

Yellowstone Science

A quarterly publication devoted to the natural and cultural resources



Theodore Roosevelt and Predators
NAS Report on the Northern Range
Right of Way: A Bison Encounter

Volume 10

Number 2



Rite of Passage

Frontier. For every generation the word means something different. One hundred-fifty years ago, Euro-Americans saw the frontier as any territory west of the Mississippi River. By 1890, the U.S. Census Bureau proclaimed the frontier closed. Yet, a hundred years later, Alaska was the last frontier. I remember as a child growing up in central Florida, watching from the front yard as the Gemini, Mercury, and later Apollo rockets propelled us to what some still call the “final frontier.” In more recent times microbiologists have shown us that a frontier remarkably vast may lie at our feet in the microbial world of a hot spring.

Webster takes all of this into account when trying to define the word, offering dozens of nuanced variations on a theme: *Exploratory. Pioneering. The farthestmost limits of knowledge or achievement; A line of division between different or opposed things. The front.* If there were a Yellowstone Dictionary, after the word frontier, it would read: “see northern range.” This critical wintering habitat for so much of the park’s wildlife fulfills all the definitions offered above. Pioneering, yes. Exploratory, certainly. In fact, when you consider the twists and turns of wildlife management in Yellowstone over the last century, what unfolds is the evolution of modern resource management as we know it today. In retrospect, some of the management practices of the past, such as elk reduction, may seem ignorant or even barbaric. And yet, for the time, that was the accepted practice. We should be careful not to judge our predecessors too harshly. Today, we would like to think we are at the forefront of the field. Decades from now, with the searing clarity that comes only with hindsight, what will people say of the policies we set into action today?

It is here where history meets science. Like any exploration, for every generation the journey has often been rocky. Elk and overgrazing, erosion, elk reduction, the disappearance of aspen, the removal and now return of the wolf—in the last 80 years, those who care passionately about the park have engaged in an ongoing debate on these subjects as part of a larger discussion on the range’s overall ecological well-being. Throughout this rite of passage, headlines too tell the story, maybe not the whole story, but they characterize the feelings and temperament of their day. We here at *Yellowstone Science* have delved into the park’s archives to uncover some of the newspaper headlines on the northern range from the last 40 years. What is revealed in them on page two is both entertaining and enlightening. You be the judge.

The management of the northern range has been controversial for nearly a century. Our readers know that in these pages we have covered northern range issues in the past, including the launching of the National Academy of Sciences review as requested by Congress in 1998. This review was intended to bring some resolution to the controversy. Their report, *Ecological Dynamics on Yellowstone’s Northern Range*, is now complete and with their permission we are reprinting their conclusions and recommendations in this issue. Within it, there are important lessons for everyone. Also in this issue, Jeremy Johnston offers an interesting historical perspective on the northern range in his examination of President Theodore Roosevelt’s views on elk and predators.

As I reflect on this landscape and the impassioned feelings it stirs in so many, I’m reminded of four lines from one of my favorite poems by T.S. Elliot. In “Little Gidding,” which was his final poem, he writes:

*We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.*

In this century of actively caring for the northern range, each generation has undergone a rite of passage that charges us to do our best to be good stewards of the land on our watch. As we look ahead to the 21st century, it’s essential to embrace that past and with the direction provided by the highest scientific court in the land, look ahead to the future. Perhaps, in the end, there is no resolution to this issue, only another frontier. If history should one day judge our actions, at least and at best, we will be able to say, in good faith, that we did the best we could with the information we had at the time.

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Cover photo: President Roosevelt on a 1905 bear hunt in Colorado. Photo courtesy Theodore Roosevelt Collection, Harvard College Library. Above: The northern range. NPS photo.

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WILDLIFE MANAGEMENT IN THE NATIONAL PARKS

Debating the Nature of Nature in

Park Elk Starving Because of Overpopulation

Florida Wants Killing Elk

House Protests Elk Slaughter in Yellowstone

Wolves may keep Yellowstone elk herd down

State Residents Protest U.S. Plan to Slaughter Park Elk

YELLOWSTONE GRAZING

Udall wants science to drive park debate

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Report sought by Congress is a mixed bag for Park Service

Find out more at elkreport.com

4,000 Elk Killed In Yellowstone

Elk management debated

Elk Shoot Suspended By Park Service

Kniesel Takes Elk Battle to White House

Scientists examine park's policy of natural regulation

By SCOTT McMILLION
Chronicle Staff Writer

Hansen Asking Congress To Stop Slaughtering

MAMMOTH HOT SPRING
by elk has removed protect of Yellowstone National P into a wider, shallower str researchers said here Sam



Elk To Mourn Elk Of Yellowstone Elk

Top News

Elk and Bison Not Causing Ecological Damage at Yellowstone Park

Senate Hearing Will Attempt to End Elk Killing in Wyoming

Yellowstone National Park Service announced today that it will not resume the controversial elk hunting program in the park.

Elk, bison and other large mammals are not causing ecological damage at Yellowstone National Park, according to a new report.

The Senate hearing will attempt to end the killing of elk in Wyoming. The hearing is expected to take place in the next few weeks.

The report, which was prepared by a team of scientists, found that elk and bison are not causing ecological damage at Yellowstone National Park.

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Ecological Dynamics on Yellowstone's Northern Range:

The Report of the National Academy of Sciences Chapter 5: Conclusions and Recommendations

After years of debate over the management of ungulates on Yellowstone's northern range, the United States Congress in 1998 mandated the National Research Council (NRC), the working arm of the National Academy of Sciences (NAS), to assemble the nation's premier scientists to address the management of wildlife in Yellowstone. Their report, "Ecological Dynamics on Yellowstone's Northern Range," is now available to the public. With the Academy's permission, we are reprinting Chapter 5: Conclusions and Recommendations. The full report has been published electronically and may be viewed at the National Academy Press web site at www.nap.edu or through a link with Yellowstone's official web site, www.nps.gov/yell/nature/northernrange.

The NRC will publish the report in book form later this spring, and this summer it will be available for purchase at sales outlets operated by the Yellowstone Association in park visitor centers. The report may also be ordered through the National Academy Press web site. Readers interested in reading more about this issue may wish to consult past issues of *Yellowstone Science* 7(3) and 8(2), which were devoted to the controversy and the NAS review.

Nature is Dynamic

A pervasive theme in this report is the dynamic nature of the northern Yellowstone ecosystem. Over long periods, a changing climate and major geological processes have resulted in dramatic restructuring of the landscape and associated plant and animal communities. The Greater Yellowstone Ecosystem (GYE) has experienced large-scale disturbances including fire, floods, blow downs, ungulate and predator population fluctuations, and outbreaks of diseases and insects that affect plants and animals. In addition, during the late 1800s, intense reduction of carnivores and ungulates diminished or eliminated populations of key species. Furthermore, the northern range is part of a larger system where human activities

are steadily increasing. Thus, we probably cannot ever manage Yellowstone National Park (YNP) to maintain some agreed-upon stable condition, if that were to become a management objective. We lack sufficient knowledge, resources, and capability to sustain any environmental state through active management.

Given the ever-changing nature of the northern range on both temporal and spatial scales, can we determine which of the changes we observe in ungulate numbers and range, forest conditions, and riparian conditions are within the bounds of natural variation and which, if any, are caused by human activities? To answer the question we must assess ecosystem resilience, resistance, and stability. Is the system easily modified? Does it readily recover from perturba-

tion? Are there thresholds that result in major or irreversible changes in processes, ecosystem conditions, or population numbers?

Theory and field studies have shown that some ecological systems change abruptly from one relatively stable state to another. In these situations, simply removing the factor or factors that caused change may not return the system to its previous state. For example, sustained, heavy livestock grazing in arid grasslands of the western United States, in the absence of fire, has led to invasion and establishment of shrubs and trees (Archer 1994). Once trees gained sufficient stature to capture much of the moisture supply, elimination of grazing did not result in reestablishment of grassland (Glendening 1952). Such a process is consistent with

“state and transition” models and with the existence of multiple stable states (Allen-Diaz and Bartolome 1998). These conceptual models help us to appreciate the complexity of ecosystem relationships and processes and should be used to evaluate management of the northern range.

How do these concepts help us to evaluate changes in the GYE? Many aspects of the northern range have been intensively studied, but it has not been experimentally shown, for example, how large a reduction in the consumption of aspen by ungulates would be required to permit their “recovery.” Consequently we do not know whether changes in plant communities during the 1900s indicate that a new state, characterized by fewer communities dominated by willows and aspen, is likely to persist. Research outside the park, however, does not support the hypothesis that a new state has become established (Kay 1990). To evaluate whether the northern range is approaching a threshold, beyond which willow and aspen communities will be unable to reestablish themselves, we must have some idea of the range of natural variation (Landres et al. 1999). Are changes on the northern range within limits to be expected since Europeans arrived? How important are rare events? The “natural” interval between large fires is thought to be on the order of 200 to 300 years—can we realistically expect to manage such events? Despite claims to the contrary, we found no evidence that the northern range is approaching a threshold after which we would observe irreversible changes, such as loss of local reproductive potential of key plant species (e.g., sagebrush or aspen), that would not have occurred if the park actively controlled ungulates. This finding results, in part, because much of the evidence of dramatic changes comes from communities that are successional or the result of disturbance (e.g., aspen and riparian communities) (Houston 1982). However, changes in sagebrush cover and grassland composition, vegetation types that are neither successional nor the result of disturbance, have also occurred.

In view of the profound changes that

have occurred around the GYE, it is no longer possible to have an ecosystem that is identical to the natural state that existed there before European settlement—that is, containing about the same numbers and distributions of all the species of plants and animals. YNP still has all the species present there 150 years ago, but many of the large mammals can no longer respond to change as they used to—through migration or dispersal (Wambolt and Sherwood 1999). No aspect of the ecosystem can be considered “natural” in that sense. The question is whether the ecosystem appears to be headed for some state that is very different from any previous state that we know about in the past few thousand years. We do not think it is. Vegetation changes observed in the past 130 years or so appear to have been influenced more by ungulate browsing than by climate change.

Management for Ecosystem State or Ecosystem Process?

Natural resource managers typically try to reduce variation around some desirable ecosystem state. For wildlife managers, a desirable state usually is defined by a consistent harvest of the target species, stable vegetation communities, and a small loss of the target animals to severe weather. Restoration ecologists, on the other hand, try to achieve desired ecosystem dynamics by reducing or eliminating human perturbations and restoring natural ecosystem processes and the ecosystem components that drive these processes. Given the inherently dynamic state of most ecosystems, Boyce (1991, 1998) and others have suggested that a more appropriate management goal for YNP is to follow the “restoration” approach and maintain or restore ecological processes rather than try to maintain a particular ecological state. Management for processes would include maintaining or restoring the spatial and temporal variation that characterizes the natural ecosystem. Holling and Meffe (1996) persuasively argued that maintenance of natural variation is critical to the functioning of ecosystems and runs counter to most traditional management pre-

scriptions. Because Yellowstone is influenced by periodic major events, both natural and human caused, it is probably impossible to maintain a particular state by active intervention. For example, the fires of 1988 resulted in substantial changes in the mosaic of vegetation communities, but these changes appear to be an integral component of the system and within the bounds of disturbances that periodically occurred in YNP (Romme and Despain 1989). Also, 1996 and 1997 floods throughout the GYE altered riparian communities and triggered new riparian recruitment, as expected from low-frequency, high-magnitude hydrological events (Skidmore et al. 1999).

