# 15 An adaptive approach to elk management in Rocky Mountain National Park

THERESE L. JOHNSON, Rocky Mountain National Park, Estes Park, Colorado 80517; therese_johnson@nps.gov
RYAN MONELLO, Rocky Mountain National Park, Estes Park, Colorado 80517; ryan_monello@nps.gov

## Introduction

A native elk *(Cervus elaphus)* population exerts significant influence on ecosystem processes and conditions in Rocky Mountain National Park. The appropriate elk population size and associated effects on plant communities have been questioned since the 1930s. The population ranges across park boundaries, to winter in the town of Estes Park and on adjacent U.S. Forest Service land.

Elk management in the region is controversial, driven by a number of issues. Inside the park, these focus on changes in plant communities, particularly declines in willow *(Salix* spp.*)* and aspen (*Populus tremuloides* Michx.*)* that have occurred on the primary winter range over the past 60 to 70 years. Elk viewing is very important to park visitors and local residents, particularly in the fall during the mating season when there are phenomenal opportunities to observe elk in very accessible areas. In addition to the importance of the visitor experience, this raises issues regarding tourism and local economies. Other issues are related to human–elk conflicts, especially in Estes Park, including motor vehicle accidents and the impacts of elk on gardens and ornamental plants.

National Park Service (NPS) management policies (NPS 2001) direct managers to preserve natural resources and processes in an unimpaired condition to perpetuate their inherent integrity, recognizing the importance of naturally evolving ecosystems. Natural conditions are defined as those that would occur in the absence of human dominance over the landscape. Observed changes in plant communities in Rocky Mountain National Park have presumably occurred in response to both natural processes and the influence of modern humans. The challenge for managers is to determine what changes are appropriate given NPS mandates.

Humans have influenced ecological conditions in the park and Estes Valley over thousands of years. Native Americans used the area seasonally, and used game drives to harvest elk from 4,000-6,000 years ago until the late 1700s. Since 1860, when Euro-Americans settled in the Estes Valley, human land uses have included market hunting, livestock grazing, logging, fire use and suppression, agriculture, water diversions, elimination of wolves and grizzly bears, predator control, introduction of exotic plant species, development, and recreational activities. Development has continued to increase in the valley, and today there are over 10,000 residents in the Estes Park area. Elk populations in and adjacent to the park have been managed in various ways, ranging from complete extirpation and re-establishment through transplants to regulated population control and natural regulation. Given these substantial human influences, the park's statement for management (NPS 1992) recognizes that natural processes have been interrupted and acknowledges (1) the need for data to define the range of natural conditions and processes, and (2) when necessary, the need for active management to achieve this range.

The value of adaptive management is widely recognized. Defining objectives is critical to an adaptive approach. Clearly there is value in using a non-deterministic

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approach to define objectives in national parks when all key ecosystem components and processes are intact or nearly so (e.g., Yellowstone National Park). However, in the absence of an intact ecosystem, a deterministic approach for defining objectives provides an important basis to evaluate the need for changes in management direction. Accordingly, because of the lack of an intact ecosystem in Rocky Mountain National Park—especially the fact that predators are missing, combined with the significant human presence in key winter range areas—we believe measurable objectives must be defined and a management strategy to achieve those objectives must be developed.

## Research

Managing natural systems requires understanding how systems functioned historically, as well as a capacity to predict the consequences of various actions. Accordingly, NPS and U.S. Geological Survey Biological Resources Division began a major research initiative in 1994 to provide critical information on existing conditions and examine the roles of several key ecosystem processes in Rocky Mountain National Park. A key part of the initiative focuses on using empirical data collected in the park to parameterize a spatial ecosystem simulation model (Coughenour 1993) that integrates various ecosystem components and processes, including elk populations, plant communities, climate, fire, hydrology, and predators, and incorporates stochastic variability. The model will provide managers with an objective decision-making tool with the means to assess natural conditions and predict the results of different potential management scenarios. A final report from the 1994 initiative is nearing completion. Results available to date, highlighted in the following paragraphs, provide some important information for managers.

After elk reductions ended in 1968, the population steadily increased to a current estimate of about 2,700-3,400 animals (Lubow et al. 2001). The population comprises three sub-herds: two that winter within park boundaries and a third that winters in the town of Estes Park. These sub-herds exhibit different population dynamics, most notably significantly higher calf recruitment and survival in the town sub-herd than the park sub-herds (Lubow et al. 2001). After 1968, the park sub-herds initially increased at an annual rate of 7% and then gradually slowed their rate of growth to reach an estimated food-limited carrying capacity of approximately 1,000 animals by 1991 (Lubow et al. 2001). The park sub-populations have been relatively stable, fluctuating around this level for 10-15 years. The town sub-population is currently estimated at 1,700-2,400 and appears to be increasing at an annual rate of 5% (Lubow et al. 2001). Preliminary food-limited carrying capacity estimates for town range from 2,000 to 3,700 animals (Lubow et al. 2001; F. Singer, unpublished data; M. Coughenour, unpublished data), making it unclear whether this sub-herd is at carrying capacity or growing.

Carrying capacity in the town area in 1996 was estimated to be only 5% less than if the area were still in a pristine condition. This is because an increase in forage quality and quantity on fertilized and irrigated pastures and lawn have largely offset the decrease in forage caused by development (F. Singer, unpublished data; M. Coughenour, unpublished data). It is expected that continued development has resulted in and will continue to contribute to further decreases in carrying capacity.

