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Developing Sustainable Management Policy for the National Elk Refuge, Wyoming

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NUMBER 104

Developing Sustainable Management Policy for the National Elk Refuge, Wyoming

TIM W. CLARK, DENISE CASEY, AND ANDERS HALVERSON, VOLUME EDITORS

JANE COPPOCK, BULLETIN SERIES EDITOR



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Welcome to Readers

The board, staff and supporters of the Northern Rockies Conservation Cooperative, including an anonymous donor foundation, helped bring this publication to life. We did so as an act of faith in open dialogue and as an act of hope for a better relationship between people and the elk, birds, wolves, grasses, soil and water found on and around the National Elk Refuge in Jackson Hole, Wyoming. As of this writing, in the year 2000, there is an enormous opportunity before us to make things better. But improvements only come with sustained effort by a critical mass of people.

Our faith has already been rewarded by the high quality of work put forth by the authors of this volume and by the facts of its publication and distribution to you. Our hope will be rewarded fully if this bulletin is of material value to you.

Thank you for taking time to consider the ideas and information included in this title, and more, thank you for putting this good material to work.



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Member, Board of Directors
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Preface

Garry Brewer and Tim Clark have worked cooperatively on improving natural resource management policy in several contexts—endangered species, ecosystem management, and professional problem solving. In early 1998 Garry Brewer, then director of the University of Michigan’s Erb Environmental Management Institute, approached Tim Clark with the idea of pooling resources to address a management problem in Jackson Hole, Wyoming. In turn, Tim—professor at the Yale School of Forestry and Environmental Studies and president of the Northern Rockies Conservation Cooperative in Jackson—approached the manager of the National Elk Refuge, Barry Reiswig, about the possibility of focusing attention on this world-renowned refuge, which supports thousands of elk each winter and many other species year round. In recent years, questions have been raised about what management policies and practices are appropriate for the refuge, how they should be carried out, by whom, and for whose benefit.

The timing for this appraisal was opportune. First, rising levels of conflict in recent years in the region highlighted a need to resolve a number of substantive and procedural problems concerning management of the refuge and the elk. Second, the National Wildlife Refuge System Improvement Act, passed by Congress in 1997, calls for comprehensive planning on all wildlife refuges. Third, not only have there been changing uses and values of the refuge in recent decades, but the public has been demanding more involvement in management of natural resources. Fourth, the Department of the Interior decided in 1999 to undertake a multi-year, multi-million-dollar environmental impact statement on management of the National Elk Refuge. Finally, new leaders are emerging who recognize the need and opportunity for change.

Overall, these conditions made our collective effort to examine management policy on the refuge highly relevant and useful. It created an opportunity to take stock of past and present policies and to learn how society might manage its resources more sustainably, make more effective policy decisions, and strengthen democratic fundamentals in the future.

Thus, with Barry Reiswig’s enthusiastic cooperation and funding from Garry Brewer’s Erb Institute, Tim Clark invited four Yale FES students to spend the summer of 1998 in Jackson to answer four primary questions. Their findings are published as four chapters in the present volume. Anders Halverson looked at the question “*How should the elk be managed on the National Elk Refuge?*” Christina Cromley asked “*What are the lessons from managing bison on the refuge over the last fifteen years?*” Noah Matson investigated the question “*What is the status of biodiversity on the National Elk Refuge, how can it be monitored, and how can it best be sustainably managed?*” Finally, Brad Kahn took on the question “*What are the uses and values of the National Elk Refuge?*” Additional chapters include Christina Cromley’s history of elk movements in western Wyoming and reprints of two articles by Tim Clark, one describing the lack of a “commons institution” in the elk situation and one providing

a regional context for understanding elk management, both of which suggest improvements.

The next step was to use the four student papers as the springboard for a “civic dialogue” held on March 23, 1999, at the National Museum of Wildlife Art. Diverse citizens and agency personnel contributed to this day-long conversation about elk and refuge management issues and how to achieve consensus. This program and some of the participants’ reactions to it are described in the introductory chapter of this bulletin.

The final step was to approach Jane Coppock, the Editor of the Bulletin Series of the Yale School of Forestry and Environmental Studies, to see if the School would accept our work for publication in the Bulletin Series. Especially because the Series aims to support publication of material that speaks directly to on-the-ground conservation issues, the volume was eagerly accepted and has received financial as well as editorial support from the School.

Where to go from here?

In late 1999 and early 2000 initial meetings were held among several government agencies for preparation of the environmental impact statement for the National Elk Refuge. This bulletin is being offered now at the outset of the EIS and other planning efforts for several reasons. First, with this volume we invite all those who are interested in the future of the refuge to participate in a constructive civic process. Second, these reports can serve as an information base on which citizens and officials can deliberate about how best to manage the elk and their habitat into the new century. Finally, the bulletin suggests some practical, problem-solving ideas for finding our community’s common interests. We hope that readers with diverse perspectives and needs will use this volume extensively in their deliberations, decisions, and actions. We hope, too, that all participants will come to this important dialogue with open minds, an interest in learning, and a vision of the legacy we want to leave our children.

The Editors

Introduction

Tim W. Clark

Northern Rockies Conservation Cooperative, Yale School of Forestry and Environmental Studies,
Yale Institution for Social and Policy Studies

Garry D. Brewer

University of California, Berkeley, Dean of UC Extension and Professor of Environmental Policy and Management,
Energy and Resources Group

The National Elk Refuge in Jackson Hole, Wyoming, is renowned for the thousands of elk that winter there and the many other wildlife species that can be observed year-round. The refuge sits near the center of the Greater Yellowstone Ecosystem (Figure 1), a bioregion of nineteen million acres of national parks, forests, and wildlife refuges with national and global importance. Over ten million visitors enjoy the ecosystem each year, with three million viewing the refuge. The refuge was established in 1912, and generations of committed citizens and federal and state agency officials have taken care of the elk and their habitat over the last nine decades. An important public resource, the refuge's twenty-five thousand acres are all that remains of a much larger, historic winter range. Much of the Jackson Hole elk herd of sixteen thousand animals winters there, while in summer these same elk roam over a million or more acres of public lands, mostly managed by the U.S. Forest Service and U.S. National Park Service. Because this region is a leader in natural resource policy and management, what happens on the National Elk Refuge and adjacent public lands has ramifications far beyond their boundaries.

Currently, there is growing attention on the policies and practices by which the refuge is managed. A vigorous debate is underway in the region about what management goals are appropriate and how management should be carried out, by whom, and for whose benefit. At the same time, the 1997 National Wildlife Refuge System Improvement Act mandates comprehensive planning on this and other refuges. Finally, an upcoming environmental impact statement on elk and bison management in Jackson Hole under the National Environmental Policy Act will further focus the debate. Taken together, these exigencies now provide a rare opportunity for a strategic reassessment of the last few decades of management and open up the possibility for a new, more sustainable direction for policy.

Managing natural resources is becoming more complex as contexts change, as new demands are made on existing institutions, and as people strive to solve emerging problems in diverse and sometimes contradictory ways. No matter what the biological details, management usually boils down to two questions:

- How we are going to use natural resources?
- Who gets to decide?

Taken together, these exigencies now provide a rare opportunity for a strategic reassessment of the last few decades of management and open up the possibility for a new, more sustainable direction for policy.

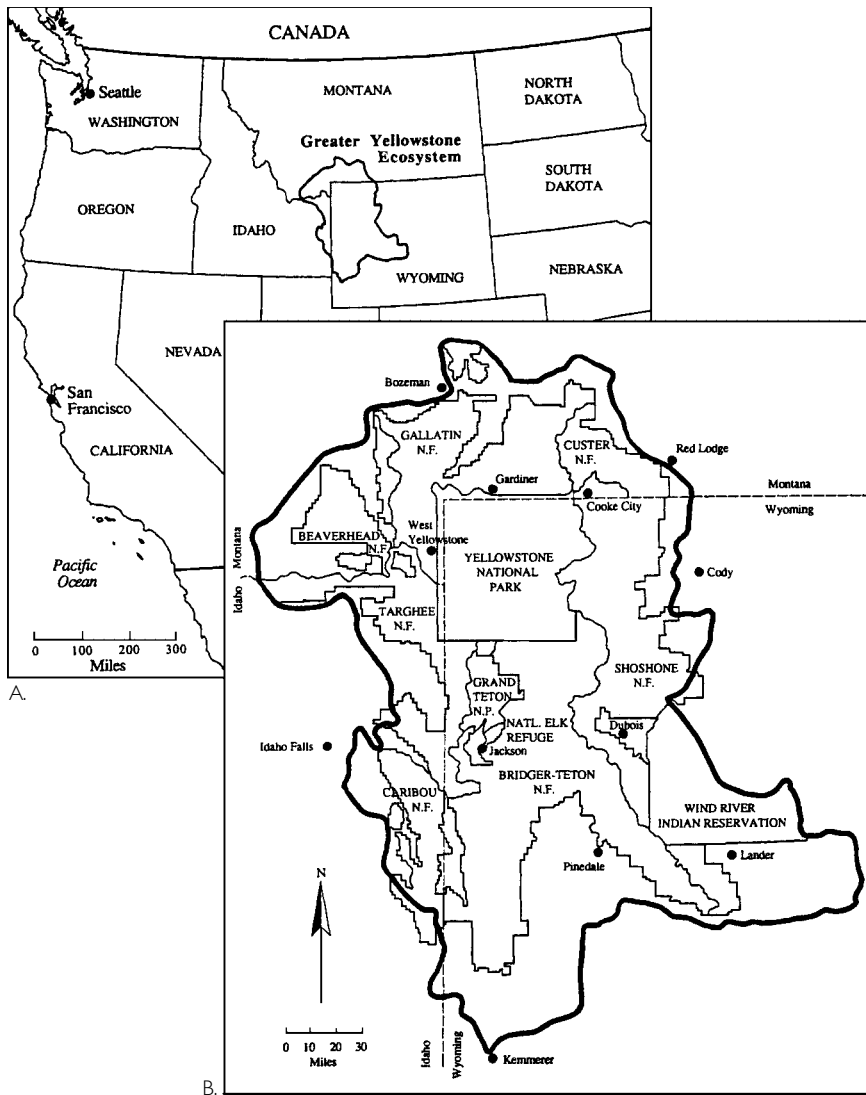


Figure 1 A: Location of the Greater Yellowstone Ecosystem in the Central Rocky Mountains of the United States. B: Administration of the Greater Yellowstone Ecosystem showing major jurisdictions.

We need to harvest the vast experience that is available in Jackson Hole—and elsewhere—in dealing with complex natural resource problems and turn it into practical lessons to improve management of the refuge and the elk. By doing so, we can forge best practices for wildlife conservation, build social capital, upgrade our community problem-solving capacities in the public interest, and create a workable model for others to follow. This volume provides the public and officials with key biological and social science data and policy analytic work that can help all of us decide how best to conserve this unique wildlife refuge, the biodiversity it harbors, and the surrounding landscape.

THE ELK MANAGEMENT DECISION PROCESS

Managing wildlife and land is actually an ongoing process of humans making decisions, not about elk behavior, but about our own actions. Should we limit how much we feed the elk? Should we vaccinate them? Or hunt them? Should we encourage them to range more widely off the refuge in winter? Should we leave them alone? How should we set management goals? Should we adopt a new policy for managing the elk? The management process is about people and what we value, how we interact, and especially how we set up and carry out practices to limit our impacts on the environment, including detrimental affects on wildlife. Because the outcome determines what happens to a public resource, the management process is—or should be—open and public.

The “decision process” has three stages. First, the activities that lead up to a decision include gathering, processing, and disseminating information about the issue, such as data on people’s values and beliefs, the behavior of organizations, and institutional practices as well as the wildlife and ecosystem. This stage also calls for open discussion, debate, and lobbying about the meaning of the data and what should be done with the information. Second, a decision is made based on all the information and debate, resulting in a prescription (plan, law, program, etc.), which should be realistic and detailed enough so that everyone knows what to expect. Finally, the follow-up activities include implementing the decision (administration and enforcement), evaluating the program (done by those formally involved as well as by outsiders), and eventually terminating old ways of doing things and moving on to new ways. Appraisals—formal and informal, public, comparative, and continuous—are particularly important in providing feedback for midcourse “corrections.” Appraisals and adaptation constitute learning.

Because managing elk involves many different people, agencies, and organizations, each with potentially different interests, information, roles, analytic and political challenges, and perspectives, we need to be careful about how we organize ourselves to carry out this decision-making process. A good process will not happen on its own, nor will it come about by recycling standard operating procedures, bureaucratic arrangements, existing conflict, and old ideas. Rarely do people discuss the difficulties and limitations of struggling to decide significant, complex public issues. Yet these interactions make all the difference in whether the decision process—in this case, how elk and the refuge will be managed—will succeed or fail.

Many people despair that decision making is a messy, politicized, irrational process (it’s even called the “garbage can” approach by some people). But recognized standards for good decision processes do exist, and everyone involved should try to make the overall process meet these standards. The decision-making process should be, first of all, rational, comprehensive, and integrated. At the same time it should be selective, targeted, and focused. The biophysical and social information considered in decision making should be reliable; if not, some measure or description of uncertainty (or risk) is needed.

The management process is about people and what we value, how we interact, and especially how we set up and carry out practices to limit our impacts on the environment, including detrimental affects on wildlife.

Decision making should be open and accessible to those with something to contribute or something at stake. The process should also be open to scrutiny. It should be inclusive: “selective omission” may serve personal or special interests and cause unproductive conflict. Timeliness is also essential. The lag between finding a problem and fixing it should be as short as possible, and obsolete or unworkable practices and policies should be corrected promptly. Decision processes should also be honest, flexible, and efficient. Overall, decision making should make things better, not worse.

THE CHALLENGES WE FACE IN MANAGING ELK

In the most general terms, the goal is to manage the refuge and conserve elk in a healthy population in a healthy environment with broad public support. Clearly, there is a shared interest among many people in attaining this goal. But it is equally clear that not all is well: In recent years lawsuits have been filed concerning management of the elk refuge. Conflict has mushroomed among groups that have special interests in the Jackson Hole elk herd, the valley’s growing bison herd, hunting in general, and related issues. The incidence of diseases such as brucellosis and (possibly) tuberculosis has raised concerns. The loss of biodiversity and the presence of some invasive weeds are also troubling. It seems that, beyond the vaguest and simplest statement of our shared goals, our interests diverge. Where is our common interest?

Conflict comes from different views of the problem and what to do about it. These perspectives consist of what people believe and value and how they seek to achieve their values or goals. People’s beliefs and values become organized over time into personal “ideologies” and group subcultures, which serve at the subconscious level to guide people’s behavior. Perspectives function as a “lens” on the world for people to make sense or meaning out of their experiences. Most people are unaware of their own perspective. It is so much a part of their makeup that it is invisible to them, yet they are usually very emotional about defending what they believe in. Even scientists are not free of deep-seated belief systems, although they often view themselves as being neutral, impartial, and objective. At its best, however, science should recognize people’s perspectives and how they figure into natural resource management and policy issues.

Overall, the elk management situation we face is a complex, ill-structured problem with multiple components. It is a *biological* problem because it involves animals and plants and their environment. It is a *political* problem because people with different values are in conflict. And it is a *procedural* problem because there is disagreement about how to understand and resolve the biological and political problems. These intermixed issues make the elk management “system” complex and unpredictable. It is not easy to understand how the many elements are interrelated; like natural systems, human systems show organized forms of complexity with purposeful interactions, and they have emergent, irreducible properties that cannot be understood solely in

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terms of their constituent parts. It is impossible to predict the probabilistic behavior of complex systems by statistical procedures. Ultimately, we cannot expect our “fixes” of constituent parts to solve the problems of the whole system.

Because of these structural aspects of the elk management problem, it is accompanied by a lot of “informational noise.” Information does not appear all at once in a clearly defined package that is easily recognizable by society or even by the professionals directly involved. Part of our task as a community will be to sort out which information is relevant to defining and resolving the problems, what is missing, how to interpret it, and how to complete our picture, or definition, of the problems we face.

Because the elk management problem is complex both socially and technically, it will be difficult to achieve consensus on what the “problem” actually is and what a politically acceptable “solution” might look like. Even if we reach consensus, it may not be possible to get concerted, cooperative action from all participants to remedy the situation. But however we come to define it, the problem will not be solvable by technical means alone (although some people will try to do so) because, at heart, the elk management problem is not a biological, scientific problem: it is a problem of conflicting human values.

Because the elk management problem is complex both socially and technically, it will be difficult to achieve consensus on what the “problem” actually is and what a politically acceptable “solution” might look like.

AVOIDING THE PITFALLS

A broad community of people and organizations will be making numerous decisions over the next few years about management of the Jackson Hole elk herd, the National Elk Refuge, and intersecting issues—federal and state government agencies, local citizens, businesses that depend on viewing or hunting elk, environmental groups, and many others. As these decisions are made, we—whoever wishes to participate—need to watch out for a number of common pitfalls.

- **Let’s not reduce the problem to technical issues.** In the face of political tensions, technical experts often insist that science is the main thing that matters, which only compounds the conflict by sidestepping the critical issues of people’s values and views. In this case there may be a tendency to reduce the overall complexity to biological models of elk carrying capacity, for example. These models are important, but they do not capture the overall problem or suggest what to do about it. Again, the problems in the elk case have many levels of complexity in social and biological systems that we need to address head on. Ignoring them won’t make them go away.
- **Let’s not be waylaid by the inevitable conflict.** Ideological clashes will spawn many conflicts between old and new ways of doing things, between interest groups, between agencies, and between government and non-governmental sectors. Cooperation is possible, but too often conflict and confrontation dominate. As one individual put it, opponents “face one another in a spirit of exasperation, talking past each other in mutual incomprehension...a dialogue of the blind talking to the deaf.” Our

valuable natural resources deserve more than special-interest-based, negotiated settlements, token public participation, rushing to the courts to dispose matters, bullying by government agencies, or whatever happens behind closed doors. All concerned parties must work through their differences to find common ground, a job that requires insight, skill, knowledge, and especially time and leadership.

- **Let's not fall back on the same, weary, problem-solving methods.** In recent years in the Greater Yellowstone area, notably in grizzly bear and bison management, "science" and "bureaucracy" have been the dominant tools put forward to solve these complex problems. Although most will agree that both are *necessary* to solve natural resource management problems, neither is *sufficient* because the problems are neither wholly scientific nor bureaucratic in nature. Too often, politicians, officials, managers, scientists, and the public treat complex, ill-structured problems (such as elk management) as though they were "tame" problems for which definitions are clear and straightforward methods are available. They thus ignore the real-world politics that comes to dominate and are ill equipped to deal with it reasonably, practically, and morally.

- **On the other hand, let's not fool ourselves into thinking we can jury-rig an adequate solution with add-on methods from other fields.** A conglomeration of "off-the-shelf" methods from public relations, sociology, or conflict resolution, overlaying a core of biological and bureaucratic problem solving, will probably not help us solve the fundamental problems of elk management. Nor is there some clever, new method or model waiting to be discovered by natural resource managers. This kind of "methods-thinking" is a false hope. It will not produce the integrated, rational, justifiable, and publicly supported results needed for problems of this scope.

These are, of course, not the only pitfalls. As this decision process unfolds, we as a community need to step carefully and shield ourselves against these all-too-common weaknesses in policy making.

BUILDING PARTNERSHIPS FOR EFFECTIVE PROBLEM SOLVING

People who are concerned about the National Elk Refuge and elk management must create a decision process for themselves that meets the highest standards. The best way to design good policy is, first, with a partnership that can effectively understand and address all the problems at hand, and second, with an integrated, adaptive, problem-solving approach.

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CAPABLE PARTNERSHIPS

It is clear today that the public wants to be involved in elk management and other conservation issues in the region and nation. Pimbert and Pretty (1995) have compared different kinds of public involvement in decision making, ranging from passive participation to self-mobilization. In *passive participation*, the public is merely told what is going to happen or what has already happened, while the information being shared belongs only to officials (and perhaps the outside professionals who generated it). This kind of participation is being rejected by the public. So too is *participation in information giving*, in which people participate by answering questions posed by experts and officials without having an opportunity to influence proceedings. The public is also rejecting *participation by consultation*, in which people are consulted and someone records their written or spoken views. In this case, experts or officials define both the problem and the solution and may (or may not) modify them in response to public input; otherwise, the public is left out of the process. NEPA is an example of participation by consultation. The next level is *functional participation*, in which members of the public join groups that respond to predetermined objectives. Their involvement comes, not at an early stage, but after all the major decisions have been made. Facilitators are often used in this type of participation, which is also being rejected.

Today the public demands more in-depth involvement. In *interactive participation* people participate in joint analysis, which, in turn, leads to action plans and formation of new local groups or the strengthening of existing ones. Through interactive participation, multiple perspectives are built in, and systematic and structured learning actively takes place. This kind of group takes control over local decisions so that people have a stake in maintaining structures or practices. When these kinds of participatory partnerships are not possible, however, some people become *self-mobilized*, taking initiatives to change systems independently of government. Such an approach may challenge the existing structure of authority and control. That is why interactive participation is the preferred way to go.

A genuine partnership, involving diverse people working cooperatively and interactively to address a common problem, would be a highly productive model for elk management in Jackson Hole. One common way of building partnerships is through a community-based effort, which requires government, businesses, environmentalists, community leaders, and residents to engage one another in resolving specific environmental conflicts. "Community-based conservation" originated in the 1990s as a popular form of problem solving. More broadly, it can be considered a revitalized form of governance. Some of these projects are relatively successful, but many are limited by their inability to build "social capital" or by domination of bureaucratic, controlling government agencies. Unfortunately, failure reinforces old ideologies and corrodes trust and future working relations. To make community-based conservation work, participants must be able to loosen the bonds of narrow

A genuine partnership, involving diverse people working cooperatively and interactively to address a common problem, would be a highly productive model for elk management in Jackson Hole.

perspectives and timeworn ways of doing things—a tall task for some rigid individuals and deeply entrenched organizations. Cooperative partnerships require people with appropriate knowledge, skills in problem solving, and good will, and they also require flexible, open organization. Such an approach would offer many benefits in the elk case.

EFFECTIVE PROBLEM SOLVING

It is certain that the elk case will not be resolved with a little technical tinkering. Something more fundamental, substantial, and practical is needed. Elk management should be viewed as a “systems” challenge—a system of decision making. The ideal problem-solving methods we want are *adaptive, integrated, and interdisciplinary*. The three-part scheme outlined below, invented decades ago to address complex problems, is an alternative to the conventional approaches so often applied to natural resource management problems. This simple framework—substantiated by extensive research and practical applications—enables users to manage enormous amounts of ecological and social complexity. It helps people understand situations, outcomes, events, and processes in real-life contexts, and it reveals opportunities to change things for the better.

The ideal problem-solving methods we want are adaptive, integrated, and interdisciplinary.

This framework will not provide quick answers. It is only a set of principles to organize and integrate knowledge to solve problems. It has a “checklist” of things to consider in any conservation project so that users can construct a realistic map of the social context and decision process and use it to define and solve problems. It is rational, integrated, and comprehensive. As Brewer and deLeon (1983: 22) noted, “Other approaches may appear to offer simpler or easier solutions, but each usually turns up lacking in important ways—not the least of these being their relative inability to help one think and understand, and hence to become a more humane, creative, and effective problem solver.” This approach, detailed in the appendix of this volume (“Interdisciplinary problem solving: Next steps in the Greater Yellowstone Ecosystem”), is often described as being *problem-oriented, contextual, and multi-method*.

The three activities that constitute effective problem solving follow. But, first, participants in problem-solving exercises must commit themselves to two standpoints: (1) to be as unbiased and as free as possible from parochial interests, cultural biases, ideologies, disciplinary rigidities, and fixed bureaucratic loyalties; and (2) to seek the common good, which is—in the best description we’ve come across—“a commonwealth of human dignity.”

1. Explore the problem fully. How we characterize the elk management problem will largely determine how we respond to it. Too often in environmental issues, people decide on *biological* solutions before they define the *conservation* problems. If we miscast or under-represent what is involved, we almost guarantee the misallocation of resources and increase chances of failure.

Goals: What goals or ends, both biological and social, does the community want? Are the values behind the goals clear? These may be refined over the course of the analysis.

Trends: Looking back at the history of the situation, what are the key trends? Have events and processes moved toward or away from the specified goals?

Conditions: What factors, relationships, and conditions created these trends, including the complex interplay of factors that affected prior decisions? What models, qualitative and quantitative, might be useful at this stage to explain trends?

Projections: Based on trends and conditions, what is likely to happen in the future? It is important to project several scenarios and evaluate which is most likely. Is this likely future the one that will achieve our goals?

Alternatives: If trends do not seem to be moving toward the goal, then a problem exists and alternatives must be considered. What other policies, rules, norms, institutional structures, and procedures might help us to achieve our goals? Evaluate each in terms of the goals. Select one or more and implement them.

Elk management is concerned with establishing who will make decisions about how we use resources.

2. Ensure an adequate decision process. Elk management is concerned with establishing *who* will make decisions about *how* we use resources. Participants must successfully influence this process if we expect to save species and their habitats. Remember the standards for good decision processes described earlier.

Pre-decision

Intelligence: What information—biological and social—do we need to make good decisions about elk management? Do we have it? What is missing? How do we get it? How will it be integrated and used? Does everyone have the information who wants it?

Promotion: Who is advocating which courses of action for what reasons? Is there adequate opportunity for debate? Who might be served by which courses of action and who might be harmed?

Decision

Prescription: Will the new policy be adequate to solve the problems we have identified? Will it be efficient, effective, and equitable? What are its goals?

Post-decision

Invocation: How will we “invoke,” implement, or enforce the new rules? Who will do it, where, when, and how? Is it authoritative? Are adequate assets available to carry it out? Is it clear under what circumstances we will invoke the new rules, i.e., do people know what to expect?

Application: How will the new rules be administered? By whom? What sanctions will apply if people violate the new rules?

Appraisal: What standards will we use to evaluate whether the new policies have succeeded? Who will do the evaluations? Who will get and act on the evaluations? How will their actions be appraised?

Termination: How will we know when to end this policy and move on to something more fitting? Who will decide? How can we start the process over again smoothly?

3. Understand the context. The human social context is too easily overlooked, ignored, or viewed as a constraint to the central biological task of elk management, when, in fact, it is central to understanding the problem and finding a permanent solution. “Map” the social process as realistically as possible.

Participants: Which individuals and organizations are participating? Who wants to participate or should participate?

Perspectives: What demands are participants making? What expectations do they have? On whose behalf are demands made, i.e., what groups or beliefs do people identify themselves with?

Situations: What is the “ecology” of the situation—geographic features, for instance? Are there any crises? Which institutions are or should be involved? Is the situation organized or not, and is it well organized?

Values: What “assets” do participants have in terms of power, wealth, skill, knowledge (enlightenment), affection, well-being, respect, and rectitude?

Strategies: How are these assets being used? Are people’s strategies educational, diplomatic, economic, or militant? Are these used persuasively or coercively?

Outcomes: What are the results of each decision activity? Who benefits and who is harmed in terms of which values or assets?

Effects: What institutions and practices are promoted and which are set back?

Attending to these three aspects of problem solving increases the chances that, as we tackle the problem of elk management in Jackson Hole, the process will be procedurally and substantively rational, politically practical, and morally justified.

A CIVIC DIALOGUE

“The significant problems we face cannot be solved at the same levels of thinking we were at when we created them.”—Albert Einstein

The elk case represents a strategic opportunity to improve wildlife conservation in Jackson Hole, to integrate competing agency ideologies, and to include diverse groups of people. The idea is to create “a community of good judgment with a license to think.” We need the political will to engage in this kind of

The elk case represents a strategic opportunity to improve wildlife conservation in Jackson Hole, to integrate competing agency ideologies, and to include diverse groups of people.

fundamental sociopolitical change. Government agencies, which now currently control the form and dynamic of the management process, are vested in certain ways of doing things. To modify this arrangement will require change on the part of officials and professionals as well as the public. It will also require “transformative” leaders to encourage and enable change, innovation, and entrepreneurship, excite followers to new levels of activity, and move discussion, self-perception, and action to a new “moral” level.

Foremost, elk management policy should seek a common interest outcome. Finding the common interest is “a process of balancing, accommodating, and integrating the rich diversity of culture, class, interest and personality which characterizes” all policy making (McDougal *et al.* 1981: 207). Many special interests speak out in community decision making and exert influences in favor of decisions that benefit them, sometimes at the expense of the community’s common interest. When special interests dominate public decision making, it can result in less than desirable outcomes.

Several steps have been taken already to move problem solving in the elk case in a more adaptive, cooperative direction. We need to capitalize on these and continue our efforts. This *Bulletin*, the many people who contributed information and ideas, and the scientific information about biological and social issues are all ways to encourage a good management process in the public interest. As described in the appendix of this volume, there are additional designs available for upgrading our efforts, including workshops for “capacity building,” leadership and staff development, and case analyses and appraisals aimed specifically at policy learning. The community might also consider problem-solving exercises, seminars, or prototyping exercises to improve interdisciplinary and interagency coordination.

Toward the goal of finding common interests, a civic dialogue was held on March 23, 1999, at the National Museum of Wildlife Art in Jackson, Wyoming, to address elk management. The Northern Rockies Conservation Cooperative (NRCC) of Jackson, Wyoming, organized this effort in cooperation with the U.S. Fish and Wildlife Service, other organizations, and many individuals. Diverse citizens and agency personnel spent the day in conversation about the elk and how best to conserve them. The impetus for this dialogue was the planning effort over the next few years directed at improving National Elk Refuge management as mandated by Congress. The dialogue began with short presentations from the four student authors of the reports in this volume, followed by a free-ranging discussion on how best to manage the refuge. The specific question addressed by the group was “How can consensus be achieved in terms of elk, bison, and biodiversity on the National Elk Refuge?”

Here is a sampling of responses to the civic dialogue from participants:

“I was quite impressed with the student papers and presentations. Not only were they well researched and replete with valuable information (all of which should be considered in any NEPA process), but they highlighted the complexity surrounding

This Bulletin, the many people who contributed information and ideas, and the scientific information about biological and social issues are all ways to encourage a good management process in the public interest.

the management issues on the refuge. Hopefully, they will be used to increase the public's understanding of this complexity. It would be a shame to have their work simply wind up in the file cabinets of a governmental agency or published in an academic journal that no one reads except peers. Either finding or creating fora for disseminating the information is critical."

"The best aspect was getting various interest groups there to discuss items outside of a particular project, question or controversy. It is good to have a philosophical discussion without the weight of a particular proposal or issue with imminent time lines."

"The three take home lessons are to have more such dialogues, to encourage dialogue among the refuge personnel and members of the public and different interest groups in the public, and to view the refuge in a larger ecological and community context (and carry out management with this broader perspective)."

"(1) This approach gives a forum for each participant to not only hear out other opinions, but to assess in his or her own mind the legitimacy of other opinions. This process of assessing legitimacy is going on whether we acknowledge it or not. It's part of figuring out where the power lines and networks are and aren't. The main thrust of such an assessment of legitimacy is whether a claim to a right or benefit has a public or private 'color,' and if the latter, whether granting it harms the community. I think it's best that this happen in a community forum instead of through preaching to the choir, as it were. (2) The situation in Jackson Hole has reached the point of 'irresistible force meets immovable object.' It's recognition AND acceptance of this fact that opens up other possibilities. This is also the point at which the policy sciences are most fruitful, because they encourage rethinking things in a fundamental way, and of course provide a framework for the rethinking. (3) The question/problem (for me) is one of governance. The answer seems to depend on whether issues such as those impinging upon the National Elk Refuge are sufficient to carry the weight of changing how we make decisions generally. I think they are."

"It has been a catalyst for trying to bring together a 'larger' circle of people to reassess the problems—specifically, the need for an Environmental Impact Statement as a result of the Fund for Animals lawsuit, and generally, managing elk and bison—and most importantly, biodiversity—into and out of Jackson Hole."

"In my opinion, it would be helpful to offer a series of community-wide discussions in which various viewpoints could be more comprehensively developed and then discussed—perhaps one or two viewpoints per session. It may also be useful to conduct some national surveys about Refuge management to solicit input from a national public about both the NER and a broader vision for the National Refuge System. Otherwise, there is the risk of marginalizing the national public's voice."

"I think continued meetings would help. I think it is important to involve any group

"The three take home lessons are to have more such dialogues, to encourage dialogue among the refuge personnel and members of the public and different interest groups in the public, and to view the refuge in a larger ecological and community context (and carry out management with this broader perspective)."

that can upset collaborative processes and might sue. While we don't want to 'give in' to special interests, it is important to include them in discussions to gauge their true concerns and where they might be willing to compromise. I also think some of the next steps might come from participants on their own (i.e., their own personal contacts)."

Clearly, the civic dialogue proved its worth. These kinds of comments make us hopeful that there are people, organizations, and agencies in the region with a lot to offer in terms of thoughtfulness and analytic skills, that they are concerned and willing to contribute time and energy to solving these intransigent problems, and that they want to be part of interactive, participatory processes to manage public lands and resources. We have a rare opportunity ahead of us in deciding how to manage the National Elk Refuge, the Jackson Hole elk herd, and related resource issues, and as a community we can improve the management process as well as the biological outcomes.

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The National Elk Refuge and the Jackson Hole Elk Herd: Management Appraisal and Recommendations

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ABSTRACT

The federal government established the National Elk Refuge and began feeding the elk herd in Jackson Hole, Wyoming, in 1912. Currently administered by the U.S. Fish and Wildlife Service, the program has four goals: to preserve critical winter range for the elk herd, to keep the elk from depredate the nearby ranches, to provide habitat for other species on the refuge, and to provide compatible human benefits. In many ways, the program has been a remarkable success. The once-dwindling elk herd has rebounded and been used to repopulate other areas of the country, depredation has been reduced, the refuge provides habitat for a wide variety of species, and both the herd and the refuge have provided many tangible and intangible human benefits. Numerous problems face the U.S. Fish and Wildlife Service, however. Disease and habitat loss threaten the elk herd, ranchers face economic losses from the risk of interspecific disease transmission, the dense concentration of the elk on the refuge is degrading habitat for themselves and other species, and the human benefits derived from the herd and the refuge are at risk for the same reasons. Furthermore, these problems have become increasingly difficult to resolve as relations between the U.S. Fish and Wildlife Service, the other responsible agencies and non-government organizations, and the general public have become increasingly contentious. This paper appraises the management of the National Elk Refuge and the Jackson Hole elk herd and makes recommendations for resolving some of the problems facing the U.S. Fish and Wildlife Service. These recommendations include increasing public involvement in management decisions, increasing agency knowledge of the social context, holding decision seminars and other problem-solving exercises, and increasing the role of the USFWS in land-use decisions outside the refuge.

In 1994, U.S. Fish and Wildlife Service (USFWS) Director Mollie Beattie called on the agency to take an ecosystem approach to fish and wildlife conservation (USFWS 1984). The current director, Jamie Rappaport Clark, has also called on the Service to “look for new and innovative ways to achieve species and habitat conservation” (J. Clark 1997). This paper examines the role of the USFWS in the management of one of the most important components of the Greater Yellowstone Ecosystem—the Jackson Hole elk herd. Since it created the National Elk Refuge (NER) and began feeding the elk in Jackson Hole, Wyoming, in 1912, the United States government has spent tens of millions of dollars to conserve the herd and to protect nearby ranches from wildlife depredation. One of the first and most visible attempts in the nation to conserve an individual population of what was once a dwindling species, the federal program has in many ways been remarkably successful. The Jackson Hole elk herd has grown to record levels, the herd has been used to restock or supplement herds throughout the United States and Canada, ranches suffer relatively little depredation, and the refuge has become a preserve for a wide variety of species besides elk (Smith 1991; NER Narrative Reports; NER Mission statement).

However, the management of the NER and the Jackson Hole elk herd has become increasingly controversial in recent years. In the courtroom, in the press, on the streets and in meetings, participants frequently argue about issues epidemiological, ecological, and economic. Distrust and ill will among private citizens and the various responsible agencies have rusted the decision-making

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process and made it difficult to resolve such problems openly, comprehensively, and fairly.

Because the NER is one of the flagships of the National Wildlife Refuge System, successful and innovative management may have implications for other national wildlife refuges, for the Greater Yellowstone Ecosystem, and for other attempts at ecosystem management in general (see Clark and Minta 1994).

This paper has three goals: (1) to describe the history of the management of the Jackson Hole elk herd and the NER and the sources of conflict in recent decades; (2) to analyze the management problems using a framework known as the policy sciences; and (3) to recommend strategies that may help the USFWS resolve some of those issues.

STANDPOINT AND METHODS

During the summer of 1998, I interviewed more than 30 people for this project, including representatives from the NER, Grand Teton National Park, the Bridger-Teton National Forest, the Wyoming Department of Game and Fish (WDGF), the Teton County Commissioners, the Teton County Planning Department, the Jackson Hole Land Trust, the Jackson Hole Conservation Alliance, the Teton County Natural Resource District, the Wyoming Wildlife Federation, the Greater Yellowstone Coalition, and local outfitters. I also reviewed 20 years of local newspapers and collected many articles relevant to the NER and the Jackson Hole elk herd. I also read and compiled books, journal articles, and government documents about the NER, the USFWS, wildlife law, wildlife management, and ecosystem management.

I analyzed the data using an interdisciplinary problem-solving framework known as the policy sciences. This framework was designed to help researchers, managers, and decision makers avoid the piecemeal, technically-focused, problem-solving efforts that are so common today (Lasswell 1970). It provides a means of orienting to the problems at hand and their contexts so that practical solutions can be found. Original formulations of this approach can be found in Lasswell and Kaplan (1950), Lasswell (1971), and Lasswell and McDougal (1992). Reviews of the way in which this framework has been applied to other management problems can be found in Clark and Willard (in press) and in Clark *et al.* (1999). A good introduction to the uses of the policy sciences in natural resource management can also be found in Clark (T. Clark 1997).

Very briefly, the policy sciences framework includes three "legs," each of which contains a series of questions that policy analysts must ask if they seek to gain a comprehensive view of the problem at hand. First, in *problem orientation*, the analyst asks questions about both his or her own goals and the goals of the other participants. Since a problem is by definition a discrepancy between a desired state of affairs and an actual or projected state of affairs, it is critical to understand the desired state of affairs, or goals, first (Weiss 1989; Dery 1984). Second and third, the analyst seeks to understand the trends and

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conditions that have led to the current situation. Fourth, the analyst must make projections about the future given the current conditions. Finally, the analyst considers alternatives and makes recommendations for change. Second, the *social process* is a series of questions about the who's and what's. Who are the participants? What are their perspectives? What are their base values? In what situations do they interact? What strategies are they using? What are the outcomes? What are the long-term effects? (Clark and Wallace 1998) Third, the *decision process* includes questions about the how's. How are the participants gathering information? How are they promoting their own point of view? How are policies prescribed? How are they enforced? How are the policies appraised for effectiveness? How are they terminated when they are no longer relevant? (Clark and Brunner 1996)

I present this brief description of the policy sciences so the reader will know the methods I used to analyze the management of the Jackson Hole elk herd and the NER. This paper effectively serves as an appraisal of management and is therefore part of the decision process. The outline of the paper itself essentially follows the problem orientation format. However, I have avoided using policy sciences terminology throughout the rest of the paper in hopes of increasing readability for those unfamiliar with the framework.

STANDPOINT OF THE U.S. FISH AND WILDLIFE SERVICE

Part of the Department of the Interior, the USFWS was pieced together out of the Bureau of Biological Survey and the Bureau of Fisheries in 1940. Since that time, it has undergone name changes, lost some responsibilities, and gained others. Today, the agency employs about 7,500 people at more than 700 offices in both regulatory and land management roles (USFWS, undated). Traditionally, the agency has been segregated into several different divisions. The 92,000,000-acre National Wildlife Refuge System is the largest such division of the USFWS. The system includes 509 individual units in all 50 states and the territories (Fink 1994; NWRSA 1997; Chandler 1985).

Very little, if any, overall strategy has guided the creation of the individual refuges since President Theodore Roosevelt created the first refuge on Pelican Island in Florida in 1903. Instead, refuges have been created to serve localized needs and influences (Fink 1994). The first attempt to provide legislative guidance to the system, the Refuge Recreation Act of 1962 (RRA), was very limited in scope. It authorized the Secretary of the Interior to administer individual wildlife refuges for the purpose of "public recreation when in his judgment public recreation can be an appropriate incidental or secondary use," (Fink 1994; Public Law No. 87-714, 76 Stat. 653 (1962), current version codified at 16 U.S.C. §§ (460(k)-460(k)(4) (1988)).

It was not until the National Wildlife Refuge System Administration Act of 1966 (NWRSA) that Congress consolidated individual refuges into the National Wildlife Refuge System under the jurisdiction of the USFWS and provided some administrative guidance. However, the NWRSA conspicu-

*Who are the participants?
What are their perspectives?
What are their base values?
In what situations do they interact?
What strategies are they using?
What are the outcomes?
What are the long-term effects?*

ously lacked a statement of purpose for the system as a whole. The individual refuges retained their diverse authorities and missions (Fink 1994). In addition, the NWRSAA lacked a planning and public participation requirement. While the 1946 Administrative Procedures Act established decision-making procedures for all federal agencies, it exempted all matters related to “public property” and thus created a loophole for the four federal land management agencies. While acts like the 1976 National Forest Management Act, the 1976 Federal Land Planning and Management Act and the 1978 National Parks and Recreation Act established rule-making procedures for the USDA Forest Service, the Bureau of Land Management, and the National Park Service, there was no corresponding act for the USFWS until 1997. The National Environmental Policy Act of 1969 (NEPA) and the Endangered Species Act of 1973 (ESA) placed some restrictions on the management of the National Wildlife Refuge System, but the agency and the individual refuges retained a great deal of discretion over planning and actions they chose to undertake and the people they chose to include (Moote and McClaran 1997; Fink 1994).

According to a former deputy director of the USFWS, Mike Brennan, the managers of the national wildlife refuges have traditionally had an “inside-the-fence mentality.” Managers were reluctant to try to influence land-use and wildlife decisions outside the refuges and were hesitant to allow individuals and organizations from outside the fence to influence refuge management decisions (Brennan, pers. comm.). In addition, the USFWS has provided very little administrative guidance to its refuge managers since the early 1970s (Reiswig, pers. comm.). Former USFWS director John Turner once told Congress that the regional offices still implemented planning without adequate central oversight and that this had resulted in “a wide variety of hybrid and localized planning efforts.” The lack of guidance also meant that community and political pressures had a great deal of influence on refuge management (Fink 1994).

To rectify some of the problems with the administration of the National Wildlife Refuge System, Congress passed a law amending the NWRSAA in November 1997. Known as the National Wildlife Refuge System Improvement Act (NWRSIA), the legislation was the product of negotiations between Secretary of the Interior Bruce Babbitt, House Resources Committee Chairman Don Young (R-AK), and others (Babbitt 1997). According to the NWRSIA, “The mission of the system is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.”