If natural processes in YNP are to be managed or restored, we must change our focus from an emphasis on specific outcomes (the presence or absence of a species or state) to an emphasis on rates and variation. Ecological processes include production of crowd-pleasing cohorts of elk and bison calves in spring, but they also include the interrelationships between all species, including competition, predation, winter starvation, and changes in vegetation communities. Because ecological processes are dynamic, ecological communities change in time and space, with or without human intervention.

The need to understand and permit the full range of ecological processes is emphasized by interactions between disparate elements of the northern range. Frank et al. (1998) compared the grassy rangeland of the northern range to the Serengeti ecosystem in Kenya and Tanzania, an area that supports a higher diversity of large herbivores than the northern range. Nonetheless, herbivores have a key role in altering the transformation of materials in the functioning of both systems. Nutrient turnover rates are high in herbivore-dominated systems (including Yellowstone), and these grassland systems have rapid cycling of nutrients driven by high harvesting rates by herbivores. Removal of herbivores would transform the system into one dominated by detritivores, with slower cycling of nutrients.

Hobbs (1996) identified two major challenges to fully integrating the role

of ungulates into ecosystem science. First, we need to better integrate the behavior of animals into ecosystem models. Many of the links between ungulates and ecosystem processes are the result of choices made by individual animals, such as selection of feeding sites, choice of forage items, and migration in response to climate, food availability, and other external pressures (e.g., hunting). Decisions about selection of habitats, feeding patches, and diets occur at a variety of scales (Senft et al. 1987, Bailey et al. 1996) and they have a profound influence on patterns of interaction between herbivores and ecosystems. Second, we need to better understand the interactions between population dynamics of animals and plants and ecosystem processes. Few studies have examined large-scale responses of ecosystems, including the response of animal and plant populations, to changes in herbivore density. Yellowstone's northern range may offer us an unusual opportunity for such studies. If the recent past is an indication of the future, we can expect large fluctuations in herbivore density and thus in their influence on ecosystem processes such as recycling and redistribution of materials, and successional dynamics.

Management for ecosystem processes remains a challenge for the future, and currently is more a conceptual guide than a prescription for immediate action. In their plea for more enlightened management of large systems, Holling and Meffe (1996) noted the following:

Our advice to 'retain critical types and ranges of natural variation' must remain for the present as a management goal to which to aspire, as a conceptual underpinning for management, rather than an operational dictum. In practice this translates to adopting a conservative approach to changing parameters of systems we understand poorly but that we wish to manage. It means that the default condition, unless clearly proven otherwise, should be retention of the natural state rather than

manipulation of system components or dynamics. It argues for humility when managing large systems (Stanley 1995).

The northern range's natural state is a dynamic one. Retention of natural processes is as close as we can come to this recommendation.

Despite our inability to manage natural processes, general guidelines are emerging for designing programs to monitor and detect environmental trends, and this remains an area of intensive research and evaluation (e.g., Dixon et al. 1998 and accompanying papers). It will be a challenge for YNP to look to opportunities of the future, without forgetting lessons from the past.

Public education also is important. The National Park Service (NPS) should explain the importance of ecosystem processes, trophic level relationships among species, primary production, and nutrient cycling. Although emphasis on biodiversity is certainly justified, the role of the area's landscape, climate, and history in maintaining the biodiversity of the area and its dynamic nature should be explained. That implies a focus on the web of life and its complexity in the lands under NPS jurisdiction and the change over time that characterizes natural systems, rather than on preconceptions about "the balance of nature" or the desirability of having many large, "charismatic"

animals visible. NPS would do well to consider YNP a natural laboratory for public education, increasing public appreciation with an enhanced understanding gained through a park visit.

Large-Scale Interactions and Patterns

A second recurrent theme in our report has been the importance of spatial scale. The northern range is an incomplete ecosystem for large herbivores that rely on heterogeneity in the distribution of foods that vary seasonally in abundance, quality, and availability. A large spatial extent provides reserve areas that may not be preferred during normal years but can be used during times of shortage. The importance of the heterogeneity that normally accompanies a large spatial extent was emphasized by Walker et al. (1987), who examined drought-caused mortality of ungulates in African reserves that varied in size from 442 to 19,000 km². Mortality was relatively low in the large reserves because animals expanded their normal range and used reserve areas that were far from normal water sources during droughts. Walker et al. (1987) concluded that culling was unnecessary if there was sufficient spatial heterogeneity to provide reserve forage. Similarly, during severe winters ungulates in the northern range use areas outside park boundaries. However, many of these key areas are not



A radio-collared wolf stalks elk. Photo courtesy Bill Campbell.

longer accessible because of human activity and habitat fragmentation.

A large spatial extent is also important to preserve key ecosystem processes in the face of disturbances that recur over periods of centuries and affect areas of tens to thousands of square kilometers. The large fires that burned much of YNP in 1988 are the most obvious example of such a phenomenon; other examples include the eruption of Mount St. Helens in Washington and major floods. These major events create patchiness in the environment, and they may provide for the simultaneous occurrence of a critical set of characteristics that permit, for example, the establishment of, or change in, plant communities (Coughenour 1991, Turner et al. 1997, Foster et al. 1998).

In addition to providing forage reserves for ungulates, a large spatial extent allows animals to spread out the effects of their consumption. In YNP, ungulates use some areas heavily but others only lightly. In spring and early summer, the ungulates follow the emergence and greening-up of actively growing, nutritious plants, grazing intensively in a limited area for a period, then moving on, allowing the plants to recover. Thus, spatiotemporal heterogeneity is key to maintaining nutritious forages over an extended period, and the sequential greening of vegetation provides the impetus for herbivores to move on and allow the plants time to recover. These interactions should permit long-term sustainability of the system; however, intensive long-term use during extreme winter conditions may not permit some communities of woody plants to persist.

Weather, Wolves, and Aspen in Yellowstone

Major controversy focuses on the causes of the virtual absence of recruitment of tree-sized aspen on the northern range since 1920 (Romme et al. 1995, Ripple and Larsen 2000b). Not all the circumstances that permitted aspen to recruit before 1920 are known, but the most important factor currently preventing recruitment of tree-sized aspen is heavy browsing by elk. If browsing by

An aspen stand on the northern range. NPS photo.



elk were greatly reduced or eliminated for a long enough time, as seems to have happened during the market hunting period of the 1880s (Romme et al. 1995), recruitment of tree-sized aspen would be likely under the current climate. What circumstances that previously existed, but are no longer present, might have permitted recruitment? The most obvious is that elk did not use aspen for winter survival because they migrated to lower areas with alternative winter food sources. Another possibility is that a combination of severe winters and a healthy predator population greatly reduced elk numbers or their distribution.

Weather during the 1800s—the end of the Little Ice Age—was consistently cooler and wetter than that of the 1900s (Chapter 2). This factor alone could account for smaller elk populations wintering on the northern range. In addition, wolves were present during the 1800s and they likely influenced the density and distribution of elk. Ripple and Larsen (2000b) suggested that wolves played a key role in the recruitment of aspen. They reviewed evidence showing that wolves can limit herbivore population size, but more importantly, wolves modify the location and feeding behaviors of ungulates that feed on aspen, thereby leading to localized recruitment of tree-sized aspen. Ripple and Larsen's hypothesis can account for small-scale recruitment of aspen, and

with the addition of severe weather it can also account for synchronized, large-scale episodes of aspen recruitment. For this to occur may require the simultaneous effects of weather and predation.

Severe weather during the winter following the 1988 fires resulted in the death of about 25% of the northern range elk population (Singer et al. 1989). Similar events occurred throughout the 1900s, most recently in 1996–1997. Elk populations have been subjected to annual harvest outside YNP ever since its establishment, and late-season hunting was initiated in 1968. Thus, the condition of the animals and the winter range is likely to have been better since 1968 than if the population size had been regulated solely by natural factors, including competition for forage and starvation. When subjected to a severe winter, a population strongly regulated by food supply and with limited ability to migrate out of the area is likely to experience high rates of mortality, resulting in a population considerably smaller than its prewinter size. If the elk population declined to a small fraction of what the northern range could support, then predation by wolves, whose numbers appear to be largely independent of elk population density, could prevent rapid recovery. A low enough density of elk would allow some aspen to grow tall, and sustained predation by wolves and other predators

could maintain the elk population at a low density for long enough to permit recruitment of tree-sized aspen. In this scenario, establishment of tree-sized aspen requires (a) the elk population to decline rapidly after it has achieved a size too large to be maintained by the food available, (b) migration to be restricted, (c) a severe winter that causes starvation, and (d) a vigorous predator population that can keep the elk population from rapidly recovering. These conditions have been absent from the northern range since at least the late 1800s, when most (but not all) of the present tree-sized aspen stands were formed. Such a scenario is not greatly different from that which explains recruitment of fir on Isle Royale (Post et al. 1999), an island where long-range moose migration is prevented. Wolves hunted moose more efficiently during winters with heavy snowfall, thereby depressing moose populations and releasing fir from heavy browsing.

Several types of interactions have been proposed to account for predator-prey systems in which predation can maintain low densities of prey, but food limitations prevail at high densities (e.g., Walker and Noy-Meir 1982, Sinclair 1989, Boutin 1992). In general, theory suggests that prey populations are kept at lower levels only until predator populations decline or food sources increase. If this situation were to occur on the northern range, aspen recruitment would be episodic and occur at unpredictable and infrequent intervals.

Indicators of Unacceptable Change

If YNP continues to follow a policy that permits the natural range of variation, it will need to monitor ecosystem attributes that might indicate unacceptable change. Research in the park is only decades old, but some insights into past conditions are provided by analyses of lake sediments, tree rings, pollen profiles, and floodplain sediment profiles. These analyses of long-term trends identify the dynamic processes that led to current conditions of the Yellowstone ecosystem, but the linkages between past and present processes in the northern range have not been

clearly demonstrated by research. Modification of the Yellowstone ecosystem through reintroduction of wolves, expansion of wintering areas for ungulates north of the park, and continued implementation of external hunting of ungulates, in the context of a changing climate, creates a degree of complexity that makes projection of long-term conditions in the park and northern range difficult. The committee consequently recommends that a comprehensive, integrated program of research and monitoring be established to measure the consequences of current and future changes in the external and internal driving variables. This program should include continued studies of animal and plant populations and their interactions, studies of predator-prey relationships, and studies of changes in the behavior of ungulates and predators as the system adjusts to the reestablishment of wolves. Concurrent studies of riparian and aspen recruitment; sagebrush communities; stream fluvial geomorphic processes in relation to riparian vegetation dynamics; rain, snow, surface flows, and groundwater levels; and other ecosystem components are also needed.