Willow growth and size in Rocky Mountain National Park appears to be primarily determined by the intensity of elk browsing, which was found to significantly reduce willow height (Peinetti et al. 2001a; Zeigenfuss et al. 2001), volume (Peinetti et al. 2001a), and the number of leaves per stem (Peinetti et al. 2001a) on the primary winter range. Elk also substantially reduced willow size over the long term, with willow volume and height being 98% greater inside a 35-year-old ungulate exclosure located on the primary winter range (K. Schoenecker, unpublished data).

Over the past 50-60 years, riparian shrub cover (primarily willow) has declined about 20% in key areas on the primary winter range. Reductions in stream sinuosity and length (69% and 47% decrease in water surface area in Moraine and Horseshoe parks, respectively), primarily due to large beaver declines since 1940, have played an important role in the decline of willow in these areas (Peinetti et al. 2001b). There has also likely been a large transition from tall-willow areas to short-willow areas. It is possible that new willow plants on much of the primary elk winter range in the park will not reach heights much greater than 1 m with the current density of elk and their level of consumption.

Aspen stands on the primary elk winter range and in the heavily browsed Kawuneeche Valley have either not exhibited aspen regeneration for over 30 years and are overmature and deteriorating, or have already been eliminated (Baker et al. 1997; Olmsted 1997; Suzuki 1997). However, on a broader landscape scale aspen stands throughout the rest of the park are successfully regenerating (Suzuki 1997; M. Kaye, unpublished data). Elk currently browse all of the young aspen suckers on the primary elk winter range. Olmsted (1997) found large trees decreased by 42%, with 40% of the stands displaying a noticeable decrease in viable mature trees. Baker et al. (1997) and Olmsted (1979) found aspen cohorts only regenerated on the primary winter range when the elk population size was estimated to be fewer than 600. With one exception, there was no evidence of suckers outside of ungulate exclosures maturing into trees (height > 2.5 m) after 1970, indicating that existing aspen stands are overmature and in danger of losing their above-ground component (Baker et al. 1997; Olmsted 1997). If current trends continue, it is expected that all of the clones on the primary elk winter range will eventually be lost, potentially indicating that the system is outside of its range of natural variability (Weisberg 2000).

Preliminary results from simulation modeling suggest that under natural conditions predation by wolves may have limited elk numbers and resulted in increased willow size and cover on the primary winter range (M. Coughenour, unpublished data). Preliminary results for aspen are mixed, ranging from a slower rate of aspen decline to different levels of long-term persistence on the primary winter range (Weisberg 2000; M. Coughenour, unpublished data).

## Management Approach

Once final research results are available, an elk and vegetation management plan and environmental impact statement (EIS) will be developed to evaluate the full range of future management possibilities. Public input gained through this process will be critical to management decisions. Science will allow managers to define a range of ecologically acceptable conditions that reflect the natural variation in which the system evolved, but science will not produce a precise objective. In addition, several different methods of achieving objectives may be possible. Therefore, there will be some latitude within the indicated range of acceptable conditions for public input to guide management decisions.

We will use an adaptive approach as we proceed with elk management decisions. After objectives have been defined and a management strategy developed through the EIS process, we will implement the strategy in an experimental context, monitoring ecosystem responses and comparing them with responses that were predicted by simulation modeling. As our ecological understanding improves over time we will continue to refine our strategy. Recognizing that reintroduction or recovery of the original array of predators and the elimination of human impacts is improbable, it is expected that this will be a long-term process over many decades, and will continue indefinitely.

## Discussion

Balancing ungulate populations and associated ecosystem effects is a concern in many U.S. national parks. In recent years the natural regulation policy of NPS has been questioned and the need to open dialogue recognized (Wagner et al. 1995). The natural regulation policy is often misunderstood as a strictly “hands off—let nature take its course" policy. Clearly, NPS policy allows for active management intervention to correct for human-caused deviations from natural conditions (NPS 2001). However, the way in which policy has been implemented at Rocky Mountain National Park in the past has not encouraged an active process of evaluating the need for intervention. This is largely because specific criteria for management of a naturally regulated system were not established (Stevens 1980). Clearly iterated, ecologically defined management objectives are needed (Wagner et al. 1995). Park managers are redefining how policy is implemented at Rocky Mountain National Park, with a focus on defining ranges of acceptable conditions, in specific, measurable terms.

Clearly, management is a complex endeavor, one that requires compromises and trade-offs. Differing management objectives among state and federal agencies and local communities will provide significant challenges, and solutions will require cooperation. Simulating natural processes could require active management, and some of the methods that are evaluated could be unacceptable to segments of the public. Because of the inherent uncertainties in potential ecosystem responses, a conservative approach that minimizes long-term risk may be prudent. Non-intervention may pose greater risks to park values and resources than active intervention (Berry et al. 1997). Modeling used in an adaptive context will allow evaluating risks associated with alternative actions or inaction.

It is unlikely that naturalness, as defined in terms of conditions that would prevail without human influence, will ever be achieved in a pure sense. However, by defining acceptable limits of variation in ecological processes managers can develop an operational definition of "natural" that is appropriate in a contemporary context. Ultimately, decisions will be based on society's values, as well as science. As societal values evolve, policies for management of public resources will change to reflect those values.

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