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# Ecological Studies of Bison in the Greater Yellowstone Area: Development and Implementation

## Introduction

**B**ison (*Bison bison*) of the Greater Yellowstone Area (GYA) are perhaps best known to the scientific community from the classic study of Meagher (1973) that reviewed their ecological status and management from the time of establishment of Yellowstone National Park in 1872 through the last National Park Service (NPS) removals of bison within the park in 1966. Since cessation of herd reductions in the park, bison numbers within Yellowstone increased (Dobson and Meagher 1996), as did range use (Meagher 1989b), including increased frequency and magnitude of movements beyond the park boundaries in winter (Meagher 1989a; Pac and Frey 1991; Cheville et al. 1998).

A free-ranging bison herd, distinct from the Yellowstone park herd, was established through the release of a captive group in the southern end of the GYA in 1969. This herd utilizes portions of Grand Teton National Park and the adjacent National Elk Refuge (National Park Service 1996).

Bison of both the northern and southern GYA harbor the exotic bacterial organism *Brucella abortus* (Mohler 1917; Thorne et al. 1978), the causative agent of brucellosis. Brucellosis can cause abortion in domestic and wild ungulates and un-

dulant fever in humans. Concerns over the potential transmission of brucellosis from bison to domestic cattle in Montana, as bison move beyond the northern and western boundaries of Yellowstone in winter, has prompted the state of Montana to kill bison leaving the park since 1984-85 (Dobson and Meagher 1996).

Through the spring of 1996, almost 2,000 bison were killed beyond the park boundaries (Meyer and Meagher 1995; National Park Service 1998). These management ac-

tions have been and remain controversial (Peacock 1997). In 1996, NPS and the state of Montana developed and implemented a new interim program to control the number of bison moving beyond the park boundaries (National Park Service and State of Montana 1996). An estimated 1,100 bison were removed from the Yellowstone park population in the winter of 1996-97 alone (P. Gogan, unpublished data).

A number of ecological factors and park management practices have been suggested as contributing to bison movements. These include upward trends in bison numbers coincident with a series of mild winters in the 1980s. Some hypothesize that the increased size of the bison population impacts the forage resources available in winter. The interaction between bison movements and available forage may be compounded in some winters by snow conditions, which may render forage unavailable to bison. Furthermore, it has been suggested that bison use of plowed and groomed portions of Yellowstone's road system in winter: (1) provides access to forage resources not otherwise available; (2) results in an energy savings to bison, which facilitates over-winter survival; and (3) results in elevated numbers of bison in the park when these two factors are combined (Meagher 1993).

The authors worked cooperatively to identify many data gaps in bison ecology and to develop and implement a multi-faceted research

program to secure the required information. We describe the status of the research program, the coordination between studies, the inclusion of additional studies of the ecology of bison in the GYA, and the realized and intended end products of these studies.

### **Program Development**

The bison research program began in the fall of 1995 when biologists from the park's Yellowstone Center for Resources contacted their counterparts in the National Biological Service (NBS, subsequently reorganized as the U. S. Geological Survey Biological Resources Division, or USGS-BRD, in 1996) to discuss information needs relative to the ecology of bison in Yellowstone. Two preliminary studies were implemented in the park in 1996 (Dawes 1998; Ferrari 1999). The identified information needs quickly expanded to a comprehensive list of research projects relative to the northern GYA. Inclusion in these discussions of biologists from Grand Teton and the National Elk Refuge resulted in identifying and adding research projects for the southern GYA to the list. Identified research projects included:

- A synthesis of trends in bison numbers and habitat use between 1968 and 1998;
- Statistically reliable estimates of the number of bison in Yellowstone;
- Bison seasonal movement patterns and habitat use;
- The role of extrinsic factors

(such as snow conditions and forage availability) in seasonal distribution;

- Effects on bison of winter grooming of portions of the road system within Yellowstone;
- Impacts of bison on the vegetative communities within Grand Teton and Yellowstone;
- Impacts of killing or removing bison on bison population dynamics;
- An ecosystem-level model to calculate bison ecological carrying capacity within Yellowstone; and
- An ecosystem model-based analyses of bison and elk population dynamics and habitat-use relationships in the southern GYA.

These studies were designed to integrate fully with the pilot studies then under way (Dawes 1998; Ferrari 1999). We determined that all data for the northern GYA should be gathered in a manner compatible with a synthesis of findings within the ecosystem model.