Understanding the Consequences of Alternative Management Approaches

Resource managers at YNP use natural regulation as the management approach for the biota of the northern range for scientific reasons and to meet public expectations. In any natural resource management context, the selection of an approach is inevitably in part a value judgment. What is our intent? What do we, as a society, or other decision-making level, want from or for the resource? Although managers generally strive to design multiple-use management approaches, in fact there often is an underlying policy purpose. In Yellowstone, managers could manage the system primarily to facilitate visitor interaction with game species, for ecosystem diversity, for scenic values, or for a combination of those values. The current decision to use natural regulation as opposed to management that actively reduces ungulate populations

and thus decreases grazing and browsing pressure on the northern range is based in part on science (i.e., the determination that ungulate populations are at sustainable levels given the productivity of the range's vegetation), and in part it is a value judgment (based on the goals humans have set for the system).

The committee was asked to evaluate NPS's natural regulation management approach. It was not asked or appropriately constituted to look in depth at alternative management approaches. But in studying the dynamics of ungulate-ecosystem interactions in the northern range of the Yellowstone region and researching the impacts of natural regulation on the ecosystem, the committee gained insights about other approaches and learned lessons about associated scientific advantages and disadvantages. These insights may help YNP resource managers plan future actions for the northern range, use adaptive management principles, learn from the information generated, and change management approaches as needed, as more information becomes available. Adaptive management requires clearly defined goals (but not adherence to a specific management policy), and it is predicated on use of a scientifically sound, comprehensive, integrated research program and long-term monitoring to determine the successes and/or consequences of management decisions.

The following text explores the scientific lessons that might be learned from various management approaches, including natural regulation. The committee recognizes that NPS managers must balance many factors beyond science in its decision making, but we can assist that process by projecting some of the possible ecological consequences of those decisions.

Reduction of Elk and Bison Populations Within the Park

Although the committee concludes that the number of ungulates in the northern range is less than the number at which density-dependent factors would cause it to decline (Chapter 4), experience from population reductions conducted in the 1950s and 1960s and

from elk density/vegetation response studies elsewhere in the Rockies supports the view that a smaller population might allow recovery of some plant communities now degraded or unable to establish new recruits (e.g., woody riparian species including willows, aspen, and sagebrush communities). The likelihood that ungulate populations will be less than they have been recently is greater now that wolves are present.

Experimental management to reduce ungulate populations, especially elk, and perhaps bison, could test the hypothesis that lower densities of these animals would allow increased recruitment of tree-sized aspen, expansion of willow communities, and growth of sagebrush to large sizes. The most effective way to reduce elk numbers in YNP would be to shoot them, but doing so might be contrary to the desires and values of the public. Visitors would see fewer of them, and shooting is likely to arouse strong public reaction. In addition, reducing ungulate numbers at this time would confound our ability to understand the effects of wolf reintroduction on ungulates. Finally, there is concern that a reduced ungulate population might disrupt food availability for the several wolf packs that now have a satisfactory food base within the park and lead the wolves to seek a domestic food base outside the park.

Reduction of Elk and Bison Populations Outside the Park

To test the hypothesis that reduced ungulate populations might allow recovery of woody plant communities, resource managers might experimentally reduce populations outside the park by working with the multiagency Northern Range Coordinating Committee to increase hunter harvest. This approach might partially test the concept that reduced elk numbers can enhance conditions of several northern range ecosystems (e.g., aspen, riparian, and sagebrush communities). An indirect social effect might be benefits to the local economy through increased outfitter clientele. However, this management approach also might confound our ability to understand the effects of wolf reintroduction, and the key disadvantage of the approach is that hunting success cannot be assured because elk might remain within the park, even during severe weather.

Improve Opportunities for Increased Out-Migration

Because lower elevation winter range outside the park has been greatly reduced, YNP resource managers could work with other state and federal agencies and land owners adjacent to the park to add more lands at lower elevations for winter use by ungulates. Elk herds throughout the northern Rockies

tend to migrate from high to lower elevations as winter develops; the intensity of winter conditions usually influences the distance they move. Although hunting pressure at the park boundary may reduce migration seasonally, lack of open migration routes and land available for foraging at lower elevations also may influence migration. Lack of low-elevation winter range may eventually create an elk population that does not migrate outside the park but uses only the in-park northern range and higher elevation summer ranges. Already there are non-migratory elk populations within inner basins of YNP.

Continued efforts to increase land available for elk winter range might reduce ungulate effects on ecosystems within YNP during harsh winters or permit a large ungulate herd to be sustained within the northern range area with less damage to woody vegetation. Increasing the amount of winter habitat available also might prevent the transition of some of the northern range herd from migratory to nonmigratory, a phenomenon that over time could have long-term effects on the conditions of the northern range. This approach has numerous social and economic implications beyond the scope of this scientific assessment. For example, lands north of YNP in the Paradise Valley of the Yellowstone River have been used for ranching for decades, and many areas are fenced. At the same time, the human population of the Paradise Valley is increasing rapidly, giving rise to increased boundary controls and diverse opinions about wildlife use of private property. Finally, national forest lands in the mountains bordering the valley already have elk, and these animals usually move to lower elevations in limited areas in the valley in winter.

Natural Regulation

YNP resource managers consider the northern range to be in acceptable condition and the role and numbers of ungulates and other wildlife appropriate for a national park, and the best available scientific evidence does not indicate that ungulate populations are irreversibly damaging the northern range (Chapter 4). In addition, several signifi-



Yellowstone resource management specialist Roy Renkin discusses the northern range with the NAS committee during a 1999 visit. NPS photo.

cant changes have been made in the northern range in recent years, including the reintroduction of wolves and expansion of the winter range outside the park; the long-term influence of these changes cannot yet be determined. Thus, YNP resource managers could continue to manage the northern range as they are now. That is, YNP managers would continue to let the populations of elk, bison, and other ungulates fluctuate without any direct (inside Yellowstone) controls, letting a combination of weather, wolves, range conditions, and external controls (e.g., outside-the-park hunting, land uses, and population reduction by state agencies, such as the Montana Department of Livestock's program for bison) influence the population numbers.

Experimentation with continued use of natural regulation within YNP, recognizing the many external influences, would test whether the elk population has reached a dynamic equilibrium since the low numbers of the 1950s and 1960s. It would also allow time to observe the influences of the addition of a top predator and more available winter range. It will require careful monitoring to obtain full value from the experiment and to detect potentially serious changes in the ecosystem before they become severe or even irreversible.

Conclusions

Animal Populations

Density-dependent and density-independent factors interact to regulate the elk and bison populations in the northern range. Responses of elk and bison to potential regulatory factors are different: bison tend to expand their range when their populations exceed roughly 2,500, whereas reproductive rates in elk decline when their populations exceed roughly 15,000. Despite the density-dependent factors that affect elk and bison, their populations have fluctuated for a variety of reasons, including variation in weather and because ungulates and their food do not always vary in a synchronized way. Without rigorous management intervention, and perhaps even with it, ungulate populations will continue to fluctuate.

The pronghorn population has fluctuated widely and has been declining recently. Adverse factors include coyote predation and hunting on private land outside the park. Pronghorn may be affected by competition with elk, mule deer, and bison during severe winters. Bighorn sheep also may be responding adversely to many of these same factors.

Wolves will affect the population dynamics of ungulates as well as those of other predators in YNP, as they do elsewhere. The nature and magnitude of the effects are not predictable at present, although it is likely that wolves will reduce elk numbers. They might increase the magnitude or frequency of elk population fluctuations and might cause changes in the behavior of ungulates, especially elk, including changes in areas where they forage and spend time. The effect of wolves on bison is likely to be less variable and dramatic than their effect on elk, their primary prey in YNP.

Ungulates and Vegetation

Tree-sized aspen have not been added to the population in the northern range since about 1920. Currently, herbivory by elk is high enough to prevent any such recruitment, and apparently it has been since 1920. Although there have been fluctuations in climate since then, none has been large enough or persistent enough to account for the failure of aspen recruitment. Two untested hypotheses, working independently or in conjunction, could explain past recruitment. One is that enough elk migrated out of the park in severe winters to greatly reduce browsing pressure on aspen. The other is that wolves, before their extirpation, affected the distribution and abundance of elk so that at least some recruitment of tree-sized aspen and willows occurred even when elk were moderately abundant. If the latter were the case, then the wolves recently reintroduced into Yellowstone, including those in the northern range, could promote the recruitment of adult aspen and willows.

All tree-sized aspen in the northern range are more than 80 years old, and in the absence of recruitment, they will die

out. Species associated with aspen will likely decline as well. Elk also are reducing the size and areal coverage of willows. Not enough is known about groundwater fluctuations or the role of secondary chemicals in herbivory to determine whether they are also affecting willow abundance.

Plant architecture and areal coverage of sagebrush has decreased during recent decades through browsing by elk, pronghorn, bison, and mule deer. In addition, herbivory has altered community composition, size, and recruitment. The effects are more significant at lower than at higher elevations in the northern range.

The composition and productivity of grassland communities in the northern range show little change with increasing grazing intensity. Humans, however, have changed the grasslands substantially by introducing exotic grasses and by other actions, many of which began before thorough inventories were initiated. Although conifer forests are used by ungulates, ungulates have little effect on conifer distribution and recruitment except for localized hedging of young conifers invading shrub and grassland areas.

The summer range does not seem to be limiting to the ungulate populations. Densities are relatively low on the summer range because the animals are spread out over larger areas than during winter-range use. Ungulates apparently have little effect on summer range communities, with the exception of young aspen, which are severely browsed.

The Northern Range

The condition of the northern range is different today than when Europeans first arrived in the area. The committee judges that the changes are the result of the larger numbers of elk and bison in the area, combined with human development and possibly climatic variability. The committee concludes, based on the best available evidence, that no major ecosystem component is likely to be eliminated from the northern range in the near or intermediate term. Further, although we recognize that the current balance between ungulates and vegetation does not satisfy



Yellowstone's highly visible wolves in Lamar Valley present park managers with extraordinary educational opportunities. NPS photo.

everyone—there are fewer aspen and willows than in some similar ecosystems elsewhere—the committee concludes that the northern range is not on the verge of crossing some ecological threshold beyond which conditions might be irreversible. The same is true of the region's sagebrush ecosystems, despite reductions in the number and size of plants in some lower-elevation areas.

Natural Regulation

True natural regulation (i.e., letting nature take its course with no human intervention) has not been possible for more than a century, nor is it likely to become possible in Yellowstone's foreseeable future. Because of development on the park's borders, ungulates do not have free access to areas outside YNP that they formerly used during times of environmentally imposed stress. Because ungulate populations are influenced by activities both inside and outside the park, the conclusions in this report should not be interpreted as either vindication or criticism of YNP's natural regulation policy.

YNP's practice of intervening as little as possible is as likely to lead to the maintenance of the northern range ecosystem and its major components as any other practice. If the park decides that it needs to intervene to enhance

declining species like aspen, the smaller the intervention, the less likely it is to do unintended damage. For example, if YNP decided to maintain tree-sized aspen in the park, putting exclosures around some stands would be an intervention much less likely to trigger unanticipated processes than an attempt to eliminate or greatly reduce populations of ungulates.

Large ecosystems in general and YNP's northern range in particular are dynamic. They change in sometimes unpredictable ways. The recent reintroduction of wolves, which has restored an important component of this ecosystem, adds to the dynamism, complexity, and uncertainty, especially in the short term. The near future promises to be most instructive about how elk and other ungulates interact with a complete community of predators.

