucellosis, tuberculosis, or other communicable diseases, identifying the positive testers, and removing them from the herd.

Transitional Range – Range used by ungulates as they move from their summer range to their winter range and vice versus in the spring.

Threatened Species – A plant or animal species likely to become endangered species throughout all or a significant portion of their range within the foreseeable future. A plant or animal identified and defined in accordance with the 1973 Endangered Species Act and published in the Federal Register.

Undulant Fever – A disease in humans caused by *Brucella*.

Vaccine – A suspension of killed or attenuated microorganisms that, when introduced into the body, stimulates an immune response against that microorganism.

Vector – An organism that carries pathogens from one host to another.

Viable Population – A population of sufficient size and genetic variability that it maintains its vigor and its potential for evolutionary adaptation.

Vision Statement – A concise statement of the desired future condition of the planning unit, based primarily on the agency's mission, specific establishing purposes, and other relevant mandates (USFWS Manual 602 FW 1.5).

Zona Pellucida – The outer membrane of a mammalian egg.

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BLM	Bureau of Land Management, U.S. Department of the Interior
GTNP	Grand Teton National Park
GYIBC	Greater Yellowstone Interagency Brucellosis Committee
MFWP	Montana Fish, Wildlife and Parks
NER	National Elk Refuge
NPS	National Park Service, U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service, U.S. Department of the Interior
USFS	U.S. Forest Service, U.S. Department of Agriculture
USIECR	U.S. Institute for Environmental Conflict Resolution
WGFC	Wyoming Game and Fish Commission
WGFD	Wyoming Game and Fish Department

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Bohne, J., Biologist, Wyoming Game and Fish Department, Lander, WY
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Brimeyer, D., Biologist, Wyoming Game and Fish Department, Jackson, WY
2003 Personal communication regarding wildlife in the Jackson Hole area.

2005 Personal communication regarding elk and bison management.

Camenzind, F., Biologist, Jackson Hole Alliance, Jackson, WY
2003 Personal communication regarding coyotes on the National Elk Refuge.

Campbell, C., Assistant Superintendent, Chief of the Ranger Division, Grand Teton National Park, National Park Service, Moose, WY
2003 Personal communication by telephone about human safety and hunting accidents in Grand Teton National Park.

Clause, D., Biologist, Wyoming Game and Fish Department
2004 Personal communication regarding mule deer.

Cole, E. K., Wildlife Biologist, U.S. Fish and Wildlife Service, Jackson, WY
2002 Personal communication regarding habitat and wildlife on the National Elk Refuge.

Fedorchak, R., Acting Chief of Interpretation, Grand Teton National Park
2003 Personal communication with Joanna Behrens regarding park visitor use.

Gray, R., Biologist, Wildlife Conservation Society, Jackson WY
2002 Personal communication regarding cougars in Jackson Hole.

Griffin, J., Outdoor Recreation Planner / Assistance Manager, National Elk Refuge, U.S. Fish and Wildlife Service, Jackson, WY
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Gustafson, R., Economic Research Service, U.S. Department of Agriculture
2005 Personal communication regarding Wyoming cattle market.

Halbert, N., Assistant Research Scientist, Department of Veterinary Pathobiology, Texas A&M University
2006 Personal communication with Carol Cunningham regarding bison and brucellosis.

Haynes, S., Biologist, Grand Teton National Park. National Park Service, Moose, WY
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Huffaker, S. M., Director, Idaho Fish & Game
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Kerasote, T. Kelly, WY resident
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Lemke, T., Biologist, Montana Department of Fish, Wildlife and Parks
2003 Personal communication regarding biology.

Moody, D., Trophy Game Coordinator, Wyoming Game and Fish Department, Lander, WY
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O'Ney, S., Resource Management Biologist, Grand Teton National Park, Moose, WY
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Quigley, H., Teton Cougar Project Director.
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Raynes, B., Ornithologist and Author, Jackson, WY
2002 Personal communication regarding birds in Jackson Hole.

Riegel, C., Biologist, Biota
2003 Telephone conversation regarding vehicle collisions with elk on U.S. Highway 89 between the south entrance to Grand Teton National Park and Flat Creek Bridge at the north end of Jackson, July 30. (Biota was the contractor with the database and provided an unpublished report to the Jackson Hole Wildlife Foundation.)

Roffe, T., Veterinarian, U. S. Fish and Wildlife Service, Bozeman, MT
2003 Personal communication regarding fertility control techniques, diseases.

2005 Personal communication regarding bovine paratuberculosis.

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Smith, B. L., Biologist, National Elk Refuge, U.S. Fish and Wildlife Service
2002 Personal communication regarding elk, bighorn sheep on the refuge.

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Stottlemeyer, R., Biologist, U. S. Geological Survey
2003 Personal communication regarding nitrates on the National Elk Refuge.

Swanekamp, L., Master's Student, Montana State University, Bozeman, MT
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Wachob, D., Director of Research, Teton Science School, Jackson Hole, WY
2004 Personal communication regarding the yellow-billed cuckoo in Jackson Hole.

White, C., Wildlife Biologist, Idaho Department of Fish and Game
2003 Personal communication regarding elk and wolves in Idaho.

Wockner, G., U.S. Geological Survey
2002 Personal communication regarding snow-water equivalents and winter elk habitat.

Wolff, S., Biologist, Grand Teton National Park
2002 Personal communication by telephone regarding wildlife in Grand Teton National Park.

2004 Personal communication by telephone regarding bighorn sheer.

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Primary Role of Group Members: Represented respective agencies at meetings; participated in public meetings; helped identify issues; helped formulate themes of alternative management plans for the EIS; provided input used to develop goals and alternative sets of objectives, and strategies; provided input into analysis of alternatives, reviewed draft planning document; and provided information as requested.			
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Gary Pollock	Management Assistant, Grand Teton National Park	B.S. Zoology 25 years experience	Helped develop objectives and strategies for EIS alternatives.

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Ken Dolan	Economist, USDA-APHIS	B.S. Economics M.B.A. International Business 7 years experience	Wrote sections in the EIS addressing potential effects on livestock production and related economics.*
Steve Haynes	Vegetation Management Specialist		Advised on Grand Teton National Park habitat issues and provided information used in analyzing alternatives in the EIS.

* In addition to material written by Ken Dolan, agricultural production sections also included disease-related material prepared by URS subcontractor Hayden-Wing Associates and by the project manager (e.g., assessments of changes in competition between elk/bison and livestock, depredation, crop damage).

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