With the exception of the NWRS lands in Alaska (which are governed by the planning provisions of the Alaska National Interest Lands Conservation Act), the NWRSIA requires each individual refuge or group of refuges to have a comprehensive management plan by 2012. Management plans must be revised every 15 years thereafter. Among other things, each plan must identify and describe significant problems that may adversely affect the populations and

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habitats of fish, wildlife, and plants within the planning unit and the actions necessary to correct or mitigate such problems. In preparing the plans, the USFWS is required to consult with adjoining federal, state, local and private landowners, and affected state conservation agencies, and to coordinate the development of the conservation plan or revision with relevant state conservation plans for fish and wildlife and their habitats. In addition, the USFWS must “develop and implement a process to ensure an opportunity for active public involvement in the preparation and revision of comprehensive conservation plans” (NWRSA 1997).

In sum, the National Wildlife Refuge System has become a more consistent and organized bureaucracy over the years and has become more open to public input. How does the legislative and administrative history of the National Wildlife Refuge System pertain to the NER in particular? Both newspaper accounts and interviews with veteran NER officials indicate that the history of the management of the NER has mirrored the trends and conditions in the system as a whole (Griffin, pers. comm.; Jackson Hole News 1984a). First, in previous decades, the managers of the refuge appear to have had a narrow view of their mission. For example, in the 1980s, bison from Grand Teton National Park began feeding on the feed lines laid out for the elk. The managers declared this to be a problem. “The Elk Refuge was set up to preserve some of the last winter range for the Jackson Hole elk,” one official said. “We don’t have any problems with bison in Jackson Hole, but we do have serious concerns with them on the refuge. We don’t want to see a National Elk and Bison Refuge” (Jackson Hole News 1986). Second, NER managers seem to have resisted opening the decision process to public scrutiny. For example, in 1984, refuge manager John Wilbrecht ordered his staff to kill some of the bison that had entered the refuge. He gave the order without informing the public of his decision. When word leaked out to the local newspaper that five bison had been killed on the refuge, reporters were outraged and the newspaper published a sarcastic editorial about the lack of openness on the refuge (Jackson Hole News 1984a, 1984b; Griffin, pers. comm.).

After the bison incident, the public spoke out. Local residents apparently resented both the closed decision process and the limited vision of the mission of the NER (Jackson Hole News 1984b; Cromley on bison management planning, this volume). After years of meetings and public debate and two changes in administration, refuge officials appeared both to have a broader view of the purpose of the refuge and to be more open to public scrutiny (Reiswig, pers. comm.; Cromley on bison management planning, this volume).

Barry Reiswig took the helm at the NER in 1996. Since that time he has followed the lead set by his predecessor Mike Hedrick and has sought to improve lines of communication with the public and the other agencies. He has also declared bison to be welcome on the refuge and expressed his concern for other species that rely on the refuge (Thuermer 1997a; Teton County Natural Resources District 1998; Reiswig, pers. comm.). In addition, refuge biologist

In addition, the USFWS must “develop and implement a process to ensure an opportunity for active public involvement in the preparation and revision of comprehensive conservation plans” (NWRSA 1997).

Bruce Smith has stepped outside the refuge in recent years and worked with other agencies to study the Jackson elk herd as a whole (Smith, pers. comm.). However, refuge officials still appear hesitant to engage in public and private land management decisions around Jackson Hole that may affect the elk herd. With some notable exceptions, refuge officials do not try to influence management decisions on the Bridger-Teton National Forest, Grand Teton National Park, state lands, or private lands. Reiswig says he hesitates to become involved in such decisions because it would require additional funds and manpower, he does not want to stir up the latent anti-federal sentiment that pervades Wyoming, and he does not see it as a primary part of the USFWS mission. Managing the whole elk herd, he says, is primarily the mission and the responsibility of the state (Reiswig, pers. comm.).

GOALS OF THE U.S. FISH AND WILDLIFE SERVICE

By 1911, hunting and habitat destruction had reduced the total number of elk in North America to around 50,000 animals. One of the largest remaining herds lived in about 2,100 square miles around Jackson Hole. The approximately 20,000 animals summered in the high country of what is now southern Yellowstone National Park, Grand Teton National Park, and the Bridger-Teton National Forest and migrated up to 100 miles in the fall to the valley floor and perhaps to points even further south (Smith 1991). However, the Jackson Hole elk herd began collapsing around the turn of the century as ranches covered traditional winter range and blocked migration routes. In the spring of 1909, dead elk were so thick on the valley floor that one rancher claimed to have walked a mile on their carcasses (Bama 1997). On the flip side, the elk also caused problems for the ranchers by raiding the feed they had set aside for cattle. Some ranchers reportedly spent freezing nights on their haystacks defending their livelihoods from the hungry elk (Bama 1997). After these events were repeated in 1910 and 1911, the outcry from conservationists and desperate ranchers reached Washington, D.C. (Preble 1911). Between 1911 and 1913, Congress set aside 1,000 acres of federal lands and appropriated \$70,000 to purchase emergency feed and 1,760 acres of privately owned ranch land for the elk (Smith 1991; Wilbrecht *et al.* 1995). The goals of the federal government were twofold: to preserve elk in the United States for ethical and economic reasons by protecting one of the last remaining herds and to prevent the Jackson Hole elk herd from depredating local ranches.

Today, thanks to additional donations and appropriations, the refuge encompasses 24,700 acres. But since it still represents a small portion of the herd's historic winter range, managers have continued to feed the elk on the refuge in all but nine of the last 86 years (USFWS 1998). The WDGF, which pays half the cost of feeding the elk on the refuge, also operates three smaller feed grounds nearby. In the winter of 1998, about 8,500 elk ate supplemental feed on the refuge, 3,000 more than esteemed biologist Olaus Murie estimated the refuge could naturally carry (Murie 1951). Several thousand additional elk

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wintered on the three nearby state feed grounds and on standing forage on other public and private lands (Thuermer 1998).

By securing thousands of acres of winter range and supplementing the natural forage with supplemental feed, the federal government has achieved today the goals it laid out in 1912. Very few elk raid ranchers' winter feed lines, winter mortality in the elk herd is now between two and three percent, the population is at an all-time high, and elk from Yellowstone National Park and the NER have been used to supplement or re-establish herds in 25 states and two provinces (Smith 1991).

Over the last several decades, new goals for the NER have also evolved. In a 1987 mission statement, refuge officials declared that it was their goal not only to protect critical elk winter range, but also to preserve "habitat for endangered species, birds and other big game animals, and provide compatible human benefits associated with its wildlife and wildlands" (Griffin, pers. comm.; NER 1987). The NER has succeeded in achieving these goals by default and also through active management. Forty-seven different mammals have been found on the refuge, including moose, bison, bighorn sheep, mule deer, coyotes and pronghorn antelope. One hundred seventy-five species of birds have been observed on the refuge including bald eagles, trumpeter swans, and ospreys. Humans derive benefits from the refuge in many tangible and less tangible ways. For example, economists estimate that elk hunters generate about \$4.5 million of local economic activity each fall (Boyce 1989). In addition, a 1997 USFWS report notes that 562,441 people visited the refuge in that year, and 30,000 tourists viewed the elk on sleigh ride tours of the refuge. Elk-related tourism generated about \$2.5 million in direct revenue for the local economy, the report claims, and generated 41 jobs with a total employment income of \$662,500 (USFWS 1997; Matson, this volume; Kahn, this volume).

In summary, there are four goals for the managers of the NER: (1) to conserve the Jackson Hole elk herd by preserving winter range; (2) to keep elk from depredate on nearby ranches; (3) to preserve habitat for other species including endangered species, birds and other big game animals; and (4) to provide human benefits associated with the NER's wildlife and wildlands. In many ways, managers have been remarkably successful in attaining these goals. However, officials also acknowledge that the goals are becoming increasingly difficult to achieve due to interagency conflict and conflict with the public and special interest groups (Reiswig, pers. comm.; Griffin, pers. comm.).

THE PROBLEMS

The ways in which problems are defined dictate the ways in which they can be resolved. This paper only considers the problems faced by the USFWS with regard to the Jackson Hole elk herd. It defines a problem as anything preventing the USFWS from achieving the four goals listed above. In turn, the problems are broken into two categories. Substantive problems include those things that directly threaten the goals of the USFWS as described above. Procedural

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problems include those issues that indirectly threaten the goals of the USFWS by preventing officials from resolving the substantive problems.

SUBSTANTIVE PROBLEMS

At root, all the substantive problems can be traced to one thing—that the feeding program on the NER and the other feed grounds concentrates too many elk in too small an area in the winter months. The resulting density of elk has had several repercussions.

Brucellosis

One of the biggest controversies in the Yellowstone region in recent years has been caused by a disease known as brucellosis. The disease is caused by a bacterium called *Brucella abortus* which attacks the reproductive organs and lymphatic system of its host. When the disease infects elk, bison, and cattle, it causes spontaneous abortion and usually causes sterility in cattle. Although it is rare, the bacteria may also infect humans and cause a potentially crippling or even lethal disease known as undulant fever (Smith and Roffe 1992).

Brucellosis was first discovered in the United States in 1864 in Louisiana cattle (Keiter and Froelicher 1993). The first tests of Yellowstone bison in 1917 and NER elk in 1930 found those populations to be infected as well, probably by domestic livestock (Smith and Roffe 1992). As the disease did not seem to be overly detrimental to the elk or bison populations, it was not considered a major problem by wildlife managers for many years. However, beginning in 1934, the federal government joined the states in an attempt to eradicate the disease from the country's cattle herds. Costing about \$1.3 billion to date, the program has relied on various methods to eliminate the disease, including vaccination and the occasional slaughter of infected herds (Keiter and Froelicher 1993). The Animal and Plant Health Inspection Service (APHIS), the Department of Agriculture agency in charge of administering the federal program, also regulates interstate transport of livestock. If the agency certifies a state as brucellosis-free, the state is allowed to ship cattle across state lines with few restrictions. However, cattle from states that are not certified brucellosis-free must undergo expensive tests and quarantine before they can be shipped to other states. Thirty states, including Wyoming, are now certified brucellosis-free, and APHIS officials hope to have eradicated the disease from all of the country's livestock within the next year (Thorne, undated; Keiter and Froelicher 1993).

The successful eradication program in domestic livestock has placed increased attention on the infected elk and bison herds around Yellowstone, one of the last strongholds of the disease. The issue was catapulted into the national spotlight in the winter of 1988-89 when the state of Montana killed 569 bison as they exited Yellowstone National Park to prevent the animals from potentially infecting the state's cattle. Although there are no documented cases of wildlife transmitting brucellosis to cattle in the wild, fear of losing its brucello-

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sis-free certification was enough to spur the state of Montana to action (Smith and Roffe 1992). Although it has not received as much national attention, the Jackson Hole elk herd is also heavily infected with brucellosis. According to USFWS biologists, about 28 percent of the elk that wintered on the NER between 1970 and 1991 tested positive for the antibody to brucellosis. Thirty-nine percent of the adult females tested positive during that time. Both Wyoming Game and Fish and USFWS biologists agree that the high rate of brucellosis in the Jackson Hole elk herd is caused by the concentration of animals on feed grounds. In fact, one survey showed that only one to two percent of those elk of the greater Yellowstone area which do not feed at feed grounds were infected by the disease. And according to Wyoming Game and Fish veterinarian Tom Thorne, those non-feed ground elk that tested positive for the disease probably picked it up at a previous visit to a feed ground (Thorne, undated; Smith and Roffe 1992). Wyoming is one of the few states that has established multiple permanent elk feed grounds on such a large scale. Most other states rely more heavily on habitat acquisition and have almost no brucellosis problem within their elk herds.

Other diseases

Brucellosis is not the only disease of concern. Bovine tuberculosis, caused by *Mycobacterium bovis* bacteria, has been present in game-farm elk and deer in the United States and Canada for at least two decades. Wyoming does not allow game farming. But in 1992, 14 captive elk and deer herds in the United States and Canada tested positive for TB, including four in Montana, one in Colorado, and one in Nebraska (Roffe and Smith 1992). Managers of the Jackson Hole elk herd fear that as game farming grows in the surrounding states, so too does the risk that the disease will leap from the captive herds to the wild population. If it did, it could be devastating (Reiswig, pers. comm.).

Mycobacterium bovis usually gets its first foothold in the lymph nodes and spreads slowly to all tissues in the body. Although slightly different from the bacteria that usually cause human tuberculosis, people can readily contract bovine tuberculosis. Treatment in both humans and animals is long, difficult, and prone to failure (Roffe and Smith 1992). Given the proximity of the NER to the town of Jackson, an infection of the Jackson Hole elk herd would be potentially catastrophic for humans and animals alike.

Other diseases of concern include chronic wasting disease, which is related to mad cow disease and has been found recently in deer in southern Wyoming and northern Colorado, septicemic pasteurellosis, a bacterial disease, and scabies, a mite that causes elk to lose their hair and eventually freeze to death (USFWS 1998).

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Habitat

Refuge managers have become increasingly concerned in recent years about the effect of the concentrated elk herd on the refuge itself. Studies based on old photos, exclosures, and surveys have shown a decline in the amount of woody vegetation on those portions of the refuge most commonly frequented by the elk (Matson, this volume; USFWS 1998; Smith, pers. comm.). Elk browsing kills and limits regeneration of species like willow, aspen, and cottonwood. As refuge managers have broadened their focus to animals other than elk, they have become more concerned about the decline in woody plants and the consequent degradation of habitat. The reduction in such woody species has been linked to a decline in passerine bird nesting in Yellowstone National Park (Jackson 1992). It may also limit fish habitat (Smith, pers. comm.).

Cost

In this age of budget cuts, the cost of the feeding program may also become a problem. The WDGF currently shares the cost of feeding the elk on the refuge with the USFWS. In the winter of 1997, the two agencies spent \$443,000 on pelletized alfalfa. Previous winters were similar (USFWS 1998). Although the record-keeping system makes it difficult to calculate exactly how much has been spent on feed and labor over the years, it probably adds up to several million dollars in today's dollars (NER Narrative Reports). While neither agency has indicated any intention of reducing the amount of money spent on the feeding program, both are facing tightened budgets. Such sums cannot go without scrutiny forever.

In sum, all the problems described above are areas where the current and historical goals of the USFWS are not being achieved or are directly threatened. All these problems are related to the large number of elk that are concentrated by the feeding program on the NER in the winter.

Other effects

There are also other, less-studied side effects of the feeding program. For example, because winter mortality has been reduced to two or three percent, the biggest source of mortality in the herd is hunting. This may be exerting different selective pressure on the animals and changing their fitness in an altered management regime. In addition, with supplemental feed so accessible, the herd may have lost its memory of some natural winter range in which to survive the lean months in January, February, and March. Again, this loss of herd memory may affect the fitness of the animals in a changed management regime. Finally, the feeding program has unquestionably changed human perceptions of the elk. Several people interviewed described the elk as "domesticated," a perception with several repercussions. First, although the elk may be challenging to hunt, the knowledge that the animals were feeding on a feed line only a few months earlier may make the experience less enjoyable. In addition, the perception of domestication encourages the development of winter range by developers who believe a bale of hay can replace an acre of habitat.

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PROCEDURAL PROBLEMS

The substantive problems with the management of the Jackson Hole elk herd and the NER cannot be resolved without working out the procedural problems.

U.S. Fish and Wildlife Service

USFWS officials believe the best way to solve the substantive problems is to disperse the herd as much as possible. For many years, federal officials sought to accomplish this goal by acquiring more land for the NER. However, except for a few small parcels, the skyrocketing cost of land in Jackson Hole makes further expansion of the refuge unlikely even if the anticipated political objections could be overcome.

Thus, refuge manager Barry Reiswig is now pursuing other tacks. First, he would like to reduce the number of elk that winter on the refuge by reducing the overall population of the herd. Under a 1975 agreement signed by the WDGF and the USFWS, the number of elk wintering on the refuge is not supposed to exceed 7,500 animals. This agreement clearly states that it is the responsibility of the Game and Fish Department to maintain the objective number of refuge elk through hunting programs (Cooperative Agreement 1974). However, the number of elk wintering on the refuge has exceeded the objective every year since 1986. In 1996-1997, about 11,000 elk wintered on the refuge (USFWS 1998).

According to officials with the WDGF, the elk population began to get out of control in 1984. In that year, the department faced tremendous criticism and political pressure for allowing the total herd size to drop "too low." Only about 5,000 animals were counted on the feed lines that year. Outfitters protested in the streets and legislators criticized the department staff (Gerty 1987a; Jackson Hole News 1984c, 1984d, 1984e). In response, the department changed the hunting rules and allowed the population to increase. Although it has been trying to reduce herd size in recent years, officials say it will probably take several years to change the population growth trajectory. Eventually, state officials say, they would like to return the herd to its objective size (Bohne, pers. comm.; Holz, pers. comm.).

According to Reiswig, however, even the objective level of 7,500 animals may not be low enough to solve the many problems associated with such a large herd. He would like to see the objective number of elk wintering on the refuge reduced to around 5,000 elk (Reiswig, pers. comm.; WDGF 1996). Thus the USFWS is pursuing other means of dispersing the herd as well. For example, NER officials are proposing to install a sprinkler irrigation system to increase the standing forage on the refuge. Reiswig hopes this will reduce the need for feed lines and encourage the dispersal of the elk (Reiswig, pers. comm.; USFWS 1998).

The substantive problems with the management of the Jackson Hole elk herd and the NER cannot be resolved without working out the procedural problems.

State

The state has staunchly opposed the USFWS proposal to reduce the objective number of elk wintering on the refuge to 5,000 animals. Instead, state officials are seeking to solve the problems associated with a concentrated herd through its Brucellosis, Feedgrounds, Habitat or “BFH” program. The “habitat” portion of this moniker refers to the state’s efforts to restore habitat on lands outside the refuge. Each year, state officials work with the Forest Service to conduct prescribed burns and apply other habitat restoration techniques on hundreds of acres of crucial winter range on the national forest. State officials also work with groups like the Rocky Mountain Elk Foundation, the Jackson Hole Land Trust, the Teton County Government, and private landowners to discourage development on private land which is crucial winter range (Thorne *et al.*, undated).

As part of the BFH program, the state is also seeking to control brucellosis through vaccination. Beginning in 1984, the WDGf began vaccinating elk for brucellosis on its feed grounds (Jackson Hole News 1984f). The vaccine, known as strain 19, had previously been used to control the disease in cattle. The program currently costs the state between \$80,000 and \$100,000 a year (Thorne, undated). WDGf veterinarian Tom Thorne asserted that studies on the feed grounds showed the vaccine was about 60 percent effective in reducing brucellosis in elk (Drake 1998). However, other researchers at the University of Idaho and Colorado State University questioned the science by which Thorne arrived at those statistics. Edward Gorton, University of Idaho professor of wildlife resources and applied statistics, wrote, “It appears to me that the vaccination program of elk in Wyoming has been carried out on the basis primarily of hope and faith that it will lead to increased calf survival rather than on the basis of solid evidence that such vaccination will reduce fetal losses among Wyoming elk populations.” Gorton added that he believed the department instituted the vaccination program “for political reasons due to the need for Wyoming’s Game and Fish Department to demonstrate to the ranching community and their legislators that the department is doing what [it] can to protect Wyoming’s brucellosis-free status” (Drake 1998).

Thus, in the winter of 1998, the USFWS refused to allow the WDGf to begin vaccinating elk on the refuge. Barry Reiswig said the service denied permission to the WDGf for several reasons. First, he said, the vaccine has not been proven effective and may cause other ecological problems that have not yet been studied. Second, Reiswig said he believed vaccination for brucellosis was effectively treating the symptom and not the cause. Reiswig believes brucellosis is like the canary in the coal mine: it should be warning managers that the current management regime may be untenable in the long term. If managers cover up brucellosis with a technological fix without creating a comprehensive disease management program, Reiswig said, they may be setting themselves up for worse problems from other diseases later (Drake 1998; Reiswig, pers. comm.).

However, procedural problems in the form of conflict between the responsible agencies and other interested parties have prevented the resolution of the substantive problems (Bohne, pers. comm.; Reiswig, pers. comm.).

In February 1998, Wyoming Governor Jim Geringer filed suit in federal court seeking a declaratory judgment about whether the USFWS had the right to prevent the state from vaccinating the herd on the refuge. The state asserted that it had primacy over wildlife management in Wyoming and therefore had the right to vaccinate the elk on the refuge whether the USFWS approved or not. The case was resolved in favor of the USFWS (Gearino 1998; Drake 1998).

In sum, both state and federal officials are trying to solve the substantive elk management problems in several different ways. However, procedural problems in the form of conflict between the responsible agencies and other interested parties have prevented the resolution of the substantive problems (Bohne, pers. comm.; Reiswig, pers. comm.). Since current and future substantive problems will never be resolved until the procedural problems are at least partially resolved, the rest of this paper focuses on the procedural problems facing the USFWS.

PROBLEM ANALYSIS

THE SOCIAL PROCESS

This section summarizes the participants other than the USFWS, which was discussed earlier, and their perspectives (see also Kahn, this volume).

Wyoming Department of Game and Fish

The WDGF is controlled by the Wyoming Game and Fish Commission. The commissioners and the director of the agency are appointed by the governor of Wyoming. Thus, the agency's policies have come to reflect closely the views of the governor, especially in recent years (Thuermer 1995; Sadler 1995).

The current governor, Jim Geringer, is a Republican who often espouses states' rights ideology. For example, in 1995, he gave a special reception for the commissioners from Nye County, Nevada—the founders of the Wise Use Movement (Jackson Hole News 1995a). Geringer has also frequently complained about the heavy-handed tactics of the federal government in such matters as federal land management and the enforcement of the Endangered Species Act (Testa 1995; Jackson Hole News 1995b).

Another way to understand the perspective of the WDGF is through its mission statement, which declares that the department is to provide “an adequate and flexible system for the control, propagation, management, protection and regulation of all Wyoming wildlife” (Wyoming Statutes 23-1-103). This broad mandate reflects the many pressures facing the agency. On one hand, it is responsible for controlling and regulating wildlife to prevent animals from depredating on private property. If it fails to do so, the agency must reimburse the landowner for damage. In 1994, for example, the department spent almost \$1 million to reimburse landowners for wildlife depredation. This costly mandate reflects the power of the agricultural community in the state. In

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many ways, the agricultural community is one of the department's most important constituents and controlling wildlife one of its most important duties (Thuermer 1997b).

However, the department is also responsible for the propagation and protection of wildlife, and it is not just the enabling statute that makes this such an important function. The WDGF derives almost all its revenues from hunting and fishing licenses (Marlin 1996). In sum, the WDGF faces powerful forces on all sides. Any attempt to change the management regime in recent years has faced tremendous resistance from one side or the other. For this reason, agency officials seem keenly aware of what they perceive to be "politically viable" and are hesitant to change the status quo.

U.S. Forest Service

The Bridger-Teton National Forest encompasses 1,460 square miles of the Jackson Hole elk herd's 2,000-square-mile range, including 73% of the herd's 120 square miles of crucial winter range as defined by WDGF biologists (WDGF 1987).

The National Forest Management Act of 1976 requires the Forest Service "to provide for adequate fish and wildlife habitat to maintain viable populations of existing native vertebrate species." However, the Multiple Use Sustained Yield Act of 1960 also requires the national forests to be "administered for outdoor recreation, range, timber, watershed and wildlife and fish purposes." In addition, the Bridger-Teton National Forest is rich with oil and gas deposits and is frequently the site of drilling operations. Obviously, these diverse mandates occasionally come into conflict in the national forest. For example, wildlife biologists are frequently concerned about the effect of the extensive oil and gas drilling operations, not only on the elk but also on other vertebrates like grizzly bears (Jackson Hole News 1992). Recreational users came into conflict with wildlife interests in 1990 when the Forest Service created a winter travel plan for the forest. Biologists were concerned that snow machines were scaring elk off critical winter range and the Forest Service ended up banning them from certain areas (Jones, pers. comm.).

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National Park Service

Grand Teton National Park and Yellowstone National Park encompass 384 square miles of the elk herd's range. However, very little of this is defined as crucial winter range by the WDGF biologists (WDGF 1987).

It is the mission of the National Park Service as a whole "to conserve the scenery and the natural and historic objects and the wildlife therein" (National Park System Organic Act 1916). While this mission would seem to place the Jackson Hole elk herd high on the list of management priorities for these parks, Grand Teton National Park has at least two other mandates that make this difficult.

First, Grand Teton National Park is one of the only parks in the country that allows hunting. Congress placed this provision in the enabling legislation for the park at the insistence of Jackson locals who were concerned that the Jackson elk herd would otherwise become too large and inaccessible. The hunting program is jointly administered by the National Park Service and the WDFW. The two agencies hold meetings every year to determine how to structure the hunt. Hunters who draw permits are deputized by the Park Service and then allowed to hunt the elk as they move from the summer range in the park onto the adjacent NER (Righter 1982).

While it may be a valuable population management tool for the state, this hunt also creates several problems. First, it is controversial: many members of the public as well as the Park Service dislike having hunting on the national park (Cain, pers. comm.). Second, the hunting pressure pushes the elk off the fall transition range in the park and into the no-hunting zone on the southern half of the NER sooner than they otherwise would go there. This means the elk consume forage on the refuge that might otherwise be available in the winter; less natural forage on the refuge means that supplemental feeding must begin sooner (Reiswig, pers. comm.; Smith, pers. comm.).

Second, Grand Teton National Park is one of the few parks in the country that allows livestock grazing. This provision is problematic in terms of elk management for two reasons. First, the APHIS disapproves of any potential commingling between brucellosis-infected wildlife and cattle for fear of interspecific disease transmission (Thuermer 1997c). In addition, the cattle within the park consume the same forage as the elk. Although it has not been examined in detail, cattle grazing may limit the amount of forage available for the elk within the park in both summer and winter. Summer forage is almost as critical as winter forage for the elk because, without a winter feeding program, elk would have to rely heavily on fat reserves built up over the summer to get through the winter (Smith, pers. comm.).

In sum, the management of Grand Teton National Park is critical to the management of the NER. Grand Teton National Park Superintendent Jack Neckels and wildlife biologist Steve Cain are well aware of these issues, but national and agency mandates and powerful local constituencies force them to make many compromises in management (Neckels, pers. comm.; Cain, pers. comm.).

Teton County Government

Teton County encompasses all of the 2,000-square-mile range of the Jackson Hole elk herd, including the NER, Grand Teton National Park and most of Bridger-Teton National Forest. The Teton County Planning and Zoning Commissioners and, ultimately, the Teton County Commissioners (a separate body) make decisions about how landowners can develop their land based on recommendations from the Teton County Planning Department. Since much of the 26 square miles of remaining crucial elk winter range is in

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I interviewed Teton County Commissioner Sandy Shuptrine and the Teton County Planning Director Bill Collins. According to them, the planning department typically seeks wildlife recommendations from the WDGF when considering planning and zoning decisions. They also seek comment from the National Park Service and the U.S. Forest Service concerning lands within or adjacent to the park or the national forest, but these recommendations are not always heeded. For example, in early June 1999, the Teton County Commissioners were deciding about a small subdivision and invited comment from the WDGF. Department biologists recommended a riparian setback, and then the County Commissioners voted 4 to 1 against accepting the recommendation. "This is a pattern," Shuptrine said, "and I'm afraid that it creates a sense of resignation among the advising agencies like the WDGF." For this reason and because of pressures from higher up in the agency, Shuptrine said, "I feel like Wyoming Game and Fish hangs back in giving us hard information and opinions" (Shuptrine, pers. comm.).

Both Shuptrine and Collins noted that 97 percent of Teton County is in federal hands and that commissioners on both boards tend to believe that a lot of leeway should therefore be given to the landowners who hold the remaining three percent. Although the commissioners may recognize that the private land is often the prime, valley-floor real estate that is so important to wildlife, they also seem to discount this information because they believe game managers can make up for any loss of habitat through such things as the feeding program. For example, during one discussion about a subdivision, a pro-development commissioner stated simply, "The elk will go where we tell them to go" (Shuptrine, pers. comm.; Collins, pers. comm.).

Non-Government Organizations

Perhaps the most important NGOs are the Wyoming Outfitters Association and the Jackson Hole Outfitters and Guides Association. These groups have been extremely active, vocal, and effective in their advocacy of outfitter interests and, more specifically, of a large elk herd. In 1984, for example, the outfitters, in conjunction with a sister group known as Concerned Citizens for Elk, complained that the population of the Jackson Hole elk herd had dropped too low. The organizations advocated increased feeding and reduced hunting on elk cows. They held demonstrations, wrote letters to the editor, and complained to their legislators. As a result, WDGF officials say they decided to allow the herd size to increase. The current population, much higher than the agreed objective, is a direct result of the 1984 protests. The outfitters have also relied on lawsuits to pressure both state and federal agencies (Bohne, pers. comm.; Jackson Hole News 1984d, 1984e).

Interestingly, the group that represents the hunters in the valley and across Wyoming is often at odds with the outfitters. Although not all members feel the

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same way, a staff member and former head of the Wyoming Wildlife Federation, Lloyd Dorsey, has called on the state to phase out the feed grounds because of all the problems they cause (Dorsey, pers. comm.). The hunters are also often at odds with the outfitters over the allocation of hunting permits. The outfitters typically want more licenses issued to out-of-state hunters, and the resident hunters want just the opposite. In fact, the two groups have frequently disputed the permit allocation system (Gerty 1987b).

Another influential NGO in the valley is a relative newcomer, the Fund for Animals. This organization came to Jackson with a former Kentucky resident named Andrea Lococo in 1996 (Jackson Hole News 1996). Since her arrival, Lococo has organized protests and filed lawsuits against elk and bison hunts on the NER and elsewhere (Sosnow 1994; Stanford 1997). Most recently, the Fund for Animals won an injunction blocking a proposed hunt on the Grand Teton bison herd. The agencies had justified the hunt as the best possible means of controlling the bison herd size. However, the Fund For Animals argued the Environmental Assessment for the bison hunt was insufficient because the agencies had not considered terminating the feeding program as an alternative means of keeping the population in check (Simpson 1998). As their most recent victory demonstrates, Lococo and the Fund for Animals are a force to be reckoned with in the valley even though their following appears to be small.

THE DECISION PROCESS

This section analyzes how the USFWS participates in the decision process surrounding the management of the Jackson Hole elk herd and then looks at the decision process on the NER itself.

Management of the Jackson Hole Elk Herd

There have been many attempts at interagency cooperation in elk herd management in this century. The first such attempt, with a group called The Commission on the Conservation of the Elk of Jackson Hole, Wyoming, was created by a federal organization known as the President's Committee on Outdoor Recreation. Active from 1927 to 1935, the group included representatives from the relevant federal agencies, the governor of Wyoming and several NGOs, including the Izaak Walton League, Camp Fire Clubs of America, the National Association of Audubon Societies, the American Game Association and the Boone and Crockett Club. The commission accomplished several things. It recommended that herd numbers be stabilized at a number "not in excess of 20,000 head of all ages," supported land acquisition efforts for the refuge, and funded biology and management studies for the herd (Wilbrecht *et al.* 1995).

During the 1940s and 1950s the relevant federal and state agencies continued to meet and discuss elk herd management in a less formal setting. Perhaps the biggest issue this group faced with regard to elk herd management was the enlargement of Grand Teton National Park in 1950. The controversy involved

There have been many attempts at interagency cooperation in elk herd management in this century. The first such attempt, with a group called The Commission on the Conservation of the Elk of Jackson Hole, Wyoming, was created by a federal organization known as the President's Committee on Outdoor Recreation.

whether and ultimately how hunting should occur in the park. Finally, after years of conflict, the WDGF, the USFWS, the Forest Service and the National Park Service created the Jackson Hole Cooperative Elk Studies Group in 1958. According to one former manager of the NER, “The principal purpose of this committee is to coordinate plans, programs, and findings of studies, and to provide an exchange of ideas, information, and personnel to study the elk herd and its habitat” (Wilbrecht *et al.* 1995).

The Cooperative Elk Studies Group consists of two committees that mirror its two functions. The Executive Committee includes the manager of the NER, the superintendent of Grand Teton National Park, the Bridger-Teton National Forest supervisor, and the regional supervisor of the WDGF. This committee meets once a year to coordinate management decisions regarding the elk herd. The Technical Committee includes biologists and other staff members from all of the member agencies. This committee meets as often as needed to coordinate studies and public relations campaigns, exchange technical information, and make recommendations to the Executive Committee. Since staff members of the different agencies frequently meet in small groups and conduct work together, there is a fuzzy line between informal contacts and formal meetings under the mantle of the Technical Committee. Among other things, members of the Technical Committee have cooperated on studies of elk calf mortality, the effects of winter recreation on elk, public relations, and habitat restoration. In many ways the Cooperative Elk Studies Group has proven an effective forum for interagency cooperation. However, officials with the WDGF and the NER both said that the group’s effectiveness had been limited in recent years by internal disputes over fundamental policy issues, including who has responsibility for the elk, population objectives, and the vaccination program. The lawsuit between the state of Wyoming and the USFWS over brucellosis vaccination also clouded relations within the group (Reiswig, pers. comm.; Bohne, pers. comm.).

The disputes within the Cooperative Elk Studies Group may also be the result of its limited membership. No members of the public or even the local government are invited to the meetings. Thus, the decision makers have very little social context in which to make their decisions. Leaving the public out of management decisions is not uncommon among federal agencies. Traditionally, agencies like the USFWS and the WDGF have adhered to the “rational model” of bureaucratic planning and decision making. The rational model grew out of the progressive movement in the 20th century and is characterized by the belief that the public interest is rational and unitary. The public is allowed to participate in planning and value judgments, but not in implementation, which is considered the domain of agency experts (Voth *et al.* 1994; Moote and McClaran 1997). This model is based on the expectation that such a division is the best way to achieve the ultimate goal of the rational model—efficiency. Several recent journal articles have questioned, however, whether the goal of efficiency should be the number one priority and whether the

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rational model is the best means of achieving that goal (Voth *et al.* 1994; Moote and McClaran 1997; Gericke and Sullivan 1994). First, one of the prime goals in democracy is public participation in the decision-making process, whether or not it is efficient. Second, several authors have noted that disenfranchising the public from the process of implementation is in fact very inefficient. When participants feel their voices are not heard or understood, they are more likely to appeal and litigate the resulting decision (Gericke and Sullivan 1994).

My interviews indicate that feelings of disenfranchisement may be partially responsible for the recent spate of lawsuits over the management of the NER and the Jackson Hole elk herd. Consider the words of outfitter Harold Turner: “My voice isn’t being heard,” he said. “Not that my voice is any more important than anybody else’s. But, you know, I think the government’s the government. And I’m not sure they listen to anybody unless they have to, unless somebody forces them to” (Turner, pers. comm.).

Management of the National Elk Refuge

NER officials have made a notable effort to open up the decision-making process to the public in recent years. For example, in the fall of 1997, Barry Reiswig approached the Teton County Natural Resource District and asked for help in creating a group of community members to discuss management issues on the refuge (TCNRD 1998).

The Teton County Natural Resource District is part of a state-run program that seeks to help local communities protect their natural resources by providing them with education, expertise, and a forum for discussion. Previously focused on agricultural issues, the district has sought to expand its horizons in recent years as ranching has dwindled in the area and tourism and recreation have boomed. Thus, when Reiswig asked for help, the board members jumped at the opportunity (Jorgensen, pers. comm.). District Supervisor Larry Jorgensen invited about 30 people he thought would be interested to the first meeting in October and several more to the next meeting in January. The attendees included local landowners, state and federal officials, and representatives from other interested groups. However, the meetings were not open to the public and were not advertised (Jorgensen, pers. comm.).

According to several people who attended, the meetings were a pleasant and effective means of encouraging the participants to begin thinking about management issues on the refuge. However, facilitator Dana McDaniel believes part of the reason the meetings were so successful was precisely because they avoided controversy. While they mentioned issues like brucellosis, habitat degradation, and overpopulation of the elk herd, they did not try to address these issues in a comprehensive manner. They did not even try to come up with a vision or a mission statement for the group. Instead, they focused on technical issues like hardening the elk-crossings on one of the streams in the refuge to prevent further habitat degradation and the best means of installing a new irrigation system on the refuge (McDaniel, pers. comm.). Reiswig has also

NER officials have made a notable effort to open up the decision-making process to the public in recent years.

made less formal attempts to open up the decision process on the refuge to the public by meeting with many constituents in various venues.

Lawsuits

Wyoming's lawsuit against the USFWS over vaccinating elk on the refuge is not the only one that has been filed over the management of the Jackson Hole elk herd and the NER. In fact, lawsuits over management have been increasing rapidly in recent years. In 1991, animal rights activists sued to stop the refuge's annual elk hunt. The refuge won (Jackson Hole News 1995c). In 1991, the Parker Ranch filed suit against both the state and federal governments because, the owner alleged, they were responsible for the wildlife that had infected his cattle herd with brucellosis. Although the judge threw that case out because Parker could not prove that wildlife had transmitted the disease, he lambasted both the state and federal governments for not doing more to eradicate brucellosis in wildlife (Thuermer 1992; Keiter and Froelicher 1993). In 1993, the Wyoming Coalition sued the WDFW after the agency shortened the elk hunting season around Jackson Hole. Again the WDFW won (Thuermer 1993). In 1998, the Fund for Animals sued the state and federal governments to stop a bison hunt on the NER and on other public land. The agencies had concluded that a hunt was the best way to keep the bison population in check. However, a district court judge granted an injunction to the Fund For Animals in October 1998 because, he said, the agencies had failed to consider eliminating the feeding program as an alternative means of keeping the population in check (Odell 1998; Urbina 1998).

Such lawsuits may, in some ways, be a desirable part of the decision process. Ideally, they serve to resolve certain issues in an authoritative and comprehensive manner. However, lawsuits are undesirable for several obvious reasons. First, they are costly and time consuming. Second, they tend to breed ill will and distrust. And finally, as one state official said, "You wind up with someone who doesn't know anything about elk making decisions about how to handle the herd" (Bohne, pers. comm.). If managers implement a better decision process, they may be able to reduce the number of lawsuits.

Summary

The increasing number of conflicts over the management of the NER and the Jackson Hole elk herd are symptoms of an insufficient decision process. If present trends continue, management is only going to become more difficult in future years for the USFWS and the other agencies involved for several reasons:

- (1) The decision-making process does not adequately take the social process into consideration. Because many of the participants directly affected by management decisions are not involved in the decision process, they are unlikely to accept the decisions that are made.

The increasing number of conflicts over the management of the NER and the Jackson Hole elk herd are symptoms of an insufficient decision process. If present trends continue, management is only going to become more difficult in future years for the USFWS and the other agencies involved for several reasons.

- (2) Neither the USFWS nor the interagency organizations are engaging in an explicit problem orientation. Without an open discussion of their goals, the participants are unlikely to come up with a comprehensive problem definition. Without a comprehensive problem definition, the participants will probably continue to focus on smaller issues and will never fully consider the alternatives.
- (3) The decision process appears to be narrowly focused and incomplete, yielding similar decisions and solutions. As work begins on the creation of a management plan for the refuge, it may be the ideal time for the USFWS to reexamine its role, its goals and its alternatives.

ALTERNATIVES AND RECOMMENDATIONS

SOCIAL PROCESS RECOMMENDATIONS

From its inception, many different groups from inside and outside the region have helped turn the NER into what it is today. Both local ranchers and national conservationists pushed the federal government to create the refuge. However, today, very few groups are involved in the management of the NER or the Jackson Hole elk herd. Managers have also expressed surprise at the lack of knowledge among local residents about these issues.

Increasing the number of participants in the management of the Jackson Hole elk herd and the NER may aid managers. Gericke and Sullivan (1994) and Moote and McClaran (1997) note that there are several advantages to increasing public participation in agency decision making. First, studies have found that the general public typically has more moderate views on natural resource management issues than either the participating agencies or the special interest groups (Knopp and Caldbeck 1990). Involving the general public may therefore reduce the level of conflict. Second, public participation will give the agencies a firm understanding of the values and opinions of their constituents and thereby allow them to make better decisions. Third, the public is more likely to approve of the final decision if they feel they have been involved in the decision making. Fourth, it helps build long-term trust between the agency and the public. All of these factors may limit the conflict and lawsuits that currently plague management of the herd and the refuge.

Increasing the number of participants in decision making might be accomplished through specific activities such as the Teton County Natural Resource District meetings or “decision seminars,” outlined below. It might also include less formal activities. Either way, the key to involving the public is to show them that their opinions count in the final decision. In addition to increasing local knowledge about the NER, it may also be helpful for managers to increase their knowledge about the social context. To date, much of the research money on the NER goes into biological and ecological studies despite the fact that such problems and their potential solutions are relatively well understood. Very little money goes into social science research despite the fact that it is human

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value judgments that are responsible for the problems. Social science research may help managers understand the problems better. Managers may want to hire professional social scientists to conduct polls and determine local attitudes and values associated with the elk herd.

PROBLEM ORIENTATION RECOMMENDATIONS

The way in which problems are defined is critical to the way in which they are resolved. Currently, the substantive and scientific problems such as brucellosis and habitat degradation are heavily emphasized. Placing more emphasis on the procedural problems that plague management of the herd and the refuge may also aid refuge managers.

The decision seminar is a format that has been used successfully to solve problems all over the world (Burgess and Slonaker 1978). However, to date, such problem-solving exercises have not been used in the Greater Yellowstone Ecosystem. Such seminars might be very useful in solving the problems with management of the Jackson Hole elk herd as well as the NER. Clark (on the GYE, this volume) reviews the potential use of such seminars in the Greater Yellowstone Ecosystem. Brewer (1986) reviewed methods for conducting such seminars.

The managers of the NER may also wish to hold one or a series of decision seminars. Such a seminar could be held over a period of several days. The goal of the seminar should be to find the common interest in the management of the NER and the Jackson Hole elk herd. The structure of the seminar should be clearly spelled out from the beginning. There are three critical components to any decision seminar. First, the goals of the seminar must be clearly set out and understood by the participants. The goals should allow for refinement and promote consensus. Perhaps the goal of the first such seminar should simply be to improve the decision-making process on the NER and the Jackson Hole elk herd.

Second, the decision seminar must integrate multiple methods and disciplines. Such interdisciplinary methods encourage a diversity of approaches to problems and innovative solutions. For this reason, I recommend inviting a variety of participants from both within and outside the region and from a variety of disciplines. At a minimum, the invited participants should include: (1) the Wyoming Game and Fish commissioners and the director; (2) local representatives of the WDGF, representatives from the other relevant agencies, and representatives from the Teton County government and the town of Jackson; (3) representatives from influential NGOs and academic institutions; (4) representatives with extensive experience in the use of such decision seminars for the management of natural resources.

Third, the participants must have a clear idea of the local context. Again, this can be facilitated by inviting all the local interest groups and agencies. The seminar may also be more productive if USFWS officials were to gather more information about the social context before the seminar.