Recommendations

Given the complexities involved in managing Yellowstone's dynamic ecosystems, there is a continuing need for rigorous research and public education. The committee offers the following recommendations designed to enhance understanding of key processes affecting Yellowstone's ungulate populations, vegetation, and ecological processes.

Park Management and Interpretation

- To the degree possible, all management at YNP should be done as adaptive management. This means that actions should be designed to maximize their ability to generate useful, scientifically defensible information, including quantitative models, and that the results of actions must be adequately monitored and interpreted to provide information about their consequences to guide subsequent actions.
- There is insufficient scientific knowledge available to enable us to predict the consequences of different management approaches. Thus, long-term scientific investigations and experiments are needed to provide solid scientific evidence for evaluating management options.
- The NPS educational and outreach program can play an important role in fostering public understanding of the complex and dynamic nature of ungulate ecology in the GYE, which is an essential adjunct to effective management of northern Yellowstone ungulates. Therefore, we encourage the NPS to increase its focus on entire ecosystem relationships, processes, and dynamics of the GYE, especially emphasizing the importance of primary production and trophic-level relationships.

Vegetation

- A rigorous study focusing on aspen populations throughout the GYE should be undertaken to quantify the relative importance of the factors known or hypothesized to influence aspen stand structure. It should include establishing an increased number of large exclosures with a long-term commitment to monitoring the effects of restricting herbivory by ungulates. The study sites should be discussed in the NPS ecosystem interpretive program.
- A careful examination of the variables that are most strongly affecting the riparian ecosystems on the northern range is needed, especially the relationship between herbivory and groundwater availability. This should include an understanding of fluvial

processes, surface and groundwater hydrology, and biotic processes.

- Research should continue on northern range sagebrush/grassland communities.
- Research is needed to determine whether it is possible to differentiate ungulate use of tall and short willows based on both the food-deprivation levels of the ungulates (i.e., winter starvation) and the levels of secondary chemicals in the plants.

Animal Populations

- The behavioral adaptations of elk and other ungulates, and the changes in patterns of habitat use as a consequence of the presence of the wolf as a large predator newly restored to the system, should be closely monitored as a basis for understanding the dynamic changes that are taking place within the system.
- The changes taking place in the interactions among the large predators of YNP and their effects on the trophic dynamics of the ecosystem should be closely monitored as wolves become an established component of the system.
- A thorough study of current and likely future trajectories of the pronghorn population and the role of human effects on this population is needed, including the influence of disturbance by visitors and the Stevens Creek bison facility. The study should eval-

uate the likely consequences of a full range of potential management options, from doing nothing to actively controlling predators and providing artificial winter feed.

- Periodic surveillance for pathogens (including brucellosis) in wild ruminants in the northern range should be continued, and a more thorough understanding of population-level threshold dynamics gained. Samples could routinely be obtained from animals immobilized for research, found dead, or killed by hunters.

Biodiversity

- A periodic (every 10–15 years) and comprehensive biodiversity assessment is needed on the northern range to evaluate potential direct and indirect impacts of ungulate grazing, both of terrestrial and aquatic environments. Initially, species should be identified as consistent indicators of habitat change. These species should then be monitored intensively during periods between comprehensive assessments.

Human Influences

- A comprehensive research effort is needed to assess the influence of seasonal densities, distribution, movements, and activities of people within YNP and adjacent areas on wildlife species, their habitat use patterns, behavior, foraging efficiency, vegeta-

tion impacts, and other aspects of their ecosystem relationships.

- The effects of changing land-use patterns in the landscape surrounding Yellowstone on the park's biota and natural processes, such as fire, need to be investigated.

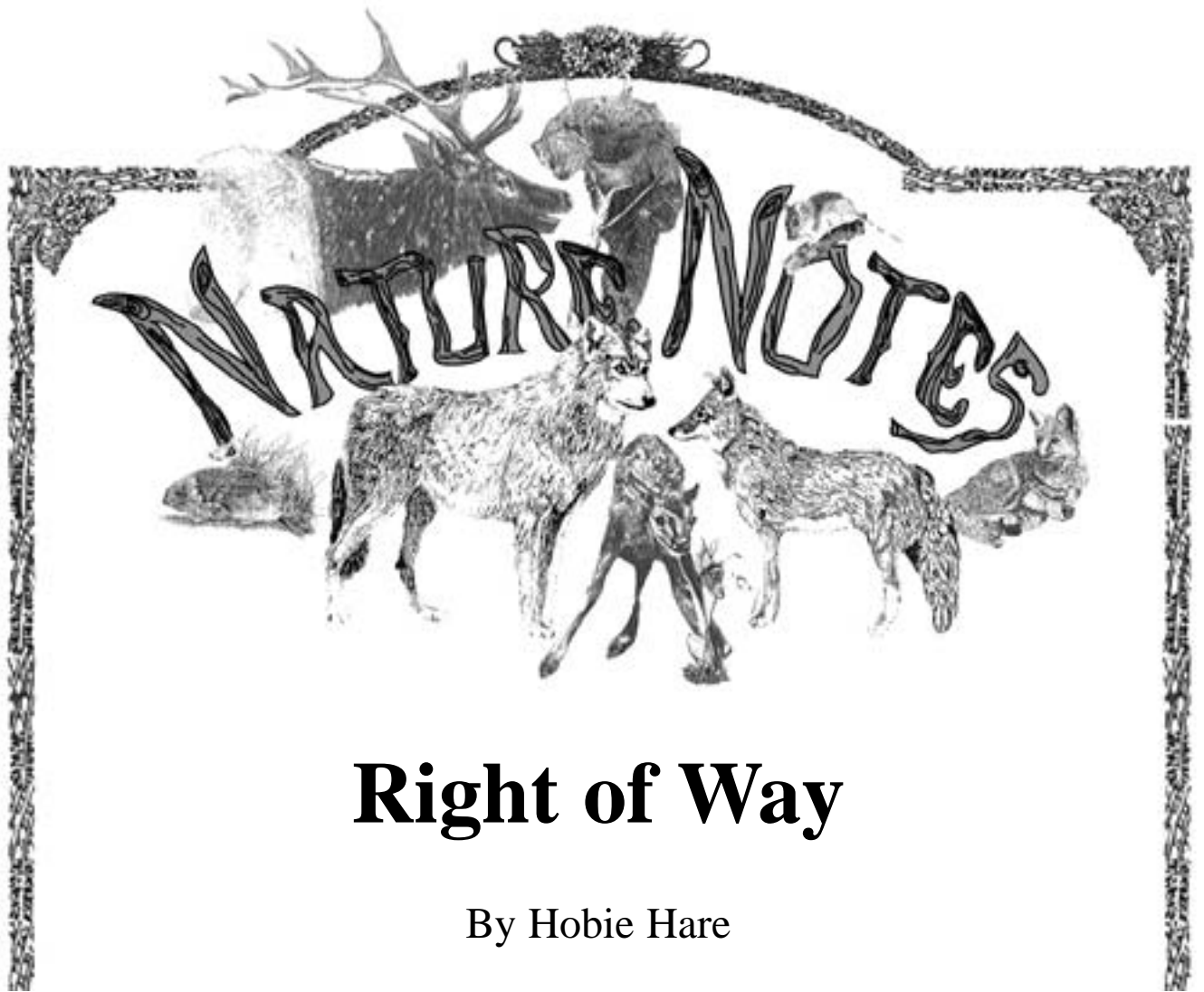
Epilogue

GYE is dynamic, and change is a normal part of the system as far back as we have records or can determine from physical evidence. Based on that record of change, it is certain that sooner or later the environment of the GYE will change in ways that cause the loss of some species and changes in community structure. Human-induced changes, both within the GYE and globally, are likely to accelerate these changes.

Although dramatic ecological change does not appear to be imminent, it is not too soon for the managers of YNP and others to start thinking about how to deal with potential changes. Before humans modified the landscape of the GYE—limiting access to much of it and interrupting migration routes—animals could respond to environmental changes by moving to alternative locations. To a lesser degree, and over longer time frames, plants could adapt as well, especially in places with significant topographic relief. But many options that organisms formerly had for dealing with environmental changes have been foreclosed because of human development of the region. Human-induced climate change is expected to be yet another long-term influence on the ecosystem. Reconciling the laudable goals of preserving ecosystem processes and associated ecosystem components with human interests and influences on wildlands will be a growing challenge in the future, not only in the GYE. That reconciliation will involve conflicting policy goals, incomplete scientific information, and management challenges. Resolving these conflicts will require all the vision, intellectual capacity, financial resources, and goodwill that can be brought to bear on them. 🌍



Pronghorn antelope. NPS photo.



Right of Way

By Hobie Hare

Editor's Note: Occasionally a story comes across my desk that takes me back to a former life, working as a naturalist, spotting otters, and tending the fires at the West Thumb warming hut. For anyone who has visited or spent a winter in the interior of Yellowstone, this Nature Note will ring familiar. For those readers who have never been there, the following will give you a sense of Yellowstone in winter and the experience of sitting low and exposed on a snowmobile, while looking up into the eyes of the park's largest mammal. Here are one person's reflections on an encounter with a bison during his first winter in the interior of the park.

Heading home by snowmobile a few days before winter's longest night, I encounter a lone bull bison standing on the groomed road just south of Hayden Valley in the Mud Volcano area, resting. He initially gives no sign of noticing me, or of being bothered by my presence. At the same time, he is probably hoping that I will just go away, in the direction from which I came, and leave him in peace. I wait, with my engine still running.

Now wary, the bull moves slowly and deliberately away from me. Yet he stays on the road—his other options are either to move off into three feet of snow to his left, or to go down a steep bank leading to an ice-covered expanse of the Yellowstone River on his right. With the comfort and mobility it offers, this narrow strip of groomed road has become a lifeline, a survival and dispersal corridor that we have both come to expect and depend on in winter.

Standstill. And we do, two lone figures facing off on this empty stretch of road. I remember the importance to wintering wildlife of slowing way down and conserving energy, which is not so easily replenished at this time of year. The bull shakes his massive head, moves a few unsteady steps,

NPS photo.



and continues to stand in the road, staring at me with his large dark brown eyes, perhaps assessing my next move.

I get the message. I stop, and turn off my snowmobile. I am awed by the silence and the serenity of this moment. I hear and then feel the late afternoon wind shift its direction and velocity, and quickly put a face mask on top of my balaclava to ward off the chill. The wind and cold does not seem to bother the bison, standing silently, with his thick coat of fur protecting him from the freezing wind. I hear the rapid, powerful flapping of a raven's wings long before I see it glide slowly above us, and then disappear from this winter scene.

The bull bison and I continue to watch each other for a long while on this gray and cloudy December afternoon, neither of us acting or reacting. For several minutes I find myself breathing in the sharp, cold air, deeply and slowly, exhaling in unison with the bison.

The bull turns and faces the bank sloping sharply down toward the Yellowstone River. He exhales deeply, as if finally deciding to move on. He swings his head a final time in my direction. Mistakenly, I take this to mean that I can pass to the right while he remains safely on the other side of the road.

Instead, in a burst of energy he jumps from the road, bulldozing his way through the deep drifted snow to where the riverbank begins to drop off. I gaze down to where he looks like he is heading, to the river, where the ice does not look particularly thick and the route looks arduous.