We recognized that the most desirable approach was to conduct a comprehensive research effort to address information needs simultaneously. Our next step was to identify potential principal investigators among USGS-BRD and university researchers. Researchers were selected on the basis of their demonstrated ability to conduct comparable studies of bison or other ungulate species in the GYA or elsewhere. Principal investigators were charged

with developing pre-proposals for a package of studies designed to be coordinated and conducted simultaneously so as to realize the maximum synergistic benefit of interactions between researchers. Conducting the studies simultaneously would also result in sharing of resources between both the ecological studies (Table 1) and on-going investigations of the epidemiology of brucellosis in bison. This package of pre-proposals was submitted to the office of the director, USGS-BRD, for funding.

#### **Program Implementation**

We required principal investigators to develop full proposals and secure two written peer reviews of each proposal. A separate independent panel was assembled to review each proposal and accompanying written peer reviews. Members of the panel were selected on the basis of their knowledge of the GYA or bison ecology. Two individuals were selected to serve as co-chairs of the review panel and were charged with submitting a written report of the panel's evaluations to USGS-BRD. The panel met in early June 1997. Each principal investigator made a verbal presentation of the proposed study to the panel. The panel's written evaluation was received the same week (Gasaway and Messier 1997). Principal investigators were required to submit written responses to the review comments or revise the study plan, or both. Funding was released to principal investigators after each

study proposal had undergone complete peer reviews.

A condition of bison research within Yellowstone was that

**Table 1. Ecological studies of bison in the GYA developed jointly by the National Park Service and USGS Biological Resources Division. YNP = Yellowstone National Park, INEEL = Idaho National Engineering and Environmental Laboratory.**

<b>Project Title</b>	<b>Principal Investigator (italics) and Co-Investigators</b>	<b>Funding Source; Status of Project</b>
Utilization of forage by bison in the Gibbon, Madison, and Firehole areas of YNP	<i>L.R. Irby</i> S. Dawes	NPS-NRPP; completed
Assessment of the risk of transmission of <i>B. abortus</i> from bison to elk in the Madison–Firehole winter range	<i>R.A. Garrott</i> M. Ferrari	NPS-NRPP; completed
Statistical analysis and synthesis of 30 years of Yellowstone bison data	<i>M.L. Taper</i> M. Meagher	USGS-BRD; completed
Seasonal habitat selection and movements of bison in YNP	<i>P.J.P. Gogan</i> E.M. Olexa, K.A. Keating	USGS-BRD; on-going
Development of aerial survey methodology for bison population estimation in YNP	<i>R.A. Garrott</i> L.L. Eberhardt, S.C. Hess	USGS-BRD; on-going
Determining forage availability and bison use patterns in the Hayden Valley of YNP	<i>L.R. Irby</i> T. Olenicki	USGS-BRD; on-going
The effects of groomed roads on the behavior and distribution of bison in YNP	<i>R.A. Garrott</i> D.D. Bjornlie	USGS-BRD; on-going
Population characteristics of YNP bison	<i>P.J.P. Gogan</i> K. Podruzny, E.M. Olexa, J.A. Mack	USGS-BRD; on-going
A model-based synthesis of bison and elk habitat use in the Jackson Valley	<i>T. Hobbs</i> F.J. Singer	USGS-BRD / NPS-NRPP; on-going
Spatial ecosystem modeling of Yellowstone bison and their environment	<i>M.B. Coughenour</i>	USGS-BRD; on-going
Genetic analysis of <i>Brucella</i> from bison and the generation of a PCR-based diagnostic system for epidemiological and ecological	<i>R. Rodriguez</i> F. Roberto	USGS-BRD INEEL; on-going

studies		
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the park's resource council, an interdivisional operations coordination group, had to review and approve the study plans. Further conditions of the package of bison ecological studies within Yellowstone were that progress reports be filed with the director of the Yellowstone Center for Resources and that all researchers attend biannual coordination meetings with park biologists and other principal investigators. One USGS-BRD requirement for the studies was that all data files generated during the research activities be provided to USGS-BRD and NPS no later than two years after the completion of each study. Each file must have an associated metadata file that is compliant with Federal Geographic Data Committee and National Biological Information Infrastructure standards.

All studies are either completed or under way, and to date principal investigators have complied with all conditions (Table 1, Table 2).

### Discussion

One of the mandates in the 1998 National Parks Omnibus Management Act is that "the Secretary [of the Interior] is authorized and directed to assure that management of units of the National Park System is enhanced by the availability and utilization of a broad program of the highest quality science and information." This mandate highlights the

importance of science in management of park resources. Accordingly, the GYA bison ecology research program is planned and integrated so as to provide the "highest quality science" for management purposes. It was conceived and has progressed as a joint cooperative effort between management and research biologists. The program is intended to greatly enhance the understanding of bison ecology in the broad sense and integrate past research and the results of new research into a predictive model of the role of bison in the GYA.