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DECISION PROCESS RECOMMENDATIONS

Managers of the NER have long acknowledged that it is impossible to manage the refuge without seeking to influence management of the herd. The biggest threat to the Jackson Hole elk herd remains the loss of their winter range. And if population numbers remain the same, the more winter range that is lost outside of the refuge, the more elk that will be crowded onto the refuge itself. This will increase the substantive problems. Thus, officials may want to increase their involvement in land use decisions off the refuge. Refuge officials have traditionally avoided trying to do this largely because neither they nor the other participants believe the USFWS has the authority to do so (Reiswig, pers. comm.). However, as Michael J. Bean and Melanie J. Rowland point out in their excellent book, *The Evolution of National Wildlife Law* (summarized below), this is not necessarily the case (Bean and Rowland 1997).

The idea that the state has the ultimate authority over game management traces its roots back to the 19th century when the U.S. Supreme Court decided a number of cases pertaining to wildlife. In *Geer v. Connecticut* (U.S. 1896), Justice Edward White articulated what has come to be known as the state ownership doctrine. He held that the states had the right “to control and regulate the common property in game...as a trust for the benefit of the people.” The Supreme Court confirmed that decision in a 1912 case known as *The Abby Dodge*. Almost immediately thereafter, however, the court began to back away from the idea that the state ownership doctrine precludes federal wildlife regulation. In a series of later cases the Supreme Court found that the federal government has the constitutional right to regulate wildlife through its treaty-making power, property power, and the commerce clause. Some of the cases involving property power and the commerce clause appear to be particularly relevant to the issues surrounding the management of the NER and the Jackson Hole elk herd (Bean and Rowland 1997).

The precedent-setting case of *Hunt v. United States* (U.S. 1928) began after the U.S. Forest Service decided to lower the deer population on the Kaibab National Forest because officials feared overbrowsing was damaging the forest. When state officials tried to block the deer removal program on the grounds that it violated their game laws, the United States brought suit and the case made it all the way to the Supreme Court. Although the state relied on *Geer v. Connecticut* as the cornerstone of its defense, the Supreme Court did not even mention that case in its final decision. The court found that “the power of the United States to thus protect its lands and property does not admit of doubt...the game laws or any other statute of the state...notwithstanding” (Bean and Rowland 1997).

A 1976 case known as *Kleppe v. New Mexico* confirmed the decision in *Hunt v. United States* and several other such cases. It is, according to Bean and Rowland (1997), “the Court’s most recent, and probably definitive, pronouncement on the property clause as a basis for federal authority to regulate wildlife.” The case revolved around a 1971 law known as the Wild Free-

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Roaming Horses and Burros Act that declared all unclaimed horses and burros on federal lands to be “an integral part of the natural system of public lands” and protected them as such. When New Mexico authorities captured some wild burros and sold them at auction, the Bureau of Land Management demanded their return. The state instead filed suit seeking to have the law declared unconstitutional. In a unanimous decision the Supreme Court found the law to be constitutional and decided that while the “furthest reaches of the power granted by the property clause have not yet been definitively resolved . . . [the property power] necessarily includes the power to regulate and protect the wildlife living there.” The same decision stated that “it is far from clear . . . that Congress cannot assert a property interest in the regulated horses and burros superior to that of the state” (Bean and Rowland 1997).

The federal government may also have the right to regulate game management under the Commerce Clause of the Constitution. The Ninth Circuit Court upheld federal hunting regulations under the Airborne Hunting Act in a 1979 case known as *United States v. Helsey*. The court found that “Congress may find that a class of activities affects interstate commerce and thus regulate or prohibit all such activities without the necessity of demonstrating that the particular transaction in question has an impact which is more than local” (Bean and Rowland 1997).

In sum, as Bean and Rowland (1997) put it, “It is clear that federal authority to regulate wildlife under the commerce clause is of equal stature to that conferred by the property clause. Accordingly, federal regulation of wildlife pursuant to the commerce clause is unrestrained by the state ownership doctrine. In fact, the contention that state ownership bars federal wildlife regulation has received no authoritative judicial support since the 1912 decision in *The Abby Dodge*, a decision that, though never overruled, has been given a quiet internment.”

On this basis, it appears that managers of the NER have the authority to help manage the Jackson Hole elk herd outside refuge boundaries. As stated earlier, the USFWS also has a need to influence land use outside the refuge if it is to achieve its goals. I believe there are several ways the USFWS could increase its influence outside of the refuge without generating excessive conflict with the public or with other agencies.

First, USFWS officials could seek to sway the decisions of the Teton County commissioners regarding private land use. Both Commissioner Sandy Shuptrine and Planning Director Bill Collins have said they would welcome more involvement by NER staff in planning decisions. Refuge staff would not have to take an advocacy role; they could simply spell out the effects that county actions might have on the elk herd. The local government clearly acknowledges the importance of the elk herd to the economy of the valley and thus, the USFWS would not need to assume an adversarial role if it were to help the WDFG evaluate and describe Teton County’s land use decisions.

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Second, the USFWS might choose to try to influence land use outside the NER through partnerships with various NGOs. For example, the WDGF has already teamed up with various NGOs, such as the Jackson Hole Land Trust and the Rocky Mountain Elk Foundation, to preserve critical elk winter range through easements and outright purchase of land. Mark Berry, the director of stewardship of the Jackson Hole Land Trust, has said he would welcome more contact with refuge staff and would be pleased to engage in a joint conservation project with the USFWS (Berry, pers. comm.).

Third, the USFWS also has funds available to help landowners improve wildlife habitat on their land through the Partners for Wildlife Program. Since its inception at the national level in 1987, the program has developed partnerships with more than 14,000 landowners. In 1996 NER staff member Rox Rogers initiated the Partners for Wildlife Program in Jackson Hole, and in 1996 and 1997, three private land agreements in Teton and Lincoln Counties received funding. However, since Rogers departed, the program has not received as much attention. This program may be a valuable way to preserve elk winter range around Jackson Hole and thereby alleviate some of the substantive problems with the management of the elk herd on the NER (Jackson Hole News 1997).

Fourth, the USFWS could seek to influence land management decisions on the national forest. This would not be unprecedented. Many years ago the predecessor to the USFWS, the Bureau of Biological Survey, helped the national forest map out critical elk habitat on the Bridger-Teton National Forest (Thuermer 1991). The USFWS might choose to aid the Forest Service and the WDGF in their habitat restoration programs.

CONCLUSION

It is worth noting once again that the creation and management of the NER and the feeding program have proven remarkably successful. The once dwindling elk herd has rebounded to record levels, depredation on nearby ranches has been held to a minimum, and the refuge has provided benefits to a host of other species including humans. Despite this success, however, both substantive and procedural problems have been increasing in recent years. Disease, habitat loss, and habitat degradation threaten the elk herd, the nearby ranches, the other species that depend on the refuge, and the associated human benefits. Conflict over the best way to resolve these problems is both the cause and the result of an increase in distrust and ill will between the responsible agencies and other interested parties.

If the refuge managers wish to resolve the substantive problems, they must first begin to resolve the procedural problems. Although there is no overnight cure, I believe there are several ways to begin. First, managers may want to increase their knowledge of the social context. Second, they may want to increase the numbers of private citizens and NGOs involved in the decision process. Third, they may want to hold a decision seminar or other problem-

If the refuge managers wish to resolve the substantive problems, they must first begin to resolve the procedural problems.

solving exercise. And finally, managers may want to become more involved in land use decisions outside the refuge through incentive programs, partnerships with NGOs, and advice to other governments and agencies.

The NER is one of the flagship national wildlife refuges in the United States, and the Jackson Hole elk herd is one of the largest and most well known in the country. In addition, the substantive and procedural problems faced by the managers of the NER are similar to those faced by other refuges across the country. For these reasons, management decisions made on the NER will have regional, national, and perhaps even international implications. It is therefore critical that leaders find ways to resolve the problems that increasingly plague management of the refuge and the Jackson Hole elk herd. If they succeed, they may help the USFWS find “new and innovative ways to achieve species and habitat conservation.”

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Historical Elk Migrations Around Jackson Hole, Wyoming

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ABSTRACT

Natural resource managers today are facing increasingly complex challenges when deciding how to manage elk in and around Jackson Hole. One challenge is how to handle the unintended consequences, such as increased likelihood of disease transmission, from feed grounds around Jackson and around the state. Historical migrations might have prevented some of the problems experienced now with high concentrations of elk. This paper attempts to answer two questions: Where did the elk that spent the summer in the Jackson Hole region spend their winters before and around the time of white settlement? What effects did white settlement have on elk habitat and natural migration patterns? This study mainly concerns migrations through Jackson Hole and those to the Green River Basin. The evidence in primary and secondary sources suggests that elk did indeed migrate through Jackson Hole to the Green River Basin and Red Desert area of Wyoming. However, settlement of the area by whites around the turn of the century seems to have shortened these migration routes, so that elk now over-winter in Jackson. However, it may also be that a population of elk always stayed in Jackson Hole. The study concludes that re-establishing historical migration routes *may* be an ecologically and biologically viable option.

Thousands of elk reside in Jackson Hole, Wyoming, a valley south of Yellowstone National Park. Olaus Murie, renowned wildlife biologist and resident of Jackson Hole, once described elk as one of the “burning topics” in Jackson Hole (Murie and Murie 1966: 121). They remain so today, especially with recent efforts to prepare an environmental impact statement and a long-term plan for elk management. Jackson Hole stands at the center of controversy over elk in large part because it is the site of the National Elk Refuge. The federal government created the refuge in 1912 and initiated an artificial feeding program to ensure the survival of the herd through the winter months, when finding forage is difficult. The designation of the refuge and the artificial feeding programs were viewed as ways to protect the elk and to keep them out of the haystacks of area ranchers. Both the natural forage and supplemental feed concentrate elk on refuge land in the winter, and this concentration of elk has led many people to associate the valley with the elk herds that spend the winter there.

Jackson Hole may not have always been the first choice for elk in the winter, however. Their presence on the refuge in what many consider unnaturally high numbers has been a primary source of a long-standing controversy. Many people speculate that elk only passed through Jackson Hole on their way to warmer valleys in the Green River Basin and Red Desert southeast of Jackson. Numerous secondary sources assert these migrations as fact (e.g., Blair 1987; Murie 1951; Nelson 1994; Richter 1982; Saylor 1970). For example, Allred (1950: 597) stated that “the great semidesert area lying in southern Sublette and Fremont Counties and northern Sweetwater County, in western Wyoming, until 1913 was undoubtedly one of the greatest wildlife wintering areas in the United States.” Allred (1950) discussed parts of shed elk antlers and mounds of

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collected antlers and skulls as physical evidence of migrations and tales from ranchers as sociocultural evidence of migrations. These sources cited fences, poaching, and easily accessible artificial feed in Jackson Hole as factors that contributed to the end of the migrations.

Thus, while the refuge and feeding programs were effective in protecting the elk herd, natural resource managers today must deal with the unintended consequences of the programs' success, one of which is the concentration of elk in the Jackson area. Such concentration may prove beneficial to the tourist industry by attracting tourists to the region, to hunters, hunting organizations, and state game agencies by bringing in revenue from guiding hunts or selling licenses, and to citizens by making elk easy to observe; however, high concentrations can create problems for managers, such as taxing the forage base and facilitating the spread of diseases like brucellosis and tuberculosis. Migrations might have alleviated some of the problems experienced now with high concentrations of elk. Migration routes and corridors also contribute to the health of species by providing avenues for outbreeding and gene flow among different populations (Smith 1996).

In this study, I attempt to answer two questions: Where did the elk that spent the summers in the Jackson Hole region spend their winters before and around the time of white settlement? What effects did white settlement have on elk habitat and natural migration patterns? This study mainly concerns migrations through Jackson Hole and those to the Green River Basin. The evidence comes from secondary sources in various public libraries and from primary sources in the archives of Yale University, Yellowstone National Park, the American Heritage Center in Laramie, Wyoming, the Museum of the Mountain Man in Pinedale, Wyoming, the National Elk Refuge in Jackson, and the Teton County Historical Society in Jackson.

Elk migrate during limited periods, and direct observation will most likely occur by those who live near or frequent migration corridors. The first written records of elk migrations do not appear until whites began to settle the region around 1870. While early settlers' records provide valuable information regarding migration routes, the archival evidence suggests that settlement itself almost immediately shortened migration patterns. This means that there was limited opportunity for direct observation of elk migrations to the Green River Basin and Red Desert if they did exist. The scarcity of records of direct observation, however, does not mean that it is impossible to determine whether such migrations occurred. I have constructed a historical picture of elk migrations by "triangulating" a number of sources and pieces of information—information about ecological conditions and interactions between Native Americans and game species, direct observations by early settlers, secondhand reports of direct observations, and early proposals by game managers to establish wildlife refuges for elk and other species in the area of the Green River Basin and Red Desert. No single piece of evidence provides a strong case that the majority of elk that summered in the mountains around Jackson once

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migrated through the valley. Taken as a whole, however, the evidence strongly suggests that such migrations did indeed occur, perhaps with the exception of a small population that over-wintered in Jackson.

GEOGRAPHY AND HABITAT OF JACKSON HOLE AND THE GREEN RIVER BASIN: WAS MIGRATION A BIOLOGICAL POSSIBILITY?

A primary factor in the quality of habitat is the availability of food, or forage. While information regarding the availability of forage alone cannot lead to conclusions about migrations, it can suggest whether elk migrations to the Green River Basin and Red Desert were desirable and possible.

Northwestern Wyoming contains three valleys that roughly form a triangle. Jackson Hole lies to the north, Star Valley to the south, and the Green River Basin to the southeast. While elk today do not migrate to the Green River Basin, it provides habitat for elk that is in many ways preferable to that in Jackson Hole. It is more verdant than Jackson Hole (Calkins 1973). Most of Sweetwater County itself, through which the Green River flows, receives less than eight inches of precipitation a year and contains high plains desert habitat (Garceau 1997). However, the Green River corridor widens into valleys with arable land that is suitable as wildlife habitat. Less snowfall in the Green River corridor also makes forage more accessible than in Jackson Hole, which receives several feet of snow a year that creates a barrier between the wildlife and forage. Allred (1950: 1-2) claimed that the “heavy beamed, immensely barred, eight-pointed elk antlers” found in the Green River basin constituted evidence that the basin provided forage of high nutritive quality.

While it seems clear that elk would benefit from migrating to the Green River Basin for easier access to forage, two conflicting hypotheses exist regarding the potential movement of elk from the Jackson region to the Green River valley. One report, written by Glen Cole in 1969, claims that, by the time the snow was deep enough to force elk out of Jackson Hole, deep snow would also block mountain passes out of the valley (Anonymous, undated). This argument assumes that snow is the trigger for migration. Altmann (1956), however, claims that cold temperatures and the absence of food (because summer grazing leaves forage so short it is almost flush with the soil by late August) drive elk to the lower country rather than snowfall.

Some of the archival literature discusses the migration of elk to the Green River Basin in relation to the preferable habitat found there. In a report on the Jackson Elk herd in 1927, it was said that: “Formerly herds of elk from the southern part of the Yellowstone National Park and from the high regions along the Continental Divide immediately south of the Park passed Jackson on their autumn migration and wintered in the Green River Basin. The settlement of the country and the introduction of cattle and sheep deprived the elk of this wintering group. As a result the migrating herds now stop in Jackson Hole and vicinity, a region of scant summer rainfall and heavy winter snows in which the elk are unable to get sufficient forage” (Commission on the Conservation of the

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Jackson Hole Elk 1927: 1). This passage highlights the milder winter climate in the valleys surrounding the Green River, which would provide more forage and more accessible forage in the winter. The passage also claims that the migrations did indeed occur.

Why, then, do elk stop their migrations in Jackson if preferable winter habitat lies just south in the Green River valley? To answer this question, I will refer to archaeological and archival evidence that the migrations did indeed occur and that changes wrought in the natural environment by white settlement most likely led to termination of these migrations.

INDIAN USE AND EARLY EXPLORATION

Early use of Jackson Hole by Native Americans might also provide some insight into the historical migration patterns of elk. Information regarding Native American use of the valley can help to establish a baseline of conditions that existed around the time of white settlement, against which to measure changes caused by settlers.

The first well-dated archaeological evidence indicates that people began using the region about 6500 to 7500 B.C. (Wright 1992). The valley eventually became home to or was used by various Indian tribes, including the Bannocks. The oldest evidence of use by nomadic tribes includes an obsidian knife approximately 8,000 years old. It is speculated, however, that these bands occupied the valley only in the summer to gather plants and fish and traveled to more favorable hunting grounds in the winter (Betts 1978). That they moved to more favorable hunting grounds suggests that elk may not have been abundant in Jackson in the winter.

About 150 years before the arrival of white settlers, Indians seemed to have abandoned the valley altogether. Tribes with knowledge of the plant and fish resources of Jackson were displaced by Shoshonean-speaking people who lacked the skills or the desire to harvest plant and fish resources. These tribes inhabited areas outside the valley, presumably where wildlife was abundant. The Blackfeet and Gros Ventres lived to the north, the Crows to the northeast and east, and the Shoshonis to the southeast in the Green River Basin (Betts 1978). Communal hunts occurred in the Green River Basin, as well as on the Great Plains, and on the Snake River Plains west of the Tetons (Betts 1978).

The earliest whites to visit the region, explorers who came to establish fur trading posts, did not stay. John Colter traveled through Jackson Hole in 1807-1808 to make trading contacts with Native Americans for Manuel Lisa's trading posts (Marean 1955). Explorers' journals provide the earliest written records regarding wildlife. While my research did not include an exhaustive survey of them, I examined some writings by explorers that suggest that elk migrated to the Green River Basin. Osborne Russell, who traveled the Rocky Mountains from 1834-1843, reported seeing thousands of antelope migrating down the Bear River toward "their winter quarters which is generally in the Green River valley" (quoted in Blair 1987: 7). A small population of pronghorn antelope

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continues today to migrate three hundred miles between summer ranges in Jackson Hole and winter ranges in southwest Wyoming (Smith 1996). There may be a correlation between antelope and elk migrations: if traveling that distance proved (and proves) advantageous for antelope, it is postulated, it would also have been advantageous for elk (Blair 1987).

SETTLEMENT BY WHITES

Information about habitat, Indian use, and early explorers' observations is not conclusive about the presence or absence of elk in Jackson Hole in the winters on its own. Moreover, it is always difficult to determine the exact causes of wildlife population numbers and behavior. But it is fairly clear that activity by white settlers played a large role in altering the migration patterns of elk. It is clear that new patterns of settlement brought by homesteaders changed whatever dynamic had existed.

The mere presence of people in the region may have changed migration patterns. Indians reported that emigrant trains chased game away from trails (Blair 1987). The Oregon Trail ran north of present-day Sweetwater County, and "emigrant traffic scattered buffalo herds, drove off game, and destroyed grass and timber" when traffic on the Oregon Trail increased during the California Gold rush in the middle of the nineteenth century (Garceau 1997: 17). In 1862, Ben Holladay, a freighter, opened the Overland Trail south of the Oregon Trail. It ran east to west across what is now Sweetwater County, and the settlements of Rock Springs, Bitter Creek Station, and Green River arose as stage stations on the trail (Garceau 1997). By 1869, the Union Pacific Railroad track was completed, and it followed the Overland Train across Wyoming (Garceau 1997). Sweetwater County, in which the Green River Basin is located, began to develop as a ranching and mining frontier.

Green River City became the center of freighting and supply for ranchers in the Green River Basin. In the 1870s, ranchers allowed their cattle to roam in the basin during the winter months, and cowboys rounded them up in the spring. Rancher J. M. Huston, who participated in those early days of open-range herding, said that "We used the west side of the river for summer range, and the desert and river in the winter time" (quoted in Garceau 1997: 22). By 1877, there were at least 11,377 cattle and 1,965 sheep in the area, most of them grazing on public government land.

It did not take long for the population of Sweetwater County to double from 2,561 in 1880 to about 5,000 in 1890. The new settlers brought more livestock, taxing the forage on public lands. To combat overgrazing of public lands, cattle and sheep ranchers began to establish private ranches throughout the county. With private ownership came fences (Garceau 1997).

In 1876, about the time of settlement of present-day Sweetwater, reports from the explorers in the Jackson region suggest that game was also present in Jackson Hole as late as December of that year. Members of an expedition led by Lieutenant Doane reported following a herd of elk on December 1, 1876,

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around the present location of Moose (Potts 1960, 1990). But game was so scarce along the shore of the Snake River that members of the Doane expedition had to shoot horses for meat (Potts 1960, 1990). Eight years later, in 1884, John Carnes and John Holland became the first year-round residents of Jackson Hole (Marean 1955). The town of Jackson itself was created in 1901. With this development came cows, sheep, permanent dwellings, and fences.

Most of the literature that mentions elk migrations suggests that settlement and changes in the landscape coincide with changes in elk migrations. Nelson (1994: 279), for example, states that “When white men first came to Wyoming, the elk summered in the mountains and migrated to the desert plains in the winter. Gradually, as their migration routes were settled by homesteaders, the elk ceased to migrate and tried to winter in the mountains. They starved by the thousands and also caused quite a problem by raiding the ranchers’ haystacks.” Blair (1987) says that the Red Desert and Green River herds of elk were driven back into Jackson Hole by the excessive hunting and settlement they experienced in the Red Desert and Green River.

Saylor (1970) also blames settlement of the Green River Basin in the 1880s and 1890s for shortened elk migration routes. Barbed wire fences on ranches blocked the migration routes. A 1927 report by the National Conference on Outdoor Recreation reported that serious die-offs of elk first occurred when animals were cut off from their natural winter range by this settlement and the fences that came with it. The elk began to collect in Jackson Hole around haystacks (Commission on the Conservation of the Jackson Hole Elk 1927). This report indicates that not only were migration routes blocked, but haystacks provided for an easy source of food in the winter. Artificial feed may have the same effects today as haystacks in the early part of the century in holding animals in place.

Preble (1911: 20) also mentions the appearance of wolves in Jackson Hole, “which were formerly unknown there,” about 1898 or 1900. He goes on to say that they came from the Green and Wind River regions, “probably following the introduction of stock.” While it is impossible to say for sure, if elk were becoming scarce in the Green and Wind River regions and more abundant in Jackson Hole, another factor for the appearance of wolves in Jackson may have been the declining prey base in the Green River and Red Desert. Wolf packs that were introduced in Yellowstone National Park are now found on the National Elk Refuge, most likely because of the abundant elk found on the refuge. Like much of the other historical evidence available, this is not direct evidence of migration, but it supports other evidence.

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EVIDENCE OF MIGRATIONS: DIRECT OBSERVATIONS AND REPORTS OF DIRECT OBSERVATIONS

While early settlers may have changed the distribution of elk in the region, their accounts provide the best indication that elk migrated through Jackson to the Green River Basin. Ira Dodge of Cora, Wyoming, for example, reported that

20,000 elk passed his place in the fall headed for the Red Desert just north of the Green River (Commission on the Conservation of the Jackson Hole Elk 1927). A book written by the granddaughter of one of the first residents of Pinedale, Wyoming, Pauline Canfield Bayer, tells a similar tale. Ms. Bayer used to watch the “annual trek of the elk” from the Jackson region to the desert (Bayer 1988: 152). She reports that they came down through the Hoback Canyon and the Gros Ventre, across the sagebrush flats of Pinedale to the desert. Settlers killed the elk for meat and trapped them to ship east.

While these are the only two direct observations I found in the literature, many secondary sources contain references to direct observation. Much of the writing that suggests that elk once migrated to the Green River Valley via Jackson Hole began when early settlers worried that settlers might in fact drive the elk to extinction. One of the most famous advocates of elk protection and one of the first residents of Jackson, Stephen Leek, wrote letters and notes indicating that migrations through Jackson to the Green River Basin did indeed occur. Leek devoted much of his time to elk, traveling around the country on the Orpheum Vaudeville circuit with photographs of elk in Jackson Hole. He was even called “The Father of the Elk.”

One of the main threats that Leek addressed was illegal hunting, or poaching. Elk were pressured not only indirectly by settlement and the use of forage by livestock, but also directly by “tuskers,” or tusk hunters, who killed elk by the hundreds for their eye teeth. Many poachers came from outside the valley to profit from tusks, which ran as much as \$100 a pair (Betts 1978). The first official attempt to protect elk from white poachers came in the late 1890s in response to a group of tuskers who built cabins in the northern end of the valley and sold elk meat, hides, scalps, and tusks to commercial interests outside the valley (Betts 1978). Guides and outfitters organized an association to help game wardens enforce Wyoming’s anti-poaching laws, and several residents reported poaching activities to authorities (Saylor 1970; Jacoby 1997).

Leek mentioned elk migrations in a report on tusk hunting. He said that “many thousands [of elk] again passed through toward the south as a neighbor remarked ‘You see that black trail yonder on the mountain-side, ten thousand elk have passed over it on their way south to the Red Desert’” (Leek, undated: 1). Leek also made a direct reference to elk migrations in a letter to Mr. Carroll Sprigg of Dayton, Ohio, dated April 7, 1923. Leek says that while “elk used to go lower than this valley to winter, domestic sheep and wire fences forbid their going there any more.” In this letter, Leek also provided some clues about the obstacles to elk preservation at the time. He says that ranchers were beginning to favor sheep over cattle because sheep require less range. This, Leek said, would be detrimental to wildlife because sheep would reduce the availability of winter forage for elk. Leek made it clear, however, that “the future of the elk depends entirely upon the people of this new country” and that “in place of getting their ill will by placing restriction upon the range that they believe is of no benefit to the elk, and ignoring their wishes, it would be better to seek

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their good will and co-operation, make it possible [sic] for them to make a living without getting sheep, and to their interest to perpetuate not only the elk but all game animals of this region.” Thus, Leek recognized that protecting elk required consideration of social and political factors as much as biological factors.

Other secondary sources containing reports of direct observation include reports written just after the migrations were said to end as well as literature written in the middle of the century. Wogenson (1951: 2), for example, reported that elk migrated to the Red Desert and Green River basin. An anonymous speech in the National Elk Refuge files (Anonymous 1936: 2) reports that while up to forty thousand elk stayed in Jackson in the winter “many more migrated south onto the Red Desert where they found sufficient forage to carry them through the winter months.” The Bureau of Biological Survey (Sheldon *et al.* 1935) also reported that “narratives of old-time experiences with game” describe “the annual trek of the elk, the bison, and the antelope when autumn storms cause them to pick their way out of the higher mountains through the Gros Ventre Basin and the Hoback River country into the more favorable winter ranges of upper Green River and the sagebrush areas of western Wyoming.” The Sheldon report included a map of suspected former migrations.

Finally, former National Elk Refuge director Almer Nelson interviewed Emile Wolff and others who settled in Jackson Hole between 1885 and 1890. In a report on the interviews, Nelson (1960) indicated that thirty-five to forty thousand elk stayed in Jackson Hole between 1885 and 1890, that “great bands [also] drifted into the surrounding mountains during the summer months from their winter range on the Red Deserts, Green River, Wind River and other parts of Wyoming,” and that others went west into Idaho over the Teton Pass, Misqueto Creek, and the Koerner Trail.

One final indication of elk migrations to the Green River Basin is the proposal to set up game preserves, in part for elk, in the Green River at about the same time that the above references mentioned the change in migration patterns. Frank Dunham proposed a winter game preserve on the Red Desert north of Green River in Sweetwater County (Blair 1987; Commission on the Conservation of the Jackson Hole Elk 1927). The state game warden made a similar proposal in 1907, including a six-mile-wide strip of land near the head of the Green River Divide (Commission on the Conservation of the Jackson Hole Elk 1927). Finally, the Wyoming legislature passed a proposal in 1909 recommending the protection of an area similar to those proposed in the two earlier proposals.

The migrations seemed to have ended by the early 1900s. Casebeer (1960), a Teton National Forest range conservationist, reported that 1882 was the first record of a disastrous winter loss of elk and that the winter of 1886-87 marked the beginning of the end of migrations to the Green River. Almer Nelson’s (1960) interviews with early Jackson residents supports Casebeer’s reports.

One final indication of elk migrations to the Green River Basin is the proposal to set up game preserves, in part for elk, in the Green River at about the same time that the above references mentioned the change in migration patterns.

Nelson indicated that thirty-five to forty thousand elk stayed in Jackson Hole between 1885 and 1890. While some reported that the last migration occurred as early as 1905 because of settlement of the Upper Green River Valley (Wogenson 1951), others dated the last migratory movement of elk from Jackson to the Upper Green River Valley as late as 1913 (Casebeer 1960) or even 1917 (Allred 1950). An anonymous speech (Anonymous 1936: 2) reported a less firm date, but also placed “the last such migration of elk south...early in this century.” The report cited settlement and sheep herding—reducing available forage for wildlife—as reasons for the termination of migrations. Some reports indicated that a few elk may have started the migration south as late as the winter of 1920-21, when a lone cow was found in a stand of aspen on Shoal Creek, or as late as 1918 when elk could be seen on the ridges of Hoback Basin (Hansen 1922).

EVIDENCE THAT ELK HAVE ALWAYS STAYED IN JACKSON

While much of the evidence indicates that the majority of the elk that summered in Jackson went further south for the winter, there may have always been some elk that wintered in Jackson. A report called “The Government Ranch in Jackson Hole” stated that in 1877 a *Field and Stream* magazine correspondent reported that 15,000 elk wintered south of Yellowstone in the Shoshone and Snake River valleys (although this report is considered to be exaggerated). Wogenson (1951: 2) reported that estimates of the elk herd in Jackson at the turn of the century ranged from “20,000 to 30,000 animals, with some claims of even 60,000.” An anonymous speech in the National Elk Refuge files (Anonymous 1936: 2) also reported that “some of the early settlers have told me that they estimated there were between thirty-five and forty thousand elk here [in Jackson] in the winter.” Leek also reported that “many thousands remained [in Jackson Hole], they were in sight on every hillside, they lined the banks of every stream, they over-ran every ranch in the lower valley” (Leek, undated: 1). He reported, too, that “during the fall of 1910 the elk were driven down from the mountains early by heavy snow storms in more than their usual numbers, but now because of extensive settlements and many wire fences on the upper Green River the elk could not [sic] longer migrate to the Red Desert to winter, but must all remain in Jackson’s Hole” (Leek, undated: 1).

The possibility that elk remained in Jackson during the latter part of the nineteenth century does not preclude the possibility of their also migrating to the Green River Valley and Red Desert. In a study of elk behavior in the early 1950s, Altmann (1956) found that elk break into smaller groups for migration. It seems that many of the citizens making reports on the location of elk were witnessing and recording changes in migration patterns, changes that eventually led the entire elk herd to stay in Jackson Hole over winter.

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CONCLUSION

Evidence in various archives indicates that migrations of elk did indeed occur through Jackson Hole to the Green River Basin and Red Desert. It is difficult to say whether elk herds were also always found in Jackson Hole, although at the time of the settlement of Jackson, evidence suggests that herds broke into smaller groups, with some staying in the valley and some migrating further south to the Red Desert. Factors such as hunting pressure, fences, competition for forage from sheep and cattle, and later the availability of artificial feed seem eventually to have led the entire elk herd to stay in Jackson Hole.

Thus, re-establishing historical migration routes *may* prove a biologically and ecologically viable option. It *may* provide one way to improve management to maintain the health of the herd while also meeting the demands of the many interest groups concerned with elk management.

However, I would like to stress that the information in this paper is meant only to inform the policy process and to provide a historical picture of ecological conditions and does not constitute a management recommendation. For a more complete examination of the biological and ecological potential for re-establishing migrations, see Allred (1950), who discusses attempts by the Wyoming Game and Fish Commission in the 1940s and 1950s to re-establish these corridors. The information provided here is not sufficient to evaluate the potential success of any proposed policy, however. The problems experienced in elk management extend beyond the biological. For example, tension over state and federal control and over agency jurisdiction continues to pervade the elk question. As Stephen Leek observed early in the century, wildlife preservation depends on people, on their interests and demands. Citizens today continue to advocate the inclusion of “representatives of the Jackson Hole community” to “develop a community-based, long-term vision for wildlife management in Jackson Hole” (Day 1998). As with historical debates about elk management, current debates involve the way that communities interact as much as the way animals behave. Only after considering the social and political conditions can the potential for creating and implementing a policy to re-establish historical migration be adequately evaluated.

Thus, re-establishing historical migration routes may prove a biologically and ecologically viable option. It may provide one way to improve management to maintain the health of the herd while also meeting the demands of the many interest groups concerned with elk management.

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Developing Sustainable Management Practices: Lessons from the Jackson Hole Bison Management Planning Process

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ABSTRACT

The National Elk Refuge in Jackson, Wyoming, provides critical habitat not only for elk, but also a host of other wildlife and plant species, including bison. The refuge, in cooperation with state and other federal agencies, began developing an environmental assessment and management plan in the early 1980s for bison that winter on the refuge. The issue evoked much controversy over how to manage the refuge's wildlife. Dissatisfaction with the agencies' handling of the problem led many Jackson community members to become centrally involved in the process. After nearly two decades, the agencies released a final plan and Finding of No Significant Impact (FONSI) in 1997 which many community members accepted. However, the process is not over: lawsuits have blocked implementation of the plan. Examining the obstacles and achievements in the bison planning process offers an opportunity for learning to improve decision making and to inform other refuge planning processes, including a refuge-wide management plan and an environmental assessment for irrigation. The bison planning process showed the need to identify clearly and comprehensively problems and possible obstacles to implementation early in the process. This necessitates consideration not only of technical and natural science information, but also consideration of the social and political context through methods such as ongoing contact with various publics, surveys, monitoring bison and human interactions, and clarifying agency mandates. Identifying problems also requires clarification of how the community and refuge officials and personnel view the purpose of the refuge and its place in the larger community. One way to clarify such refuge goals is to determine more systematically how people value the refuge, including as wildlife habitat, as open space, and as a place to spend time outdoors. Involving the public early in the decision-making process can also help to clarify goals and potential problems as perceived by those outside the agency. Finally, it is important to understand the role of agencies in decision making. In addition to acting as agents for the public, agencies play a key role in the initial and subsequent framing of a problem and can influence public perception of the refuge and its purposes.

From the top of any peak looking down into Jackson Hole, Wyoming, one notices a sharp line, almost as crisp as a line on a map, on the northern end of town where housing and commercial development ends and open space begins. The open space constitutes the National Elk Refuge, one of the first refuges for wildlife and refuges from development. The precious resources protected by the refuge evoke both pride and controversy over resource management within the Jackson Hole community. The crisp visual line blurs when one places the refuge in its larger ecological, political, and social setting.

The bison is one species that blurs that seemingly clear boundary. South of Yellowstone National Park, a herd of about 300 bison inhabits Jackson Hole.¹ The herd spends much of the winter seeking forage on the refuge. Heated debates have engulfed the development of a Jackson bison management plan and environmental assessment (EA), a cooperative process involving the National Elk Refuge, the National Park Service, and Wyoming Department of Game and Fish. It is challenging meeting the management plan's goal of "maintain[ing] a free-ranging bison herd in Jackson Hole, as free from human intervention as practically possible" (Grand Teton National Park *et al.* 1996: 1)

¹ The NER, south of Grand Teton National Park and north of the town of Jackson, was created in 1912 to protect migratory elk that wander out of the protective boundaries of Yellowstone National Park. Later additions of land to the refuge and federal legislation pertaining to national wildlife refuges expanded the purpose of the refuge to include the protection of migratory birds and other wildlife and plant species.

while managing for other species such as elk, minimizing the risk of disease transmission, and implementing management decisions in a complex natural and social environment. The current bison management plan must be seen as part of a continuous process that has improved over the last two decades but has not reached a resolution.

The debate over bison involves a host of issues, some scientific, many political, such as the kinds of science and analysis needed to formulate practical and effective alternatives, the role of state and federal governments in management, the ethics of hunting, and the onus of preventing transmission of the disease brucellosis from wildlife to cattle. The millions of people that live, work, and visit Jackson hold a range of views on how to manage the valley's bison and other wildlife. In addition, the debates are being carried out amid national controversy over managing bison in Yellowstone National Park. The way the Jackson Hole community, working with government agencies, resolves this issue holds lessons for other resource management debates.

The focus of this paper is the planning process that led to the current form of the bison management plan. The goals of the paper are (1) to outline briefly the history of the bison management planning process and EA; (2) to place bison management in a larger community context; and (3) to find the lessons for future natural resource management. With the National Wildlife Refuge System Improvement Act of 1997 mandating all wildlife refuges to develop management plans, learning from the bison EA and management planning process is timely, vital, and can help to improve future planning processes.

A number of methods were used in gathering data for this project. Review of government documents, newspaper and magazine articles, letters, and other written material provided much background information. Participation in meetings on bison and other natural resource issues in the region as well as interviews with government officials, conservationists, ranchers, researchers, and others involved in the bison EA provided data on the social and political situation leading to the ongoing debates over managing bison. Field visits to the refuge were also conducted. In addition, the analysis draws on policy theory from natural resources and other fields to provide insight into the development of the EA. The information was integrated and analyzed using a conceptual, integrative, policy framework called the policy sciences (Lasswell and McDougal 1992).

ARE BISON ON THE REFUGE A PROBLEM?

The intermingling of dwindling bison populations and bison conservation efforts has a long history in the land surrounding Yellowstone National Park, known today as the Greater Yellowstone Ecosystem (GYE). An estimated 40 to 60 million North American bison were reduced to 50 to 1,000 individuals during the nineteenth century as a result of buffalo hunters, possibly disease, the carving up of western lands and bison habitat by railroads and settlers, and other natural and human causes (Flores 1991). In Jackson Hole, the last bison

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were killed by the mid-1800s. The only surviving free-roaming bison herd in Greater Yellowstone—the largest wild herd in the country—resided in Yellowstone National Park (Dary 1989).

The Yellowstone herd was protected under laws prohibiting killing of wildlife in Yellowstone, and bison in Wyoming were protected under a state law passed in 1871.² By 1945, six years after the Wyoming State Legislature repealed the state law, three of the Yellowstone bison wandered into Jackson Hole. In 1948, 20 of the Yellowstone bison were reintroduced to Jackson Hole by the Jackson Hole Wildlife Park, a private, non-profit group sponsored by the New York Zoological Society, the Jackson Hole Preserve, Inc., and the Wyoming Game and Fish Commission. The bison were property of the state of Wyoming until the expansion of Grand Teton National Park in 1950 encompassed the Jackson Hole Wildlife Park. After the expansion, the National Park Service began managing the herd in cooperation with the Wyoming Game and Fish Department.

The Jackson bison, totaling 15-30 individuals until about 1963, were confined to an enclosure during early management days. Management actions in the 1960s focused mostly on winter feeding, hazing animals that left Grand Teton National Park back into the park, and testing for and vaccinating against the disease brucellosis. Brucellosis, if contracted by domestic livestock, can cause severe economic losses to cattle ranchers.³ In 1963 brucellosis was discovered in the herd. Officials killed all thirteen adult bison to eradicate the disease from the herd, and four yearlings and five calves that had been vaccinated were kept. Twelve bison certified brucellosis-free were introduced from Theodore Roosevelt National Park in 1964. The same year, Grand Teton National Park and the U.S. Department of Agriculture signed a brucellosis plan, which prescribed vaccinating all new calves and testing adults every three years. Managers were unaware at the time of the ineffectiveness of calf vaccinations (Grand Teton National Park *et al.* 1996, Camenzind 1994).

About the same time, in the 1960s, the park began moving toward a more “hands-off” management policy allowing natural processes such as starvation and predation to regulate wildlife populations. By 1969, managers stopped hazing bison back into the park and allowed the nine bison to range free (Gerty 1986). Until about 1975, the herd spent the summer in the park and the winter west and north of the park (Gerty 1986).⁴ A limited number of bison began appearing on the refuge in the winter of 1968-69. By 1975 the entire herd—18 animals—began wintering on the refuge. From the winter of 1991-92 to the winter of 1995-96, 149-252 bison (97-100% of the herd) wintered on the refuge (Grand Teton National Park *et al.* 1996).

Managers at first accepted bison seeking forage on the refuge since human settlement in the region limits ungulate winter range. However, agency officials soon began to perceive bison as a problem. In 1980, bison began eating supplemental feed provided for elk on the refuge. By 1982, managers tried unsuccessfully to haze bison away from the elk feed lines. The district

² In 1871, the Wyoming Territorial Legislature passed a law to protect the few remaining bison in the state. The state legislature adopted the law in 1890 when Wyoming became a state. The law did not apply in national parks, however, so it did not affect Yellowstone. In 1894, the apprehension of a bison poacher in Yellowstone spurred the passage of the Lacey Act, which protects bison and other wildlife in national parks. The Lacey Act is still in effect, but the Wyoming state legislature repealed the state law protecting bison in 1939 (Camenzind 1994).

³ The Cooperative State-Federal Brucellosis Eradication Program began on July 19, 1934. It was instituted under an amendment to a bill, the Jones-Connelly bill, designed to begin a cattle reduction program to relieve the cattle industry from economic depression and Midwestern drought conditions. Efforts began in 1935 to test cattle voluntarily for brucellosis. In 1935, elk from the Jackson Hole area became the first wildlife species to be tested for brucellosis. To ensure uniformity in eradication efforts among states, a Uniform Methods and Rules (UM&R) document was adopted in 1947. By 1954, Congress authorized the goal of eradicating brucellosis from the United States. As early as 1960, the Brucellosis Committee began to see the presence of brucellosis in wildlife, especially the Yellowstone population, as problematic to eradication efforts (Frye and Hillman 1997).

⁴ After closing the wildlife park, then Superintendent Bob Kerr promoted moving the herd to “a more compatible environment,” but that recommendation was not taken (Gerty 1986).

supervisor of Wyoming Game and Fish said that “the more bison we’ve got, the more problems” (quoted in Gerty 1986). A Game and Fish biologist said that brucellosis was one reason for controlling the herd (Stump 1982). He also said that bison interactions with elk were perceived as a problem because “now they’re taking forage away from the elk” (quoted in Associated Press 1982). A refuge biologist said, “We don’t want to see a National Elk and Bison Refuge” (quoted in Gerty 1986). These statements indicate a prioritization for elk over bison and different standards for different species.