As he deliberately descends the bank, I make my own move. I start my sled and ride about 50 yards past the point where he has left the road, and then stop again, cutting the engine. I glance back to see him looking back at me, then toward the ice-covered river. He steps onto it with his full body weight. I shudder, holding my breath, expecting to hear the ice give way and the bison crash through.

The ice holds. The bull ambles to safety on the opposite bank. Then he begins to move at a more rapid gait to join a small herd of bison grazing in the snow about a half mile away.

This final vision remains in my mind as I also move at a faster pace to rejoin my own winter community on the northern shore of Yellowstone Lake. Snow begins to fall and swirl as I head homeward. It gradually picks up in intensity, slowly burying the landscape with a new, sparkling white layer.

That night I watch as the snow continues to fall outside my window, and ponder how this thickening of Yellowstone's deepening winter blanket will be perceived by both visitors and residents alike. It will be greeted warmly by the many park visitors, winter enthusiasts here to celebrate the holidays in and around Yellowstone. I am less sure how the park's bison and other wintering wildlife will perceive it, for this season presents great challenges to the animals that visit or call greater Yellowstone home. I drift off into a deep December sleep, dreaming that in the future we will all be able to find peace, space, and room to roam in this increasingly crowded place. ❄️

Hobie Hare just finished his first winter season working in the interior of Yellowstone as an interpretive ranger in the Lake-Fishing Bridge area. He has also been a summer interpreter for two seasons in Yellowstone's West District, and in the spring and fall works as an environmental education ranger with the Expedition: Yellowstone! program.

Hobie initially came out West nearly 10 summers ago to teach international teenagers English in an outdoor setting in Montana. He taught English as a Second Language at Montana State University for five years before embarking on a more conservation-minded educational career path in the fall of 1999. Hobie has also lived and worked in Costa Rica, Venezuela, Japan, Thailand, and Australia, but now calls greater Yellowstone home.



Photo courtesy Hobie Hare.

Preserving the Beasts of Waste and Desolation:

Theodore Roosevelt and Predator Control in Yellowstone

By Jeremy Johnston

The early history of wildlife management in places like Yellowstone is often assumed to have been based on a consensus that predators such as wolves, coyotes, and mountain lions should be killed. Although President Theodore Roosevelt sought to curtail the slaughter of predators in Yellowstone in the early 1900s, his role in park policy is often misinterpreted, and he has been portrayed as both a hero and a villain. This confusion is the result of not only a divergence of opinions on predator control, but Roosevelt's own writings and changing views. In his book *The Wilderness Hunter*, which detailed his experiences in the Dakota Badlands during the 1880s, Roosevelt referred to wolves as "the beasts of waste and desolation."¹ In this same book, Roosevelt depicted cougars as "bloodthirsty" and "cowardly" predators with a "desire for bloodshed which they lack the courage to realize."² Yet despite his depiction of predators as destroyers of cattle and wildlife, Roosevelt was a careful student of predators and their natural behavior. As he spent more time studying predators in their natural setting, his attitudes toward their role in nature began to change, so much so that by 1908 he ordered predator control of Yellowstone's cougars be stopped in order to allow these predator populations to curtail growing elk populations. This change in Roosevelt's perspective toward Yellowstone's pred-



ator population was influenced by several factors, including his goal of establishing a wildlife reserve in Yellowstone, his personal interest in hunting, and his increased understanding of the role of predators in an ecosystem.

Roosevelt's Defense of Yellowstone as a Wildlife Sanctuary

Theodore Roosevelt's interest in natural history began at a very early age. At eight, young Roosevelt viewed a dead seal in a New York marketplace. "That seal filled me with every possible feeling of romance and adventure," Roosevelt later reminisced.³ The young Roosevelt returned to the market to

measure and weigh the seal. Eventually, he obtained the seal's skull, and began a natural history collection that would continue to grow throughout his life. In 1872, shortly after the creation of Yellowstone National Park, Theodore Roosevelt received a rifle and taxidermy lessons from his father for his birthday. These gifts would further his studies in natural history as well as introduce the young man to the sport of hunting. Roosevelt continued to pursue his natural history studies into his college years, when he initially sought a degree in natural history before deciding on law as a field of study. Despite this change in career goals, Roosevelt continued to study wildlife throughout his life.

Hunting would also play an important role in Theodore Roosevelt's life, not just for the collecting of natural specimens for study, but for recreational enjoyment as well. Roosevelt best summed up his feelings towards the sport of hunting in the preface to *The Wilderness Hunter*:

In hunting, the finding and killing of the game is after all but a part of the whole. The free, self-reliant, adventurous life, with its rugged and stalwart democracy; the wild surroundings, the grand beauty of the scenery, the chance to study the ways and habits of the woodland creatures—all these unite to give the career of the wilderness hunter its peculiar charm.

*The chase is among the best of all national pastimes; it cultivates that vigorous manliness for the lack of which in a nation, as in an individual, the possession of no other qualities can possibly atone.*⁴

This great interest in hunting and natural history would eventually lead Roosevelt into the American West.

Roosevelt first visited the West in 1883, when he arrived for a bison hunt in the Dakota Badlands. After successfully completing his hunt, Roosevelt invested in a cattle ranch, marking the beginning of his close connection with the West. Roosevelt returned the next year to investigate his ranching operations and escape the grief and hardship caused by the deaths of both his first wife, Alice, and his mother. Roosevelt spent several of the following years herding cattle and having a number of adventures which included fighting drunken assailants and capturing thieves who stole his boat. Hunting also occupied a great amount of his time during these years. Roosevelt hunted a variety of animals throughout the Badlands and into Wyoming and Montana, and continued to spend much of his time at his ranch until the winter of 1886–1887 wiped out most of his cattle herd. In later years he occasionally returned to the ranch, using it as a base for hunting excursions and other sightseeing trips. From there, Roosevelt embarked on two trips into Yellowstone National Park in the 1890s. His experiences and observations from these trips formed the basis for many of his wildlife management policies in Yellowstone National Park.⁵

Roosevelt's interest in the American West soon focused on Yellowstone and the threats to its wildlife posed by railroad development proposals and poaching. He became aware of these problems in 1885 when he met with George Bird Grinnell, editor of *Forest and Stream*, then the leading natural history magazine in North America, and a founder of the Audubon Society. Grinnell had led a campaign to protect Yellowstone's ungulates from market hunting and commercial development ever since his first visit to Yellowstone

in 1875. Roosevelt wanted Grinnell to explain some negative remarks he printed in a review of *Hunting Trips of a Ranchman*, Roosevelt's first book describing his western adventures. Grinnell had given the book an overall favorable review, but noted that Roosevelt tended to generalize his observations of wildlife and had relied on some tenuous sources for information. During the meeting, Grinnell defended his remarks pertaining to Roosevelt's book, and Roosevelt realized the validity of Grinnell's arguments. Along the way, the two men realized their shared interests in hunting and the West and became good friends. Soon after, they founded the Boone and Crockett Club, an organization that, among other goals, worked to defend Yellowstone and its wildlife. Using *Forest and Stream* as its mouthpiece, the Boone and Crockett club criticized poaching and proposals for railroad developments within Yellowstone. This publicity helped result in the passage of the Lacey Act of 1894, which established Yellowstone's first efficient judicial system, making it possible to punish poachers for their illegal activities. The Boone and Crockett club also stopped efforts to complete a railroad through the northern section of Yellowstone. When railroad developers wanted

to decrease the park's boundaries, publicity generated by the Boone and Crockett club created a public outcry to "save Yellowstone."⁶

Through his efforts with Grinnell, Roosevelt began to envision the park as a sanctuary and breeding ground for wildlife. Roosevelt hoped that if the park's wildlife were protected, their populations would dramatically increase and spread to the surrounding regions. This would ensure the continuation of hunting, his favorite pastime, outside the park's boundaries. It would also alleviate his fear that as settlement increased, the West would become a series of private game reserves creating a situation where only the rich could hunt. As his political career progressed to the presidency of the United States, Roosevelt found himself in a position where he could achieve these goals by micro-managing Yellowstone's wildlife policies.

Roosevelt and Yellowstone's Predators

Although the hunting of many ungulate species ended in 1883 by a directive of the Secretary of the Interior, park officials continued killing predators throughout the end of the 19th century and into the early 20th century. Many



An editorial cartoon's depiction of Roosevelt's 1903 Yellowstone visit. Note the mountain lion perched outside the window. From the *Anaconda Standard*.

conservationists of the day, including Roosevelt, believed limiting predation would increase ungulate populations, allowing them to recover from the results of the intensive market hunting that occurred in the park before the ban on hunting.⁷

Roosevelt's support of predator control was not just the result of an altruistic conservationist urge. His own desire to hunt cougars in Yellowstone was also a factor. On December 17, 1901, Roosevelt wrote to Yellowstone's acting superintendent, Major John Pitcher, asking "what is the practice about killing mountain lions? If I get into the Park next June I should greatly like to have a hunt after some of them—that is, on the supposition that they are 'varmints' and are not protected."⁸ Going on a cougar hunt in Yellowstone also would provide Roosevelt with an opportunity for him to get reacquainted with his friend and hunting guide, John B. Goff.

Hunting Mountain Lions

Roosevelt had first met John B. Goff in January 1901. Shortly after Roosevelt was elected vice president, Goff guided him on his first cougar hunt using hounds, in Colorado. Although cougars greatly interested Roosevelt, he had seen very few of them in wild. His knowledge of the animal had come mostly from the tales of outdoorsmen he met in the Badlands.⁹

During his hunt with Goff, Roosevelt thoroughly enjoyed himself and learned much about cougars. Fourteen cougars were killed during the trip, 12 of them by Roosevelt alone. If this sounds like senseless slaughter, it should be remembered that in a time before high-tech film and advanced scientific methods were used to study wild animals, hunting was one of the only available ways to closely examine wildlife. Roosevelt's narrative of the hunt, found in *Outdoor Pastimes of an American Hunter*, published in 1905, was "the first reasonably full and trustworthy life history of the cougar as regards its most essential details."¹⁰ Clinton Hart Merriam, director of the Division of Biological Survey,

agreed with Roosevelt. After receiving cougar skulls from the hunt, he wrote Roosevelt that "your series of skulls from Colorado is incomparably the largest, most complete, and most valuable series ever brought together from any single locality, and will be of inestimable value in determining the amount of individual variation."¹¹ The 1901 hunt not only provided specimens for classification; Roosevelt gained a better understanding of the predation habits of cougars, learned about their diet by examining stomach contents, and dispelled the myth of cougars being man-killers. This information formed the basis for Roosevelt's decisions regarding predator control in Yellowstone.¹²

Roosevelt planned to return to Colorado for a second hunt with Goff for bear in 1903, but his plans never came to fruition. Philip B. Stewart from Colorado Springs, a close friend who

had accompanied Roosevelt on the 1901 cougar hunt, took on the task of organizing the hunt, but one obstacle after another confounded his plans. First, Goff was wounded by an over-eager tourist he was guiding on a hunt. Roosevelt expressed his frustration to Stewart in a letter, "I hope he beat the 'tourist' who inflicted the wound severely."¹³ Goff recovered rapidly, and promised enough cougar to keep Roosevelt satisfied, but on January 22, 1903, Roosevelt wrote Stewart to cancel the hunt. "Many things are conspiring to make it unlikely that I can go," he complained.¹⁴ Instead, Roosevelt scheduled a grand tour of the western states for the spring of 1903, with one stop at Yellowstone.