The importance and value of data on bison population ecology is underscored by the extensive treatment given to the available data in a recent National Academy of Sciences review of the status of brucellosis in the GYA (Cheville et al. 1998). The report repeatedly stresses the need for more and better information of the types being gathered by these studies. Furthermore, data from these ongoing studies have direct and immediate application to the "stream" of decisions on bison management represented by the interim bison management plan (1996) and other ongoing planning documents in Yellowstone and Grand Teton and future management actions. The data generated thus far have been used in the final environmental impact statement (EIS) for the interagency bison management plan for the state of Montana and Yellowstone Na-

tional Park (2000), including responses to public comments. Park managers and management biologists relied on these data throughout the bison management EIS process and, more importantly, used them to re-

**Table 2. Additional research associated with the cooperative initiative on ecological studies of bison in the GYA. YNP = Yellowstone National Park.**

<b>Project Title</b>	<b>Principal Investigator (italics); Co-Investigators</b>	<b>Funding Source; Status of Project</b>
Snowpack distribution in Grand Teton National Park, Wyoming	<i>K. Hansen</i> P. Farnes, C. Heydon	NPS-NRPP; completed
Snowpack distribution across Yellowstone National Park, Wyoming	<i>K. Hansen</i> P. Farnes, C. Heydon	NPS-NRPP; completed
Evaluation of management alternatives in the <i>Draft Environmental Impact Statement of the Interagency Bison Management Plan</i>	<i>M. Boyce</i> R. Angliss, J. Mack	NPS-NRPP; completed
Winter bison monitoring in the Hayden Valley and Gibbon to Golden Gate sections of YNP	<i>G.L. Kurz</i> D.A. Reinhart	NPS Fee Demonstration Program; completed
Assessing impacts of winter recreation on wildlife in YNP	<i>S. Creel</i> R. Garrott, A. Hardy	NPS Fee Demonstration Program; on-going
The application of conservation genetics to the long-term management of bison in five national parks	<i>J. Derr</i> J. Templeton	USGS-BRD / NPS-NRPP; on-going
Applying dynamic modeling and adaptive management to brucellosis control in the Yellowstone area	<i>J.E. Gross</i> B.C. Lubow, M.W. Miller, T.J. Kreeger	U.S. Department of Agriculture / USGS-BRD / State Partnership Program; on-going
Reproduction and demography of brucellosis infected bison in the southern Greater Yellowstone Area	<i>J. Berger</i> S. Cain, T. Roffe	NPS-NRPP, USGS-BRD; on-going

evaluate and adjust the preferred management alternative identified in the final EIS. Preliminary findings from some studies have been presented to the Greater Yellowstone Interagency Brucellosis Committee, an interagency group addressing the control of brucellosis in the GYA,

and at regional (Bjornlie and Garrott 2000a; Gogan et al. 1998a; Gogan et al. 2000; Hess et al. 2000a; Olenicki 2000) and national (Bjornlie and Garrott 2000b; Gogan et al. 1998b; Hess et al. 2000b) scientific meetings.

The integration of studies and intended synergistic effects of concurrent studies of bison ecology throughout the GYA have worked well to date. The biannual meetings between principal investigators and park biologists have been very productive, with a great deal of exchange and discussion of preliminary findings and refinements in collaboration and research methodology. Data have been gathered at a lower cost and the results have been more informative than would be expected from a sequential series of individual studies. However, the final test will be the extent to which the gathered data are appropriate for setting values for parameters in the spatial ecosystem model (Table 1).

The core group of ecological studies has become a nucleus attracting funding from other sources and generating additional interest from researchers investigating other facets of bison ecology and management in the GYA such as the studies "Assessing Impacts of Winter Recreation on Wildlife in YNP" and "Applying Dynamic Modeling and Adaptive Management to Brucellosis

Control in the Yellowstone Area" (Table 2).

We suggest that the model developed here for studies of bison in the GYA provides a framework for the development of interdisciplinary studies of landscape-level issues in other national parks and protected areas. Key elements of our approach are extensive and continuous communication between management biologists and research biologists, and extensive planning and review of study designs to maximize the effectiveness of the research. However, this program was developed in a state of management crisis, with tremendous disagreement over the state of knowledge of bison ecology, and, consequently, over the wisest management alternative. A far more desirable approach is to provide the levels of funding and staffing to both management and research organizations to enable collaborative program development that anticipates research and management needs five to ten years into the future so that the frequency of management crises may be minimized.

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