To address the “problem” of bison competing with elk for supplemental feed, managers established separate feed lines for bison in 1984. The same year, bison gored five U.S. Fish and Wildlife Service horses on the refuge, killing one. Five adult bison were killed as a result. Managers began to see bison as a threat to property and human safety, in addition to claims that supplemental feed for bison reduced winter mortality, placed human influence on a previously naturally regulated population, induced economic costs, and posed property and human safety concerns. Bison also began entering the town of Jackson, although efforts to haze bison further north onto the refuge were successful (Gerty 1986; Griffin 1998; Grand Teton National Park *et al.* 1996). Thus, bison were at this time seen as a problem on the refuge. Throughout this management history, a total of sixty-one bison were shot by private individuals or in management actions.⁵

THE PLANNING AND ENVIRONMENTAL ASSESSMENT PROCESS

THE FIRST PLAN AND ENVIRONMENTAL ASSESSMENT

About 1982 an existing interagency team of biologists, the Jackson Hole Cooperative Elk Studies Group, began drawing up a bison management plan when it became clear that the bison’s seasonal migration to the elk refuge would persist (U.S. Fish and Wildlife Service and National Park Service 1988; Stump 1982). Wyoming Game and Fish officials from Cheyenne told the department’s Jackson representatives not to work on the plan cooperatively because they wanted to develop their own plan (Smith 1998). Thus, Game and Fish biologists took the lead on the plan in 1983, which some questioned since the National Elk Refuge is federal land administered by the U.S. Fish and Wildlife Service. The Wyoming Department of Game and Fish released a management plan for comment in 1985 which called for maintaining the herd at 50 animals, using hunting to cull the approximately 89-animal herd (Lloyd-Davies 1985).⁶

Wyoming Game and Fish offered several justifications for the reduction. They claimed that bison consumed food on the elk feed lines, acted aggressively toward elk, caused property damage, and might transmit brucellosis to cattle grazing in Grand Teton National Park. The plan also stated that “the U.S. Fish and Wildlife Service finds no biological justification for perpetuating a bison herd on the National Elk Refuge, as the Service currently maintains three bison

⁵ Thirteen adults were killed to manage for brucellosis in 1963. During the winter of 1974-75, a private landowner with an inholding in the park killed two bulls on his property. In 1983-84 NER personnel killed five bulls that gored and killed U.S. government horses. In 1987, two bison were shot on the Twin Creek Ranch adjacent to the NER, and in 1988 a single bull was shot on private land near Marbleton, Wyoming. From 1988-1991, thirty-seven bison were shot by agency personnel and sport hunters in an attempt to manage the population size, including three bison shot on private land in the Green River valley in 1990. In 1997, at the request of the Wyoming Livestock Department, the Wyoming Game and Fish Department shot a bison deemed too close to cattle in the Green River Basin (Simpson 1997b).

⁶ A reduction plan required reclassification of bison as wildlife on the National Elk Refuge by the Wyoming Livestock Board, since they were only classified as wildlife on national forest and park lands (Staff 1985). The Wyoming Livestock Board consists of sheep and cattle ranchers appointed by the governor (Gerty 1986). A bison hunt was instituted in Montana the same year.

management refuges” (quoted in Lloyd-Davies 1985). This justification raised a question in many people’s minds regarding the mission of the refuge and the prudence of attempting to prioritize management for one species (Harvey 1998). Several people also mentioned that the refuge manager at the time did not want bison on the refuge and encouraged management practices to minimize their presence (Camenzind 1998b; Griffin 1998; Harvey 1998).

The agency also argued that the increase in bison numbers put the herd over the target population. Such a justification was circular, since it did not independently substantiate the need for the proposed reduction, but instead became a problem only after the reduction target was adopted as a program objective. Such circular arguments have been identified as a common problem termed “self-reference” in literature on group dynamics (Smith and Roffe 1992). Agencies and other “social entit[ies]” tend to define a condition and then “use this definition as the exclusive basis for reflecting on what needs to be redefined” (Smith and Roffe 1992). An analogy may be helpful to explain this concept. “If we notice that water is wet and decide that its wetness is a problem, we may seek a ‘solution’ by attempting to eliminate the wetness of water. No matter how hard we try, that approach is hopeless. By giving up the hope of changing the wetness of water, we no longer become embroiled in the hopelessness of that task and see other alternatives to trying to change what is unchangeable” (Smith and Roffe 1992: 59). In the case of bison, the “wetness of water” may be compared to the migratory nature of bison, an unchangeable condition. Thus, by defining the condition of roaming bison as a problem and setting a population target of 50, the agencies fell victim to the natural tendency to define problems in an irreconcilable way and were unable to look beyond their problem definition.

In 1987, based on the Wyoming Game and Fish plan, the National Elk Refuge (U.S. Fish and Wildlife Service) and Grand Teton National Park devised a management plan and EA. The goal of the plan was to manage a growing herd, reduce economic hardship, and manage for potential safety concerns. The plan set a population size of 50 animals, using an agency hunt to kill 40-50 of 90 total animals and conducting research on the impacts of the herd after the reduction. Officials claimed that a population of 50 would prevent economic costs and risks to humans and livestock and that reducing the herd would not adversely affect the diversity and abundance of other species (National Elk Refuge and Grand Teton National Park 1987).

The public responded negatively to the plan. They questioned justifications given for maintaining the herd at 50 and the perception of problems posed in the plan (Harvey 1998; Lichtman 1998; Thuermer 1998a; Thuermer 1998b). The Greater Yellowstone Coalition, a group of conservation organizations, sponsored a public meeting to stimulate participation in the issue (Thuermer 1998b). Three wildlife biologists stated that the management team was in violation of the National Environmental Policy Act (NEPA)⁷ because the EA did not sufficiently justify plans to reduce the herd (Clark *et al.* 1988; Thuermer

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⁷ NEPA requires that a comprehensive EA be undertaken before any major federal action can occur to clarify any potential ramifications of the action and to insure that the action is not in violation of such federal laws as the Clean Water Act and the Endangered Species Act.

1988b). Many claimed that the plan lacked data concerning economic costs, and only one case (the goring of government horses) had been reported involving a threat to property or safety (Thuermer 1988b). Opponents also felt that it was irrational to initiate research after a reduction, rather than before, to establish baseline conditions and an appropriate population size (Camenzind and Good 1988; Thuermer 1988b). Many people saw an increasing bison population as a success rather than a problem (Associated Press 1988). One group called for a redefinition of the refuge's purpose (Camenzind and Good 1988; Thuermer 1988b). The problem, many argued, would come with reduced genetic viability from a limited herd size (Heller 1988).⁸

The idea of problem definition, discussed in further detail below, remained central to the entire first phase of the development of the EA. For example, many people asked what goal was met by maintaining 50 bison and what goal was hindered by bison's presence on the refuge. If the refuge set the goal of maximizing elk for hunting or public viewing, bison might be seen as a problem and the alternative of 50 seen as an acceptable population target. However, the absence of adequate evidence to indicate that bison hindered elk numbers, hunting opportunities, or favorable public opinion of the refuge raised questions in the public's mind. The public also questioned the "elk only" goal of the refuge, and so questioned the notion that bison, another species favored by the public, on the refuge was a problem in and of itself.

ROUND TWO: RE-INITIATION OF THE ENVIRONMENTAL ASSESSMENT PROCESS

Because of the opposition, managers withdrew the plan. In 1988, the refuge, Grand Teton National Park, Wyoming Game and Fish Department, and Bridger-Teton National Forest adopted the "Interim Agreement for Management of the Jackson Bison Herd," which remained in effect until December 31, 1994. The plan advocated managing the herd at 90 to 110 animals through various reduction strategies. They reclassified the first EA as a scoping document and ordered the completion of another EA by 1994.

Officials from the park stated that the revised plan increased the target population because "that is close to the current herd size" and that population control measures would remain in place "until our research determines . . . the suitable number of animals for the herd" (quoted in Piccoli 1988). The plan also called for hazing bison into the park. Some agency officials felt the plan's importance rested more with the interagency cooperation framework it established than with the bison population numbers (Piccoli 1988). Critics stated that the plan merely continued the status quo, still failed to offer a rationale for the target population, and failed to reflect public comments from earlier draft plans (Thuermer 1988c).

In 1989, Wyoming Statutes 23-1-101 and 23-1-302 designated bison as wildlife in Wyoming (WY Stat § 23-1-302; WY Stat. § 23-1-101). Prior to this, outside of national forest and park lands, bison were designated as livestock and

The idea of problem definition, discussed in further detail below, remained central to the entire first phase of the development of the EA. For example, many people asked what goal was met by maintaining 50 bison and what goal was hindered by bison's presence on the refuge.

⁸ Smaller populations face a greater chance of extinction through chance events such as disease or severe weather because animals with similar genetic makeup are equally susceptible to such events.

subject to the control of the Wyoming Livestock Board (Gerty 1986). The new designation had three main effects. First, it subjected bison to regulations developed by the Wyoming Game and Fish Commissioners, a board of citizens⁹ appointed by the governor. The commission and the Wyoming Livestock Board designated bison as wildlife on the Shoshone and Bridger-Teton National Forests and on selected federal lands in Teton County.¹⁰ Second, it allowed the Wyoming Livestock Board to designate bison on public or private lands as a threat to livestock health or improvements on private and public lands and to require the Game and Fish Commission to remove them. Finally, it provided authorization for a wild bison reduction season.

With the authorization from Statutes 23-1-101 and 23-1-302, Wyoming Game and Fish personnel hunted the herd in 1988-89. They gave sixteen bison shot to Native American groups. The refuge attempted to minimize publicity and gave no advance notice of the hunt, but word leaked out and many groups were upset not only by the hunt, but also by the agency's attempt to keep it quiet (Piccoli 1989; Griffin 1998). In 1989-90 and 1990-1991, the refuge, park, Wyoming Game and Fish Department, and Bridger-Teton National Forest held a hunting permit program. Over 3,800 people applied for 20 permits at a price of \$200 for Wyoming residents and \$1000 for non-residents.

The revised management plan and both hunts, however, resulted in public outcry. Some remarked on the irony of the Wyoming game agency and U.S. Fish and Wildlife Service condoning the shooting of an animal honored on the state seal and the seal of the Department of Interior, the parent authority of the U.S. Fish and Wildlife Service (Thuermer 1989). One resident lamented that "since the bison is no longer appreciated or respected as the state animal, we should consider changing the emblem of the buffalo on the state flag to a steer, or a cowboy or a buffalo chip" (Rupert 1989). The agencies received criticism for exerting their energy toward bison control activities in the interest of elk and livestock and neglecting to account for the values of promoting a dynamic bison population. Agencies failed to conduct public attitude surveys, economic valuation studies, or a risk assessment (Day 1989; Piccoli 1989; Thuermer 1989b). The agency plan, many claimed, failed to meet the goal of maintaining a self-sustaining population (Thuermer 1989b). An agency member even admitted "probably none" of the perceived problems in the plan would be solved by killing 15 to 20 bison (Camenzind 1989).

After the death of thirty-seven animals through hunting, the Legal Action for Animals filed a lawsuit against the U.S. Fish and Wildlife Service (*Legal Action for Animals v. Wyoming Game and Fish Dept. 1990*). The plaintiff claimed that the U.S. Fish and Wildlife Service failed to follow the NEPA process before taking action and that the state and federal government lacked scientific evidence to show that killing bison offered the best way to manage the Jackson Hole herd (McKeever 1994). An out-of-court settlement halted the reductions and suspended the interim plan until the completion of the EA, but the refuge manager said, "I think we're going to have to dispel the notion that

⁹ The citizens tend to be hunting and fishing oriented, with ties to livestock industry, ranchers, and sportsmen (Reiswig 1998).

¹⁰ These designation affected lands north of U.S. Highway 89 and 189-191 north of Hoback Junction.

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we're going to have a free-ranging bison herd that is like it was in past time.” He also remarked that the herd survived because of supplemental feeding and that increased shooting would follow the termination of the moratorium (Eastridge 1990).

From 1987-1993, managers increased biological research efforts.¹¹ They studied bison distribution and migration to identify major use areas. Investigations of interactions of bison and elk on feed lines on the refuge were shown to displace but not harm elk (Helprin 1992). Managers also reviewed ways of maintaining genetic integrity (Shelly and Anderson 1989), although scientists outside the agencies contested the results. The timing and distribution of bison calving was also studied. The agencies rejected proposals by independent scientists, including Mark Boyce, to conduct a risk assessment and social survey.

INCREASED CONCERN ABOUT BRUCELLOSIS

The agencies felt increasing pressure to control bison movements and numbers after 11 of 16 bison killed in the agency hunt in 1989 tested positive for brucellosis (Thuermer 1989a). The same year, the Parker Land and Cattle Company in Dubois lost its entire stock of breeding cattle, valued at \$500,000, to brucellosis. The company sued agencies in the Department of the Interior in charge of wildlife management, including the National Elk Refuge (U.S. Fish and Wildlife Service), Grand Teton National Park, and Yellowstone National Park (National Park Service). Parker alleged under the Federal Tort Claims Act that his cattle contracted brucellosis from Jackson bison and that the federal government was liable because of negligence in managing its wildlife and failing to warn him of the brucellosis risk (Keiter and Froelicher 1993).

The court ruled in favor of the government, concluding that imported cattle, stray cattle, artificial insemination, and domestic animals could have been the source of infection (Carlman 1994; Keiter and Froelicher 1993). However, it also concluded that the Park Service and U.S. Fish and Wildlife Service managed their herd in a negligent manner because they failed to constrain free-roaming bison or vaccinate elk (Keiter and Froelicher 1993). This ruling “sends a powerful message to federal land managers that they must take affirmative steps to protect domestic livestock from wildlife infected with brucellosis” (Keiter and Froelicher 1993).¹²

Thus, while the Parker Land Company lost in the courts, to many, the court's decision renders brucellosis in wildlife a more ominous threat to government agencies and the cattle industry. To some, this threat has biological origins. To others, it has bureaucratic and political origins. While the judge ruled that the infection came from cattle, many ranchers believe the court case focused attention on public-lands grazing (Wilkinson 1997).

It also focused attention on the government's obligation to manage diseases in wildlife (Keiter and Froelicher 1993). The court effectively ruled that the free-roaming bison herd constitutes negligence on the part of the park and that the U.S. Fish and Wildlife Service is demonstrating negligence by not vaccinating elk.

¹¹ Research projects include: (1) a study conducted from 1987-1989 by Grand Teton National Park personnel to determine seasonal distribution and migration routes; (2) a study by a graduate student at Utah State University to determine bison-elk interactions (Helprin 1992); (3) a review of literature on genetic management of small herds and sterilization as a management strategy conducted by the U.S. Fish and Wildlife Service Cooperative Wildlife Research Unit in Laramie, Wyoming (Shelly and Anderson 1989); (4) a study by Grand Teton National Park of bison calving and distribution conducted from 1991 to 1992; and (5) a study of scenarios involving genetics and population size of bison in Jackson Hole (Berger 1996).

¹² Legal professor and scholar Robert Keiter points out that “the decision reflects a fundamental misapplication of FTCA precedent, namely unabashed judicial use of the FTCA to devise federal wildlife brucellosis policy in the absence of any congressional guidance” (Keiter and Froelicher 1993: 38). In previous cases involving rock climbing and dangerous trails, the court determined that the park's discretionary decision not to warn climbers and hikers was coherent with their existing policies. In *Johnson v. United States* (10th Cir. 1991), the plaintiffs alleged that the park had not properly warned against the dangers of mountain climbing. The Tenth Circuit court ruled that the park was not liable because its decision not to warn was coherent with its overall policy of not regulating climbing activity in the park (Keiter and Froelicher 1993). In *Zumwalt v. United States* (10th Cir. 1991), a case alleging Park Service liability for not posting warning signs on a dangerous wilderness trail, the Tenth Circuit court determined

Parker also filed a claim, under Wyoming wildlife law, with the Wyoming Game and Fish Commission¹³ for property damage of over one million dollars. A state-funded compensation program covers damages to livestock by trophy game animals. The commission denied the claim, concluding that the program does not cover non-game species such as bison nor does it cover diseases. They also concluded that the evidence was not strong enough to implicate wildlife. The Wyoming Supreme Court upheld the decision on appeal, in a 4 to 1 vote. While Wyoming Game and Fish triumphed, three of the five justices “held that brucellosis transmission from elk or bison to cattle is a compensable form of damage under the wildlife damage statute” (Carlman 1994).

Researchers have shown that cattle can contract the disease if they consume infected placental remains or afterbirth left by calving bison, elk, or other wildlife, although this method of transmission has never been documented in the wild (Wuerthner 1990; Robinson and Neal 1990). The U.S. Animal and Plant Health Inspection Service (APHIS), part of the U.S. Department of Agriculture, is charged with controlling brucellosis in domestic livestock¹⁴ and grants brucellosis-free status to states with no infected cattle herds, rendering interstate sale of cattle easier. APHIS declared Wyoming brucellosis-free in 1985. Between 1980 and 1989, five herds in the state became infected with brucellosis, all unconfirmed cases in which wildlife were suspected of transmitting the disease.¹⁵ The state maintained its brucellosis-free status because the infections were presumed to be caused by wildlife. APHIS and state veterinarians began to pressure Yellowstone and Jackson to manage bison with the primary goal of eradicating brucellosis. APHIS claims that “the responsibility to protect cattle from becoming infected through exposure to wildlife rests with the Wyoming Game and Fish Department and various federal agencies that control federal lands” (Barton *et al.* 1997).

In a review of the Wyoming Brucellosis Program released in July of 1997, APHIS claimed that “there currently are no brucellosis preventative or control measures being applied to the bison and elk that frequent [sic] the National Elk Refuge” (quoted in Drake 1997). However, APHIS did recognize measures taken by Wyoming Game and Fish employees to keep elk and cattle apart when feeding. These measures included fencing, hazing using snowmobiles, helicopters, and other vehicles, and killing elk that persist in efforts to feed at cattle haystacks (Barton *et al.* 1997). APHIS also recommended that Jackson Hole ranchers test their cattle for brucellosis (Thuermer 1997). This would affect three ranches in particular.

The negative publicity resulting from the brucellosis requirements, much like the attention brought to public land grazing in the Parker case, worry cattlemen. The cattlemen want steps to be taken to assure animal health officials and cattlemen in other states that no brucellosis problem exists in their cattle (Barton *et al.* 1997). Steve Thomas, one member of the conservation community, said, “We see this [requirement of testing cattle] as penalizing [ranchers] for some obscure policy of zero tolerance” (quoted in Thuermer

the decision not to warn was in line with its overall policy (Keiter and Froelicher 1993).

While the previous cases involve visitors to the park and *Parker* involves diseased wildlife, the court in *Parker* failed to consider existing Park Service or U.S. Fish & Wildlife Service wildlife management authority, “specifically the degree of discretion they retain in establishing wildlife policy under the relevant organic legislation” (Keiter and Froelicher 1993). Keiter argues that without determining such discretion, the court cannot properly assess whether a duty to warn is not required under existing park policy. He further argues that lack of congressional mandates regarding wildlife and brucellosis, the U.S. Fish and Wildlife Service’s dedication to wildlife conservation, and the policy of naturalness held to by the Park Service exempt them from FTCA liability and provide them with discretionary judgments (Keiter and Froelicher 1993). Finally, Keiter points out that the court ruled that only the Park Service and U.S. Fish & Wildlife Service—not the Forest Service or Bureau of Land Management—hold the duty to warn ranchers.

¹³ The Wyoming Game and Fish Commission, a group of citizens appointed by the governor of Wyoming, oversees the Wyoming Game and Fish Department. The Commission is composed primarily of those with ties to the livestock and hunting industries (Reiswig 1998).

1997). Thomas also said that “the recommendations they make are totally beyond the scope of their mission...It seems to me as if they ought to stay out of wildlife management and the business of the parks” (quoted in Simpson 1997a).

Furthermore, the state threatened to sue the Park Service and the U.S. Fish and Wildlife Service for not controlling brucellosis in their wildlife populations (Simpson 1997a). Rancher and former Senator Cliff Hansen stated, “I can think of no reason at all why these new rules from APHIS make sense....To my knowledge, none of us has ever had any problem with brucellosis” (quoted in Wilkinson 1997).

ROUND THREE OF THE ENVIRONMENTAL ASSESSMENT

The unfolding events involving brucellosis affected the draft EA and long-term management plan released in 1994 by the National Elk Refuge, Grand Teton National Park, and Bridger-Teton National Forest, and the National Wildlife Health Center. Governor Jim Geringer became involved in the issue in 1995, seeking assurance that the Park Service would do what it could to keep bison and cattle apart to ensure that Wyoming kept its brucellosis-free status (Staff 1995). To address concerns over brucellosis, the plan advocated minimizing bison-cattle interactions, using a new vaccine, and conducting a risk assessment. This plan increased the target population to 150-200 individuals, with a maximum of 200 allowed under the condition that a portion of the herd wintered off the refuge. To reach this objective, the plan called for public sport hunting, irrigation of forage at the Hunter-Talbot site east of the park and north of the refuge, and the baiting of bison at the Hunter-Talbot area to keep them in the park. Introduction of new individuals to ensure genetic diversity was also proposed (Grand Teton National Park *et al.* 1994).

Once again, public debate ensued. The agencies received 160 letters from state and federal agencies, Native American tribes, organizations, and individuals. The Wyoming Stockgrower’s Association represented perhaps the most conservative viewpoint and suggested that for “health and safety considerations, we also strongly recommend that the bison be distributed away from the National Elk Refuge, especially during the winter season” (quoted in Gentle 1994). While the Wyoming Stockgrower’s Association wanted the herd fenced and culled to 50 disease-free animals (Thuermer 1996), many other individuals and groups, including independent scientists, claimed the herd size was still unjustified and not high enough to maintain genetic fitness. Opponents also considered irrigation of park land and baiting animals in violation of park policy and in danger of setting a poor precedent. The risk assessment, many members of the public claimed, should come before, not after, adopting a management strategy and should include an assessment of risk from diseases other than brucellosis. Some suggested the need for studies to understand actual private property losses from bison, sociological surveys on the economic and other values of bison to the public, a more thorough economic analysis of

¹⁴ APHIS began its eradication efforts in 1934. The efforts began to reduce the cattle population due to drought conditions, but many states saw this effort as an opportunity to reduce losses from brucellosis. APHIS works with state governments and livestock producers, and only 26 herds in the country were known to be infected as of April 1997 (Barton *et al.* 1997).

¹⁵ These herds include the following: (1) On March 16, 1982, two cows that aborted in a herd at Bondurant, Wyoming tested positive for brucellosis. No source of infection was proven, but this herd commingled with elk and “wildlife was considered the most probably source” (Barton *et al.* 1997: 3). (2) In 1983, an infected herd was found in Cora, Wyoming (Sublette County). The Black Butte elk feed ground lies within the outer borders of the ranch and “no source of infection could be found other than diseased elk” (Barton *et al.* 1997: 3). (3) Seven cattle tested positive in November of 1984 in Jackson, and “no source of infection other than wildlife was found” (Barton *et al.* 1997: 3). (4) A dairy herd in Lincoln County tested positive in October 1985, and “the owner revealed that elk frequented his property and were known to feed with the dairy cattle” (Barton *et al.* 1997: 3). (5) In 1989, a herd in Dubois was found to be infected. The conclusion of a court case was that “the Parker brucellosis outbreak was most likely caused by contact with infected elk or bison as those are the only two known sources of the disease in the entire State of Wyoming” (Barton *et al.* 1997: 3).

costs of managing bison as well as an economic analysis of contributions of bison to Jackson Hole and an analysis of bison's impact on elk (Curlee 1995; Anonymous 1994).

Representatives from Wyoming's Agriculture and Game and Fish Departments, the state Livestock Board, APHIS, the U.S. Forest Service, the National Park Service, and the U.S. Fish and Wildlife Service began meeting in January 1995 to revise the plan. Ron Micheli, director of the state Agriculture Department said, "This group was assembled to protect the class-free status of Wyoming cattle" (quoted in Neal 1996).

The Totem Studies Group, a citizen-based problem-solving forum, was formed within the Jackson Hole community in 1995 to "develop and apply an innovative intelligence-gathering and decision-making process to guide natural resource management practices in the Greater Yellowstone Ecosystem" (Curlee and Day 1995b). Many members felt frustrated with management practices and expressed concern not only over bison management, but also over decision making and models of public participation (Curlee 1998). The overall goals of the group included identifying and creating the best possible future for the GYE bison herds, using the project as a pilot to redesign the decision-making process for wildlife management in the GYE, disseminating ideas and knowledge, and forging new relationships (Curlee 1998). The group began by clarifying the "bison problem" as three-tiered, including population size, the specific process leading to the management of bison, and barriers such as rigid organizational cultures.¹⁶ The membership of this group (Jackson citizens, conservationists, agency personnel, county commissioners, educational institutions, Native Americans, members of the agricultural community, and independent scientists) demonstrates inclusiveness in decision making.

In 1996, the agencies issued another EA and long-term plan. The accepted herd size grew to 200-250 animals, with no more than 200 wintering on the refuge. It called for the same strategies to manage the herd as the previous plan (i.e., hunting, irrigating the Hunter-Talbot site, baiting bison into the park, minimizing bison-cattle interactions, using a new vaccine, and conducting a risk assessment). It also called for a Native American hunt (Grand Teton National Park *et al.* 1996).

The public responded to the 1996 plan with similar comments as the 1994 plan. Agencies received 144 letters. One letter advocated the reduction of the herd to fifty and complete depopulation and repopulation with a disease-free herd, and one letter argued against a free-ranging herd (Anonymous 1996). The majority of people who wrote letters, however, felt the elk feeding program presented a larger problem, believed the alternative set a poor precedent for park policy, set an inadequate population goal to maintain genetic viability, and was deficient by presenting bison on the refuge as a problem and a pest species rather than as a valuable member of the wildlife community (Anonymous 1996).¹⁷

¹⁶ The groups defined the problem as follows: "In the specific case of bison management, the problem can be conceptualized in three concentric circles. In the innermost circle are the specific issues of bison management, such as conflicts with livestock ranching and other land uses, or in other words the subject. In the middle circle is the decision-making process that acts on the subject. And in the outermost circle are the contextual variables influencing the decision-making process, such as bureaucratic culture and structure, federal and state tensions, and human values and attitudes" (Curlee and Day 1995a).

¹⁷ Twenty-six letters suggested the "problems" associated with bison in fact arose from the elk feeding program (33 letters mentioned the need to address elk feed grounds either in conjunction with bison feeding or as a problem); 21 letters stated that the environmental consequences are not adequately evaluated; 14 letters questioned the different management priorities for elk and bison and/or mentioned that the bison herd needs to be considered in a larger context; 14 letters questioned the justification for the preferred alternative and the science used to indicate consequences; 13 letters complained that special interests were being favored (one letter referring to wildlife special interests, twelve letters to livestock and or hunting); 11 letters questioned the strategy of keeping bison in the park and irrigating the Hunter-Talbot area either because it seems unfeasible and/or violates the park's natural regulation policy; 10 letters questioned the ability of the plan to maintain genetic viability and/or the strategy of introducing female bison to maintain a genetically viable herd; nine letters request more

The agencies listened to the comments, revised a number of the alternative proposed in the final plan released in 1996, and released a Finding of No Significant Impact (FONSI) in August 1997. The overall goal of bison management, according to the final Bison Long Term Management Plan and Environmental Assessment, is to “maintain a free-ranging bison herd in Jackson Hole, as free from human intervention as practically possible” (Grand Teton National Park *et al.* 1996). Specific objectives include maintaining a self-sustaining population, minimizing potential for the transmission of brucellosis from bison and elk to domestic livestock, reducing bison dependency on supplemental feeding, maintaining recreational opportunities associated with a free-ranging herd, and minimizing the potential for bison-human conflicts and bison-induced property damage (Grand Teton National Park *et al.* 1996; Grand Teton National Park and National Elk Refuge 1997).

The FONSI examined four key management issues, including herd size, herd reduction methods, winter distribution, and disease management. It received the support of diverse groups. The plan proposes to maintain the bison population at 350-400 animals over a running five-year average.¹⁸ Herd reduction methods include public hunting and culling of animals for use by Indian tribes and low-income groups. The Wyoming Game and Fish Department will administer hunts on the National Elk Refuge and national forest lands. Grand Teton National Park will consider reduction within the park if reduction goals are not met outside the park. Agencies will also consider shipping bison live.

Bison will be allowed to continue wintering on the National Elk Refuge, eating natural forage and supplemental feed. They will be hazed from the southern portion of the refuge to avoid human conflict. Finally, attempts will be made to minimize the potential for brucellosis transmission among bison, elk, and other wildlife and cattle and to work toward eliminating brucellosis. Disease management plans include a risk assessment for the potential of transmission from bison to cattle, a bison vaccination program (pending the development of a safe and effective vaccine), and the vaccination of all cattle grazed in and trailed through Grand Teton National Park. Officials from Grand Teton National Park and the Bridger Teton National Forest will also work with grazing permittees to minimize transmission from bison to cattle (Grand Teton National Park and National Elk Refuge 1997).

LAWSUIT REQUIRES NEW PLAN, CONTROVERSY CONTINUES

The plan was released and accepted by a diverse group of stakeholders and agencies. The controversy continues, however. The lawsuit filed by the state of Wyoming over vaccinating elk on the refuge against brucellosis and the state opposition to allowing a special Native American hunt indicate that inter-agency cooperation on the bison management plan and EA is not stable.

In addition, the Fund for Animals filed a request on October 2, 1998, to stop a controlled bison hunt (Gearino 1998a). The judge ruled to stop the hunt on October 30 and ordered the U.S. Fish and Wildlife Service to complete an EA

biological and socioeconomic research (5 letters requested a delay in reduction pending such research); eight letters raised the issue of grazing on public lands (five letters raised the issue of grazing in the park as part of the problem; three letters opposed grazing on public lands); seven letters mentioned the responsibility of APHIS for driving the issue (2), the financial responsibility it should take for vaccinating cattle (4), and the financial responsibility it should take for a risk assessment (1); six letters mentioned the need for a better, less positivistic problem orientation, justifications, information, and public participation; four letters mentioned the lack of transmission in Grand Teton National Park, the success of cattle vaccination programs, and/or the well-being of livestock producers; three letters criticized the effectiveness of the Greater Yellowstone Interagency Bison Committee; three letters promoted eradicating brucellosis and two letters opposed it; three letters suggested conducting a risk assessment; two letters promoted the idea of carrying capacity as a determination of population size over genetic viability, and two letters opposed such a strategy for calculating a target population; two letters criticized the use of brucellosis as a justification for reducing the herd, three letters opposed the hunt—calling it “public bloodletting sitting duck slaughter” and criticizing the words “popular” and “beneficial” to describe the hunt as euphemisms for slaughter—and three letters made suggestions concerning the location of the hunt, price of the licenses, and method of hunting; one letter supported and one letter opposed the distribution of meat to Native Americans; three letters criticized the Native American hunt as a political ploy; two letters supported such a hunt; and two letters promoted receiving more input

or environmental impact statement on its elk feeding program. The judge ruled the EA should have included consideration of the effects of bison and elk supplemental feeding. The judge dismissed arguments by the Fish and Wildlife Service that the elk feeding program was exempt from NEPA because it began in 1912 and that the bison hunt was exempt from NEPA because it was conducted by a state game agency rather than a federal agency (Gearino 1998a).

The controversy persists in Montana, as well, over bison that migrate out of Yellowstone National Park. While the social dynamics differ in Montana—the ranching community, for example, seems more concerned about transmission of brucellosis in Montana than those in the Jackson Hole region—many of the same agencies and pressures may affect Jackson Hole in the future. APHIS and state veterinarians retain much power over regulations concerning cattle, brucellosis, sanctions for states with brucellosis-infected wildlife, and the perception of possible risk transmission from wildlife to cattle.

In addition, the elk herd maintains a brucellosis infection rate of between 25 and 35 percent annually (Camenzind 1998a). The high prevalence has been attributed to feed grounds, which Wyoming Game and Fish and others maintain are necessary to keep elk separated from cattle herds. There is currently discussion among agencies and local groups about reducing the dependence on feed grounds.

Finally, the National Wildlife Refuge System Improvement Act of 1997 mandates a refuge-wide management plan. Given the controversy over elk population and management, bison management, and other refuge issues, the refuge can expect controversy over the development of this plan. Understanding the factors that led to the controversy in the bison EA process and learning from the process can help future planning.

FACTORS CONDITIONING THE FIFTEEN-YEAR PROCESS AND RESOLUTION

The process of developing an EA and long-term management plan brought many specific management issues to the surface, including herd size, methods of controlling the population, disease transmission, and carrying capacity. However, integral components of these discussions include issues that strike a deeper chord with the Jackson and GYE communities. These issues involve philosophical debates about managing wildlife and about the changing nature of the West. They involve resolving fundamental differences in worldviews, values, and priorities.

Essentially, a clash of individual and cultural values is deeply embedded in the bison debates. The questions regarding bison result from “the pictures in our heads” about the way the world should work as much as from empirical observations (Lippman 1922). People develop inner visions of the land, wildlife, and humanity’s role in the environment. They identify “problems” and demand “solutions” based on beliefs regarding their natural and man-made environments.

from Native Americans or opening the hunt to other tribes in addition to plains tribes; one letter raised the issue of the legality of hunting bison on U.S. Fish and Wildlife Service land; three letters re-requested more information concerning sterilization; two letters questioned the killing of bison in the park; one letter promoted depopulation; one letter promoted test and slaughter for scientific purposes (Anonymous 1996). These estimates were taken from a compilation of comments and should be considered rough estimates.

¹⁸ The running five-year average means that the herd may fall below or rise above this limit during certain years, as long as an average of 350-400 animals is maintained over five years.

Differences, of course, exist within groups based on individual identities and values, but many groups speak with one public voice. Individuals tend to identify and align themselves with groups of people holding similar values (Lippman 1922) and representatives of these groups advocate on behalf of a group consensus (Smith and Berg 1987). For example, agency officials who define bison as a “risk” that can be controlled hold a vision of the proper balance of big game species, bison as a wildlife species, and how to manage wildlife. Ranchers, environmentalists, ecologists, and others also hold visions of a proper balance between wildlife and domestic livestock or wildlife and human development.

Bison, as free-ranging herd animals, are difficult to control, and discussions over fundamental worldviews intersect in discussions of management over wildlife. Bison migrations run counter to jurisdictional boundaries. When animals such as bison and wolves cross political boundaries and affect the region’s cattle interests, they also cross ethical boundaries relating to land management (Bohne 1998). Managing for such species challenges the status quo, and yet the public holds deep affection for charismatic species such as bison (Bohne 1998), which symbolize for many the West and the ethic of conservation (Geist 1996).

BRUCELLOSIS AND ESCALATING TENSION IN THE LIVESTOCK INDUSTRY

Mandates about wildlife and livestock interests that predate the admission of Wyoming to statehood exemplify the mix of values people have traditionally and continue to place on this land. As early as 1864, “the U.S. Supreme Court held that “states should hold wildlife in trust for the public” (Steller 1995). The Wyoming Constitution also includes a clause which “specifically directed the legislature to protect livestock interests,” a clause that demonstrates the political power of the livestock industry (Carlman 1994: 93).¹⁹ Ira N. Gabrielson of the Wildlife Management Institute reported to the Wyoming Game and Fish Commission in 1952 that “only in Wyoming had he found laws which gave “so much special consideration to livestock operators at the expense of the fish and game resources” (quoted in Carlman 1994: 94).

The *Parker* case described above is one indication of competing values, agency jurisdictions, and conceptions of the best allocation of land, power, and responsibility for wildlife and cattle management. Jackson lawyer Leonard Carlman (1994: 98-99) points out that, “While the specific agent of change in *Parker* appears to have been a microscopic bacteria, large economic, demographic, and political forces continue to bring about inevitable changes in the American West. These changes are typically described in terms of a transition from an extractive, intensive use of land to one which emphasizes recreational land use and a resettlement of the West by people employed in the trade of information and expertise. As large scale cultural change proceeds, the legal relationship between wildlife and livestock interests in Wyoming is likely to

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¹⁹ Similar laws followed. In 1925, the Wyoming legislature authorized compensation for animal depredations, and in 1929 they instituted a damage compensation law. In 1980, an amendment was added to the damage claim law that added livestock killed or injured by trophy game species to a list of damages including land, crops, and grass (Carlman 1994).

experience its own set of related changes.” Many of the public comments regarding the bison management plan are statements about livestock management, the livestock industry, and the changing social makeup of the West that echo Carlman’s insight.

For example, many people questioned what management priorities drive bison policy, specifically after brucellosis became a more central issue in the 1994 and 1996 plans. At the heart of the issue, according to many, is the question “Is brucellosis a livestock or wildlife problem?” (Clark 1994). One resident promotes treating “the whole brucellosis problem in a comprehensive and unified way, which means acknowledging that elk management and cattle management are at least as much a part of the picture as is bison management” (Harvey 1995). Similarly, Camenzind stated that “since brucellosis appears to be more of a problem for cattle than for wildlife, solutions should be developed within the cattle industry, not at the expense of the wildlife populations” (Camenzind 1995).

Refuge manager Barry Reiswig stated his belief that “it’s more realistic to have a program of managing the risks of possible transmission of brucellosis from wildlife to domestic cattle as recommended in the NAS report” than to manage for eradication (U.S. Fish and Wildlife Service 1997). The Wyoming Department of Agriculture makes different claims. Director Bill Gentle feels that the brucellosis-free designation Wyoming now enjoys “is jeopardized by an unmanaged bison herd or a herd for which disease management is not provided” (Gentle 1994). He goes on to claim that “only herd reduction or population control will control the bison population” (Gentle 1994). At least one rancher in Jackson Hole agrees with the Department of Agriculture. He is quoted in a local newspaper as saying, “I think there is a place for bison, but I don’t think they should be uncontrolled” (quoted in Thuermer 1995). He seems worried because “the last four area ranchers whose herds had infected animals are all out of the cattle business” (Thuermer 1995).

The livestock industry in fact represents a diversity of interests. One cattle rancher, Henry N. Hall, wrote, “I am a *cattle* farmer and I do not believe that these bison present any brucellosis threat to cattle,” and he requested the bison herd size be increased to 400 (quoted in Adams 1996). Lisa Jaeger wrote, “I work for ranchers here in Pavillion and I think that killing bison for fear of brucellosis is crazy” (quoted in Adams 1996). Many ranchers feel that their practices, including calf vaccinations, keep their herds brucellosis-free and that feed grounds help to keep elk away from cattle, making the risk virtually zero (Barton *et al.* 1997). Many feel trapped by government agencies and complain about inconsistency in agency mandates. They also refrain from actively opposing bison and elk because they realize a decision between wildlife or cattle on public land would most likely be a loss for cattle (Wilkinson 1997). The ranchers resent requirements by APHIS (Wilkinson 1997).

Thus, the debate over brucellosis involves not only actual biological disease management, but also the reconciliation of different groups’ expectations

At the heart of the issue, according to many, is the question “Is brucellosis a livestock or wildlife problem?” (Clark 1994). One resident promotes treating “the whole brucellosis problem in a comprehensive and unified way, which means acknowledging that elk management and cattle management are at least as much a part of the picture as is bison management” (Harvey 1995).

about disease, wildlife, and livestock management. Many in the conservation community complain that since brucellosis has little effect on bison populations, the risk aversion measures taken should come from the livestock industry. Many within the livestock industry point to 35 brucellosis-free years as evidence that current measures they take against brucellosis work. Yet, changing regulations and expectations about the presence of brucellosis in Yellowstone's domestic and wildlife populations and who should manage the risk continue to fuel debate.

OTHER CONTROVERSIES IN THE REGION

Many related controversies exist in the region that may affect bison management on the refuge. For example, there has been ongoing debate about grizzly bear and cattle interactions, the delisting of grizzlies from the Endangered Species Act, the reintroduction of wolves into the GYE, the interaction of wolves with livestock and wildlife, and oil and gas leasing. Many of the same organizations and individuals interact in attempting to resolve these issues. The relationships—positive and negative—that develop in one case can affect other cases.

There has also been a recent effort to find ways to conserve open space in the West (e.g., Glick *et al.* 1998). In Jackson, the effort includes a controversy over extending cattle grazing leases in Grand Teton National Park, where cattle may intermingle with not only bison, but also predators such as grizzlies.²⁰ Currently, there are eight permittees with allotments in Grand Teton National Park and two with trailing privileges.²¹ While ranchers contend that they help to preserve open space and the ranching culture by grazing in the park, others argue that domestic cattle grazing runs counter to park mandates and favors a special interest. In addition, APHIS requests all ranchers grazing livestock in the park to test their cattle, which places a large expense on cattle operations and may generate negative publicity in other states (Thorne 1998).

Increasingly contentious conflicts over wildlife, steeped in deeply-held fundamental worldviews, can erode trust among all stakeholders. However, a perception of improved relations in other areas, such as relations with the U.S. Forest Service (USFS) over oil and gas leasing, can lead to a more open and trusting atmosphere. Park biologists are also putting more of an effort into understanding what is happening with bison, and there is daily interaction among members of the community and the park (Lichtman 1998).

MANAGEMENT PHILOSOPHIES

Philosophies over managing nature are in flux. These philosophies change with time and differ among constituent groups and among and within agencies. As an example, the bison management plan refers to “range condition” and “maximum carrying capacity.” These paradigms originally developed to manage livestock, and one resident conservation biologist claims that these philosophies “may not be in synch with current dynamic views of ecological systems

²⁰ A controversy erupted, for example, when Grizzly Bear 209 was taken from Grand Teton National Park in 1996 and killed because he repeatedly preyed on cattle that grazed in the park.

²¹ Five of the permittees graze cattle in the park, the first beginning on May 15 and the last ending on November 9. Park officials attempt to separate cattle from birthing bison. Since scientists claim the most likely way for bison to transmit brucellosis to cattle is through aborted fetuses, these dates roughly follow the end of the bison birthing season. However, bison are not highly predictable in their birthing periods, and the birthing season can last from February into June (Barton *et al.* 1997; Griffin 1998).

that largely debunk the ‘stability’ models of the past and place importance instead on ecological processes and interaction forces, and even view disturbance regimes (e.g., pest outbreaks, wildfire, flooding, etc.) as important elements for the maintenance of ecosystem elements and function” (Curlee 1995).

Another resident and zoologist points out that a more appropriate model to manage bison may be a “social carrying capacity,” measured when bison begin showing up on private property, golf courses, and other areas (Camenzind 1998b). “We will have to accept control programs. Jackson Hole isn’t big enough to let bison (or elk) control their own numbers” (Camenzind 1996). An official from the Wyoming Game and Fish Department also points out that having no cap on bison will cause problems, such as complaints from private landowners, loss of tolerance in the agricultural community, and increased pressure from APHIS to manage bison more aggressively (Bohne 1998). For example, a member of the agricultural community complained that “the ‘free-ranging’ characterization of the bison mentioned repeatedly... implies a lack of management” and that “in effect, an unmanaged bison herd creates an unfunded mandate to care for a free-roaming, brucellosis-infected, damage-inflicting bison herd, for which the citizens of this state will have to bear the costs” (Gentle 1994). Thus, a philosophy of too heavy-handed or too little management may result in similar undesired outcomes and conflict.