Roosevelt continued hoping for another hunt with Goff. Shortly after canceling the hunt in Colorado, Roosevelt wrote Stewart about the possibility of sending Goff from Colorado



After leaving his position in Yellowstone, Goff continued to hunt cougars in the Shoshone National Forest, east of Yellowstone National Park's boundary, where he was photographed circa 1907 with his dogs and a recent kill. Photo courtesy of the Park County, Wyoming, Historical Archives.

to meet him in Yellowstone. By bringing Goff to Yellowstone, Roosevelt would be able to meet two objectives: controlling predators within the park and enjoying a hunt. "The park authorities say they would like Johnny Goff to be up there with his dogs on trial for the business of killing out some of the mountain lions," Roosevelt wrote to Stewart, "then if things went right, I might get a week with him myself."¹⁵ But his plan began to unravel when Secretary of War Elihu Root noted that Roosevelt's public image might be tarnished if he killed any animals within the park.¹⁶ Root most likely felt that a hunt in Yellowstone National Park, where hunting by the general public was forbidden, would appear to be self-serving, and no less than a misuse of presidential authority. If the public got wind of Roosevelt ordering his hunting guide to Yellowstone, it could create a minor scandal.

Roosevelt attempted to resolve the issue by writing Major John Pitcher, "Secretary Root is afraid that a false impression might get out if I killed anything in the Park, even though it was killed, as of course would be the case, strictly under Park regulations... Now I have thought of this: Would it be possible, starting from within the Park, to go just outside the border and kill any

mountain lions?"¹⁷ Roosevelt then requested Pitcher to send out scouts to find a suitable area, and concluded the letter by asking if he had requested any hounds for the purpose of killing predators.¹⁸ Roosevelt wanted to be sure that if Goff could not reach Yellowstone for some reason, he would still be able to hunt cougars outside of the park boundaries by using the government's pack of dogs. Pitcher's response is not known, but it appears he did submit an application for three hounds. Roosevelt ordered Secretary of the Interior Ethan Hitchcock to send Pitcher an additional three dogs to supplement the pack. On March 2, Roosevelt ordered Pitcher to put the dogs through a trial run. "We must be dead sure we get our mountain lion," noted Roosevelt.¹⁹

Pitcher wrote a report to the president on the hunting possibilities, noting that his scouts had located "the fresh tracks of ten mountain lions, close to the point where we propose to make our camp."²⁰ He also noted that the park's buffalo keeper, C. J. "Buffalo" Jones, had captured a live lion while feeding some bighorn sheep in the area. Pitcher reported that the dogs would soon arrive in the park from Texas, and that kennels awaited them. Perhaps trying to alleviate the president's fears about public opinion, Pitcher wrote, "Now these

lions have simply got to be thinned out, and if you will lend us a hand in the matter, you will be of great help to us and no one can offer any reasonable objection to your doing so."²¹

With Pitcher's assistance, Roosevelt eagerly anticipated his trip to Yellowstone, with a side-trip outside the park to kill some cougars. Roosevelt's plans took another turn on March 21, however, when Pitcher informed the president that only four of the eight dogs had arrived, and they were untrained. Buffalo Jones was attempting to train them using his captured cougar. Pitcher also noted that he had telegraphed Mr. Poole, the dog supplier, and informed him that he needed the other four dogs, two of which must be trained or else the contract would be voided. Poole telegraphed back that four more dogs were being shipped to the park. Pitcher requested John Goff's address in order to contact him if the four new dogs were unsuitable.²²

Upon learning of the problem with the dogs, Roosevelt wrote back to Pitcher to cancel the hunt and comment, "Having had experience in the past with individuals who sold hounds, I am not in the least surprised at your news."²³ Roosevelt wrote that "an untrained hound is worse than useless. Such a pack will run deer or elk in the place of lion, and will be a perfect curse to the Park."²⁴ He also noted that bringing Goff up to the park would be unacceptable. "The more I have thought it over...[Goff] coming up would cause a great deal of talk."²⁵ He concluded the letter by noting that seeing the game of the park would be exciting enough but that, on the off chance the hounds were trained in time, he would attempt to hunt cougar.²⁶

On April 8, 1903, Theodore Roosevelt arrived in Yellowstone National Park for his long anticipated visit. Famed naturalist and writer John Burroughs accompanied Roosevelt during his visit, which lasted for over two weeks. During this time, Roosevelt and Burroughs spent most of their time studying the park's wildlife. Roosevelt fired only one shot within the park. Using a tree for a target, he tested a new revolver, only to have the spent shell fly



President Theodore Roosevelt (left) in camp near Tower, Yellowstone National Park, with John Burroughs (right), April 1903. NPS photo.



“Head of Cougar Shot Sept., 1889” by J. Carter Beard, from Roosevelt’s The Wilderness Hunter. This illustration shows how mountain lions were depicted in the past—as bloodthirsty killers.

back, cutting his cheek. The only animal Roosevelt killed during his trip was one mouse. With hope of discovering a new species of mice, Roosevelt caught his prey by throwing his hat over the mouse to entrap the small creature. He spent the evening skinning the mouse and treating the small pelt for shipment to the U. S. Biological Survey to see if it was a new species. It was not, but was a species previously unknown to the park area. John Burroughs worried newspapers might misprint the word “mouse” in their articles as “moose” and create a controversy for the president.²⁷

Roosevelt’s preparations for a cougar hunt came back to haunt him during his visit. Buffalo Jones decided to take matters into his own hands by bringing the government’s pack of hounds to the presidential camp for a quick cougar hunt. Upon Jones’ arrival at the camp, Roosevelt instructed Pitcher to order Jones and the hounds back to Mammoth Hot Springs. John W. Meldrum, the judge of Yellowstone’s court who tried to warn Jones not to bother the president, later recalled, “I met [Jones] down at the Post Office shortly after he came in and said, ‘Hello Jones, I thought you

were out with the President.’ Jones was so mad that he never said a word.”²⁸

Predator Control in Yellowstone

During the president’s visit in April 1903, he had substantial time to study Yellowstone’s wildlife. His perspective on predators began to change, especially after he witnessed the conditions of the elk herds. He saw many elk along the way to his campsite on the Yellowstone River near the Black Canyon of the Yellowstone, and noted that they “were certainly more numerous than when I was last through the Park twelve years before.”²⁹ With the help of Pitcher and their guide Elwood Hofer, who had also guided Roosevelt during his 1891 visit to the Yellowstone area, Roosevelt counted 3,000 head of elk in one sitting. He also noticed many elk carcasses lying on the ground. He paid close attention to what had caused their deaths. Two were killed by “scab,” and some by cougars, but most had died of starvation—the result, Roosevelt believed, of overpopulation. Roosevelt assumed the numbers to be too high on the basis of what he had witnessed during his visits in 1890 and 1891. Certainly, the elk numbers would have increased throughout the 1890s due to the cessation of market hunting within Yellowstone and increased power to prosecute poachers under the Lacey Act. In addition to decreased hunting, the destruction of the wolves and other natural predators in this time period would have decreased predation, allowing for a greater increase in elk numbers.

Roosevelt now began to defend the cougars’ presence in the park: “As the elk were evidently rather too numerous for the feed,” he later wrote in the account of his trip, “I do not think the cougars were doing any damage.”³⁰ Roosevelt began to worry that the elk herds would meet the same fate as his North Dakota cattle herds had in the disastrous winter of 1886–1887; that they would deplete the range, leaving little if any winter feed, and leading to starvation for themselves and other wildlife. To prevent this from occurring, Roosevelt believed the elk herds needed



to be thinned down, and that predators were needed to fulfill this function in place of human hunters. Roosevelt now realized that predators such as cougars were an important part of the Yellowstone ecosystem. This was a rare opinion for the time period, especially from a former Western rancher. Roosevelt believed the winter die-offs were an effective method of population control of elk numbers, but he considered it to be too inhumane. Instead, his background in range management focused him on establishing a balance between elk numbers and what he considered to be efficient feed on the range.

Although Roosevelt wrongly believed that cougars alone could keep down the elk numbers, he still feared that cougar predation would destroy other wildlife populations such as deer and bighorn sheep. He worried most about cougars because he thought coyotes and wolves were not as dangerous to the ungulate herds. By that time, wolves would have been too low in numbers to have had much of an impact on the ungulate herds, and Roosevelt dismissed coyotes as formidable predators. “Although there are plenty of coyotes in the Park, there are no big wolves,” he noted, “and save for very infrequent poachers the only enemy of...all game, is the cougar.”³¹ Based on this belief, Roosevelt began to advocate a limited predator control program for the cougar population. Major Pitcher assigned Buffalo Jones the responsibili-

ty for controlling cougars with the government's new hounds. However, Jones soon ran into a conflict with park military officials and resigned his position. When notified of Jones's resignation, Roosevelt knew just the man for the job—his former hunting guide, John B. Goff.

In the spring of 1905, during a bear hunt with Goff, Roosevelt wrote to Major Pitcher; A.A. Anderson, the Yellowstone Forest Reserve inspector; and Ethan A. Hitchcock, Secretary of the Interior, requesting that Goff be "given all the privileges that can be given for killing lion within or without the park."³² Goff left for Yellowstone in June, expecting the job of thinning out the Yellowstone cougar population to take four years.³³

Roosevelt's instructions to Goff indicated his newly selective approach to predator control. "Of course you can not afford to let the cougar exist in the neighborhood of where the deer and sheep are," Roosevelt wrote Goff in May, 1906, "but any cougar that are found off where there are practically nothing but elk, I should think it a good plan to leave them alone."³⁴ Unfortunately, Roosevelt failed to realize that after years of steady hunting, Yellowstone's cougar population had already been fairly well exterminated. Goff's son Byron later recalled, "Roosevelt was misinformed about the lion situation."³⁵ John Goff soon discovered that few cougars existed in the park, and he resigned after less than a year of service.

Shortly before Goff left the park, Roosevelt began to realize that the cougar population had become dangerously low. After receiving a letter from Goff, Roosevelt responded, "I am sorry to hear about the elk having had such a bad winter, but just as I have said, there are so many elk that they have begun to be too plentiful in the park, and personally I should be sorry to see all the cougar killed off."³⁶ These fears regarding the rising elk populations and loss of predator populations caused Roosevelt to rescind his predator control policies against the cougar populations. In a 1908 letter to Superintendent S. B. M. Young, Major Pitcher's

replacement, Roosevelt ordered an end to the killing of cougars in the park:

*I do not think any more cougars should be killed in the park. Game is abundant. We want to profit by what has happened in the English preserves, where it proved to be bad for the grouse itself to kill off all the peregrine falcons and all the other birds of prey. It may be advisable, in case the ranks of the deer and antelope right around the Springs should be too heavily killed out, to kill some cougars there, but in the rest of the park I certainly would not kill any of them. On the contrary, they ought to be let alone.*³⁷

Although hundreds of coyotes continued to be killed while Roosevelt was in office, cougars were left alone in Yellowstone after his directive was received. The pack of dogs purchased by the government under Roosevelt's directions was sold. The official killing of cougars did not resume until 1914, when 14 were killed. After the National Park Service assumed control over Yellowstone National Park, cougars continued to be killed: four in 1916; a total of thirty-four in years 1918 and 1919. The last reported official killing of a cougar in Yellowstone occurred in 1925.³⁸

Too Many Elk in Yellowstone?

In 1912, Roosevelt's attention again focused on Yellowstone. In an article to *Outlook* magazine, Roosevelt publicly voiced his concern over the increasing number of elk in the park. He had previously expressed worry regarding the park's elk numbers, but now feared that the problem would result in disaster. Roosevelt predicted the following:

Elk are hardy animals and prolific. It is probable that a herd under favorable conditions in its own habitat will double in numbers about every four years. There are now in the Yellowstone Park probably thirty thousand elk. A very few moments' thought ought to show any one that under these circumstances, if nothing inter-

*fered to check the increase, elk would be as plentiful as cattle throughout the whole United States inside half a century. But their possible range is of course strictly limited, and as there are no foes to kill them down, the necessary death-rate is kept up by nature in far more cruel way—that is starvation by winter. The suffering and misery that this means is quite heartrending... What is needed is recognition of the simple fact that the elk will always multiply beyond their means of subsistence, and if their numbers are not reduced in some other way they will be reduced by starvation and disease.*³⁹

The only solution, Roosevelt decided, was that "it would be infinitely better for the elk, infinitely less cruel, if some method could be devised by which hunting them should be permitted right up to the point of killing each year on an average what would amount to the whole animal increase... Of course the regulation should be so strict and intelligent as to enable all killing to be stopped the moment it was found to be in any way excessive or detrimental."⁴⁰

A number of obstacles prevented the implementation of Roosevelt's proposal for controlling the numbers of elk in Yellowstone by limited hunting. It was hard to convince the public and the military administrators in Yellowstone that the elk herds should be culled. Park administrators did attempt to solve the problem by increasing the feeding of hay to elk, decreasing domestic grazing in the National Forest Reserves, and by shipping elk outside the park, but this was not effective in Roosevelt's opinion.⁴¹ Roosevelt criticized these methods: "from time to time well-meaning people propose that the difficulty shall be met by feeding the elk hay in winter or by increasing the size of the winter grounds... But as a permanent way of meeting the difficulty neither enlarging the range nor feeding with hay would be of the slightest use. All that either method could accomplish would be to remove the difficulty for two or three years until the elk had time to multiply beyond once more to the danger-point."⁴²

Misleading publicity regarding the elk die-off in the winter of 1916–1917 seemed to confirm Roosevelt’s worst fears. This news led many people to believe the winter had killed off most of the park’s elk population. Heavy snowfall kept the elk herds from traveling to their winter range. Many elk died from starvation, which preservationists took as proof that overpopulation was threatening the future of the elk. Some people became alarmed that the species that barely survived the era of market hunting was again headed for extinction, this time from natural forces. Most of this fear was based on exaggerated counts from previous years, but the park’s new administration, the National Park Service, responded by continuing the policy of feeding hay to the elk. Roosevelt felt this would only continue to compound the problem by once again raising the elk population to uncontrollable standards.⁴³ Predator control of wolves and coyotes continued as the newly-established National Park Service assumed the management of Yellowstone National Park. The new managers also targeted the cougar populations once again. In 1916, four cougars, 180 coyotes, and 14 wolves were killed. The following year, 100 coyotes and 36 wolves were killed. In

1918, 23 cougars, 190 coyotes, and 36 wolves were killed.⁴⁴

In 1918, Roosevelt wrote to his friend George Bird Grinnell to express his concerns for the future of Yellowstone:

The simple fact is that if we got additional winter grazing grounds for the elk, or fed them alfalfa, in four years they would have multiplied beyond the limit again, and we should be faced by exactly the same difficulty that we are now. There is winter ground for a few thousand elk in the park but not much more than a fraction of the present number. As their natural enemies have been removed their numbers must be kept down by disease or starvation or else by shooting. It is a mere question of mathematics to show that if protected as they have been in the park they would, inside of a century, fill the whole United States; so that they would then die of starvation!⁴⁵

The next year, the National Park Service killed 11 more cougars, 227 coyotes, and six wolves. Predator control continued to remove what “natural enemies” of the elk were left. Former Yellowstone superintendent and National Park Service Director Horace

Albright later described the reason for this policy: “the rangers have grown to love all wild life except those predatory species which they so often observe destroying young antelope, deer, or elk. Aside from those outlawed animals, a national park ranger is never known to kill a native animal or bird of the park, or to express a desire to kill.”⁴⁶ The issues raised by Roosevelt regarding elk numbers and the role of predators have continued to be debated by the National Park Service into the 21st century. Eventually, the National Park Service used controlled hunting to maintain elk numbers at certain levels. This ended in the 1960s when bad publicity and evolving scientific theories of density dependence led to the adoption of natural regulation policies. Attitudes toward Yellowstone’s predators also changed. Many scientists began to realize the important role of wolves, coyotes, and cougars in the Yellowstone ecosystem. In 1935, the National Park Service ended predator control.⁴⁷

In 1919, Roosevelt passed away at his home at Sagamore Hill, New York. With his death, Yellowstone lost not only one of its most important defenders, but also one of its early wildlife managers. Roosevelt’s handling of predators in Yellowstone will always be debated as having been good or bad. Yet one thing is clear: Roosevelt attempted to establish policies that he believed were in the park’s best interest as he understood it at the time. Unfortunately, he did not understand many of the environmental changes that were occurring in Yellowstone, nor did he recognize how drastically the environment had been changed by those before him, especially how much damage had been done to the predator populations. He also believed that the natural increase of the elk populations and the effects of winter kills, which are now recognized as part of the natural process in Yellowstone’s ecosystem, were inhumane and needed to be managed with what he viewed as more humane methods. Despite these shortcomings, Roosevelt’s changes to Yellowstone’s predator control policies were fairly advanced for his day and age. Roosevelt must be given credit for his effort to look beyond the image of



T.R. on Officer’s Row in Mammoth, 1903. NPS photo archives.

predators as “beasts of waste and desolation” to critically examine their valuable role in the Yellowstone ecosystem. 🌲

I would like to thank Lee Whittlesey and Paul Schullery for their assistance in my research for this article.

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Jeremy at Sagamore Hill National Historic Site, New York. Roosevelt built this Queen Anne home from plans he sketched in 1885 and lived in it until his death in 1919. Photo courtesy Jeremy Johnston.

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Yellowstone Welcomes New Assistant Superintendent

On February 1, Yellowstone Superintendent Suzanne Lewis announced the selection of Franklin C. Walker as the new assistant superintendent of the park. Walker, Acting Superintendent at Yellowstone since June 2001, replaces Marvin O. Jensen who left in late 2000 to accept the position of manager of the National Park Service Soundscape Center in Fort Collins, Colorado.

Superintendent Lewis notes that Walker brings outstanding leadership and management skills to his position and has first-hand knowledge of the issues facing Yellowstone. Furthermore, his remarkable ability to communicate with diverse audiences and his proven and effective community relations and outreach record will be great assets.

Walker, a 32-year veteran of the National Park Service, began his career as a seasonal ranger at Yellowstone in 1967. He received his first permanent position in 1970, serving as a park technician at White Sands National Monument, New Mexico. Walker worked as an urban intake ranger at Jefferson National Expansion Memorial, Missouri, from 1972 to 1973, and as a park ranger at Gulf Islands National Seashore, Mississippi, from 1973 to 1977. He returned to Yellowstone in 1977, where he worked as the south district naturalist until 1980. From 1980 to 1985, Walker served as the chief of interpretation in Carlsbad Caverns National Park, New Mexico. In 1985, Walker was named to his first superintendency at Fort Clatsop National Memorial in Oregon—a position he held until 1990. From 1990 to 1998, he served as superintendent at Nez Perce National Historical Park, Idaho. From 1998 to present, Walker has served as superintendent at Saguaro National Park, Arizona.

During his tenure with the National Park Service, Frank has received numerous awards including the Department of the Interior Meritorious Service Award (1996), the General Council



Frank Walker, Yellowstone's new assistant superintendent. NPS photo.

Award from the Nez Perce Tribe (1996), the Vail Partnership Award (1995), the Western Region Superintendent's Award for Cultural Resources Stewardship (1995), and the 1985 Southwest Region's Freeman Tilden Award.

Walker received a Bachelor of Science degree in biology from New Mexico State University in 1967. He also served in the U.S. Army, Fort Lewis, Washington, as a first lieutenant from 1967 to 1969. Walker and wife, Judy, have two sons (Mark and Phillip) and one daughter (Kathy).

2001–2002 Northern Range Late Winter Elk Classification Survey

The Northern Yellowstone Cooperative Wildlife Working Group conducted its annual late-winter classification survey of the northern Yellowstone elk population February 27 and 28, and classified a total of 4,001 elk. Biologists used a helicopter to count bull, cow, and calf elk in specified sampling areas through the entire northern range during the 10½-hour survey. The northern Yellowstone elk herd winters between the northeast entrance of Yellowstone Na-

tional Park (YNP) and Dome Mountain/Dailey Lake in Paradise Valley.

Estimated sex and age ratios for the population were 14 calves, 7 yearling bulls (*i.e.*, spikes), and 36 adult (branch-antlered) bulls per 100 cows. According to YNP supervisory wildlife biologist Glenn Plumb, a member of the working group, the estimated ratio of 43 bulls per 100 cows is similar to the average ratio of 46 bulls per 100 cows surveyed since 1995, but the estimated ratio of 14 calves per 100 cows is less than the range of 22 to 34 calves per 100 cows observed during the past six years.

The low calf:cow ratio suggests that the number of calves born in 2001 which will survive to join the northern range elk population will be relatively low. The calf:cow ratio is lower this winter than in recent years, and potential contributing factors likely include drought-related effects on pregnancy and calf survival, predation, hunting, and winter-kill. According to the working group, the observed calf:cow ratio from this survey cannot be used to predict that the calf:cow ratio of the northern Yellowstone elk population will remain low in future years, or that elk abundance will decrease. The working group will continue to monitor trends of the elk population and evaluate the relative contribution of various components of mortality, including hunting, environmental factors, and predation.

Mammoth Hot Springs Historic District Listed on National Register

On March 20, 2002, the Mammoth Hot Springs Historic District was listed on the National Register of Historic Places. The National Register is the official list of the nation's cultural resources worthy of preservation. Listed properties include historic districts, sites, buildings, other structures, and objects that are significant in American history, architecture, engineering, archeology, and culture—resources that contribute to understanding the historical and cultural foundations of the nation.