There are also differences in management philosophies among agencies and differing levels of tolerance within the public for management actions taken on land owned by different agencies. For example, most groups accept hunting bison on the National Elk Refuge. In addition, while most people agree that artificial feeding is not ideal because of disease, cost, and the unnatural distribution it creates, they accept it on the refuge as necessary. All these direct intervention strategies people seem to accept on the National Elk Refuge, a wildlife refuge administered by the U.S. Fish and Wildlife Service. However, much controversy emerged over the proposal to bait bison into the park and irrigate winter range in the park. According to many, “baiting destroys the animals’ status as a free-ranging herd” (Adams 1996). Another resident remarked that “I’m not sure a case can be made that diversion of water and cultivation of irrigated pasture, with or without hay cutting, is more natural or less of a human intervention than spreading pellets at the NER. It could be seen as a transfer of artificiality from the NER into the Park” (Harvey 1995). Finally, proposed herd reductions in the park are “a serious consideration because of National Park policy prohibiting wildlife hunting in National Parks” (Curlee 1995) and would “represent a significant change in Park policy” (Harvey 1995).

PERCEPTION OF ELK AND BISON

The Jackson community has a long history of managing and protecting elk. Over 80 years ago, the citizens of Jackson and the United States set out to protect thousands of elk by establishing the National Elk Refuge and beginning supplemental feeding. In addition, elk have traditionally had a strong hunting

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constituency and are part of the identity of the Jackson community (Reiswig 1998). Outfitters in the region and the Wyoming Game and Fish Department generate revenue from elk hunting. In contrast, bison, while they enjoy support from the general public, have enjoyed a less favorable opinion from agencies (Bohne 1998). While the current refuge manager accepts bison on the refuge, past managers and other agency officials and personnel have tended to see them more as a burden because they are harder to control (Bohne 1998; Griffin 1998). Thus, management decisions are being made with different levels of tolerance for and perceptions of elk and bison.

Many in the community, however, place equal value on both species and object to the treatment of bison as a problem. They cite differences in population targets, brucellosis control programs, and acceptance of feeding as examples of inconsistent management practices for different ungulate species. Some complain that “no justification is presented that explains why it is acceptable to have elk dependent on supplemental feed but it isn’t okay to have bison dependent on supplemental feed” (Curlee 1995). Others point out that “when you realize that elk numbers are way over desired herd levels, and bison numbers are below the levels necessary to even sustain themselves over the long-term, it becomes clear that the problem is too many elk, not too many bison” (Camenzind 1996).

Many point to the differential treatment of bison and elk in reference to brucellosis as one more example of the influence of preconceived ideas about management of different species. They say that a focus on controlling brucellosis only in bison “assumes bison are a larger transmission risk than the elk population which is also infected with brucellosis. This plan singles out bison as a unique management problem” (Jackson Hole Conservation Alliance 1997). A member of the animal rights community also said that “they’re targeting bison and bison alone, and that is a problematic approach” (quoted in Adams 1996). The differing treatment of bison and elk led some to conclude that “either the agencies have a bias against bison, believing they are less desirable than other wildlife populations, or there are other ‘problems’ or forces driving the bison management Plan / EA” (Lichtman 1995). Kelly author Ted Kerasote wrote “this plan needs to go back to the drawing board and consider elk and bison as a unit” (quoted in Thuermer 1996).

People also question the agency perception that feeding bison costs too much (\$120 per winter for each bison in the herd). Ann Harvey questions “viewing this cost as a problem, when the costs of feeding elk are viewed as a necessary expense of wildlife management.” Such a discrepancy, she points out, “indicates that bison and elk are viewed differently; elk are a valuable species that should be fed in order to have the high numbers we want; but feeding bison is a ‘problem’” (Harvey 1995). Furthermore, many believe that the high level of manipulation on the refuge necessitates further justification for why manipulation of elk is acceptable but manipulation of bison is not (Curlee 1995). Thus, a question arises concerning the many values of the Jackson bison herd.

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STATES' RIGHTS AND JURISDICTIONAL BOUNDARIES

Much of the controversy involves one value in particular—power. This may be expected since, as R. M. MacIver (1947: 42) pointed out, “the central myth in the maintenance of any social system is the myth of authority,” and that myth is being debated in the bison case. Power struggles—struggles over defining authoritarian relationships—ensue amid unclear allocation of authority and control over wildlife that cross jurisdictional boundaries or fall under the jurisdiction of multiple agencies within one political boundary. Federal agencies have authority over land, but the state traditionally has managed wildlife species even on federal land. The determination of who has management authority persists as an issue among agencies, and it periodically surfaces in on-the-ground debates over wildlife management (Bohne 1998).

Some of the state’s power has been called into question in the EA. In response to the lawsuit over hunting brought by the Legal Action for Animals, for example, a Game and Fish spokesperson asserted that “the harsh reality of the animal rights movement has arrived in Wyoming. Not too surprisingly, it’s being driven by forces outside our borders. We are viewing this action as a serious threat to the state’s authority to manage wildlife and the public’s right to participate in the harvest of these, and eventually other, animals” (quoted in Thuermer 1990). This statement indicates three dominant perceptions in Wyoming politics. First, there is a mistrust of outsiders, of “forces outside our borders.” Second is the view that states should have primacy over wildlife, that outsiders threaten “the state’s authority to manage wildlife.” Third, there is a perception that it is in the public interest and within the “public’s right,” to hunt animals. In a recent talk on brucellosis in bison, elk, and cattle in the GYE, a Game and Fish official repeatedly emphasized the importance of hunting to the state (Thorne 1998).

The state management and control over hunting arose again more recently in relation to allowing a special Native American hunt of bison on the refuge. The federal agencies claim they can authorize Indians to hunt, but the state claims the hunt must also comply with state regulations, which prohibit granting special hunting privileges. The park and refuge maintain that they hold concurrent jurisdiction with the state for hunting on federal land, while the state maintains it retains sole jurisdiction for hunting.²² The norms for bison hunting—and issues of control over wildlife management on federal land—are being worked out through this case.

The issue becomes more complex because of two factors: first, Wyoming Game and Fish manages bison concurrently with the state agricultural department; second, a lawsuit filed by outfitters regarding license allocations has implications for holding a special Native American hunt. Wyoming residents opposed a proposal to allocate licenses for landowners to sell if they allowed hunting on their private land. Opponents argue that this sets a precedent for privatizing wildlife. Offering special privileges to Native Americans might push

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²² For elk hunting in the park, hunters must obtain both a state and park permit, which are essentially identical and were developed jointly (Bohne 1998).

the issue of offering special privileges to private landowners (Bohne 1998; Camenzind 1998b).

The Native American hunting issue involves a debate over jurisdictional boundaries that dates to the establishment of Wyoming as a state. In 1896 the state won a lawsuit filed over treaty rights held by Bannock Indians to hunt elk on traditional hunting grounds in Jackson Hole. The U.S. Supreme Court ruled that state law superseded treaty-international-law and that state sanctions against hunting prohibited the Bannock from using their traditional hunting ground.²³ Now, the Department of the Interior is again, according to Wyoming Game and Fish Department, pushing to establish that they can allow hunting outside of state authority (Bohne 1998).

A lawsuit by Wyoming Governor Geringer, filed in February 1998 against the Secretary of the Interior over the state's right to vaccinate elk on the National Elk Refuge, indicates another case in which the state is vying to maintain its power. The lawsuit asserted that the "plaintiff (Wyoming) has a right to control disease in wildlife located on the National Elk Refuge" (quoted in Camenzind 1998a). Geringer remarked that "this is a point of demarcation that says we have to resolve who has the primary responsibility to see to animal health" (quoted in Gearino 1998b). He believes the state should be involved in wildlife health-related issues.

While the judge ordered the state to restate its argument because it seemed not to have a sound premise, the lawsuit could have potentially given states sole authority over managing wildlife, even on federal land (Angell 1998). In addition, Franz Camenzind points out that in the struggle over the state's right to control wildlife, the state is harming itself. He observes that by pushing for authority to vaccinate on the refuge, the state is indicating that brucellosis is a true problem, rather than trying to use the money contributed toward the lawsuit to promote the health of the state's cattle industry (Camenzind 1998b).

Part of the tension comes from different political pressures among agencies. Wyoming Game and Fish is in a perhaps more political position than other agencies (Camenzind 1998b; Reiswig 1998). The department is run by a board of commissioners, appointed by the governor and composed primarily of sportsmen and citizens connected to the livestock and outfitting industries. The top two appointments on the Game and Fish Commission are now made by the governor. Many management decisions come from Cheyenne rather than regional offices. Additionally, the governor's role in appointing the commissioners renders his opinion vitally important, including his commitment to eradicating brucellosis from the state. The authorization for Wyoming Department of Game and Fish follows a different set of standards, a different path of authorization, and different laws (Reiswig 1998). Game and Fish will also be in the forefront of projected lawsuits over hunting by animal rights groups (Camenzind 1998b).

²³ The court stated that if the treaty held authority over state game laws "Wyoming, then, will have been admitted into the Union, not as an equal member, but as one shorn of a legislative power vested in all the other States of the Union, a power resulting from the fact of statehood and incident to its plenary existence....The enabling act declares that the State of Wyoming is admitted on equal terms with the other States, and this declaration, which is simply an expression of the general rule, which presupposes that States, when admitted into the Union, are endowed with powers and attributes equal in scope to those enjoyed by the States already admitted, repels any presumption that in this particular case Congress intended to admit the State of Wyoming with diminished governmental authority" (quoted in Commissioner of Indian Affairs 1896: 65).

The opinion goes on to say that "the whole argument of the defendant in error rests on the assumption that there was a perpetual right conveyed by the treaty, when in fact the privilege given was temporary" (quoted in Commissioner of Indian Affairs 1896: 65).

LEADERSHIP

Many people cited the importance of individual personalities and leadership styles—in agencies, in conservation organizations, and in the community—to the process (Bohne 1998; Curlee 1998; Griffin 1998; Harvey 1998; Lichtman 1998). Three different managers, for example, have directed the refuge during the planning process. Many people attribute at least part of the acceptance of the final FONSI to the current refuge manager for his role in listening to the public, changing the perception of the problem in the agency, and having a more open mind about various issues (Bohne 1998; Curlee 1998; Griffin 1998; Lichtman 1998). The directorship of active conservation groups such as the Jackson Hole Conservation Alliance has also changed, and some members within the organization feel that a change in leadership in the interest group community also aided the process (Lichtman 1998).

Members of the Jackson Hole community also emerged as leaders in this process. Two individuals in particular, Candra Day and Peyton Curlee, organized a “21st Century Totem Study Group” to discuss bison management within the context of the Jackson Hole Community and larger resource management issues (Curlee 1998). This active and constructive effort helped agency officials realize that leadership among members of the public could help management efforts (Griffin 1998; Reiswig 1998).

Leadership has also been observed influencing other natural resources problems, such as endangered species recovery. Often, natural resource agency personnel are trained in a scientific field and display commendable skills conducting the scientific research that informs policy decisions. However, many “natural resource” problems are fundamentally people problems. As such, valuable skills include such things as crisis management to deal with “complicated, urgent, and ambiguous” situations such as bison management (Westrum 1994: 341). A leader’s role is not necessarily to make the “right” decision but rather “to create the kind of intellectual environment in which good decisions will be made” (Westrum 1994: 342). This includes both technical skills and “the process skills that promote interdisciplinary teamwork” (Clark *et al.* 1994: 427).

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THE ROLE OF SCIENCE AND SOUND JUSTIFICATIONS IN POLICY MAKING

The “problem,” according to the plan, arises from claims that bison transmit brucellosis to domestic livestock, threaten human safety, can cause property damage, and compete with elk for supplemental feed. Lichtman, however, argues that “there is no data to support these claims” (Lichtman 1995). Franz Camenzind of the Conservation Alliance believes that minimizing the risk of brucellosis transmission and property damage is driving the planning process “at the expense of...achieving maximum, environmentally determined population levels” (Camenzind 1995). Furthermore, he points out, “the Draft Plan presents no evidence to support the credibility of either of the two driving forces” (Camenzind 1995).

While the above statements indicate that science is a necessary tool in policy making, some feel it is often abused and does not offer answers, only information that managers must interpret with other social and political information. For example, one official notes that genetic viability is being used as a tool to argue for more bison and that science can be “used unethically” (Bohne 1998). In addition, researchers from different agencies and independent researchers often differ in their conclusions about the same data or use different data to argue for different management alternatives (Reiswig 1998).

There is a growing body of literature on the role of science in policy making. In one of the earliest works on the nature of science, Thomas Kuhn described worldviews within the scientific community as “paradigms” (Kuhn 1962, 1970). Different scientific communities use unique criteria to identify problems, criteria that can “insulate the community from those socially important problems that are not reducible to the puzzle form, because they cannot be stated in terms of the conceptual and instrumental tools the paradigm supplies” (Kuhn 1962, 1970: 37). In other words, people tend to identify problems based on terms, conditions, frameworks, and criteria with which they are familiar, such as range conditions, optimal herd size, genetic viability and other “scientific” definitions. Less attention is given to understanding the social context in which such biological and ecological studies are being conducted.

More recently, two authors have observed that “where science and professionalism have come to dominate, goals are utilitarian, and no distinction is made between what is good for science and professional groups and what serves the public interest” (Schneider and Ingram 1997: 172). In addition, when the same scientists studying the biological components of a problem set management goals, those goals are often challenged because they conflict with public values (Schneider and Ingram 1997). The original goal statement of the bison management plan, for example, was to maintain a herd population of 50, which would serve agency officials by decreasing the complexity of the species managed for on the refuge.

Expert knowledge is vital in carrying out policy debates (Lasswell 1971). However, natural science is only one tool to reduce uncertainty. Understanding not only scientific factors but also varying perspectives, values, ideologies, and motivations is important in creating effective policies that meet the interests of a diversity of actors, including the wildlife over which debates are carried out. Expert knowledge thus includes experts not only on biological issues within conservation debates, but also those with expertise in understanding social and political factors that affect debates about managing the natural world, i.e., experts in “content and procedure” (Lasswell 1971: 39). In addition, employing the public earlier in the planning process can help provide another perspective to check scientific and other biases of agency experts who determine objectives in a management plan.

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OVERALL DECISION-MAKING PROCESS

A common complaint among participants relates to the overall decision-making process, including flaws with the initial conception of the problem, the justifications given for proposed alternatives, and the role of the public in the process (Clark 1994). Conservationists and environmentalists alike argued as late as 1996 that “the Jackson Hole bison plan is trying to address a problem that may not exist” (Adams 1996), specifically brucellosis. One rancher said that “we don’t think there is a problem” (quoted in Thuermer 1997). Tim Clark remarked that “the bison problem may be narrowly seen as a biological issue, when in fact it might be better understood as a community policy issue” (quoted in Thuermer 1996). Pam Lichtman of the Jackson Hole Conservation Alliance pointed out that “While the Plan/EA has been *re-written* and *re-packaged*, the agencies have not *re-examined* the underlying premise behind their proposal to manage the Jackson bison herd, which is that bison are a ‘problem’ that needs to be managed” (Lichtman 1995).

People essentially questioned what agencies based the goals and management alternatives on. For example, the original EA called for managing bison at a level of 50 to minimize their impacts on livestock, elk, other wildlife, human safety and property, and habitat. Yet, despite a population over 200, one individual claims, “such anticipated problems as impacts on other ungulates and damage to vegetation have been negligible” (Harvey 1995). She called for a stronger correlation between bison numbers and bison-caused problems before allowing culling to a low number. Even agency officials commented that as the bison population grew throughout the planning process, early arguments that higher numbers would result in more damage grew weaker (Bohne 1998). This is evidence of the importance of scientific tests, not just scientific speculation, when writing management plans.

In addition, “the agencies have paid little attention to the social dimensions of bison management, despite their central importance” (Clark 1994). These social dimensions include, among other things, “just how the bison ‘problem’ is being formulated, by whom, and with what perspective and outcome in mind” (Clark 1994). The plan, according to many, should embody the ideals of the democratic process, and preferred alternatives should be justified both by sound science and other community standards. It is important to consider community norms and opinions about the management plan “in terms of basic premises held by the community” (Clark 1994).

LESSONS AND RECOMMENDATIONS

One researcher wrote that “every retrospective analysis in problem definition is also a look ahead and an implicit argument about what government should be doing next” (Rocheffort and Cobb 1990: 3). In this sense, examining the various problems that emerged in developing the bison management plan can help in future planning processes. Despite the long process of arriving at a final plan for bison management, it reached a point where parties agreed enough to

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celebrate together (Lichtman 1998). Local conservation groups said that the plan “is an example of the agencies and the public working together to arrive at an acceptable solution” (Camenzind 1997). The controversy over managing bison is not finished, but lessons can be drawn from the obstacles and successes of the planning process. Based on interviews and the public comments written regarding the management plan, the following are some lessons for future policy debates.

UNDERSTANDING THE PROBLEM

Tom Toman, Wyoming Game and Fish district supervisor, said that “the biggest problem that I can identify is that agencies often derive solutions to problems before the problems have been clearly identified or defined” (Toman 1996). The original conception of the problem was, to some degree, an artifact of the areas of interest and expertise of those who framed it. The first team to develop a bison management plan was the Jackson Hole Cooperative Elk Studies Group, who primarily sought to protect the Jackson elk herds. There were also many pressures in and out of government to design management plans for bison that minimized conflicts between bison, elk and livestock. All of the factors listed above influencing this EA process—a GYE-wide focus on brucellosis, other regional controversies, differing management philosophies, different perceptions of elk and bison, leadership, the role of science, and overall problems with the decision process—influenced the development of a narrow initial conception of the problem.

Primm and Clark (1996) describe many problem definitions in the Greater Yellowstone Ecosystem that apply to this case. One problem definition focuses on science, claiming that inadequate research prevents policy changes. Such arguments place the focus and burden on scientists to develop policy. A second problem definition points to economics. One side claims that protection in the GYE may cost too much, while the opposing side claims that extractive industries fail to account for the true economy, which relies on intact ecosystems. Such a problem definition can lead to feelings of powerlessness in the face of larger economic forces. A third problem definition blames bureaucracy. One side argues that agencies lack skills to conduct ecosystem management, while the other side calls for agency reforms to pave the way for ecosystem management (Primm and Clark 1996). Such a definition places the focus and burden for improved decision making primarily on agency personnel. All these problem definitions—science, economics, and bureaucracy—have arisen in the Jackson bison case.

The overall lesson is that initial and subsequent definitions of a problem in a policy situation determine who is included in discussions, the type of information used to make decisions, and the alternatives discussed. While technical considerations are of utmost importance in natural resource issues, an overly narrow definition of a problem that ignores the social and political context can lead to continued controversy and continued degradation of resources.

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Clarifying the goals of the refuge and bison management

It is necessary to examine goals not only relating to bison specifically but also ones relating to the refuge and community. While the original enabling legislation for the refuge explicitly stated it was for elk, subsequent expansions of refuge land include management priority for birds and other big game animals.²⁴ The overall mission of the refuge includes preserving, restoring, and enhancing endangered species in their natural ecosystems, preserving and protecting archaeological and historical sites, perpetuating migratory bird habitat, and managing elk. Achieving the mandates of the National Wildlife Refuge Improvement Act must also be a goal.

The planning process to manage for bison on the refuge has shown that it is necessary to abide by missions broader than protecting elk and to place the management of any single species within larger ecological and community goals. Issues such as brucellosis force agencies to think beyond bison management because it also affects elk and involves regulatory agencies beyond the valley's borders (Harvey 1998). When the goal of managing the refuge is to maximize elk production, bison are seen as a problem. Expanding the goal to meet the needs and desires of the community in a sound, scientific manner shifts the problem definition. Bison are no longer seen as "the" problem, and pulling together as a community to minimize intervention by outside agencies becomes a priority.

Clarifying refuge goals might include formal activities such as an agency workshop or exercise to assess the views of managing the refuge from within the agency, as well as goal-clarification workshops conducted with the public. Groups such as the Sonoran Institute, the Center for Resolution, or the Northern Rockies Conservation Cooperative can act as advisors in such processes. It would also be informative to assess goals through more informal activities, such as monitoring formally or informally the public's reaction to various refuge activities or maintaining contact with individual citizens and community groups. For example, the response to the bison EA showed that the community sees bison conservation as a necessary refuge goal.

Reliable, comprehensive, and selective information

Many people complained that management personnel seemed to hold *a priori* views of bison management (i.e., reduction) without first completing any studies. This EA process showed that the public demands clearly articulated goals and supporting documentation for decisions made to reach those goals. People questioned the alleged problems because there were no clear goals set for bison and a striking lack of information about bison. For example, many people questioned the concern for elk, tourists, refuge and concessionaire property, and brucellosis management over bison conservation. They asked why the number of bison was set at 50, 90, or 300 and what property damage was being done. Recent studies also indicate that people value the refuge for more than the protection it provides to elk (Kahn, this volume).

²⁴This legislation includes Executive Order 3596, dated Dec. 22, 1921, which designated land on the refuge "as Refuges and breeding grounds for birds" and 44 Stat. 1246 dated Feb. 25, 1927, which grants title to certain lands to add to the refuge "for the grazing of, and as a Refuge for, American elk and other big game animals."

In addition, once clearer goals were articulated (such as the maintenance of a free-roaming herd) and biological studies were conducted concerning the potential of various alternatives to meet that goal, the alternatives drastically changed. The agencies increased the target population. They eliminated Hunter-Talbot as a possibility for winter range given both natural bison winter migrations out of the park and park mandates that conflict with baiting or otherwise artificially enhancing winter forage in the park. Adequate goal clarification of all participants and both biological and socioeconomic research can improve decision making. The research should come from both agency and independent researchers.

It is important to learn not just from scientific studies, but also from history and experience. For example, the attempt to eradicate brucellosis from the Jackson herd failed in the 1960s because of an inadequate vaccination and possibly re-infection of bison by elk. Given no safe, effective vaccine and the continued infection of elk, attempts to eradicate brucellosis from bison would probably fail. Additionally, Jackson area ranchers have grazed cattle next to bison for decades without a brucellosis outbreak, and they claim that vaccinating cattle works effectively to prevent the spread of brucellosis. One resident stated, “A serious attempt should be made to better educate the states bordering Wyoming as to the high improbability of cattle cont[r]acting brucellosis from the bison and to inform them that killing a herd of bison that may not even have brucellosis will serve no purpose” (Steller 1995). Experiential data like this can be used to promote Wyoming’s cattle as clean despite brucellosis in wildlife (Camenzind 1998b).

It is, of course, important to recognize the existence of agency constraints and the larger political context in which decisions are being made. However, this political context should not preclude founding decisions on adequate biological, socioeconomic, and experiential information. Opportunities to work within or change the political atmosphere—for example, by attempting to build trust through daily personal contact—can be sought.

Overall, data collection should be timely, being conducted before alternatives are developed, and open. An open research process can be achieved by enhancing agency research and expertise with the expertise of outside researchers as well as developing cooperative arrangements with groups such as universities, the Teton Science School, and other organized interests that include research in their daily operations. An open process can not only reduce the burden on agency personnel and budgets, but can also add credibility to the data. Given limited agency time and budgets, enlisting graduate students or outside researchers may provide the opportunity to gather social, economic, political, and ecological information in a systematic manner.

Most basically, monitoring can be done and statistics kept not only concerning bison population and distribution, but also concerning interactions with cattle, with humans, and with other wildlife. Costs of bison management can be tracked. Actual risk of disease transmission and the perception of risk

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should be determined. In a debate filled with unknowns, such data can resolve some of the questions regarding impact on human safety and property. In addition, social surveys can be conducted by a graduate student or other researcher to determine the general perception of the refuge, i.e., to determine what the public thinks the goals of refuge management should be in relation to the community.

COMMUNITY EFFORTS, INCLUSIVE DECISION MAKING, AND THE POWER OF THE PUBLIC

While the Yellowstone brucellosis controversy added pressure to agencies in Jackson, it also helped community efforts.²⁵ The Jackson community realized its place in the larger Greater Yellowstone Ecosystem and realized that to minimize intervention by agencies such as APHIS, it had to become an example of how communities can resolve issues (Curlee 1998).

Many people have stated the importance of public comments in this planning process and the organization of the public around this issue (Bohne 1998; Camenzind 1998b; Griffin 1998; Harvey 1998; Lichtman 1998; Reiswig 1998). These individuals assert that the more responsive agencies can be to the public, the smoother things will proceed. Courts play a much larger role when public sentiment is not considered early in the planning process, thereby reducing the overall efficiency and timeliness of implementation. In the bison management plan, the agencies eventually became more flexible in their views on possible alternatives, rather than trying to convince the public that what is good for the agency is good for all (Bohne 1998).

Many people in the community expressed serious concerns about the planning process for bison management, but their involvement indicates not only agency obstacles but also an opportunity for the agency. People have limited time and resources, and spending those limited resources on finding ways to solve the bison “problem” indicates a concern, respect, and affinity for the refuge. Of course, the quality of public involvement depends not only on agency efforts but also the abilities of the members of the public who are becoming involved.

While public participation seems at times to reduce the efficiency of planning processes, including the public early in decision making can actually make the job of managers easier. The broad-based acceptance of hunting by the public—with the exception of a few animal rights groups—came as a surprise to agencies (Bohne 1998). The lesson from such public opinion is that agencies can achieve broad-based support for seemingly highly controversial issues (Bohne 1998), and that public participation can help expand (or change) problem definition early in the process to help facilitate the remainder of the process. In addition, adaptive management only works with trust that is built from agency responsiveness and openness (Lichtman 1998). Those within the agency are beginning to advocate working with the public and bringing people to the refuge who are concerned with bison (or elk) to listen to them and what

While public participation seems at times to reduce the efficiency of planning processes, including the public early in decision making can actually make the job of managers easier. The broad-based acceptance of hunting by the public—with the exception of a few animal rights groups—came as a surprise to agencies (Bohne 1998).

²⁵ Bison management in Jackson differs quite a bit from Yellowstone. The herd is much smaller, migrations tend to remain on federal Department of Interior land in Grand Teton National Park and the National Elk Refuge, and Wyoming ranchers tend to accept bison more readily than their Montana counterparts because they have had no problems with brucellosis after 30 years of cattle and bison commingling (Camenzind 1998). However, the bison controversy still involves many of the same federal agencies and federal controversy, namely eradication of brucellosis.

they want, as well as to educate them about the agency's perspective (Griffin 1998; Reiswig 1998). The public has perceived this increasing openness and appreciates efforts on the part of the agency.

However, there is always the possibility that certain members of the public will disagree with decisions made by agencies, despite efforts to incorporate public input. For example, the recent lawsuit by the Fund for Animals indicates that certain groups will use the litigation process to oppose decisions obtained even through collaborative agreements. Litigation can both help and hinder the process of finding common interest in a public policy debate. It can serve to bring key issues to the attention of decision makers and the public, and the public participation process includes appeals and litigation as inherent and powerful components. While such litigation can also serve to polarize issues further and degrade trust and can decrease efficiency in making decisions because policies get tied up in court, it is a necessary component of American democracy. The best strategy for decision makers is to listen to groups early in the process and work to the best of their ability with those willing to work collaboratively on difficult natural resource policy and management issues.

Capitalizing on community groups

The Jackson community will become involved either reactively or proactively. It would benefit the agencies to involve them early in the planning process by informing the public about refuge policy and actions and finding ways to incorporate their input. The Totem Studies group provides an example of how public participation may proceed. The refuge could create partnerships with groups such as the Community Foundation of Jackson Hole, or contact key participants in the Totem Studies Group to seek an ongoing partnership. One of the primary goals of the Totem group was to improve decision-making processes, and lessons can be learned from the successes and obstacles of that group as an inclusive citizen's group.

Direct contact with members of the public in an organized and systematic fashion can help to test agency perception of public perception. For example, a perception exists within the refuge that the public views the refuge primarily as habitat for elk. The reaction of vocal residents and special interest groups to elk "starving" in the winter or numbers dropping reinforces such a perception. However, the negative reaction to plans to maintain a low population of bison indicates that a larger perception of refuge goals may already exist among many members of the public.

THE ROLE OF AGENCIES

There is often a perception within agencies that once a position is taken publicly on a management issue, it creates poor press to change that position and moving away from that position can be difficult (Reiswig 1998). However, the lesson from the bison management plan is that changing a position in light of public comments and new scientific information can lead to respect and trust

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from the community, not condemnation. The evidence of this comes from the difference between the final 1996 EA document and the 1997 Finding of No Significant Impact. The two documents differ significantly, largely in response to public comment and new data (Harvey 1998). When agencies are more open and flexible, the public feels less of a need for them to state exact management strategies in a rigid fashion (Lichtman 1998).

Many people also feel more confident about public processes because there has been a reorientation in the agency reflected in the changing dialogue. The refuge manager is interested in larger issues and in redefining old paradigms. He has told the public that he is in favor of bison on the refuge, and that once the agency realized bison would enter the refuge despite agency preference, they could move beyond the fight over where bison should or should not be. They could shift the dialogue to discuss the place of bison on the refuge (Reiswig 1998, Curlee 1998). The agencies learned from mistakes made in Montana, as well. The agencies in Montana showed no flexibility; they took a dogmatic approach. Agency officials and community members decided that they could come out political winners if they listened to the public rather than only to others within government agencies (Bohne 1998). While jurisdictional boundaries remain tentative and in constant tension, retreating into those boundaries and attempting to assert authority and control can lead to more harm for all involved than good. Agencies working together can overcome differences if they are open and come up with reasonable compromise (Bohne 1998).

Framing a policy debate

An agency also has the power to frame a policy debate, at least initially to define the language used to talk about an issue. Framing problems more comprehensively can expand the focus beyond technical issues such as brucellosis to include broad underlying problems. The public may not always appreciate the larger political and regulatory situation of agencies, which contribute to problems in reaching resolution, when public documents contain only technical issues. A more comprehensive view can also help to clarify what the community expects.

Influencing public perception

While officials must remain aware of public values as they exist, many members of the public respect agency expertise, and this respect can be used to expand the perception of refuge use. For example, a new visitor center is currently being planned. This visitor center offers a prime opportunity to educate the public that the "Elk Refuge" serves the purpose of more than providing elk habitat. Displays may be established not only to educate visitors about the refuge's elk population, but also about other biodiversity on the refuge, including bird species, invertebrates, plant and flower species, and other mammals such as bighorn sheep and bison. The place of the refuge in the Greater Yellowstone

An agency also has the power to frame a policy debate, at least initially to define the language used to talk about an issue. Framing problems more comprehensively can expand the focus beyond technical issues such as brucellosis to include broad underlying problems.

Ecosystem, including migration routes for bison, elk, bighorn sheep, shore birds, and other species would also be informative for visitors. Historical information about the formation of the refuge and the conservation success story of species such as bison might be developed in conjunction with the Jackson Hole Historical Society. There might also be displays about how the refuge fits into the community. For example, uses such as biking, fishing, hunting, and hiking might be pointed to as recreational values the community holds. Finally, displays could be developed about the law and policy of the refuge. There might even be a display on the new refuge management act and on the involvement of the refuge in controversies such as brucellosis. This will allow visitors—the American public—to realize that protected land does not necessarily mean protected resources, and that it takes active management and much time and effort to truly protect resources on the refuge and manage them in the common interest.

Again, given limited agency time and budgets, developing such displays may be difficult. However, displays could be developed in conjunction with community groups. For example, involving local schools would provide a hands-on learning opportunity for students in the community. Seasonal or temporary displays could be built by them and directed by refuge personnel and teachers. Such cooperation could also provide an opportunity to educate teachers and parents about the refuge. The historical society, wildlife museum, and Teton Science School are other potential partners.

A final strategy would be to change the name of the National Elk Refuge to the Jackson Hole National Elk and Wildlife Refuge, the Jackson Hole National Wildlife Refuge, the Grand Teton National Wildlife Refuge or a similar more encompassing name.

The power of names

A final strategy would be to change the name of the National Elk Refuge to the Jackson Hole National Elk and Wildlife Refuge, the Jackson Hole National Wildlife Refuge, the Grand Teton National Wildlife Refuge or a similar more encompassing name. While early refuges were set up for single species management, current trends in wildlife and natural resource management are moving towards more watershed, ecosystem, and multiple species management. The change in name could be justified with such management paradigms in mind, and elk could remain a priority management species. While such discussions may incite controversy, they would also provide an opportunity for dialogue to determine how people value the refuge and what they see as refuge goals and community goals for the refuge.

CONCLUSIONS

The Jackson community has been engaged in a lengthy and controversial planning process for the Jackson bison herd. While the controversy is not over, the bison EA process has shown that the Jackson community can pull together. For example, Jackson ranchers assert that if they vaccinate their cattle, bison and brucellosis pose a minimal threat, and the Jackson community has supported them in their assertions. The plan also reflects the dedication and

cooperation of state and federal agency officials and biologists, at least temporarily and regionally. The support of the final plan by environmental organizations, including the Jackson Hole Conservation Alliance, the Greater Yellowstone Coalition, and the Wyoming Wildlife Federation, also reflect the agency's willingness, in the end, to respond to public interests.

This process contains lessons for future management. Most of the process was marked by low agency responsiveness to public comments, secretiveness regarding prescriptions for managing the herd, inadequate justification for the perception of bison as a problem, discrepancies between standards for managing bison and elk, and a narrow conception of the context in which bison management was occurring. Several drafts invoked the same complaints by the public. Finally, between the last Environmental Assessment and the release of the Finding of No Significant Impact, the agencies were willing to expand the discussion to include the community and ecological context of bison management. They addressed public concerns, and they showed flexibility from earlier iterations of the problem and solutions. The lawsuit by the Fund for Animals indicates that there is still room for learning and improvement in management, however, as well as the need to realize that no plan can or will please all publics.

Management regimes for different species and resources on the refuge are difficult to separate. All involve a complex ecological, social, and political context. The tendency in complex situations in natural resource management is to look for an increasingly detailed understanding of the technical issues. While such an understanding is vital, it is also necessary for policy makers to take a more comprehensive, macroscopic view of a given situation. Framing policy debates in a broader context—such as disease management or, even more broadly, as maintaining a sustainable community—can benefit the agencies and the resources they are charged to manage.

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Biodiversity and its Management on the National Elk Refuge, Wyoming

Noah P. Matson
Defenders of Wildlife

ABSTRACT

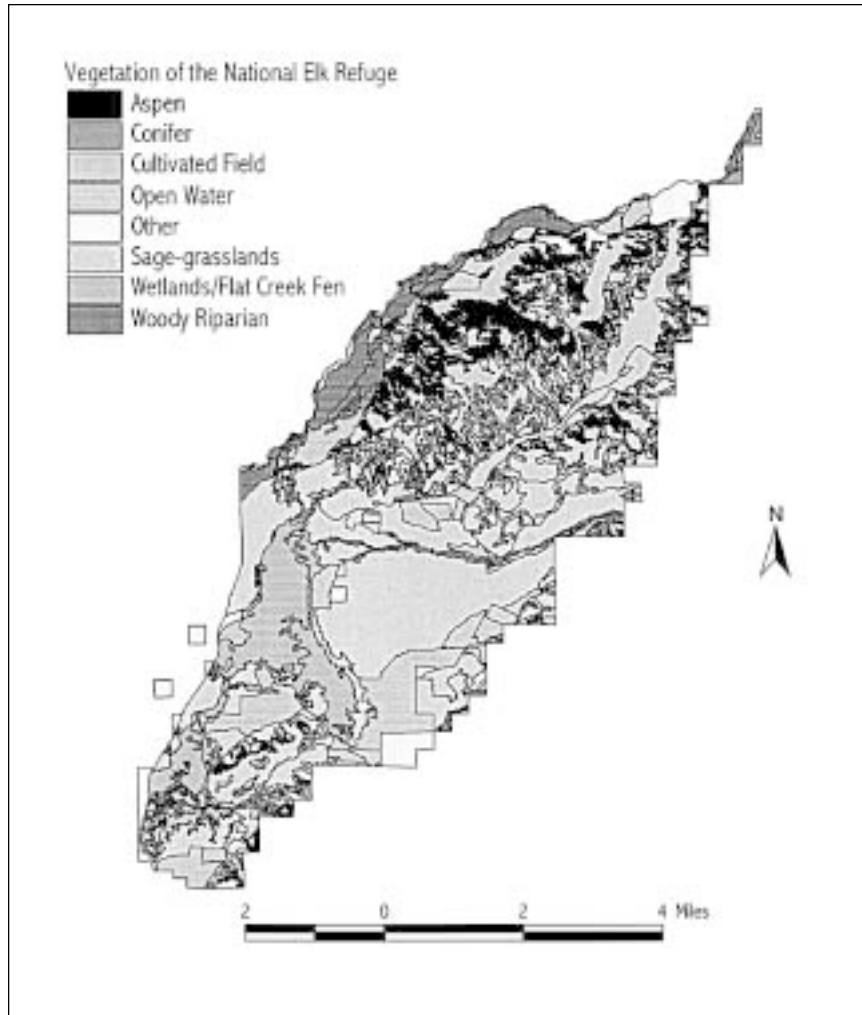
The National Elk Refuge is home to 178 species of birds, 49 species of mammals, 382 species of vascular plants, five species of native fish, five species of reptiles and amphibians, and unknown numbers of species of invertebrates and non-vascular plants. The refuge is charged with protecting, enhancing, and restoring populations and habitats of all the species found on its grounds. Since its inception, however, management has focused on elk. Supplemental feeding has supported higher numbers of elk than the refuge ecosystem can handle, and it has long been recognized that the large concentration of these ungulates has had negative impacts on a number of biotic communities. Elk have reduced and eliminated woody tree and shrub cover along riparian areas, limited aspen regeneration, reduced sage-grassland structural diversity, and rendered areas prone to exotic plant invasion. If current management continues, these vegetative communities and their associated wildlife species will continue to decline. This paper recommends that the refuge needs: (1) to define its commitment to the protection of biodiversity before it can manage biodiversity more sustainably; (2) to manage on a regional level and coordinate with other agencies and private landowners; (3) to establish a comprehensive monitoring and data analysis program to determine if management prescriptions are successful and to adapt management to changing information and conditions; (4) to reduce supplemental feeding and the size of the elk herd; (5) to take measures to restore degraded communities; and (6) to build a constituency for biodiversity. The report is designed to be a resource for future activities and a summary of past trends in management and biodiversity.

“Biodiversity is the variety of life and its processes. It includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting” (Noss and Cooperrider 1994: 5).

Just a brief field trip to the National Elk Refuge (NER) reveals that this 25,000-acre area is habitat for much more than elk. One hundred seventy-eight species of birds, 49 species of mammals, 382 species of vascular plants, five species of native fish, five species of reptiles and amphibians, and potentially thousands of species of invertebrates and non-vascular plants use the refuge for all or part of the year (Appendix B). Almost all these species are found throughout the Greater Yellowstone Ecosystem (GYE), many migrating between winter and summer ranges as well as to points far north or south. These species are associated with six main biotic communities on the refuge: sage-grasslands, sedge-marshlands (wetlands), aspen forests, woody-riparian, irrigated domestic grasses, and aquatic communities (Figures 1 and 2).

Since its inception, the NER has focused its management activities on elk and other game species. Without the attention on the Jackson elk herd, there would likely be no wildlife refuge in Jackson Hole, so the importance of elk cannot be ignored. However, the status and trends for biodiversity as a whole have never been studied. Many agencies are moving away from single species management, including the U. S. Fish and Wildlife Service (USFWS), which under the National Wildlife Refuge System Improvement Act (NWRISA) of 1997, is mandated to “maintain the biological integrity, diversity, and environ-

One hundred seventy-eight species of birds, 49 species of mammals, 382 species of vascular plants, five species of native fish, five species of reptiles and amphibians, and potentially thousands of species of invertebrates and non-vascular plants use the refuge for all or part of the year.



As part of the comprehensive management plan required by the NWRSA, the distribution, migration patterns, and abundance of fish, wildlife, and plant populations and related habitats within the refuge must be identified and described.

Figure 1 Map

mental health of the Refuge System.” In addition, the NWRSA requires the USFWS to “monitor the status and trends of fish, wildlife, and plants in each refuge.”

This paper describes the historical and present status of biodiversity on the refuge, identifies specific populations and procedures for monitoring and provides recommendations and products to help manage biodiversity sustainably. As part of the comprehensive management plan required by the NWRSA, the distribution, migration patterns, and abundance of fish, wildlife, and plant populations and related habitats within the refuge must be identified and described. In addition, significant problems that may adversely affect populations and habitats within the NER and actions necessary to correct or mitigate such problems must also be identified. This report is designed to be a resource for future activities and a summary of past trends in management and biodiversity.

METHODS

To assess biodiversity and biodiversity management on the NER, twenty personal interviews were conducted, refuge records and other literature were reviewed, and qualitative data were collected during field trips on the refuge. I interviewed individuals (Appendix A) who had researched or spent extensive time on the NER or dealt with refuge-related problems. During each interview, I asked about trends in different species and species groups and about management recommendations for biodiversity.

Refuge records contained valuable information on wildlife populations, particularly game species. The annual narrative reports provided population estimates, breeding information, unusual species occurrences or trends, and information on habitat management. Individual files on waterfowl breeding pair counts dating back to 1978 and on waterfowl brood counts dating back to 1988 were compiled. Various other records provided additional information. Literature reviews were used to gain insight into specific topics.

I made six field trips to gather observational and interview data: (1) an initial tour of the NER, led by refuge biologist Bruce Smith; (2) a feasibility study for a range survey of the NER to be conducted by Bridger-Teton National Forest vegetation biologist Deborah Deslaurier; (3) a bird survey along Flat Creek; (4) a tour of the refuge organized by the Teton County Natural Resource District highlighting ecologically stressed areas and other NER-related issues; (5) a Native Plant Society field trip led by Walter Fertig of the Wyoming Natural Heritage Program to collect information on unique plants and the Flat Creek Fen; and (6) a personal reconnaissance of the northern section of the refuge to gather qualitative data on aspen and other communities.

As early as 1941, it was recognized that the elk wintering on the NER were affecting the ecosystem. Since then, little has been done to curb these effects and certain species and communities have declined.

TRENDS IN BIODIVERSITY

“On these lands along the Gros Ventre River there is a heavy growth of willows and many patches of aspen. This winter, before the elk feeding began, there were at times as many as 3000 elk staying on those lands with a number remaining there the entire winter. The willow and aspen growths in the area already show signs of being heavily browsed. As time goes on it is very probable that the willows and aspen growths in that area will be destroyed from overbrowsing. This condition is already true of the willow, aspen, and shrubbery growths on the old portion of the refuge area” (Almer P. Nelson, Refuge Manager, 1941 Annual Narrative Report).

As early as 1941, it was recognized that the elk wintering on the NER were affecting the ecosystem. Since then, little has been done to curb these effects and certain species and communities have declined.

The NER has been collecting population data on game species since its inception. Although survey methods have changed over time, making comparisons difficult, some species have quantitative data dating back to the 1930s (Appendix C). Some species data sets are missing many data points because

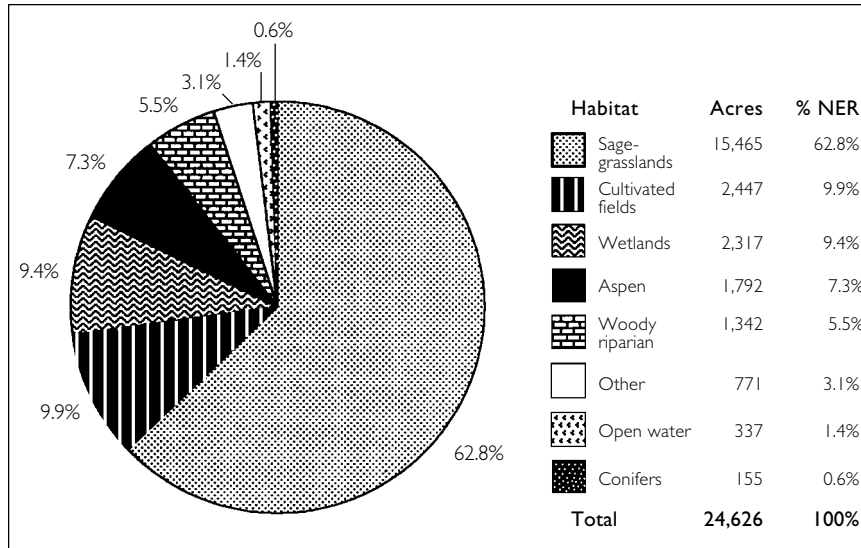


Figure 2 Areas of habitat types on the National Elk Refuge, Jackson, Wyoming. (Source: 1986 Digital vegetation map of the NER prepared by Bruce Smith)

The species most likely affected by habitat changes caused by elk are habitat specialist passerine birds and small mammals, which have not been monitored regularly or systematically in the past.

data either were not reported in the annual reports or were lost over the decades and through a move in headquarters, making analysis difficult. Table 1 shows trends and status of individual species and species groups that have quantitative or qualitative data available.

The species most likely affected by habitat changes caused by elk are habitat specialist passerine birds and small mammals, which have not been monitored regularly or systematically in the past. Wildlife populations are “intricately related to the quantity and quality of habitats required for their maintenance” (Kirsch *et al.* 1978: 486), and there have been many attempts to model these relationships (Merrill *et al.* 1996; Verner *et al.* 1986). This section documents and summarizes what is known about the vegetative and aquatic communities on the NER and relates their condition to other species. Areas and distributions of the community types were analyzed using a digital version of a 1986 NER vegetation map imported into a geographic information system (ArcView by ESRI). Although some of these community types have likely changed in area, this is the most up to date and accurate information available.

WOODY RIPARIAN

Woody riparian areas, constituting 5.5% of the refuge (1,342 acres) (Figure 2), are concentrated along the two main tributaries on the refuge, Flat Creek and the Gros Ventre River. Because they remain above snow level, shrubs and trees are vulnerable to browsing in winter when concentrations of browsers are highest. Concerned about woody shrubs, refuge manager Almer P. Nelson in 1941 photographed willows directly inside and outside refuge fencing “in order to substantiate the necessity of having the number of elk that come onto the refuge for winter feed reduced to a number that the refuge area will reasonably

Table I Summary of status of species and groups on the National Elk Refuge, Jackson, Wyoming, where information is known.

<u>Species/Group</u>	<u>Status/trend</u>
Badgers	Populations stable or increasing.
Beavers	<p>Beaver populations are down from historical populations, both on the refuge and across the country. "Through the enlargement of the refuge the Biological Survey has also become the custodian of a considerable colony of beavers that inhabit lands along the Gros Ventre River" (NER 1937). Today, there are only a handful of beavers in the area. Beavers were heavily trapped for their fur during the early part of the century. Their dam building also interferes with human activities and currently populations are controlled to limit their impact. Beavers are directly controlled on the northern section of the refuge along the Gros Ventre River to prevent them from damming water diversions to South Park and mitigation ponds on the refuge. There is also evidence that severe browsing by elk, deer, and moose may limit forage for beavers and drive down their populations.</p> <p>Beavers are considered a keystone species, modifying habitat. Many ecosystems and communities have evolved to deal with the dynamic hydrologic conditions created by beavers. Restoration of beaver populations would have positive effects on biodiversity, but would also make management of water resources extremely difficult.</p>
Bighorn sheep	The population wintering on Miller Butte has increased in the last few years, but is much lower than a peak in the early 1960s. Throughout the region, bighorn sheep populations have declined from diseases contracted from domestic sheep and potentially from competition with the increased elk population.
Bison	Almost an exponential increase in the wintering population since the late 1970s (Appendix C1). Cromley (this volume) discusses the management of the bison herd.
Coyotes	Populations fluctuate, but are not threatened. Coyotes were controlled in the late 1940s and early '50s. As many as 85 were killed in 1949.
Moose	Have maintained a fairly stable wintering population of 25 animals for 60 years, even though GTNP scientists report their numbers are down (Figure C1).
Mule deer	The wintering population has decreased since the 1960s (Figure C1). Mule deer may compete with elk for certain resources.
Muskrats	"Previous to 1936, when the refuge added 700 ac of ideal muskrat habitat, private trappers are said to have taken off about 250 'rats' annually" (NER 1957). Before 1960, the estimated population averaged 700 muskrats. After 1960, the estimated population averaged 100 muskrats. All estimates were to the nearest hundred, and thus not particularly accurate. This drop may have been a change in protocol or personnel. However, if the population was as robust as to yield 250 muskrats a year, there certainly is not that type of abundance today. It is unknown what could have caused the population to decline.
Mountain lions	There has been an increase in lion predation on and near the refuge in recent years.
Uinta ground squirrels	The population fluctuates, but is not threatened. Ground squirrels are an extremely important food source for coyotes, badgers, and birds of prey.

<u>Species/Group</u>	<u>Status/trend</u>
Shorebirds	There has been a decline in shorebirds using the refuge in the last two decades. Raynes (1998) reports a decrease in mud flats along Flat Creek that provided habitat to shorebirds.
Songbirds	There is very little known about songbird populations on the refuge. From related studies elsewhere, there has likely been a dramatic decrease in warblers, wrens, and flycatchers because of the deterioration of willows. The only songbird study took place in aspen stands for a span of 5 years. This report found a decrease in house wrens, olive-sided flycatchers, western wood peewees, and yellow warblers and concluded that the house wren and yellow warbler decreases were localized.
Raptors	Populations appear to be stable, possibly still increasing since the ban on DDT. The refuge has the closest (densest) red-tailed hawk nests documented in the literature, presumably from the abundance of prey and the low number and close proximity of appropriate nest sites.
Waterfowl	Waterfowl species have had the best and most extensive data collected, including fall migration, breeding pair, and production counts, particularly since 1978 (Appendix C2). Populations have gone through cycles, most of which seem to correlate with regional and national trends. The creation of six mitigation ponds in the northern section of the refuge in 1990 was intended to increase waterfowl habitat and thus waterfowl use. Comparing the means of total duck breeding pairs five years before and five years after pond construction, the mean number of breeding pairs using the refuge had increased ($p=0.076$, one-sided t-test). Unfortunately, without additional temporal data, comparison with a control, or more detailed information on water fowl spatial use of the refuge, it is impossible to attribute the increase to the ponds. In fact, most ducks have increased regionally and nationally during the same time period. Waterfowl production is limited by spring floods which often wipe out the first brood. This is exacerbated by the timing of water diversions to South Park.
Herptiles	An amphibian and reptile survey of the refuge was conducted in 1998 and found all expected species: boreal chorus frogs, Columbian spotted frogs, boreal toads, blotched tiger salamanders, and garter snakes. Although no trend data is available, their presence is a good sign because of amphibian sensitivity to environmental changes. There may have been a decline in amphibians with the installation of the mitigation ponds, which disrupted natural wetland areas, although amphibians are still found there.

support” (Nelson 1941: 5). Willows inside the fencing, where elk had access, were severely overbrowsed. Not only was this a problem for willows, but “it is questionable as to what effect it will have on the refuge herd should all of the willows, aspen and shrubbery growth on the area be destroyed from over browsing” (p. 6).

The number of elk wintering on the NER since then has remained about the same or larger (Figure 3). Today, numerous dead willow stumps can be found along Flat Creek and the other drainages. According to NER records, historical photos, and personal accounts from long-time residents, willow cover has declined dramatically on the refuge since its inception (Cannon 1998; Fertig 1998b; Griffin 1998; Hudelson 1998; Nelson 1941; NER 1940-1995; Galbraith *et al.* 1998; B. Smith 1998a). In 1997 NER biologist Bruce Smith installed a demonstration exclosure along a section of Flat Creek to measure vegetation growth and browse and to document the presence and potential changes in birds and small mammals. There is another exclosure on the southwestern section of the NER near the visitor center. Both exclosures show increased growth of riparian shrubs in the absence of elk and other large herbivores.

This decline in woody vegetation has occurred in other areas with high densities of elk and other ungulates. Kay and Chadde (1991), Kovalchik and Elmore (1991), Ammon and Stacey (1997), and Case and Kauffman (1997) all document decreased willow growth, cover, and reproduction in grazed areas compared with ungrazed areas. Kay and Chadde (1991, 1994) examined willow conditions in relation to the large elk herd on Yellowstone National Park’s northern range. Using long-term exclosures, they found that ungulate browsing reduced potential willow seed production by 100%. “Moreover, based on photographic evidence, few willows on Yellowstone’s northern range appear to have produced seeds for the last 50 or so years” (Kay and Chadde 1991: 96).

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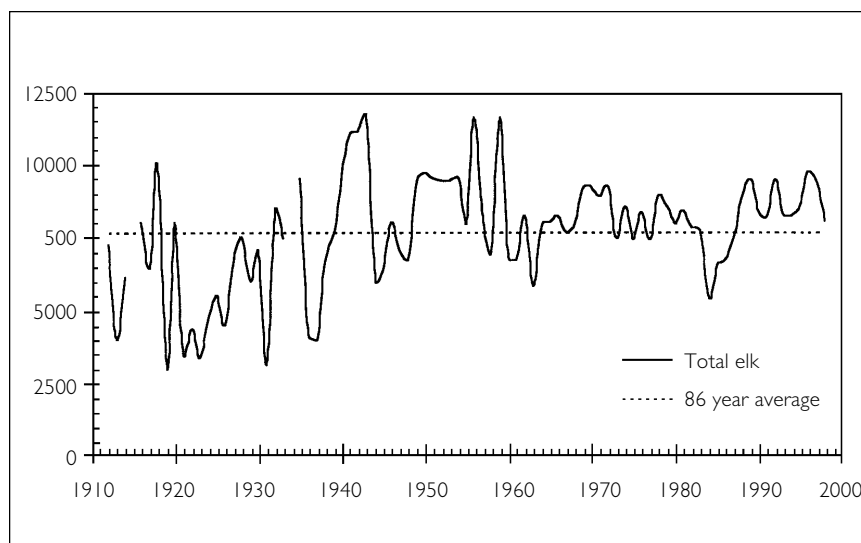


Figure 3 Yearly total and 86-year average of wintering elk on the National Elk Refuge, Jackson, Wyoming.

They found that seed production was limited by winter browsing in three ways: direct removal of flower buds, allocation of resources to vegetative growth instead of seed production following browsing, and individual plant size limitation with subsequent reduction in seed production. Without regeneration, the suppressed shrubs that have survived to this point are becoming old and decadent, continually drawing on energy reserves stored in their roots.

The same holds true for cottonwood trees on the NER. The largest concentration of cottonwoods on the refuge is along the Gros Ventre River, although they are also found along Flat Creek and some other water courses. Like other woody vegetation on the NER, most new growth in cottonwoods has been severely browsed. In their Flat Creek riparian survey, Galbraith *et al.* (1998: 1) write that “the lack of cottonwood reproduction ensures that in 50 to 100 years those trees bordering Flat Creek will be evident only as partially decomposed logs with just historical photographs to record their previous existence.” The threats to cottonwood communities are identical to the riparian shrub communities, and in fact the two communities overlap, with willows and other shrubs often found in the understory of cottonwood stands.

Riparian trees and shrubs have evolved with frequent natural disturbances. Stream banks continually shift and riparian vegetation has developed productive and reproductive adaptations to cope with the dynamic environment. One study found that after more than one hundred years of grazing, willow growth increased dramatically when grazing pressure was removed (Case and Kauffman 1997). The current NER exclosure demonstration project shows significant shrub recovery in only the first year, and willows in an exclosure erected in 1982 near the hatchery attained heights of four to five feet two years after protection from browsing (Cannon 1998). These systems can easily be restored passively just by removing or diminishing the heavy pressure of ungulate browsing.

Besides the direct improvement to vegetative communities and unknown benefits to ungulates themselves, restoration of riparian shrubs will have enormous effects on biodiversity. While making up only a fraction of the landscape, riparian habitats are disproportionately important for birds and mammals (Kovalchik and Elmore 1991; Taylor 1986). Riparian zones provide preferred habitat because they contain “easily accessible water, more favorable terrain, hiding cover, soft soil, a more favorable microclimate, and an abundant supply of lush palatable forage” (Kovalchik and Elmore 1991: 113). Over 80 vertebrate species and likely over 140 species of terrestrial arthropods are associated with willows (Moran and Southwood 1982), over 200 vertebrate species are associated with riparian shrubs in general, and over 90 vertebrate species are associated with cottonwoods (Kohley *et al.* 1998). Cottonwood stands on the NER are surrounded by lower-lying vegetative communities, like sagebrush and grasslands, and provide perches for raptors and other bird species. Six red-tailed hawk nests were found in the cottonwoods along a short reach of Flat Creek, the highest density found in the literature (R. Smith 1998). All these species are threatened by declines in their habitat.

Besides the direct improvement to vegetative communities and unknown benefits to ungulates themselves, restoration of riparian shrubs will have enormous effects on biodiversity.

Bird diversity seems to be down in riparian communities on the refuge (Wile 1998). Five birds are particularly sensitive to grazing and browsing in the riparian zone: willow flycatcher, white-crowned sparrow, Lincoln's sparrow, yellow warbler, and Wilson's warbler (Ammon and Stacey 1997; Knopf *et al.* 1988; Shultz and Leininger 1991; Taylor 1986). These five species may be valuable indicators of willow health and should be monitored closely.

AQUATIC COMMUNITIES

There are approximately 337 acres of open water on the refuge (1.4%). Although the total area is small, it is critical habitat to aquatic communities and most of the terrestrial species that use the refuge. Flat Creek, the main water course through the NER, is a nationally prized trout stream. Its water quality is generally high (TCNRD 1998). From 1934 to 1964, however, heavy sediment loads from a water diversion from the Gros Ventre River to Flat Creek filled up pools and made the creek wider and shallower. The sediment buried fish eggs and macro-invertebrates that provide forage for fish. Beginning in 1964, physical habitat improvements have been made that greatly improved productivity in the stream from 40 fish per mile to approximately 300 fish per mile (Hudelson 1998; Cannon 1998). The lack of shrub cover along most of the refuge section of the creek probably has reduced the number of trout it can support. The abundance and biomass of brown trout and the richness and diversity of benthic invertebrate species have all been demonstrated to be greater in willow-covered versus non-willow-covered sections of streambanks (Glova and Sagar 1994). Riparian shrubs moderate stream temperatures by intercepting solar radiation and by limiting radiation off the stream. Shrubs also provide important cover for trout and other fish species and are habitat for terrestrial invertebrates that provide forage for fish (Cannon 1998; Hudelson 1998). In addition, riparian vegetation is a major source of nutrients for the aquatic ecosystem, providing food for invertebrate detritivores and thus prey for fish and other species.¹

The trout fishery in Flat Creek has a large constituency, and management has been successful in maintaining natural stocks and improving habitat quality. As in much of the West, however, there is a complicated series of water rights that are not being addressed and will continue to have impacts on water flow and sediment loads. The NWRSIA requires the USFWS to "assist in the maintenance of adequate water quantity and water quality" and to "acquire, under State law, water rights that are needed for refuge purposes." As the demographics and the economy in Jackson Hole shift, the need to divert water through the refuge should be addressed.

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¹ See Cannon 1998 for a more thorough description of the habitat quality of Flat Creek.

FLAT CREEK FEN

The sedge-marshland, constituting 2,317 acres, or 9.5 % of the area, is located in the southwestern corner of the NER. Unique in Wyoming, it is in fact a calcareous fen created by ground water moving through a porous alluvial fan and upwelling at the intersection of fine sediments (Fertig 1998a; Galbraith *et al.* 1998). The ground water flows through the carbonate rocks that make up the surrounding bedrock, elevating the water pH and creating specialized habitats. Small differences in elevation in this system, even as small as an ant hill, have different moisture regimes, creating a diverse mosaic of plant species with varying hydrologic tolerances. Ten rare plants have been identified in Flat Creek Fen. Many are the only specimens known in Jackson Hole and some are found nowhere else in the state (Fertig 1998b).² The fen, or wet-meadow, is also habitat for muskrat, ducks, chorus frogs, and shorebirds.

The hydrology of this area has been affected by water diversions into and out of the fen, which may have an impact on plants with very specific hydrologic requirements. Elk populations may also have an effect on the wetland community by feeding and trampling (Hudelson 1998; Deslaurier 1998; B. Smith 1998c). Mechanical damage from elk and feeding equipment has created areas susceptible to invasions of exotic plants which may out-compete some of the rare plant species (B. Smith 1998c; Fertig 1998b).

Although this community currently appears to be healthy (Fertig 1998b), there is little documentation of what this area once looked like. There may have been much more standing water, attracting many more waterfowl and shorebirds (Deslaurier 1998). The fine sediments and rich peat of the fen are fertile soil, and early settlers likely dug ditches to drain the high water table to make the land more suitable for crops. They could then control the water level of the fields by diverting water into or out of the ditches (Deslaurier 1998). Given the unique character of Flat Creek Fen, serious attention should be given to any future actions that may adversely affect its hydrology and plant species.

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² See Fertig 1998b for a more thorough description of the plant species of special concern on the National Elk Refuge.

ASPEN FORESTS

There are over 1,650 acres of aspen habitat on the NER (6.5%), and the aerial extent and health of aspen groves have declined since the refuge's formation. Aspen seeds are small and fragile and require very specific conditions to germinate, and it is likely that most aspen clones seeded after the last ice-age glaciers retreated 10-15,000 years ago (Despain 1990). As a result, aspen trees rely almost exclusively on vegetative reproduction through root suckering to regenerate. Normally, through apical (stem tip) dominance, root suckering is suppressed by chemicals produced by the mature plants. When mature trees are killed by disturbance, adventitious shoots are released from the extensive root systems. In this way, entire stands of aspen can represent one genetic clone. Historically, fire was the main agent for disturbance and release of new regeneration. Fire removes large trees that may compete for resources with young trees, reduces the apical dominance of burned trees, and releases

nutrients into the soil, improving conditions for young trees to grow (Boyce 1989). The suppression of fire by humans during the last century has limited this process and created old stands with little regeneration. The refuge's aspens have not burned since 1879 (Dieni *et al.* 1997; Romme *et al.* 1995).

The lack of fire is not the only issue affecting aspen stands. Romme *et al.* (1995) studied aspen regeneration after the 1988 Yellowstone fires. They found that three years after the fires, sprout densities were similar in burned and unburned stands and all were equally browsed down to the height of the snow pack. Fire was unable to rejuvenate these stands in the presence of large elk numbers. Intense browsing that has limited aspens has been found throughout the GYE and the intermountain West (Boyce 1989; Kay 1997; Dieni *et al.* 1997; Baker *et al.* 1997; Despain 1990). In 1988 the NER conducted an experiment to improve aspen regeneration. Nine aspen stands were clearcut, three protected from elk by exclosures. Today, aspens within the exclosures are densely packed and exceed two meters in height. Almost all stems outside the exclosures are less than two meters tall, having been severely browsed (Dieni *et al.* 1997; TCNRD 1998).

Elk, deer, and moose also eat aspen bark and damage bark when scraping velvet from new antlers. While browsing rarely girdles a tree, damage to the trunk makes aspen more susceptible to pathogenic infections that can cause mortality in the trees (Boyce 1989).

Aspens are extremely important in the intermountain West as the only upland hardwood (DeByle and Winokur 1985). In a study conducted on East Gros Ventre Butte, across Highway 89 from the refuge, aspen groves had numbers of bird species higher than any other community type (Clark and Campbell 1981). Aspens provide habitat to over 120 vertebrate species (Kohley *et al.* 1998). Orange-crowned warbler and warbling vireo are aspen specialists and may be appropriate indicator species.

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SAGEBRUSH-GRASSLANDS

Sage-grasslands are abundant in Jackson Hole: native grasses and sagebrush communities account for 15,464 acres (63%) of refuge lands. Although they appear dry and structurally homogenous, over 100 vertebrate species and perhaps over 200 arthropod species are associated with this habitat type (Kohley *et al.* 1998; Christiansen *et al.* 1989). Elk graze heavily on the grasslands on the NER (Kremer 1998). Webster (1965) found that Hood's phlox, fringed sagebrush, rubber rabbitbrush, American vetch, tapertip hawksbeard, and prairie June grass were significantly decreased on elk range. Grazing decreases ground cover and structural heterogeneity as well as breeding bird abundance and species diversity (Kirsch *et al.* 1978; Wiens 1973). It is likely that certain species have been negatively affected by large concentrations of elk on the refuge. Many songbirds prefer sage-grasslands in specific stages of succession. Managing for structural and successional diversity will provide more habitat than is currently available.

Structural and successional diversity are also affected by fire. Sage-grasslands historically burned every 30-50 years, thinning sagebrush, replacing overly mature bushes, and maintaining a diversity of species and age classes (Ozenberger 1998). Fires have not been allowed on the NER for the last few years.

EXOTIC PLANT SPECIES

“An invasive plant is an alien plant spreading naturally (without direct assistance of people) in natural or semi-natural habitats, to produce a significant change in terms of composition, structure or ecosystem processes.” (Cronk and Fuller 1995: 1)

Fifty-two species of exotic plants have been identified on the refuge, amounting to almost 14% of the refuge’s plant species (Fertig 1998b; Appendix D). At least twelve of these species are recognized as invasive and have expanded their distributions on the refuge, particularly in the last two decades (Table 2).

Invasive plants pose a serious threat to the NER ecosystem. They out-compete native species and replace diverse systems with single-species stands of aliens. Invasive aliens directly threaten native fauna by altering habitat structure and food resources. In addition, many invasive species alter soil chemistry, geomorphological processes, hydrology, and disturbance regimes, all of which can have profound effects on biodiversity (Cronk and Fuller 1995).

Exotic species are established by seeds carried by wind, water, animals, and humans. Knowing the dispersal mechanism is important in developing a control program. Some species, primarily domestic grasses for pastures, have been purposely introduced. Others have been accidentally introduced into Teton County by the increasing human activity in the valley. Others may have been carried by birds from areas already invaded by these species. Invasive exotic plants tend to have few predators, enormous reproductive potential, and structural or life history traits that give them a competitive advantage over native species.

The NER started battling invasive exotic plants early on. In 1958 a weed map was prepared which included quackgrass (*Agropyron repens*), white top (*Lepidium draba or repens*), and “a few plants” of Canada thistle (*Cirsium arvense*) (NER Narrative Reports 1958). In 1980, in a letter to the Wyoming Department of Agriculture, the acting associate director of the USFWS wrote that “there are currently no noxious weed control programs on the Elk Refuge, for these plant species [Canada thistle (*Cirsium arvense*), ox-eye daisy (*Chrysanthemum leucanthemum L. var. pinnatifidum*), dalmation toadflax (*Linaria dalmatica*), and musk thistle (*Carduus nutans*)] have not been considered a problem by the refuge staff.” Three years later, in 1983, the refuge started using herbicides, primarily 2,4-D amine, in addition to mechanical control to curb the spread of invasive plants, which by that time had become a serious problem.

Since then, invasive species have spread and new species have established themselves. Today the most dominant invasive species are musk thistle, Canada

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COMMON NAME	SCIENTIFIC NAME
Crested wheatgrass	<i>Agropyron cristatum</i>
Cheatgrass	<i>Bromus tectorum</i>
Musk thistle	<i>Carduus nutans</i>
Spotted knapweed	<i>Centaurea maculosa</i>
Canada thistle	<i>Cirsium arvense</i>
Houndstongue	<i>Cynoglossum officinale</i>
Flixweed	<i>Descurainia sophia</i>
Dalmation toadflax	<i>Linaria dalmatica</i>
White sweet-clover	<i>Melilotus albus</i>
Yellow sweet-clover	<i>Melilotus officinalis</i>
Field pennycress	<i>Thlaspi arvense</i>
Scotch thistle	<i>Onopardum acanthium</i>

Table 2 Invasive plant species on the National Elk Refuge, Jackson, Wyoming.

thistle, and yellow sweet-clover (*Melilotus officinalis*), which have formed dense stands in meadows and pastures and along riparian areas, irrigation ditches, and road sides. Spotted knapweed is found on the northern border of the refuge, scotch thistle on south-facing dry exposures, field pennycress is found extensively in southern pastures and flixweed is found in the middles of pastures. Crested wheatgrass, originally planted for early spring pasture and to reseed pasture after the Dust Bowl, has spread along game trails and roads and has encroached on cultivated and native fields (Kremer 1998). In three years it took over a Russian wild rye field at the McBride management unit (Kremer 1998), and its spread and dominance have necessitated the remapping of vegetative communities on the NER (B. Smith 1998b).

RECOMMENDATIONS

Sustainable management of biodiversity, and everything that it encompasses, is extremely difficult. The following are recommendations to improve biodiversity management on the NER.

MAKE A COMMITMENT TO BIODIVERSITY

The NER needs to evaluate its commitment to biodiversity protection. Although the NER mission and the goals of the National Wildlife Refuge System are to protect all plants and animals on its lands, elk consistently receive priority consideration in the management of this refuge, to the detriment of other species. Given the historical context—elk were the impetus for the refuge's formation—and the huge constituency for the Jackson Hole elk herd, this has been an appropriate management priority. But with the recent establishment of a national set of principles for the refuge system (NWRSA 1997), it is clear

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that priorities need to shift. Elk will always be the centerpiece of the NER, but they can coexist with other species if management is committed to the protection and restoration of biodiversity.

MANAGE AT THE ECOSYSTEM LEVEL

The best way to manage for biodiversity as a whole is to manage at the ecosystem level. Over 90% of the bird species and over 24% of the mammal species on the refuge either migrate or have home ranges larger than the refuge, including the flagship species of elk and trumpeter swans. Clearly there is a need to coordinate efforts to maintain this biodiversity. It is unrealistic and not within the refuge's mandate to influence management of the Canadian Arctic or Central American and South American winter ranges. Coordination of ecosystem management within Jackson Hole and the GYE, however, is not only biologically necessary, but the National Wildlife Refuge System is required by NWRSA to work with its neighbors to further its goals. The NER already participates in the Jackson Hole Cooperative Elk Studies Group, the Tri-State Trumpeter Swan Recovery Group, and the countywide pest management system. The NER should continue building these relationships and contribute staff expertise to issues outside its borders. Halverson (this volume) details some examples of how this could be accomplished for elk management. The same lessons can be applied to all biodiversity.

ADAPT MANAGEMENT TO CHANGING CONDITIONS AND NEW INFORMATION OBTAINED BY REGULARLY COLLECTING, COMPILING, AND ANALYZING DATA

Each species on the refuge has hundreds of direct and indirect interactions with other species and abiotic factors that affect its survival, distribution, and reproduction. Given the complexity of ecosystems and ecosystem management, sharing ideas, data, and skills with other agencies and individuals is the only way to begin to manage this task. Management has to accept the current uncertainty in ecological science, using the best information available at the time of decision making, and follow management prescriptions with monitoring to determine if management actions are effective.

The use of monitoring to learn from management experiments is termed *adaptive management*. Noss and Cooperrider (1994) outline five characteristics of adaptive management of biodiversity: (1) maintaining optimally functioning ecosystems with all their components is an overriding goal; (2) ecosystems are extremely complex, and human understanding of them is rudimentary; (3) human activities may have severe and largely unpredictable effects on ecosystems, and these effects can be irreversible or require centuries for restoration; (4) management should therefore be conservative, erring on the side of minimal risk to ecosystems; and (5) careful, systematic monitoring of ecosystems and how we affect them can help us learn how to avoid causing further harm.

The best way to manage for biodiversity as a whole is to manage at the ecosystem level. Over 90% of the bird species and over 24% of the mammal species on the refuge either migrate or have home ranges larger than the refuge, including the flagship species of elk and trumpeter swans.

Monitoring on the refuge in the past has never had explicitly defined objectives, which may account for the lack of compilation and analysis of the data. The implied objective is to monitor population trends and to take action if populations are too high or too low. Without explicitly defined goals and thresholds in a monitoring program, the data have often remained unused. In the past, the preparation of annual reports provided time and a structure to consolidate data for one year. This practice has been discontinued for lack of time and money (B. Smith 1998b). This report compiled all existing quantitative data on waterfowl, game mammals, and fur-bearing mammals that the NER has available. Some of these data sets go back to 1940 and may provide valuable insight into the ecology and management of these species.³ Data should be periodically analyzed to determine if biological or management thresholds have been reached and necessary action taken. For example, the only quantitative study of passerine birds on the refuge identified a local decline of house wrens and yellow warblers (Dieni *et al.* 1997). No additional data were collected nor action taken. A local decline suggests that something about the refuge or the valley may have caused the decline, but without subsequent monitoring, it cannot be determined if the declining trend continued, whether it leveled out, or whether it was a stochastic event from which the population has since rebounded.

Keeping track of many different species and communities requires increased monitoring of previously overlooked species. The NER can take advantage of resources that do not require extra funding. The Teton Science School is interested in establishing a long-term relationship with the refuge to conduct monitoring and research. The Student Conservation Association (SCA) and the AmeriCorps programs attract talented college students and graduates capable of conducting analytical and monitoring work. Finally, Grand Teton National Park conducts extensive research on biota and community types similar to the refuge and has established thirty permanent bird plots in all habitat types found within the park. By establishing similar plots and protocols, the NER will be able to compare data with the park, which may provide information on differing management practices or ecological phenomena.

REDUCE SUPPLEMENTAL FEEDING AND ELK HERD NUMBERS

Maintaining historical levels of elk on a fraction of their historical winter range has been the major cause of declines in several species groups on the NER, and it will continue to be so. A major step in the restoration and protection of biodiversity on the refuge is to reduce the number of elk wintering on refuge grounds. Cromley (on elk migrations), Kahn, and Halverson (all this volume) describe the social and political context for this largely social and political issue.

Keeping track of many different species and communities requires increased monitoring of previously overlooked species. The NER can take advantage of resources that do not require extra funding.

³ These data are available on Microsoft Excel files at the National Elk Refuge.

RESTORE RIPARIAN VEGETATION

Restoration of riparian shrub communities on the refuge is of paramount importance for sustainable biodiversity management. Limiting access of browsers, coupled with a reduction in browsing intensity, would quickly restore these communities. Galbraith *et al.* (1998) suggested studying the appropriateness of riparian pasture corridors, a series of riparian exclosures with well-placed water gaps, rest/rotation systems of animal grazing, and temporary electric fencing to achieve refuge goals. Although these involve intensive management and aesthetic considerations, the refuge has considered equally intensive management practices to deal with other issues. For example, the current irrigation plan involves the investment of millions of dollars, direct habitat manipulation, and the installation of obtrusive structures.

RESTORE ASPEN STANDS

Although lack of disturbance and browsing may not be the only factors contributing to the decline of aspens, given the tremendous growth of regeneration in the experimental clearcut exclosures on the refuge, these two factors appear to be the most limiting. Once aspens grow beyond the reach of elk, about two meters, they have a much greater chance of survival. It takes four to eight years for aspen to reach these heights (Boyce 1989; Dieni *et al.* 1997; Despain 1990). One management option would be to rotate existing exclosures to new stands over this time interval and clearcut the stands to slowly rejuvenate the aspens.

Restoration of riparian shrub communities on the refuge is of paramount importance for sustainable biodiversity management.

EVALUATE PRESCRIBED BURNS TO IMPROVE THE HEALTH OF THE SAGE-GRASSLAND COMMUNITY AND TO INCREASE FORAGE FOR ELK

Structural diversity has decreased on the NER as a result of over-browsing and lack of fire. Grand Teton National Park has implemented a prescribed burn program to simulate natural fires in sage-grasslands. The refuge has burned fields in the past, but in recent years has stopped the practice (NER 1940-1994; B. Smith 1998b). This management tool should be evaluated to ensure that management is maintaining community health and to increase natural forage available to elk. Prescribed burns may be difficult to carry out safely so close to the town of Jackson, however.

AGGRESSIVELY LIMIT INVASIVE SPECIES

Invasive aliens have increased under the current control program and will continue to spread. The refuge needs to take this threat seriously. No longer do managers try to eradicate invasive exotics completely. Canada thistle, for example, can produce 680 seeds per stem and its seeds can survive 21 years in undisturbed soil (Radosevich *et al.* 1997). Clearly, complete eradication would be so intensive and expensive that it is impossible. Therefore, invasive plants need continual control efforts, including mechanical, chemical, biological, and managerial methods.

The pesticide policy of the U.S. Department of the Interior states that pesticides are to be used only after full consideration of alternatives, that full consideration be given at all times to the safety of humans, fish, wildlife, and other non-target organisms, and that quality control monitoring be conducted before, during, and after any pesticide application in ecologically sensitive areas. Pesticides should be limited in the southern section of the refuge because of potential contamination of the main drinking water supply for the town of Jackson, which has three wells drawing groundwater from under the refuge. Chemicals should also be limited near all open water sources, particularly known amphibian breeding areas.

Most invasive species enter areas that have been disturbed, including roadsides, cultivated fields, irrigation ditches, mitigation ponds, and areas damaged by concentrated ungulates and feeding equipment. To avoid further spread of invasive species, future management actions should focus on limiting disturbance.

Leafy spurge, which already “plagues three million acres of rangeland throughout the country” (Stein and Flack 1996: 15), and other extremely invasive plants have already been identified in Jackson Hole (Vilalobos 1998). The control of these plants can only be accomplished by a coordinated effort throughout the valley.

BUILD A CONSTITUENCY FOR BIODIVERSITY

Ecological complexity is only a part of the overall complexity of managing natural resources. The three related projects (Halverson, Cromley on bison management, and Kahn, this volume) explore the social, political, and decision-making processes affecting the NER and provide insight and recommendations. To that end, the public needs to become aware of the incredible diversity found on the refuge. One method would be to expand current outreach efforts, such as slide shows, sleigh ride programs, and refuge brochures, to include more details of different species and their community and ecosystem interactions to begin to build a constituency for non-game species.

PUTTING THE RECOMMENDATIONS TO USE: THE IRRIGATION PROPOSAL, A CASE STUDY

The large concentration of elk is the main factor in the decline of biotic communities on the refuge and has increased the rate of disease transmission (Halverson, this volume). The proposal to install a sprinkler irrigation system, which was evaluated in 1998-99, is designed to abate some of these problems, but does not address the central issue of elk numbers. In addition, the environmental assessment of the proposal (NER 1998) does not adequately address the direct and indirect effects on overall biodiversity. For instance, Flat Creek Fen is dependent on large groundwater inputs. What effects will the removal of large amounts of groundwater for irrigation have on the hydrology and, subsequently, the wetland plant species of the fen? How will the addition of

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fertilizers and pesticides affect the system? These issues should be addressed.

If this project is carried through, it will represent a shift in management and an opportunity to learn. The immediate goals of the project are to increase forage for elk. Given the expertise behind the farming practices proposed, there is little doubt that the standing crop of grasses will increase in project areas, and this aspect may not require monitoring. The larger goals of the project and the refuge are to reduce the need for supplemental feeding of elk, to disperse elk to limit disease transmission, and to protect biodiversity. Targeted, well-designed monitoring programs are needed to judge the effectiveness of the irrigation program in achieving these goals.

The mission of the refuge is to protect, enhance, and restore populations and habitats of all the species found on its grounds. The NER needs to ensure that management activities do not have negative impacts on its biota. A monitoring program should be designed to detect trends in key species, such as passerine birds and small mammals, in relation to the irrigation project. Plots or transects could be placed within project areas and within appropriate controls. Data should be collected before project implementation to provide a baseline. If after a few years there appears to be a downward trend in a species or group of species, the project areas could then be separated into varying management experiments. For example, one management unit might be left as is, one might cease farming and irrigation activities, and one might delay the timing of farming activities. Since populations fluctuate from year to year, it is important to conduct management experiments in comparable units over the same time periods. In this way, the NER will either be able to validate its management practices or learn from practices that do not succeed to improve future management.

The mission of the refuge is to protect, enhance, and restore populations and habitats of all the species found on its grounds. The NER needs to ensure that management activities do not have negative impacts on its biota.

CONCLUSION

Riparian trees and shrubs, aspens, and sage-grasslands have all declined in cover, abundance, regeneration, and structural diversity since the creation of the National Elk Refuge. If current management practices on the refuge continue, these vegetative communities and their associated wildlife species will continue to decline. The ecological impacts of large concentrations of ungulates have been known by refuge managers for years, yet no changes in management for biodiversity have been implemented on the refuge. As shown in Kahn, Halverson, and Cromley on bison management (all this volume), this is largely the result of social, political, and economic pressures. Building on the research described in this volume, the NER has the opportunity to make improvements in its management and decision-making processes. First and foremost in the sustainable management of biodiversity is a commitment to biodiversity and to the refuge ecosystem as a whole. These principles should guide future decision making to prevent further damage to the species and communities that make the National Elk Refuge one of the most valuable protected areas in the country.

ACKNOWLEDGMENTS

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Appendix A Interviews conducted by Noah Matson, Jackson, Wyoming, summer 1998.

Name	Affiliation	Position
Barry Reiswig	USFWS National Elk Refuge	Project Leader
Bruce Smith	USFWS National Elk Refuge	Biologist
Jim Griffin	USFWS National Elk Refuge	Assistant Manager
Debra Patla	Contract, NER; Univ. of Idaho	Biologist
Ralph Hudelson	Wyoming Game and Fish Dept.	Fisheries Biologist
Roger Smith	Teton Science School	Instructor, Researcher
Doug Wachob	Teton Science School	Research Director
John Kremer	USDA Natural Resource Conservation Service	Extensionist
Steve Cain	Grand Teton National Park	Biologist
Brian Vilalobos	Grand Teton National Park	Invasive Plant Manager
Susan Patla	Grand Teton National Park	Biologist
Tom Campbell	Biota Research Consultants, Inc.	Project Manager
Deb Deslaurier	Bridger-Teton National Forest	Vegetation Biologist
Eric Stone	Colorado State University	Ornithologist
Mike Ivie	Montana State University	Entomologist
Diane Debinski	Kansas State University	Biologist
Hank Harlow	University of Wyoming	Director, Teton Field Station
Bert Raynes	Local Audubon and birding clubs	
Darwin Wile	Local Audubon, volunteer	Refuge Biologist
Walter Fertig	Wyoming Natural Heritage Program	
Dana McDaniel-Bonham	Teton County Natural Resource District	Education and Outreach Coordinator

Appendix B1 Birds of the National Elk Refuge, Jackson, Wyoming.

Common Names		
SEABIRDS	RAPTORS	SHOREBIRDS
Eared grebe	Bald eagle	Black-necked stilt
Pied-billed grebe	Golden eagle	American avocet
White pelican	Peregrine falcon	Semipalmated plover
Double-crested cormorant	Prairie falcon	Mountain plover
BITTERNS AND HERONS	Merlin	Killdeer
Great blue heron	American kestrel	Long-billed curlew
American bittern	Cooper's hawk	Long-billed dowitcher
Black-crowned night heron	Goshawk	Marbled godwit
White-faced ibis	Marsh hawk	Solitary sandpiper
Snowy egret	Osprey	Spotted sandpiper
Cattle egret	Red-tailed hawk	Upland sandpiper
WATERFOWL	Ferruginous hawk	Western sandpiper
Bewick's swan	Rough-legged hawk	Common (Wilson's) snipe
Trumpeter swan	Sharp-shinned hawk	Whimbrel
Tundra swan	Swainson's hawk	Willet
Canada goose	Turkey vulture	Greater yellow-legs
Ross goose	GALLINACEOUS BIRDS	Lesser yellow-legs
Snow goose	Blue grouse	Wilson's phalarope
American brant	Ruffed grouse	GULLS AND TERNS
Bufflehead	Sage grouse	California gull
Canvasback	Gray partridge	Franklin's gull
Gadwall	RAILS AND COOTS	Bonaparte's gull
Barrow's golden-eye	Virginia rail	Ring-billed gull
Common golden-eye	Sora	Caspian tern
Harlequin duck	Yellow rail	Forster's tern
Mallard	American coot	Black tern
Common merganser	CRANES	DOVES
Hooded merganser	Whooping crane	Mourning dove
Pintail	Sandhill crane	OWLS
Red head		Western screech owl
Ring-necked duck		Barn owl
Ruddy duck		Burrowing owl
Lesser scaup		Great gray owl
Greater scaup		Long-eared owl
Northern shoveller		Short-eared owl
Blue-winged teal		Saw-whet owl
Cinnamon teal		Great horned owl
Green-winged teal		Snowy owl
American wigeon		

Appendix B1 Birds of the National Elk Refuge, Jackson, Wyoming (continued).

Common Names		
NIGHTHAWKS	THRUSHES	FINCHES
Poor-will nighthawk	American robin	Black rosy finch
Common nighthawk	Mountain bluebird	Cassin's finch
KINGFISHERS	Townsend's solitaire	Gray-crowned rosy finch
Belted kingfisher	KINGLETS AND	American goldfinch
WOODPECKERS	GNATCATCHERS	GROSBEAKS
Common flicker	Blue-gray gnatcatcher	Black-headed grosbeak
Yellow-bellied sapsucker	Ruby-crowned kinglet	Evening grosbeak
Downy woodpecker	PIPITS	Pine grosbeak
Hairy woodpecker	Water pipit	SPARROWS
Lewis' woodpecker	WAXWINGS	Dark-eyed junco
Red-headed woodpecker	Bohemian waxwing	Oregon junco
FLYCATCHERS	Cedar waxwing	Lapland longspur
Eastern kingbird	SHRIKES	Pine siskin
Ash-throated flycatcher	Northern shrike	Black-throated sparrow
Western wood pewee	Loggerhead shrike	Fox sparrow
Western kingbird	STARLINGS	Sage sparrow
Say's phoebe	Starling	Lark bunting
LARKS	WARBLERS	Savannah sparrow
Horned lark	Orange-crowned warbler	Vesper sparrow
SWALLOWS	Townsend's warbler	White-crowned sparrow
Barn swallow	Common yellow-throated warbler	Green-tailed towhee
Cliff swallow	Yellow warbler	Rufous-sided towhee
Tree swallow	Yellow-rumped warbler	
CORVIDS	BLACKBIRDS and ORIOLES	
Pinon jay	Bobolink	
Black-billed magpie	Brewer's blackbird	
Clark's nutcracker	Red-winged blackbird	
Common raven	Yellow-headed blackbird	
Common crow	Brown-headed cowbird	
CHICKADEES	Common grackle	
Black-capped chickadee	Western meadowlark	
Mountain chickadee	Northern oriole	
DIPPERS	TANAGERS and BUNTINGS	
Dipper	Western tanager	
WRENS	Indigo bunting	
House wren	Lazuli bunting	
Long-billed wren	Snow bunting	

Appendix B2 Mammals of the National Elk Refuge, Jackson, Wyoming.