Since the creation of Yellowstone National Park, Mammoth Hot Springs has served as its administrative headquarters. It is also the site of the first park concession facilities and the headquarters of park concession operations. The first hotels, retail store, photograph shop, and filling stations were all located at Mammoth Hot Springs, and their successors still operate within the district. The historic district encompasses 190 resources, including 187 buildings, the parade ground, campground, and flagpole (which is a remnant of the once-taller flagstaff placed on the parade ground in 1902 by the U.S. Cavalry). Thirty-six of the buildings within the Mammoth Historic District made up the original Fort Yellowstone. These structures and associated discontinuous Army-era resources—including the Fort Yellowstone cemetery, the Roosevelt Arch, Norris Soldier Station, Buffalo Lake “snowshoe” or patrol cabin, and the Bechler River soldier station and barn—have also been nominated for designation as National Historic Landmarks, indicating cultural properties of the highest significance.

Mammoth Hot Springs is also significant for its architecture. The earliest Fort Yellowstone structures date to 1891, and include the original army post headquarters, the guard house, and Officer’s Row buildings, which are still used to house park employees today. Architect Robert C. Reamer (who also designed the Old Faithful Inn, but in Mammoth used elements of the Colonial Revival and Art Moderne styles of architecture) designed the Mammoth Hot Springs Hotel, dining hall, and recreation hall.

Reamer also designed the prairie-



The Mammoth Hot Springs Hotel and dining facilities are in the newly designated historic district. NPS photo.

style H.W. Child House, sometimes called the Executive House, which was built in 1907 and is periodically threatened by runoff from the still-active adjacent Opal Terrace hot spring. Building #49, the former U.S. Commissioner’s office and jail, which is traditionally the residence of the U.S. Magistrate stationed in the park, was the first stone building in the fort, built in 1894. The following year, Oscar Roseborough built himself what is today called the mail carrier’s house, evidencing past times when private contractors or individual concessioners constructed and owned buildings within the park.

While the park currently has some 950 historic resources on the List of Classified Structures, all of which are believed to be potentially eligible, relatively few have actually been listed on the National Register of Historic Places. Yellowstone now has six national historic landmarks, five historic sites, and four historic districts.

U.S. Fish and Wildlife Service Kills Four Wolves Near Chico

On March 26, U.S. Fish and Wildlife Service officials shot and killed four wolves near Chico in Montana’s Paradise Valley after a wolf killed a calf the week before. The three males and one female were part of the Sheep Mountain pack, which typically roams south of Dome Mountain and north of Chico. One was a collared wolf that had originated in Yellowstone. FWS wolf recovery coordinator Ed Bangs said a rancher reported that one of his calves had been killed March 18, and aggressive action was taken because the wolves have caused problems previously in that stretch of Paradise Valley.

The four wolves were shot not only because of the March 18 attack, but to reduce the pack size, which had been nine. Bangs said he believes they took the right wolves out, but that he can’t be certain. With the Sheep Mountain pack reduced by four, Bangs is hoping for fewer problems in Paradise Valley. “But,” he added, “if they depredate again, we’ll do it again.”

Last year, the pack’s alpha male was shot after livestock was killed. During the winter, wolves from Yellowstone joined the Sheep Mountain pack, which inhabits a stretch of Paradise Valley where large numbers of elk congregate in the winter.

Delaware North Wins Concessions Contract

On January 31, Acting Superintendent Frank Walker announced that in a competitive bidding process, Delaware North Parks Service was selected to operate general stores in the park, replacing the long-term operator, Hamilton Stores, Inc. (HSI). HSI has provided visitor services in Yellowstone for over 80 years. Walker said, “It is truly the end of an era for Yellowstone, the Povah family, and their employees; they have been an integral part of Yellowstone’s history.”

Charles Hamilton began operating in the park in 1915 and his daughter, Eleanor Povah, her late husband Trevor Povah, and their family have continued the Hamilton Stores’ tradition for many decades.

The HSI contract has been extended through December 31, 2002, to allow for a smooth transition between companies. Additionally, Delaware North Parks Service has stated that they plan to retain as many of the current employees as possible to provide the best guest service and a seamless transition.

The 1998 Concessions Management Improvement Act and subsequent regulations require that all National Park Service prospectus documents include minimum terms and specific selection factors. The selection factors are rated by a panel of subject matter experts in the process of selecting the best offer.

Three proposals were submitted in response to the contract opportunity, including Delaware North Parks Service, Amfac Parks and Resorts, and Hamilton Stores, Inc. Delaware North is also currently authorized to provide visitor services in Yosemite, Sequoia, and Grand Canyon National Parks and Oregon Caves National Monument.

Another Earthquake Swarm

An earthquake swarm occurred in Yellowstone's central plateau from January 15 to 16, 2002. An earthquake swarm is defined as earthquakes occurring roughly in the same area over a relatively short time period. The swarm was located in an area of known seismic activity that had not been active for some time. The sequence peaked with a magnitude 2.9 quake at approximately 2 km depth, and lasted only a few hours. It was nonetheless notable, as Yellowstone's seismic activity was low during the past year, and this swarm was the first significant activity of 2002.

The sequence lasted only about seven hours, and did not show any distinct spatial or depth trends. The epicenters were near some post-caldera volcanic vents and near the area of the 1975 Norris Junction earthquake of magnitude 5.7 that was associated with north-west trending earthquake sequences. The trend of the 2002 sequence is northeast, perpendicular to the dominant seismicity northwest of the caldera, but approximately aligned with the background seismicity in this particular area that is nearly parallel to the Elephant Back fault zone, about 15 km to the southeast.

For real-time seismic data for Yellowstone visit: www.seis.utah.edu/reactivity/recent.shtml; for crustal motion data from the Yellowstone GPS (Global Positioning System) monitoring network visit: www.mines.utah.edu/~rbsmith/RESEARCH/UUGPS.html.



Location of January 15, 2002, earthquake swarm. Map by Henry Heasler.

Restoration Set for "The Triangle"

On March 25, Yellowstone Superintendent Suzanne Lewis announced that the park is scheduled to begin a project to restore native vegetation on "the triangle" area near the North Entrance. The project area is located between the Roosevelt Arch, the North Entrance, the Yellowstone Park Transportation Complex, and Park Street in Gardiner, Montana.

The area has a long history of human use. Throughout the years it has been a bus parking lot, a horse racetrack, an elk feeding ground, and an irrigated hay field. As a result of this disturbance, the 11-acre area has experienced a lack of native vegetation and a proliferation of exotic weeds, including Russian thistle—considered a nuisance and fire hazard. Four years ago, steps were taken to eradicate the weed population.

The triangle-shaped area has long been arid, dusty, barren, and flat, averaging only 10–12 inches of precipitation a year. A four-year drought has created unusually dry conditions, resulting in little vegetation and no support of any new growth. In January 2002, the area experienced a major windstorm, creating visibility problems and moving much of the topsoil toward the Gardiner Transportation building and residences and the town of Gardiner.

Studies have been done on the area and short- and long-term solutions have been identified to mitigate the situation. Starting March 27, 2002, (weather permitting) and continuing through April, clean up of the deposited topsoil and erosion-control efforts took place. Native indigenous seed was hand-sown and raked over the area, and shredded fir-cedar mulch was lightly spread and watered to establish vegetation. Native shrubs were transplanted into the area, and at least one culvert was installed under the road between the Roosevelt Arch and the North Entrance to try to reestablish natural hydrology. The triangle will be watered to help control erosion and promote growth. Isolated weed control will continue with hand pulling.

Winter Use Draft Supplemental Environmental Impact Statement

On February 19, 2002, Yellowstone and Grand Teton national parks announced that the *Draft Supplemental Environmental Impact Statement (DSEIS) for Winter Use in Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr., Memorial Parkway* was available on the Internet.

The two parks' staffs have been working to make the DSEIS available to the public as quickly as possible. Hard copies were available starting March 29, 2002. An official 60-day comment period began March 29 and will close on May 29, 2002. However, comments will be accepted from the time the document was posted on the Internet.

The SEIS includes four alternatives but does not designate a preference.

Alternative 1a: This No Action alternative allows for implementation of the current rule allowing access to the parks via snowcoaches only in the future. A phase-out of snowmobiles would begin the winter of 2002–3, with a full ban on snowmobiles the winter of 2003–4.

Alternative 1b: Also a No Action alternative, but implementation of the current rule would be delayed until the winter of 2003–4, with a full ban on snowmobiles effective the winter of 2004–5. Both of the No Action alternatives provide for access by a NPS-managed, mass transit snowcoach system.

Alternative 2: Provides for non-guided snowmobile access. It phases in proposed EPA 2010 emission standards for cleaner snowmobiles by 2005 and limits decibel levels to 75 (currently 78). It also provides for a daily cap on snowmobile numbers and calls for increased NPS management of winter use.

Alternative 3: Provides for access by guided snowmobile tours with snowmobiles of the best available sound and emissions technology. Snowmobile numbers would be limited, and visitors encouraged to use snowcoach services.

The document can be found by accessing a quick link at www.nps.gov/grte. The direct access address is www.nps.gov/grte/winteruse/intro.htm.

Comments must include a name and return mailing address (other than an email address). Comments may be submitted via email: grte_winter_use_seis@nps.gov or by mail: Winter Use SEIS, P.O. Box 352, Moose, Wyoming 83012. A link for the Final EIS and Record of Decision published in 2000 are also available at the same addresses.

Draper Museum Set to Open

As it opens to the public this summer, the Draper Museum of Natural History is opening new doors of knowledge to the natural wonders of the Greater Yellowstone Ecosystem and its surrounding region.

For the first time in the museum world, the Draper Museum in Cody is incorporating the human element into its exploration of the natural sciences of Yellowstone National Park and four Western environments—from mountain forests to plains—stretching into north-west Wyoming, southern Montana, and eastern Idaho.

Richard Leakey, a renowned paleoanthropologist best known for his battle to save the African elephant, will deliver the keynote speech during opening ceremonies starting at 10 A.M. Tuesday, June 4, at the front entrance to the Buffalo Bill Historical Center.

Since construction began in October 2000, the emergence of this fifth wing has given the Historical Center a dramatic new appearance as its main rotunda now anchors the west side. Built at a cost of more than \$17 million, the 55,000 square-foot museum is named after Historical Center trustee and benefactress Nancy-Carroll Draper.

The museum's emphasis on the human exploration of the Yellowstone region and human influences on the environment afford new opportunities to incorporate the arts and humanities into a model for a high-tech and interactive natural history museum of the future, according to Draper Museum Curator Charles R. Preston, Ph.D.

Preston, formerly of the Denver Museum of Natural History, says the

Draper Museum, bolstered by a \$1.3 million grant from the National Science Foundation, is poised to compile and conduct significant scientific research into the region's plants, wildlife, geology and related natural sciences.

For information about the Draper Museum of Natural History, and a schedule of opening events including Leakey's public lecture, visit www.bbhc.org/dmnh/index.cfm, or call the Buffalo Bill Historical Center, (307) 587-4771.

Errata

Due to an oversight in the article "Tracking Down Yellowstone's Red Fox," published in *Yellowstone Science* 10(1), Brad Swanson, Purdue University (current address Central Michigan University) should have received credit for performing the DNA analysis of all tissue samples, collecting some of the fox tissue, and the creation and analysis of Figure 3 on page 11: Red fox color frequency by elevation. We regret the error. ❁

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Yellowstone Association Institute instructor Duncan Foley teaches a course on "Geysers, Mudpots, and Hot Springs." For more information on this or other YAI courses, visit www.YellowstoneAssociation.org. NPS photo.