Common Name	Scientific Name	Common Name	Scientific Name
Masked shrew	<i>Sorex cinereus</i>	Long-tailed vole	<i>Microtus longicaudus</i>
Vagrant shrew	<i>Sorex vagrans</i>	Montane vole	<i>Microtus montanus</i>
Northern water shrew	<i>Sorex palustris</i>	Sagebrush vole	<i>Lemmys curtatus</i>
Little brown myotis	<i>Myotis lucifugus</i>	Red-backed vole	<i>Clethrionomys gapperi</i>
Long-eared myotis	<i>Myotis evotis</i>	Muskrat	<i>Ondatra zibethicus</i>
Silver-haired bat	<i>Lasionycteris noctivagans</i>	House mouse	<i>Mus musculus</i>
Hoary bat	<i>Lasiurus cinereus</i>	Western jumping mouse	<i>Zapus princeps</i>
Townsend's bat	<i>Plecotus townsendii</i>	Porcupine	<i>Erethizon dorsatum</i>
Pika	<i>Ochotona princeps</i>	Coyote	<i>Canis latrans</i>
Whitetail jackrabbit	<i>Lepus townsendii</i>	Red fox	<i>Vulpes vulpes</i>
Snowshoe hare	<i>Lepus americanus</i>	Black bear	<i>Ursus americanus</i>
Yellow-bellied marmot	<i>Marmota flaviventris</i>	Grizzly bear	<i>Ursus arctos horribilis</i>
Uinta ground squirrel	<i>Spermophilus armatus</i>	Short-tailed weasel (ermine)	<i>Mustela erminea</i>
Golden-mantled ground squirrel	<i>Spermophilus lateralis</i>	Long-tailed weasel	<i>Mustela frenata</i>
Least chipmunk	<i>Tamias minimus</i>	Mink	<i>Mustela vison</i>
Yellow-pine chipmunk	<i>Tamias amoenus</i>	Badger	<i>Taxidea taxus</i>
Red squirrel	<i>Tamiasciurus hudsonicus</i>	Striped skunk	<i>Mephitis mephitis</i>
Northern flying squirrel	<i>Glaucomys sabrinus</i>	River otter	<i>Lutra canadensis</i>
Northern pocket gopher	<i>Thomomys talpoides</i>	Bobcat	<i>Felis rufus</i>
Beaver	<i>Castor canadensis</i>	Mountain lion	<i>Felis concolor</i>
Deer mouse	<i>Peromyscus maniculatus</i>	Elk	<i>Cervus elaphus</i>
Bushy-tailed woodrat	<i>Neotoma cinerea</i>	Mule deer	<i>Odocoileus hemionus</i>
Meadow vole	<i>Microtus pennsylvanicus</i>	Moose	<i>Alces alces</i>
		Pronghorn	<i>Antilocapra americana</i>
		Bighorn sheep	<i>Ovis canadensis</i>
		Bison	<i>Bison bison</i>

Appendix B3 Amphibians and reptiles of the National Elk Refuge, Jackson, Wyoming.

Common Name	Scientific Name
Blotched tiger salamander	<i>Ambystoma tigrinum melanostictum</i>
Boreal toad	<i>Bufo boreas boreas</i>
Boreal chorus frog	<i>Pseudacris triseriata maculata</i>
Columbian spotted frog	<i>Rana luteiventris</i>
Garter snake	<i>Thamnophis sp.</i>

Appendix B4 Trees and shrubs of the National Elk Refuge, Jackson, Wyoming (* indicates exotic species).

Common Name	Scientific Name	Common Name	Scientific Name
Water birch	<i>Betula occidentalis</i>	Oregon-grape	<i>Mohonia repens</i>
Engelmann spruce	<i>Picea engelmannii</i>	Shrubby cinquefoil	<i>Pentaphylloides floribunda</i> (<i>Potentillafruticosa</i>)
Blue spruce	<i>Picea pungens</i>	Chokecherry	<i>Prunus virginiana</i> var. <i>melanocarpa</i>
Narrowleaf cottonwood	<i>Populus angustifolia</i>	Bitterbrush	<i>Purshia tridentata</i>
Quaking aspen	<i>Populus tremuloides</i>	Golden currant	<i>Ribes aureum</i> var. <i>aureum</i>
Lodgepole pine	<i>Pinus contorta</i>	Wax currant	<i>Ribes cereum</i> var. <i>pedicellare</i>
Limber pine	<i>Pinus flexilis</i>	Missouri gooseberry	<i>Ribes oxycanthoides</i> var. <i>setosum</i>
Douglas fir	<i>Pseudotsuga menziesii</i>	Prickly rose	<i>Rosa sayi</i>
Rocky Mountain juniper	<i>Juniperus scopulorum</i>	Woods rose	<i>Rosa woodsii</i>
Western serviceberry	<i>Amelanchier alnifolia</i> var. <i>alnifolia</i>	Bebb willow	<i>Salix bebbiana</i>
Mountain big sagebrush	<i>Artemisia tridentata</i> var. <i>vaseyana</i>	Booth willow	<i>Salix boothii</i>
Threetip sagebrush	<i>Artemisia tripartita</i> ssp. var. <i>tripartita</i>	Small-fruit willow	<i>Salix brachycarpa</i>
*Pea-tree	* <i>Caragana arborescens</i>	Hoary willow	<i>Salix candida</i>
Rubber rabbitbrush	<i>Chrysothamnus nauseosus</i> var. <i>oreophilus</i>	Drummond willow	<i>Salix drummondiana</i>
Green rabbitbrush	<i>Chrysothamnus viscidiflorus</i> var. <i>lanceolatus</i>	Geyer willow	<i>Salix geyeriana</i>
Green rabbitbrush	<i>Chrysothamnus viscidiflorus</i> ssp. <i>viscidiflorus</i>	Yellow willow	<i>Salix lutea</i> (<i>Salixeriocephala</i> var. <i>watsonii</i>)
Red-osier dogwood	<i>Cornus sericea</i> ssp. <i>stolonifera</i>	Dusky willow	<i>Salix melanopsis</i>
Silverberry	<i>Elaeagnus commutata</i>	Planeleaf willow	<i>Salix planifolia</i>
Broom snakeweed	<i>Gutierrezia sarothrae</i>	Canada buffaloberry	<i>Shepherdia canadensis</i>
Common juniper	<i>Juniperus communis</i> var. <i>depressa</i>	Mountain snowberry	<i>Symphoricarpos oreophilus</i> var. <i>utahensis</i>
Winterfat	<i>Krascheninnikovia lanata</i> (<i>Ceratoides lanata</i>)	Gray horsebrush	<i>Tetradymia canescens</i>
Bearberry honeysuckle	<i>Lonicera involucrata</i>		

Appendix B5 Forbs of the National Elk Refuge, Jackson, Wyoming (* indicates an exotic species).

Common Name	Scientific Name	Common Name	Scientific Name
Yarrow	<i>Achillea millefolium</i>	Elegant aster	<i>Aster perelegans</i>
Short-beaked agoseris	<i>Agoseris glauca</i> <i>var. glauca</i>	Field milkvetch	<i>Astragalus agrestis</i>
Short-beaked agoseris	<i>Agoseris glauca</i> <i>var. laciniata</i>	Silver-leaved milkvetch	<i>Astragalus</i> <i>argophyllus</i> <i>var. argophyllus</i>
Nodding onion	<i>Allium cernuum</i>	Canada milkvetch	<i>Astragalus canadensis</i> <i>var. brevidens</i>
Chives	<i>Allium schoenoprasum</i>	Lesser rushy milkvetch	<i>Astragalus</i> <i>diversifolius</i> <i>var.</i> <i>campestris</i> (<i>Astragalus</i> <i>convallarius</i>)
*Pale alyssum	* <i>Alyssum alyssoides</i>	Elegant milkvetch	<i>Astragalus eucosmus</i>
*Desert alyssum	* <i>Alyssum desertorum</i>	Sagebrush weedy milkvetch	<i>Astragalus miser</i> <i>var. decumbens</i>
White pigweed	<i>Amaranthus albus</i>	Weedy milkvetch	<i>Astragalus miser</i> <i>var. tenuifolius</i>
Cliff anemone	<i>Anemone multifida</i> <i>var. multifida</i>	Woolly milkvetch	<i>Astragalus purshii</i>
Pasqueflower	<i>Anemone patens</i> <i>var. multifida</i>	Railhead milkvetch	<i>Astragalus terminalis</i>
Sharptooth angelica	<i>Angelica arguta</i>	*Red orache	* <i>Atriplex rosea</i>
Pinnate-leaved angelica	<i>Angelica pinnata</i>	Wedgescale orache	<i>Atriplex truncata</i>
Low pussytoes	<i>Antennaria dimorpha</i>	Arrowleaf balsamroot	<i>Balsamorhiza</i> <i>sagittata</i>
Small-leaf pussytoes	<i>Antennaria microphylla</i>	Wyoming kittentails	<i>Besseya</i> <i>wyomingensis</i>
Showy pussytoes	<i>Antennaria pulcherrima</i>	Nodding beggarticks	<i>Bidens cernua</i>
Rosy pussytoes	<i>Antennaria rosea</i>	Spring water starwort	<i>Callitriche palustris</i>
Umber pussytoes	<i>Antennaria umbrinella</i>	Sego-lily	<i>Calochortus nuttallii</i>
Drummond's rockcress	<i>Arabis drummondii</i>	*Littlepod falsefax	* <i>Camelina</i> <i>microcarpa</i>
Towermustard	<i>Arabis glabra</i>	Harebell	<i>Campanula</i> <i>rotundifolia</i>
Holboell's rockcress	<i>Arabis holboellii</i>	*Shepherd's purse	* <i>Capsella bursa-</i> <i>pastoris</i>
Ballhead sandwort	<i>Arenaria congesta</i>	*Chalapa hoarycress	* <i>Cardaria draba</i> <i>ssp.</i> <i>chalapensis</i>
Nuttall's sandwort	<i>Arenaria nuttallii</i> (<i>Minuartia nuttallii</i>)	*Plumeless thistle	* <i>Carduus</i> <i>acanthoides</i>
Twin arnica	<i>Arnica sororia</i>	*Musk thistle	* <i>Carduus nutans</i>
Biennial wormwood	<i>Artemisia biennis</i> <i>var. biennis</i>	Narrowleaf paintbrush	<i>Castilleja angustifolia</i> <i>var. angustifolia</i>
Fringed sagebrush	<i>Artemisia frigida</i>		
Louisiana sagebrush	<i>Artemisia ludoviciana</i> <i>ssp. ludoviciana</i>		
Long-leaved aster	<i>Aster ascendens</i>		
Boreal aster	<i>Aster borealis</i> (<i>Aster junciformis</i>)		
Eaton's aster	<i>Aster bracteolatus</i> (<i>Astereatonii</i>)		
Leafybract aster	<i>Aster foliaceus</i>		
Western Mountain aster	<i>Aster occidentalis</i>		

Appendix B5 Forbs of the National Elk Refuge, Jackson, Wyoming (* indicates an exotic species) (continued).

Common Name	Scientific Name	Common Name	Scientific Name
Desert paintbrush	<i>Castilleja angustifolia</i> <i>var. dubia</i>	*Flixweed	* <i>Descurainia sophia</i>
Yellow paintbrush	<i>Castilleja flava</i>	Dark-throat shooting star	<i>Dodecatheon pulchellum</i>
Scarlet paintbrush	<i>Castilleja miniata</i>	Fireweed	<i>Epilobium angustifolium</i>
Alpine chickweed	<i>Cerastium</i> <i>beeringianum</i> <i>var. capillare</i>	Panicled willow herb	<i>Epilobium brachycarpum</i>
		American willow herb	<i>Epilobium ciliatum</i> <i>var. ciliatum</i>
Hoary dusty-maiden	<i>Chaenactis douglasii</i> <i>var. montana</i>	Hornemann's willow herb	<i>Epilobium hornemannii</i>
		Swamp willow herb	<i>Epilobium palustre</i> <i>var. glabellus</i>
Pitseed goosefoot	<i>Chenopodium</i> <i>berlandieri</i> <i>var. zschackii</i>	Cut-leaved fleabane	<i>Erigeron compositus</i> <i>var. discoideus</i>
Smallhead goosefoot	<i>Chenopodium</i> <i>capitatum</i> var. <i>parvicapitatum</i> (<i>Chenopodium</i> <i>moveri</i>)	Foothill daisy	<i>Erigeron corymbosus</i>
		Smooth daisy	<i>Erigeron glabellus</i> <i>var. glabellus</i>
Mountain goosefoot	<i>Chenopodium</i> <i>pratericola</i>	Spear-leaf fleabane	<i>Erigeron lonchophyllus</i>
*Canada thistle	* <i>Cirsium arvense</i>	Shaggy fleabane	<i>Erigeron pumilus</i>
Elk thistle	<i>Cirsium scariosum</i>	Shortstem buckwheat	<i>Eriogonum brevicaulis</i> <i>var. laxifolium</i>
Snowy thistle	<i>Cirsium subniveum</i>	Mat buckwheat	<i>Eriogonum caespitosum</i>
*Bull thistle	* <i>Cirsium vulgare</i>	Cushion buckwheat	<i>Eriogonum ovalifolium</i> <i>var. purpureum</i>
Leatherflower	<i>Clematis hirsutissima</i>	Sulfur buckwheat	<i>Eriogonum umbellatum</i> <i>var. majus</i>
Rock virgin's-bower	<i>Clematis occidentalis</i> <i>var. grosseserrata</i>	Western Wallflower	<i>Erysimum asperum</i> <i>var. arkansanum</i> (<i>Erysimum capitatum</i>)
Narrowleaf collomia	<i>Collomia linearis</i>	Treacle wallflower	<i>Erysimum cheiranthoides</i>
Bastard toad-flax	<i>Comandra umbellata</i> <i>var. pallida</i>	Virginia strawberry	<i>Fragaria virginiana</i>
*Field bindweed	* <i>Convolvulus arvensis</i>	Checker lily	<i>Fritillaria atropurpurea</i>
Bushy birdbeak	<i>Cordylanthus ramosus</i>	Northern bedstraw	<i>Galium boreale</i>
Golden-smoke	<i>Corydalis aurea</i>	Small bedstraw	<i>Galium trifidum</i>
Tapertip hawksbeard	<i>Crepis acuminata</i>	Prairie gentian	<i>Gentiana affinis</i> var. <i>affinis</i>
Siskiyow hawksbeard	<i>Crepis modocensis</i>	Water gentian	<i>Gentiana aquatica</i>
Meadow hawksbeard	<i>Crepis runcinata</i> <i>var. glauca</i>	Sticky geranium	<i>Geranium viscosissimum</i> <i>var. nervosum</i>
Broad-leaved meadow hawksbeard	<i>Crepis runcinata</i> <i>var. hispidulosa</i>	Sticky geranium	<i>Geranium viscosissimum</i> <i>var. viscosissimum</i>
Little larkspur	<i>Delphinium bicolor</i>	Large-leaved avens	<i>Geum macrophyllum</i> <i>var. perincisum</i>
Mountain tansymustard	<i>Descurainia incana</i> <i>var. macrosperma</i>	Prairie smoke	<i>Geum triflorum</i>

Appendix B5 Forbs of the National Elk Refuge, Jackson, Wyoming (* indicates an exotic species) (continued).

Common Name	Scientific Name	Common Name	Scientific Name
Sea-milkwort	<i>Glaux maritima</i>	Nineleaf biscuitroot	<i>Lomatium triternatum</i> <i>ssp. platycarpum</i>
Licorice root	<i>Glycyrrhiza lepidota</i>	Silvery lupine	<i>Lupinus argenteus</i> <i>ssp. argenteus</i>
Curly-cup gumweed	<i>Grindelia squarrosa</i>	Silvery lupine	<i>Lupinus argenteus</i> <i>var. rubricaulis</i>
Lowland cudweed	<i>Gnaphalium palustre</i>	Silky lupine	<i>Lupinus sericeus</i>
Northern green bog-orchid	<i>Habenaria hyperborea</i> (<i>Platantherahyperborea</i>)	Hoary aster	<i>Machaeranthera</i> <i>canescens ssp. canescens</i>
Many-flowered stickseed	<i>Hackelia floribunda</i>	Starry false Solomon's seal	<i>Maianthemum stellatum</i>
Stemless goldenweed	<i>Haplopappus acaulis</i>	*Malcolmia	* <i>Malcolmia africana</i>
One-flowered goldenweed	<i>Haplopappus uniflorus</i> (<i>Pyrocoma uniflora</i>)	Pineapple-weed	<i>Matricaria matricarioides</i>
Northern sweet-vetch	<i>Hedysarum boreale</i>	*Black medic	* <i>Medicago lupulina</i>
Rocky Mountain helianthella	<i>Helianthella uniflora</i>	*Alfalfa	* <i>Medicago sativa ssp. sativa</i>
Cow parsnip	<i>Heracleum sphondylium</i>	*White sweet-clover	* <i>Melilotus albus</i>
Teton golden-aster	<i>Heterotheca depressa</i> (<i>Heterotheca villosa</i> <i>var. depressa</i>)	*Yellow sweet-clover	* <i>Melilotus officinalis</i>
Littleleaf alumroot	<i>Heuchera parvifolia</i>	Field mint	<i>Mentha arvensis</i> <i>var. canadensis</i>
Common mare's tail	<i>Hippuris vulgaris</i>	Ciliate bluebells	<i>Mertensia ciliata</i>
Western St. Johns's wort	<i>Hypericum formosum</i> <i>var. scouleri</i>	Leafy bluebells	<i>Mertensia oblongifolia</i>
Scarlet gilia	<i>Ipomopsis aggregata</i>	Yellow monkeyflower	<i>Mimulus guttatus</i>
Mountain spicate-gilia	<i>Ipomopsis spicata</i> <i>var. orchidacea</i>	Povertyweed	<i>Monolepis nuttalliana</i>
*Prickly lettuce	* <i>Lactuca serriola</i>	*Common forget-me-not	* <i>Myosotis scorpioides</i>
Western Stickseed	<i>Lappula redowskii</i> <i>var. redowskii</i>	Common water-milfoil	<i>Myriophyllum sibiricum</i>
*European stickseed	* <i>Lappula squarrosa</i> <i>var. squarrosa</i>	Tufted evening-primrose	<i>Oenothera cespitosa</i> <i>var. cespitosa</i>
Lesser duckweed	<i>Lemna minor</i>	Pale evening-primrose	<i>Oenothera pallida</i> <i>var. trichocalyx</i>
Common peppergrass	<i>Lepidium densiflorum</i>	Plains prickly pear	<i>Opuntia polyacantha</i> <i>var. polyacantha</i>
*Clasping peppergrass	* <i>Lepidium perfoliatum</i>	Yellow owl-clover	<i>Orthocarpus luteus</i>
Common prickly phlox	<i>Leptodactylon pungens</i>	Nodding locoweed	<i>Oxytropis deflexa</i>
Keeled bladderpod	<i>Lesquerella carinata</i> <i>var. carinata</i>	Northern grass-of-Parnassus	<i>Parnassia palustris</i> <i>var. montanensis</i>
Northern linanthus	<i>Linanthus septentrionalis</i>	Meadow lousewort	<i>Pedicularis crenulata</i>
Blue flax	<i>Linum lewisii</i>	Elephant's-head	<i>Pedicularis groenlandica</i>
Western gromwell	<i>Lithospermum ruderale</i>	Lowly beardtongue	<i>Penstemon humilis</i>
Fennel-leaved biscuitroot	<i>Lomatium</i> <i>foeniculaceum</i>	Small-flower beardtongue	<i>Penstemon procerus</i> <i>var. procerus</i>
		Matroot beardtongue	<i>Penstemon radicosus</i>

Appendix B5 Forbs of the National Elk Refuge, Jackson, Wyoming (* indicates an exotic species) (continued).

Common Name	Scientific Name	Common Name	Scientific Name
Subglabrous beardtongue	<i>Penstemon subglaber</i>	*Water cress	* <i>Rorippa nasturtium</i>
Rocky Mountain rockmat	<i>Petrophyton caespitosum</i>	Western dock	<i>Rumex aquaticus</i>
Franklin's phacelia	<i>Phacelia franklinii</i>	Golden dock	<i>Rumex maritimus</i>
Hood's phlox	<i>Phlox hoodii</i>	Willow dock	<i>Rumex salicifolius</i>
Kelsey's phlox	<i>Phlox kelseyi</i> var. <i>kelseyi</i>	*Russian thistle	* <i>Salsola australis</i>
Long-leaf phlox	<i>Phlox longifolia</i>	Flax-leaved plains mustard	<i>Scoenocrambe</i> <i>linifolia</i>
Many-flowered phlox	<i>Phlox multiflora</i>	Marsh skullcap	<i>Scutellaria</i> <i>galericulata</i>
Alkali plantain	<i>Plantago eriopoda</i>	Lance-leaved stonecrop	<i>Sedum lanceolatum</i>
*Common plantain	* <i>Plantago major</i>	Woolly groundsel	<i>Senecio canus</i>
Western Jacob's ladder	<i>Polemonium occidentale</i>	Alpine meadow groundsel	<i>Senecio</i> <i>cymbalarioides</i>
Erect knotweed	<i>Polygonum achoreum</i>	Weak groundsel	<i>Senecio debilis</i>
Water smartweed	<i>Polygonum amphibium</i> ssp. <i>stipulaceum</i>	Water groundsel	<i>Senecio hydrophilus</i>
Common knotweed	<i>Polygonum aviculare</i>	Western groundsel	<i>Senecio integerrimus</i>
Douglas' knotweed	<i>Polygonum douglasii</i> ssp. <i>douglasii</i>	Balsam groundsel	<i>Senecio pauperculus</i>
Alpine bistort	<i>Polygonum viviparum</i>	Butterweed groundsel	<i>Senecio serra</i>
Slender-leaved pondweed	<i>Potamogeton filiformis</i>	Cleft-leaved groundsel	<i>Senecio</i> <i>streptanthifolius</i>
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	*White campion	* <i>Silene latifolia</i>
Silverweed	<i>Potentilla anserina</i>	*Tumblemustard	* <i>Sisymbrium</i> <i>altissimum</i>
Glandular cinquefoil	<i>Potentilla arguta</i>	Western blue-eyed grass	<i>Sisyrinchium</i> <i>idahoense</i>
Slender cinquefoil	<i>Potentilla gracilis</i> var. <i>nutallii</i>	Hemlock waterparsnip	<i>Sium suave</i>
Soft cinquefoil	<i>Potentilla gracilis</i> var. <i>pulcherrima</i>	Canada goldenrod	<i>Solidago canadensis</i>
*Norwegian cinquefoil	* <i>Potentilla norvegica</i>	Missouri goldenrod	<i>Solidago missouriensis</i>
Sheep cinquefoil	<i>Potentilla ovina</i> var. <i>ovina</i>	Low goldenrod	<i>Solidago nana</i>
Prairie cinquefoil	<i>Potentilla pensylvanica</i>	*Marsh sow-thistle	* <i>Sonchus uliginosus</i>
Mealy primrose	<i>Primula incana</i>	Hooded lady's tresses	<i>Spiranthes</i> <i>romanzoffiana</i>
Self-heal	<i>Prunella vulgaris</i> var. <i>lanceolata</i>	Thickleaved starwort	<i>Stellaria crassifolia</i>
White water buttercup	<i>Ranunculus aquatilis</i>	Longstalk starwort	<i>Stellaria longipes</i>
Shore buttercup	<i>Ranunculus cymbalaria</i>	Swertia	<i>Swertia perennis</i>
Sagebrush buttercup	<i>Ranunculus glaberrimus</i>	Green gentian	<i>Swertia radiata</i>
Unlovely buttercup	<i>Ranunculus inamoenus</i>	*Red seeded dandelion	* <i>Taraxacum</i> <i>laevigatum</i>
Macoun's buttercup	<i>Ranunculus macounii</i>	*Common dandelion	* <i>Taraxacum officinale</i>
Floating water buttercup	<i>Ranunculus natans</i>		
Bister buttercup	<i>Ranunculus sceleratus</i>		
Wasatch yellowgrass	<i>Rorippa curvipes</i>		

Appendix B5 Forbs of the National Elk Refuge, Jackson, Wyoming (* indicates an exotic species) (continued).

Common Name	Scientific Name	Common Name	Scientific Name
Alpine meadowrue	<i>Thalictrum alpinum</i>	Bracted vervain	<i>Verbena bracteata</i>
Veiny meadowrue	<i>Thalictrum venulosum</i>	American brooklime	<i>Veronica americana</i>
Panicled thelypody	<i>Thelypodium paniculatum</i>	*Water speedwell	* <i>Veronica anagallis-aquatica</i>
*Field pennycress	* <i>Thlaspi arvense</i>	American vetch	<i>Vicia americana</i> var. <i>minor</i>
Nuttall's Easter-daisy	<i>Townsendia nuttallii</i>	*Bird vetch	* <i>Vicia cracca</i>
*Yellow salsify	* <i>Tragopogon dubius</i>	Early blue violet	<i>Viola adunca</i>
*Alsike clover	* <i>Trifolium hybridum</i>	Marsh violet	<i>Viola palustris</i>
*Red clover	* <i>Trifolium pratense</i>	Upland yellow violet	<i>Viola praemorsa</i> var. <i>altior</i>
*White clover	* <i>Trifolium repens</i>	Horned pondweed	<i>Zannichellia palustris</i>
Stinging nettle	<i>Urtica dioica</i>	Panicled death-camas	<i>Zigadenus paniculatus</i>
Flat-leaf bladderwort	<i>Utricularia intermedia</i>	Heart-leaved Alexanders	<i>Zizia aptera</i>
Greater bladderwort	<i>Utricularia macrorhiza</i>		
Tobacco-root	<i>Valeriana edulis</i>		
Western valerian	<i>Valeriana occidentalis</i>		
*Common mullein	* <i>Verbascum thapsus</i>		

Appendix B6 Graminoids of the National Elk Refuge, Jackson, Wyoming (* indicates exotic species).

Common Name	Scientific Name	Common Name	Scientific Name
*Crested wheatgrass	* <i>Agropyron cristatum</i>	Riparian thickspike wheatgrass	<i>Elymus lanceolatus</i> var. <i>riparius</i>
*Redtop	* <i>Agrostis stolonifera</i>	*Common quackgrass	* <i>Elymus repens</i>
Shortawn foxtail	<i>Alopecurus aequalis</i>	Bluebunch wheatgrass	<i>Elymus spicatus</i>
*Meadow foxtail	* <i>Alopecurus pratensis</i>	Slender whatgrass	<i>Elymus trachycaulus</i>
California brome	<i>Bromus carinatus</i>	Many-spiked cottongrass	<i>Eriophorum polystachion</i>
Fringed brome	<i>Bromus ciliatus</i>	Green-keeled cottongrass	<i>Eriophorum viridicarinatum</i>
*Smooth brome	* <i>Bromus inermis</i>	Idaho fescue	<i>Festuca idahoensis</i>
*Cheatgrass	* <i>Bromus tectorum</i>	American mannagrass	<i>Glyceria grandis</i>
Bluejoint wheatgrass	<i>Calamagrostis canadensis</i>	Fowl mannagrass	<i>Glyceria striata</i>
Slimstem reedgrass	<i>Calamagrostis stricta</i>	Common sweetgrass	<i>Hierochloe odorata</i>
Water sedge	<i>Carex aquatilis</i>	Meadow barley	<i>Hordeum brachyantherum</i>
Golden sedge	<i>Carex aurea</i>	Foxtail barley	<i>Hordeum jubatum</i>
Buxbaum's sedge	<i>Carex buxbaumii</i>	Baltic rush	<i>Juncus balticus</i>
Hair sedge	<i>Carex capillaris</i>	Mountain rush	<i>Juncus ensifolius</i>
Thread-leaved sedge	<i>Carex filifolia</i>	Long-styled rush	<i>Juncus longistylis</i>
Inland sedge	<i>Carex interior</i>	Tuberous rush	<i>Juncus nodosus</i>
Woolly sedge	<i>Carex lanuginosa</i>	Slender rush	<i>Juncus tenuis</i>
Small-winged sedge	<i>Carex microptera</i>	Junegrass	<i>Koeleria macrantha</i>
Nebraska sedge	<i>Carex nebrascensis</i>	Spikefescue	<i>Leucopoa kingii</i>
Parry sedge	<i>Carex parryana</i>	Pullup muhly	<i>Muhlenbergia filiformis</i>
Clustered field sedge	<i>Carex praegracilis</i>	Marsh muhly	<i>Muhlenbergia glomerata</i>
Ross sedge	<i>Carex rossii</i>	Mat muhly	<i>Muhlenbergia richardsonis</i>
Beaked sedge	<i>Carex rostrata</i>	Indian ricegrass	<i>Oryzopsis</i>
Sartwell's sedge	<i>Carex sartwellii</i>	Reed canarygrass	<i>Phalaris arundinacea</i>
Canadian single-spike sedge	<i>Carex scirpoidea</i>	Alpine timothy	<i>Phleum alpinum</i>
Analogue sedge	<i>Carex simulata</i>	*Timothy	* <i>Phleum pratense</i>
Narrow-leaved sedge	<i>Carex stenophylla</i>	*Annual bluegrass	* <i>Poa annua</i>
Green sedge	<i>Carex viridula</i>	*Bulbous bluegrass	* <i>Poa bulbosa</i>
Brookgrass	<i>Catabrosa aquatica</i>	Nevada bluegrass	<i>Poa nevadensis</i>
*Orchard grass	* <i>Dactylis glomerata</i>	Fowl bluegrass	<i>Poa palustris</i>
Tufted hairgrass	<i>Deschampsia cespitosa</i>	*Kentucky bluegrass	* <i>Poa pratensis</i>
Slender spikerush	<i>Eleocharis acicularis</i>	Canby bluegrass	<i>Poa secunda</i> var. <i>elongata</i>
Common spikerush	<i>Eleocharis palustris</i>		
Griffith's wheatgrass	<i>Elymus albicans</i>		
Great Basin wildrye	<i>Elymus cinereus</i>		
Bottlebrush squirreltail	<i>Elymus elymoides</i>		
*Intermediate wheatgrass	* <i>Elymus hispidus</i>		
*Russian wildrye	* <i>Elymus junceus</i>		
Thickspike wheatgrass	<i>Elymus lanceolatus</i> var. <i>lanceolatus</i>		

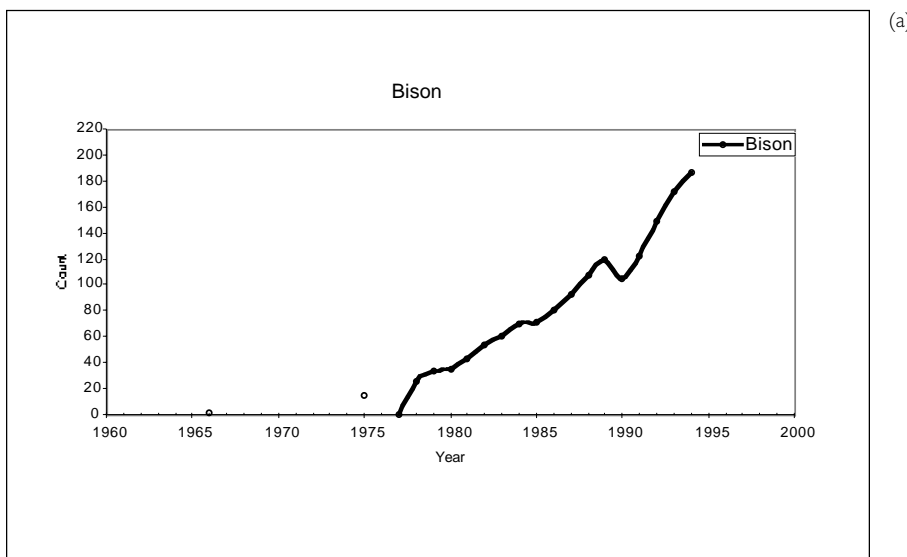
Appendix B6 Graminoids of the National Elk Refuge, Jackson, Wyoming (* indicates exotic species) (continued).

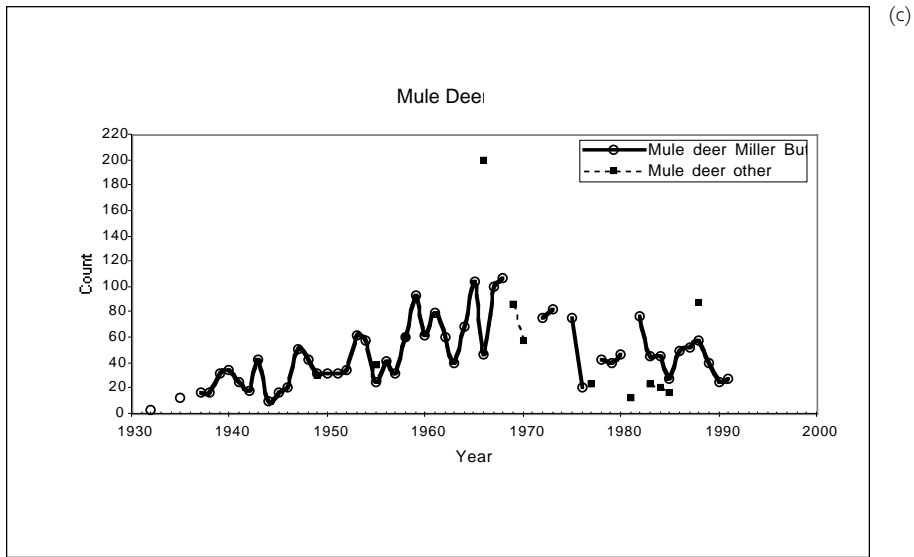
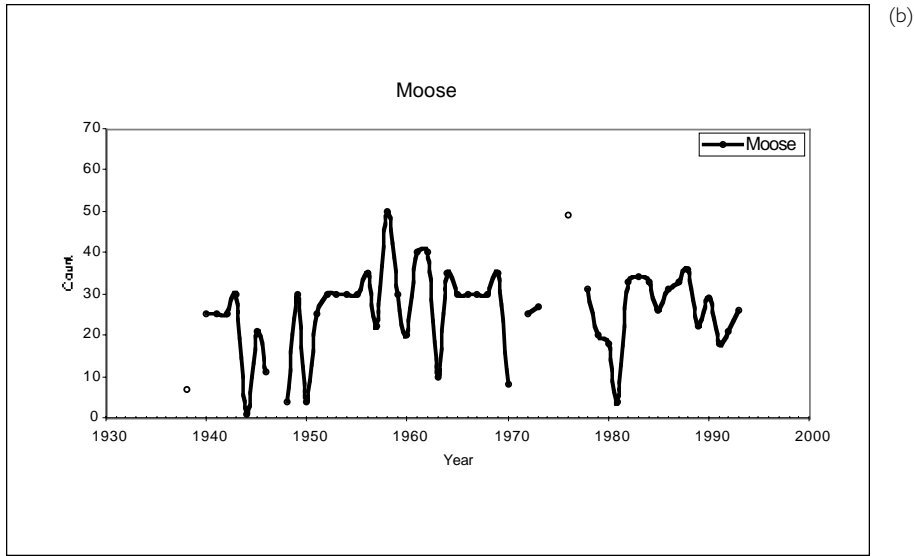
Common Name	Scientific Name
Sandberg bluegrass	<i>Poa secunda</i> <i>var. secunda</i>
Hardstem bulrush	<i>Scirpus acutus</i>
Pygmy bulrush	<i>Scirpus pumilis</i>
Soft-stem bulrush	<i>Scirpus validus</i>
Needle and thread	<i>Stipa comata</i>
Nelson's needlegrass	<i>Stipa nelsonii</i>
Green needlegrass	<i>Stipa viridula</i>
Seaside arrowgrass	<i>Triglochin maritimum</i>
Marsh arrowgrass	<i>Triglochin palustre</i>
Common cattail	<i>Typha latifolia</i>

Appendix B7 Ferns and fern allies of the National Elk Refuge, Jackson, Wyoming.

Common Name	Scientific Name
Common scouring-rush	<i>Equisetum hyemale</i>
Smooth scouring-rush	<i>Equisetum laevigatum</i>
Northern scouring-rush	<i>Equisetum variegatum</i>
Compact spike-moss	<i>Selaginella densa</i>

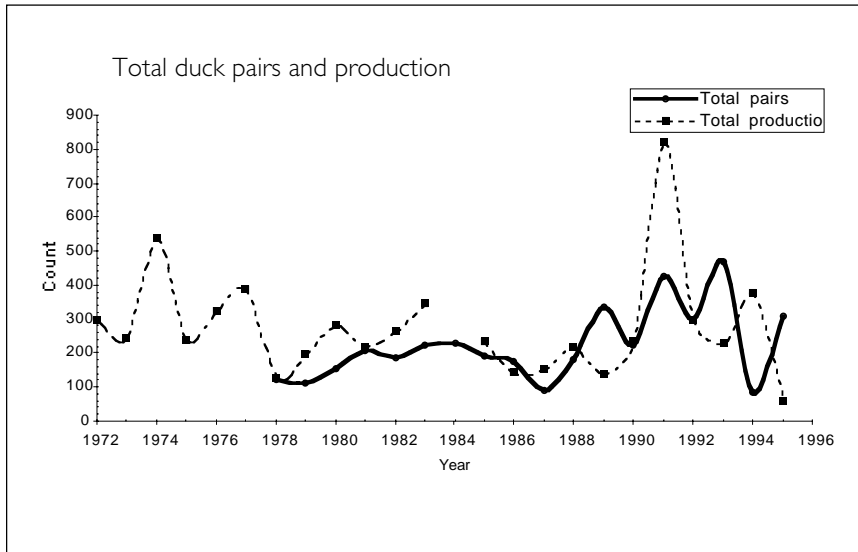
Appendix C1 Wildlife population graphs of selected wintering mammal populations and selected waterfowl breeding pair and production counts for the National Elk Refuge, Jackson, Wyoming.



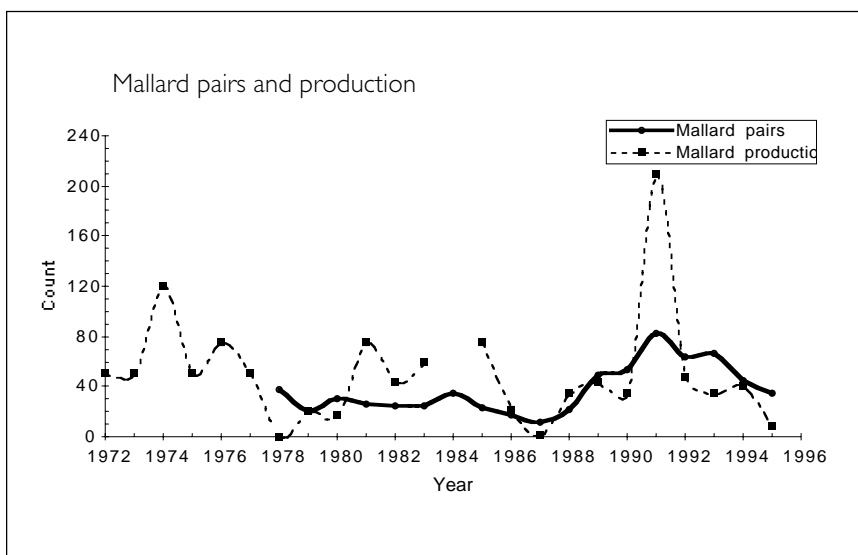


Appendix C1 Wintering populations of (a) bison, (b) moose, and (c) mule deer on the National Elk Refuge, Jackson, Wyoming.

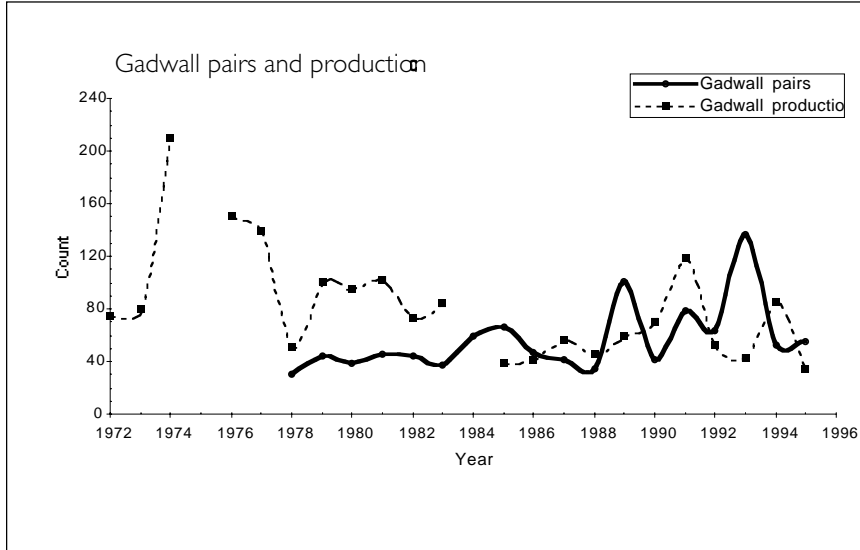
Appendix C2 Breeding pair and production counts of (a) total ducks, (b) mallards, (c) gadwalls, (d) green-winged teals, on the National Elk Refuge, Jackson, Wyoming.



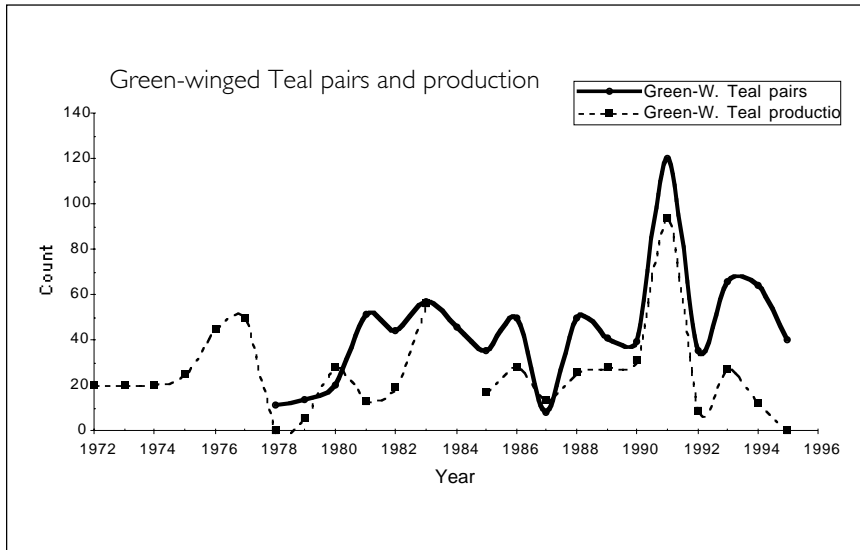
(a) Average duck pairs: 223+/- 108(SD), average production: 256+/- 16(SD)



(b) Average mallard pairs: 40 +/- 20(SD), average production: 45 +/- 48(SD)



(c) Average gadwall breeding pairs: 57 +/- 108(SD), average production: 688 +/- 26(SD)



(d) Average green-winged teal pairs: 44 +/- 25(SD), average production: 24 +/- 23(SD)

Appendix D Exotic plant species on the National Elk Refuge, Jackson, Wyoming. Compiled from Fertig 1998b with additional species added.

Common Name	Scientific Name	Common Name	Scientific Name
Forbs			
Pale alyssum	<i>Alyssum alyssoides</i>	Red seeded dandelion	<i>Taraxacum laevigatum</i>
Desert alyssum	<i>Alyssum desertorum</i>	Common dandelion	<i>Taraxacum officinale</i>
Red orache	<i>Atriplex rosea</i>	Field pennycress	<i>Thlaspi arvense</i>
Littlepod falsefax	<i>Camelina microcarpa</i>	Yellow salsify	<i>Tragopogon dubius</i>
Shepherd's purse	<i>Capsella bursa-pastoris</i>	Alsike clover	<i>Trifolium hybridum</i>
Chalapa hoarycress	<i>Cardaria chalapensis</i>	Red clover	<i>Trifolium pratense</i>
Plumeless thistle	<i>Carduus accanthoides</i>	White clover	<i>Trifolium repense</i>
Musk thistle	<i>Carduus nutans</i>	Common mullein	<i>Verbascum thapsus</i>
Spotted knapweed	<i>Centaurea maculosa</i>	Water speedwell	<i>Veronica anagallis-aquatica</i>
Canada thistle	<i>Cirsium arvense</i>	Bird vetch	<i>Vicia cracca</i>
Bull thistle	<i>Cirsium vulgare</i>	Scotch thistle	<i>Onopordum acanthium</i>
Field bindweed	<i>Convolvulus arvensis</i>		
Houndstongue	<i>Cynoglossum officinale</i>	Graminoids	
Flixweed	<i>Descurainia sophia</i>	Crested wheatgrass	<i>Agropyron cristatum</i>
Prickly lettuce	<i>Lactuca serriola</i>	Redtop	<i>Agrostis stolonifera</i>
European stickseed	<i>Lappula squarrosa</i> <i>var. squarrosa</i>	Meadow foxtail	<i>Alopecurus pratensis</i>
Clasping peppergrass	<i>Lepidium perfoliatum</i>	Smooth brome	<i>Bromus inermis</i>
Dalmation toadflax	<i>Linaria dalmatica</i>	Cheatgrass	<i>Bromus tectorum</i>
Malcolmia	<i>Malcolmia africana</i>	Orchard grass	<i>Dactylis glomerata</i>
Black medic	<i>Medicago lupulina</i>	Intermediate wheatgrass	<i>Elymus hispidus</i>
Alfalfa	<i>Medicago sativa</i> <i>var. sativa</i>	Russian wildrye	<i>Elymus junceus</i>
White sweet-clover	<i>Melilotus albus</i>	Common quackgrass	<i>Elymus repens</i>
Yellow sweet-clover	<i>Melilotus officinalis</i>	Timothy	<i>Phleum pratense</i>
Common forget-me-not	<i>Myosotis scorpioides</i>	Annual bluegrass	<i>Poa annua</i>
Common plantain	<i>Plantago major</i>	Bulbous bluegrass	<i>Poa bulbosa</i>
Norwegian cinquefoil	<i>Potentilla norvegica</i>	Kentucky bluegrass	<i>Poa pratensis</i>
Water cress	<i>Rorippa nasturtium</i>		
Russian thistle	<i>Salsola australis</i>	Trees	
White campion	<i>Silene latifolia</i>	Pea-tree	<i>Caragana arborescens</i>
Tumblemustard	<i>Sisymbrium altissimum</i>		
Marsh sow-thistle	<i>Sonchus uliginosus</i>		

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Uses and Valuation of the National Elk Refuge, Wyoming

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ABSTRACT

The National Elk Refuge is a 25,000-acre wildlife refuge in Jackson Hole, Wyoming—one of the most treasured, recognizable, and visited ecosystems in the world. The refuge was originally established in 1912 as winter range for the Jackson elk herd. Since then, its mission has expanded. Currently, many people use the refuge for activities such as hunting, fishing, wildlife observation, jogging, and biking. Conflict frequently arises over proper management of the NER, which is fundamentally not about elk habitat, forage production, or other biological or technical issues, but rather about the equitable allocation of human values. Commonly, these values are labeled as “politics” and discounted. However, ignoring values does not reduce the potential for conflict, as current lawsuits demonstrate. To understand the values that affect refuge management more explicitly, this paper uses an interdisciplinary method that integrates human values into decision making. Since 1912, there has been an increase in value interactions associated with population growth, a decline in community “ownership” of the refuge, and increased centralization, bureaucratization, and professionalization of the National Wildlife Refuge System. These important historical trends are described as a way to project future social dynamics. Criteria and priorities are described to help clarify and secure common interests in decision making about the refuge’s management.

The National Elk Refuge (NER) in Jackson Hole, Wyoming, was established in 1912. Its recently stated mission is to “provide, preserve, restore, and manage winter habitat for the nationally significant Jackson Elk Herd and habitat for endangered species, birds and other big game animals, and provide compatible human benefits associated with its wildlife and wildlands” (NER 1998: 1-5). This goal was developed in response to pressure from the local and national public to protect the region’s resources. To meet this aim, refuge managers carry out or permit a wide array of activities and uses. Commonly, decisions about use that benefit one person deprive another of important values. For example, the decision to switch from feeding hay to feeding pellets to the elk herd benefited some people while depriving others of certain advantages. The proposed bison hunt is another more recent example of conflicting values. Understanding people’s values, their uses of the NER, and their views of the “proper” mission of the refuge are essential to devising management policies that serve shared interests in a democratic society.

Throughout the history of the NER, conflicts have arisen over management decisions and their fairness in allocating benefits and losses among people. In general, no two people value, or even conceive of, various uses of the NER in the same way. Just as it is necessary to collect appropriate biological data about a management issue, it is equally vital to gather information on the human social and historical contexts, including the values at stake. Without this information, decision makers run the risk of rendering judgments that are not supported by the community (Lurie and Clark 1997).

Broadly, this paper provides information about the social context of the NER, including values and processes that influence NER management decisions. I have sought to answer three questions: What human value choices

Understanding people’s values, their uses of the NER, and their views of the “proper” mission of the refuge are essential to devising management policies that serve shared interests in a democratic society.

affect management of the NER? How have these values changed qualitatively over time? How can these values be used to inform decision making? While parts of this paper may be applied generally to all refuge management, other parts are specific and refer to ongoing NER issues.

HUMAN VALUES

TWO CASES OF VALUE CHOICES AFFECTING MANAGEMENT

In 1998, a diverse group of community members spent an afternoon outdoors on the NER building a stream crossing for elk. The group included high school students, teachers, environmentalists, county employees, and interested citizens (Odell 1998). While the stated goal of the project was to reduce bank erosion caused by migrating elk, many other values were at play. For example, many skills were necessary to organize the group and to carry out the construction. As tools were traded to give everyone an opportunity to take part, it became clear that it was important to the participants to respect one another. In turn, people expressed satisfaction at being respected. They appreciated the chance to affect management on the refuge, they enjoyed being part of a team effort, and they experienced a beautiful part of the valley that is generally closed to the public. The bridge building also served as a learning exercise for the high school students who participated. In addition to having the opportunity to learn to swing a hammer, participants heard a talk about riparian health and sedimentation in the stream. Several people emphasized how gratifying it felt simply to be outdoors helping to improve part of the refuge. All the people who participated were motivated by different specific values, only a few of which I have described. However, all participants were fundamentally interested in respect, skill, affection, enlightenment, and other values. In the end, the task of constructing the stream crossing satisfied all the participants, and in doing so, helped to secure shared goals of the community. This exercise was an integrated one in which participants shaped and shared values in a positive way. As a result, it was an ideal opportunity to meet the NER's objectives.

While activities such as this satisfy participants' expectations, conflicts still exist. Recently, the Wyoming Game and Fish Department (WDGF) sued the U.S. Fish and Wildlife Service (USFWS), the federal agency that administers the NER, to vaccinate elk on the refuge against brucellosis (*Brucella abortus*). While this suit is much more complex than the example of building the stream crossing, it is fundamentally about determining who has the power to make management decisions about elk on the NER (Neal 1998). The state of Wyoming also has a large financial stake in the suit since it risks losing its "brucellosis-free" status because of the remote chance of disease transmission from infected elk to livestock (Drake 1998). The loss of this status would translate into costly livestock testing as well as diminished trading possibilities.

Both sides offer scientific data to justify their positions, yet the information is contradictory. While the WDGF points to studies supporting the efficacy of

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the vaccine in elk, the NER and USFWS emphasize the limited effectiveness of current vaccines and the health risks to both the elk and nearby human populations. The NER argues that reducing elk population density is the only feasible way to address disease problems. This can be achieved by obtaining additional winter range, increasing natural forage, or reducing elk herd size. The NER believes that vaccination moves management in the wrong direction since elk must be crowded together during administration of the vaccine (Drake 1998).

In this case, the participants' values are in direct conflict with one another and an integrated solution is not possible. The result is a lawsuit in which the courts will decide the outcome. No matter what the decision is, however, at least one side will be deprived of important values, including power and respect. While these two examples have differences in terms of scale, values at stake, and complexity, a comparison reveals two different attempts at clarifying common objectives. In the first example, an inclusive and integrated approach was taken to solve a simple problem. In the second example, the participants have not clarified their common interests. Because the outcome is being decided by a court rather than through an integrated activity, it is likely that ultimately the result will leave the participants unsatisfied.

There are many other examples in which values are either being widely shaped and shared in a positive way or are in conflict. The irrigation project (NER 1998), bison management, including a planned bison hunt (Cromley, this volume; GTNP and NER 1996), and the supplemental feeding program (NER 1998) are some examples in which values are in conflict. The NER's major task is to seek integrated solutions wherein values are harmonized to the extent practicable. Understanding participants and their values in these issues is critical to minimizing conflict and fostering decision making in the common interest.

AN OVERVIEW OF HUMAN VALUES

The NER examples illustrate that although projects may appear to be about bridge building or elk vaccination on the surface, fundamentally what is really at play are human values that are shared or contested. Every person is motivated in each decision by a complex blend of values. These values constitute the assets that are available to participants when making decisions (McDougal *et al.* 1988). All people make decisions that they perceive will leave them better off (Lasswell and McDougal 1992). On the NER, managers make decisions that they perceive will provide the refuge and the public with better value outcomes. For example, a decision to move the sleigh ride headquarters to the National Museum of Wildlife Art benefited both the visitors and the elk, since visitors could wait in a warm area, and traffic along the road through the refuge was reduced. This move did have costs in terms of several values: wealth was required for the move and the sleigh ride concessionaire contract changed hands, in part because of a feeling of diminished respect by the former operator.

Understanding participants and their values in these issues is critical to minimizing conflict and fostering decision making in the common interest.

In the end, the decision was made because managers felt that the outcome would result in a better distribution of values for the refuge and the public.

Because of the large number of affected participants, many decisions on the NER are difficult to make and may result in conflict. For example, an outfitter who earns his living from elk hunting may promote an increase in the elk population to raise the number of hunting licenses issued and thus his wealth. At the same time, this increase may deprive a person of the pleasure of watching birds in the willows along Flat Creek because of elk over-browsing in riparian habitat.

Since each person embodies a unique combination of values, it can be difficult to analyze values. One way to organize human values is into the following eight categories (Lasswell 1971; McDougal *et al.* 1988). This convenient way to map values has been used in many other contexts. The values are listed in no particular order; all eight are always involved in human interactions. Examples from the NER will be used to illustrate how each value affects decision making.

Power is the ability to make and carry out decisions. The Wyoming Game and Fish Department has sued the NER over the power to control elk management on the refuge.

Enlightenment is the collection, analysis, and dissemination of information and knowledge. In the WDFG lawsuit, both sides are relying upon scientific studies to support their positions.

Wealth, the value with which people tend to be most familiar, is the creation, distribution, and control of goods and services or their equivalents. People have speculated that the ranching community statewide is supporting the WDFG lawsuit because of the financial risks it faces.

Well-being refers to physical or mental health, which relates to a participant's potential effectiveness in a specific situation. Community members enjoyed the bridge-building exercise on the refuge in part because it was an opportunity to get outside and exercise in the fresh air.

Skill is the acquisition or exercise of special abilities in a vocation or avocation. Building a bridge required skills such as carpentry, engineering, and organizing people. The participants seemed to enjoy themselves while demonstrating and practicing these and other skills during the project.

Affection refers to special, positive relationships with individuals, organizations, or other entities. The community of Jackson and the participants in the bridge project have a special connection to the NER, evident in comments made during construction. People noted the unique opportunity the occasion offered to be on the refuge and to enjoy the wildlife, scenery, and each other.

Respect refers to a condition in which people show and receive deference. In organizing the bridge building, the Teton County Natural Resource District included all interested people. Everyone, regardless of age or gender, was given a chance to help. This inclusiveness conferred respect upon the participants, which they clearly noted in conversation.

Since each person embodies a unique combination of values, it can be difficult to analyze values. One way to organize human values is into the following eight categories (Lasswell 1971; McDougal et al. 1988). This convenient way to map values has been used in many other contexts.

Rectitude refers to a set of ethical standards. People were happy to help build a bridge on the refuge partly because of their belief that it was the right thing to do. Their ethics supported the action taken.

METHODS

To learn about the values that affect the management of the NER, I relied on the analytic methods of the policy sciences (Lasswell and Kaplan 1950; Lasswell 1971; Lasswell and McDougal 1992). The approach highlights the importance of having knowledge about the processes that guide all management decisions in addition to information specific to the current decision (Clark 1999). For example, management of the NER requires knowledge of problem orientation and social and decision processes, as well as substantive biological, social, and economic information about the specific decision at hand. As a high-level framework, the policy sciences can help guide investigation and analysis of problems. By understanding a problem in its context, decision makers recognize the complex interactions between participants and their values and help clarify and secure common interests in each specific situation.

Most people think about the management of the NER in terms of many specialized issues, such as elk biology, habitat requirements, disease management, and biodiversity (Matson, this volume). A proposed irrigation project on the refuge is one example in which the problem has been framed in terms of technical issues, such as forage production and supplemental feeding. In contrast, this study looks at management in terms of the basic values underlying these conventional issues and how they interact to affect outcomes. An onion serves as a useful metaphor. As the top layers, such as disease management, supplemental feeding, and hunting are peeled away, inner ones reveal more fundamental issues: human values, their interactions, and the outcomes. To best manage the NER, an understanding of the issue, from the outermost layer to the innermost one, is essential.

To begin to peel back the layers of the onion in this study, 39 personal interviews were conducted. During each, I asked questions about the participant's uses, values, and perspectives with respect to the NER. I also asked how the person tried to affect refuge management and what outcomes were perceived (Adler and Adler 1994). In addition, I asked people to identify other participants to establish a list of key contacts. By identifying and contacting interested participants, I was able to include a wide array of perspectives in the study.

Literature and database reviews were used to round out the investigation (Hodder 1994). In particular, the NER annual narratives were critical to developing indicators of significant trends in use and management. They contained information about visitor numbers, participation in activities such as jogging, wildlife observation, fishing, and budgets. In addition, the NER keeps extensive records about the supplemental feeding program, including dates, elk population, feeding costs, and amounts. The WDGF maintains substantial records about hunting on the refuge, including numbers of resident

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and non-resident hunters, success ratios, and composition (age and sex structure) of the harvested elk. It is possible to calculate some of the economic benefits to the community that were derived from these activities.

WHAT HUMAN VALUE CHOICES AFFECT MANAGEMENT OF THE NATIONAL ELK REFUGE?

In essence, refuge management is not about elk or bison or other similar topics. Instead, it is fundamentally a question of how to allocate the eight human values, consistent with community (national and local) expectations, both past and present. In all the specific issues that fill a manager's agenda, decisions are made that benefit some participants, while depriving others of important values. It is these value dynamics that drive the decision-making process of the NER and lead to conflict when some stakeholders feel marginalized by a decision outcome that does not reflect their values.

The first step toward understanding the values that shape a decision is to identify the key participants in the process. For the NER, this includes a long list: U.S. Fish and Wildlife Service (USFWS), Wyoming Game and Fish Department (WDGF), Animal and Plant Health Inspection Service (APHIS), National Park Service (NPS), Jackson Hole Conservation Alliance, Town of Jackson, Teton County, homeowners, hunters, outfitters, anglers, joggers, Native Americans, the Rocky Mountain Elk Foundation, bird watchers, visitors, Boy Scouts, the national public, Wyoming state government, and others. I have chosen a subset of five of these groups to examine in detail because it represents a wide range of perspectives. While the values I discuss were evident in interviews with actual participants, they may not represent the perspectives of the entire group or organization. For example, even within the NER staff there are different perspectives about how best to manage the elk herd. In any organization or collection of people, there is always a variety of perspectives that may be lost in a general description. In addition, some participants may identify with more than one group, thus compounding a simplified view of values.

For each of the five participants, I describe their most influential values, which I determined from statements emphasized in the interviews. While this accounts for the most apparent value motives, it is important to remember that all eight values affect every decision made by each interested party. In addition, the values do not exist in a vacuum; there is interaction between the value categories. For example, a person who experiences increased wealth may also experience an increase in power and well-being. Table 1 summarizes some of the values that the five participants displayed.

U.S. FISH AND WILDLIFE SERVICE

The USFWS is the federal agency directly responsible for the management of the National Elk Refuge. The refuge was established in 1912 because human development was encroaching on elk winter range (NER 1994). Many people felt a moral obligation to feed the elk since their population decline had resulted

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Table 1 Some of the values associated with prominent participants in management of the Jackson Hole elk herd, Wyoming.

Values	USFWS	WGFD	Ranchers	Hunters/ Outfitters	Fund for Animals
<i>Power</i>	Lawsuit about vaccination	Lawsuit about vaccination	Lawsuits; political pressure	Lawsuit about licenses	Lawsuit about bison
<i>Enlightenment</i>	Carrying capacity study; brucellosis vaccination studies	Brucellosis vaccination studies			
<i>Wealth</i>	Irrigation	Hunting/fishing licenses; supplemental feed and reduced depredation	Costs of depredation; costs of cattle vaccination; costs of loss of brucellosis-free status	Income from clients	
<i>Well-being</i>	Comprehensive disease management			Nutrition from successful hunt	
<i>Skill</i>	Irrigation	Vaccination program		Challenge of the hunt	
<i>Affection</i>	Irrigation	Vaccination			"Bike bribe"
<i>Respect</i>		Brucellosis eradication			
<i>Rectitude</i>	Supplemental feeding		Private winter range	Population control	Ethical position on hunting

from human causes. This ethical belief still motivates the supplemental feeding program today, and thus, rectitude is an important motivation for the management of the elk herd. While managers feel a sense of duty to feed the elk, they also recognize that the supplemental feeding program changes the distribution of elk and increases their density as the animals crowd in at feed lines. Increased density could increase disease incidence and have adverse impacts on habitat. This recognition has fueled a movement to reduce supplemental feeding to the lowest possible level. Toward this end, refuge managers are promoting the use of sprinkler irrigation to increase the amount of natural forage and thereby reduce reliance on feed. This irrigation program, estimated to cost \$2.8 million, would reduce annual feeding costs by about \$300,000. However, it would increase maintenance costs by an amount that would almost completely offset the annual savings in supplemental feeding (NER 1998). Three values are clearly evident in this dynamic: wealth, skill, and well-being.

The costs involved, in up front spending and in savings in the future, clearly speak to the importance of wealth. In addition, the NER's supplemental feeding program is an anomaly among national wildlife refuges, and refuge managers around the country believe that feeding large game species is contrary to their mission. As a result, securing annual funds for the program is challenging. On

the other hand, sprinkler irrigation is a form of range management to which others in the agency can easily relate. As a result, there is a funding bias that favors the irrigation program as a way to reduce the costs of supplemental feeding.

Besides the wealth values associated with irrigation, proper installation and operation of the sprinkler system would require specialized skills. This would be true particularly if pesticides and fertilizers were applied, as there could be a significant risk of water pollution to Flat Creek and the surrounding wetlands (which supply drinking water to the town of Jackson as well as water to the Snake River). The judicious use of these specialized skills has been cited as an important part of the irrigation program, thus making it a critical value in the decision process.

People's well-being may be affected by a change in the distribution of elk on the winter range, which may be caused indirectly by the sprinklers. By increasing the amount of natural forage, the program's coordinators hope to keep elk off supplemental feed for a longer period. It is hoped that this will lower animal density, which may reduce the likelihood of disease transmission. Currently, 28% of the elk (39% of the adult females) on the NER have tested positive for brucellosis, a disease that causes cow elk, bison, and cattle to abort their first fetuses (NER 1998; Smith and Roffe 1992). In contrast, only 1.7% of free-ranging elk are infected (Smith and Roffe 1992). The disease is spread by direct contact with placental tissue, which is exacerbated by the increased density of elk around the feed lines. While this issue clearly points to a concern for the well-being of the elk, it is also related to human health and well-being since the conditions that favor high prevalence of brucellosis also increase the risk of tuberculosis transmission in elk. If this disease ever found its way to the NER, there would be a significant risk to human health, given the current conditions (NER 1998; Roffe and Smith 1992). As a result, the irrigation program is part of a comprehensive disease management program that the refuge is developing.

As part of this disease management program, the WDGF has proposed vaccinating the elk on the refuge against brucellosis. This proposal has served as a catalyst for a series of actions, ending in a lawsuit that was recently resolved in the courts, wherein the WDGF sued the USFWS over the right to proceed with the vaccination. This lawsuit was fundamentally about power, as both the USFWS and the WDGF were claiming the right to make decisions about how the elk are managed on the refuge. The NER management staff insisted that the decision to vaccinate should be based on scientific evidence and that the proposed program would not work because an effective vaccine has not been developed. To support their assertion, the NER hired three bio-statisticians to review the state's data on vaccination. The results of the studies found no significant effect would result from the use of the vaccine. As a result, the NER gained valuable knowledge in their case against WDGF. While it is outside the scope of this paper to address the full details of this complex case, it is important to see both sides. It is also important to see which values are at stake and whether an integrated outcome can be crafted in the common interest.

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WYOMING GAME AND FISH DEPARTMENT

The lawsuit filed by the WDGF against the USFWS was an attempt to clarify power relations among the agencies. All the primary participants, including the WDGF, admit that the issue causing conflict is the actual control of the elk herd on the NER (Neal 1998; Drake 1998). In addition to the power value, the lawsuit and the brucellosis eradication program illustrate the importance of several other values. Brucellosis is a disease that has plagued ungulates, specifically cattle, elk, and bison, since the 1930s (Smith and Roffe 1992). It is of particular concern because of its potential impacts on the livestock industry. Cattle that have been infected with the disease, or have come from herds where other cattle were infected, are subject to an array of costly tests and possible quarantine. In addition, infected cows may abort their calves. This represents a financial threat to the cattle industry.

People within a variety of government agencies, including APHIS, state veterinarians, and the WDGF have spent their careers battling brucellosis. These people see a chance finally to eradicate the disease, and the elk on the NER represent a barrier to this effort, since there is a theoretical possibility that elk or bison living on the refuge could transmit the disease to cattle if they were in close contact. When and if the disease is finally eradicated, the people who accomplish this task will receive a great deal of respect from the veterinary and livestock communities and the public. These same people have significant influence within the Wyoming state government, and it has been suggested that they are largely fueling the lawsuit. In this way, respect is also a value that is being sought in the courts.

With concern about brucellosis driving the WDGF lawsuit, it might be assumed that the agency would also favor reducing the elk herd size to decrease the density and thus the risk of transmission. However, because hunters represent a significant constituency and because the WDGF receives income from hunting permits, the agency advocates maintaining the herd at present levels. While a target population of 7,500 elk has been agreed on by the WDGF and NER, this number has been exceeded frequently in the past (Figure 1) (NER 1998). With population levels above the target, hunting is promoted as the only feasible way to reduce the herd size. Since WDGF receives a significant portion of its income from the sale of hunting licenses, there is a strong wealth incentive driving the process to keep elk populations high. This can be accomplished through increased reliance upon supplemental feed to reduce winter mortality.

WDGF is in a difficult position. The cattle industry lobbies the agency to vaccinate and to reduce elk herd density to minimize the risk of brucellosis transmission. At the same time, the agency is pressured to maintain the NER elk herd above the target population size to meet its own budget needs and to support the hunting and outfitting industries. In many ways, the lawsuit is a statement of exasperation by the WDGF as it tries to reconcile these seemingly disparate positions.

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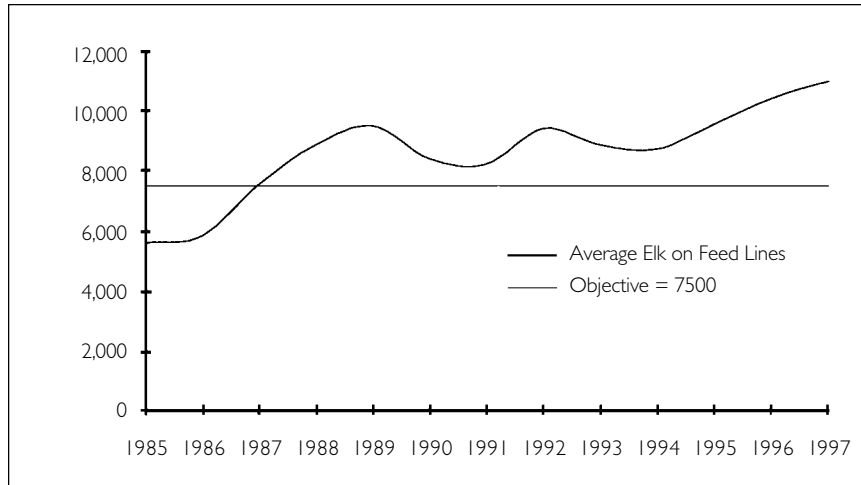


Figure 1 Average number of elk on the National Elk Refuge feed lines (1985-97). (Source: NER Annual Narratives)

HUNTERS AND OUTFITTER BUSINESSES

There is a wealth incentive among hunters and outfitters to increase the size of the elk herd: more elk mean more money for outfitters because they are able to attain more elk tags, which translates into more clients. However, this is not the only value that motivates this segment of the population.

There is a significant number of hunters who derive their winter meat supply from the fall hunt. This source of nutrition is a large incentive because they see increased well-being as an important asset. Several people also mentioned that they believe it is ethically correct to eat meat from local sources rather than from the industrial cattle yards that supply supermarkets. These people derive ethical benefits from hunting, and this serves to motivate their actions. In addition, many people feel that hunting is the only humane way to reduce herd sizes. With many natural predator populations severely restricted and winter mortality artificially reduced by supplemental feeding, hunting is seen as the only option. It is possible to reduce winter feeding to increase mortality, but this will result in bloody competition between bulls and the rest of the herd for available food as well as increased conflicts between elk and humans as the elk leave the refuge in search of other sources of sustenance. As a result, many hunters feel it is morally justifiable to reduce herd sizes.

In addition, many hunters receive value from the skill required to hunt elk in the hills of the northern refuge. This skill value may partly explain why so many people, both non-hunters and hunters alike, are appalled by the “hayfields’ hunt” in Grand Teton National Park. During this activity, people line up their vehicles and wait for the elk to cross the fields, where they can be shot in the open. The common perception is that this hunt requires no skill and that it also debases the skill required by hunters to be successful in other areas. Because skill is a valued part of the hunt on the refuge, diminishing it with the hayfields’ hunt deprives the refuge hunters of an important value. This is true even

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though the change is only in public perception, not in the actual skill required to kill an elk. In addition, successful hunters receive respect from their peers. It is likely that this value may also be diminished by the hayfields' hunt.

RANCHERS

Several of the factors that motivate ranchers' perspectives about the management of the Jackson elk herd revolve around the wealth category. If elk are not fed on the refuge in the winter months, they will search elsewhere for food, including ranches. One of the primary reasons for establishment of the NER was to reduce elk depredation in ranchers' haystacks. While ranchers would bear some of this cost, it also motivates the WDFW and the state of Wyoming since they are responsible for compensating ranchers for losses from wildlife damage.

In addition, the brucellosis issue is important to the ranching community. While the ranchers in Jackson Hole already vaccinate their cattle against the disease, many others throughout the state do not. Thus, the loss of "brucellosis-free" status represents a financial threat to the ranching industry. This change would alter how they do business by requiring additional testing before cattle could be moved to market. In addition, vaccination would be required, which would be an increased cost. As a result, the management of the Jackson elk herd has significant wealth value to ranchers throughout the state.

To affect decisions and influence values such as power and respect, the ranching community relies on political pressure and lawsuits. The cattle industry is relatively powerful in Wyoming, and the governor's office is sympathetic to its needs. Several people have hypothesized that the WDFW lawsuit is actually a way for the governor to show his ranching constituents that he is doing everything possible to address the brucellosis issue. Whether or not this is the case, the ranching community seeks and wields power and other values to affect decisions in the state.

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FUND FOR ANIMALS

The Fund for Animals represents just one of several non-profit environmental organizations concerned about elk management. This group opposes all hunting for ethical reasons. This moral position is the primary motivation for the organization's stance on many issues. While these people are clearly motivated by rectitude, there is also an affection for the elk that drives organizational decisions. One example of this is the "bike bribe," as it became known by an anti-Fund for Animals partnership, that was offered to local youths who had hunting licenses for the refuge (Kerasote 1998). The first young hunter to return his or her elk hunting license would be offered a \$1,000 mountain bike. While this resulted in a community uproar about the values it was teaching children, the Fund's action was motivated by rectitude and affection for elk (Kerasote 1998). By "saving" one elk, this effort clearly would have a limited impact on the population, but it could serve as a symbolic act about values.

The Fund for Animals has also used actual and threatened lawsuits to affect decisions (Simpson 1998). The NER recently considered a hunt for bison to control the population size. The Fund publicly announced that if the managers proceeded with this hunt, it would sue the USFWS. In fact, even before the first hunt, the Fund for Animals proceeded with its lawsuit. This was a clear attempt to affect refuge decisions and is thus a move to increase power.

It has been demonstrated that management of the NER is fundamentally about human values. All these organizations are motivated by different sets of values. However, these values are not static; they change over time with changes in the underlying conditions. For this reason, it is important to also consider broad trends that affect the current values.

HOW HAVE THESE VALUES CHANGED OVER TIME?

Understanding the current value dynamics is critical to appropriate decision making on the NER. However, decision and policy making are oriented to the future, when decisions that are made in the present will take effect (Brewer and deLeon 1983). "Since the future cannot be known in advance we must rely upon estimates based upon knowledge of [past] trends and conditions" (McDougal *et al.* 1963: 147). To understand and predict future management challenges for the NER, it is important to understand how values and conditions have changed in the past. Then reasonable projections about the future management context of the NER can be made.

Since 1912, many social, technological, and organizational changes have affected NER management. When the refuge was established, communication out of the valley was limited to horse-drawn carriages, the tourist industry in Jackson Hole was limited to a few dude ranches, and wolves preyed on elk along the Gros Ventre River (Blair 1987). Over the nine-decade history of the refuge, three important trends affecting refuge decision making are evident, based on their impact on NER management as well as impressions I formed during the interviews. First, there has been a dramatic rise in the number of uses of the refuge, as well as frequency of value interactions among participants. This increase has brought a concomitant rise in the potential for conflict over management decisions. Second, there has been a sense of diminished local "ownership" over refuge decisions, resulting from the trade-off between a local and national focus in management. Third, the National Wildlife Refuge System has become increasingly centralized, bureaucratized, and professionalized. This has resulted in a tension between understanding the specific local context and accommodating national priorities.

These three trends, among many others, can help clarify the changing value dynamics and context of refuge management over its long history. Each trend and its underlying factors will be addressed as a means to move toward understanding and predicting the future decision environment.

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The descriptions below are based on a variety of sources, including information gathered during personal interviews and data from the Jackson Hole Historical Society and the NER annual narratives.

TREND #1: INCREASING USES OF THE REFUGE AND COMPLEXITY OF VALUE DYNAMICS

When the NER was established in 1912, Jackson Hole consisted of small, isolated communities of homesteaders (Clark 1999), and the frequency of “value interactions” was relatively low. Every time individuals or organizations make a decision, their values interact with those of others who also share interests in the decision or its outcomes. For example, a formal decision not to vaccinate elk on the NER against brucellosis produces interactions among groups of people such as ranchers, refuge and WDFW managers, and the governor of Wyoming. All decision making requires the use or deployment of values, such as power or knowledge (McDougal *et al.* 1981). For example, the WDFW lawsuit requires power (legal standing), enlightenment (strain 19 research), skill (lawyers and refuge management organization), and the other values. This drawing down of values and its effects on other values can cause decisions to be contentious if one party does not feel that the outcome will improve its critical values. For example, if the NER loses the lawsuit, its primacy over wildlife on the refuge (power), vaccination studies (enlightenment), and ability to manage the lands under its control (skill) will all be diminished. Because they result in a diminishment of important values, the number of value interactions can often help determine the potential for conflict in a decision-making environment.

In 1912, the human population of Teton County numbered in the hundreds, and in 1930 when the first official U.S. Census took place in the county, it was slightly over 2,000 (McVeigh 1989; Wilbrecht and Robbins 1979). When the refuge was established, the primary objectives of management were to feed elk during the winter (well-being), prevent them from dying (rectitude), and keep them out of rancher’s haystacks (wealth, respect) (Blair 1987). This responsibility initially went to the state of Wyoming, but when costs became prohibitive, the state called on the federal government to deal with the situation (power) (Blair 1987). Many early homesteaders also relied on the refuge for meat (well-being) and employment (wealth). Because of the small and relatively uniform human population in the valley, the frequency of value interactions was low and the mission of the NER was relatively simple. While there were other uses and values associated with the NER, such as logging (well-being, wealth, skill), photography (affection, wealth, enlightenment), and fishing (well-being, skill), they were less important (Chambers-Gillette 1968).

Even though the same eight values existed throughout its history, the diversity of ways to achieve them on the NER grew. For example, early local ranchers valued the refuge as a source of income (wealth), derived from the sale of hay to feed overwintering elk. Over time, other sources of wealth were

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discovered as residents looked to the NER for income from tourism, hunting, fishing and wildlife observation. This increase in the ways to achieve wealth was mirrored in the other seven values. As the human population blossomed, new ideas about uses of the refuge were imported. Open space, aesthetic qualities, and recreational opportunities increased in importance as people left more densely settled parts of the country in search of these valued amenities. One indicator of this value change is the amount of information that the NER has collected about public use. Prior to 1965, the bulk of the data related to elk population dynamics, feeding, and hunting, while information about public use was scarce (NER 1965). Gradually, data about human activities such as sleigh rides, interpretation, wildlife observation, jogging, and other uses have been collected as the importance of these uses has increased.

Today, the eight value demands are still apparent. However, as the population of Teton County and the uses of the NER have grown dramatically, the frequency of interactions has also increased, with many new participants affecting refuge management decisions (Figure 2). As the numbers of people and uses increase, there is a greater number of stakeholders with value demands about how the refuge should be managed. While many of these valued activities

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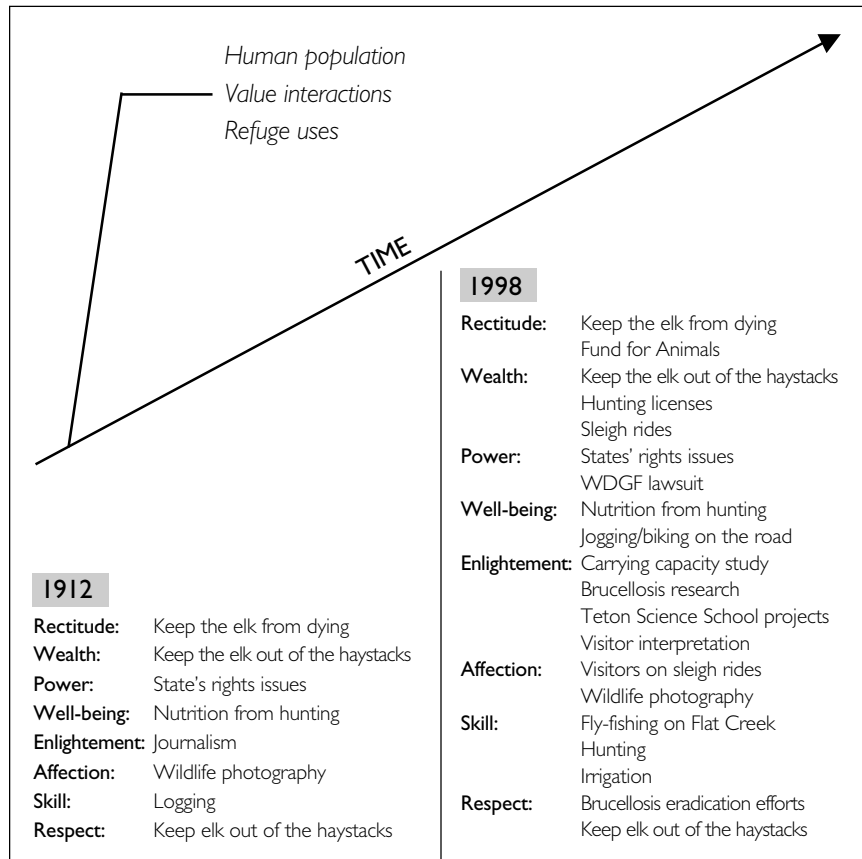


Figure 2 Representative changes in value interactions on the National Elk Refuge, Jackson, Wyoming.

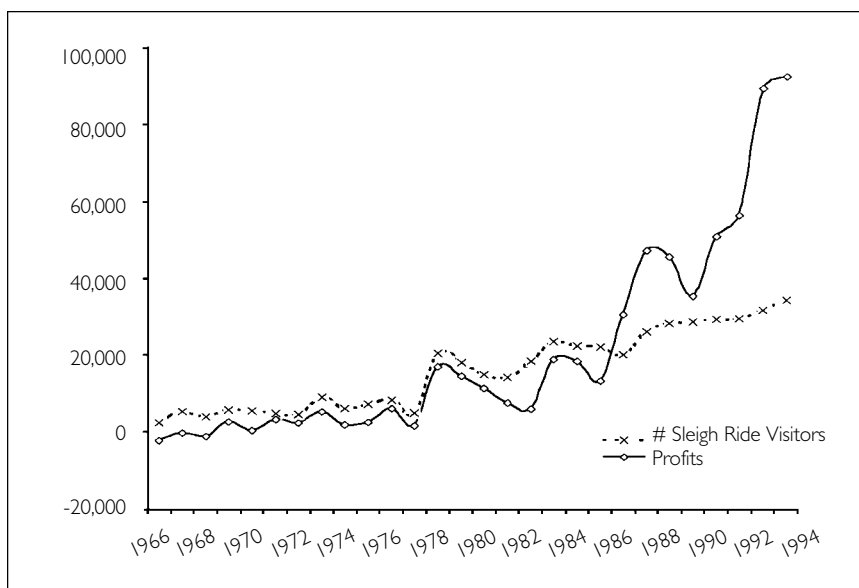


Figure 3 Sleigh ride visitors and profits on the National Elk Refuge, Jackson, Wyoming (Source: NER Annual Narratives).

have been mentioned previously, several new examples will be explained here.

During the winter months, the NER offers a concession to a local outfitter to bring visitors onto the refuge in a horse-drawn sleigh. This operation provides a significant source of wealth to the outfitter as well as to the NER and the National Museum of Wildlife Art, both of which take part of the profits (Figure 3). In the winter of 1997-8, the sleigh ride operation raised more than \$275,000 in gross income (National Museum of Wildlife Art 1998). The NER provides interpretive staff on a portion of the sleigh rides to provide information to visitors. It is important to the refuge managers to “educate” the public since the success of management efforts depends to a great extent on public acceptance, which is based on public perception. If the refuge staff can increase public understanding of key issues, they believe they can be more effective in their role as resource managers. Visitors report that they initially go on the sleigh rides because it provides an opportunity to spend time with their families and friends, but then the educational component further increases the value they place on the activity.

Many people, both community members and visitors, use the refuge road for jogging, walking, and biking. While these people undoubtedly enjoy the beautiful scenery, they also experience increased well-being from the exercise. This constituency is one which was completely absent until recently (Figure 4).

One overall trend is clear during the refuge’s history: management has become much more complex as the frequency of value interactions has increased. As the human population and refuge use has grown, management has become increasingly contentious. While this is important contextual informa-

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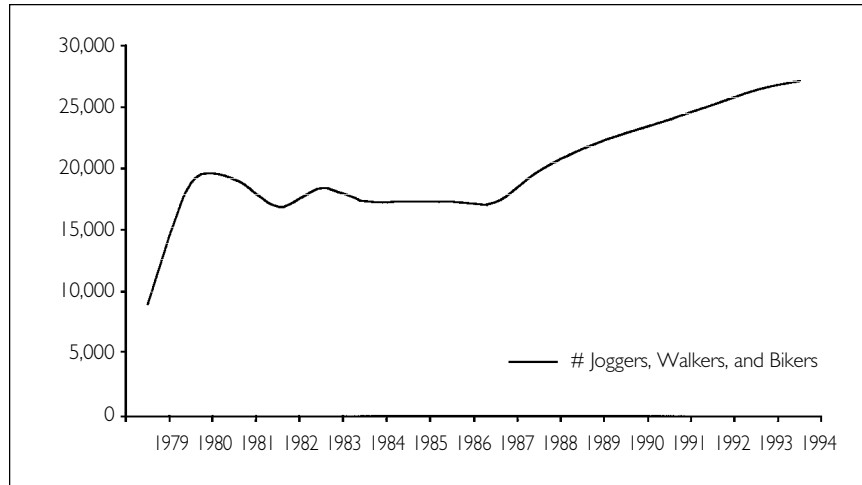


Figure 4 Number of joggers, walkers, and bikers on the National Elk Refuge, Jackson, Wyoming. (Source: NER Annual Narratives)

tion in itself, it also provides critical data about the future. If the current growth rate continues, the human population in the country may nearly double in the next 20 years (Teton County Planning Department 1994). As a result, management of the refuge is likely to become increasingly complex and contentious. It is thus critical to address the complexity in a straightforward fashion by acknowledging and understanding the values that underlie people's decisions.

TREND #2: DECLINING SENSE OF COMMUNITY OWNERSHIP

"Ownership" refers to the rights and responsibilities associated with the control of resources or processes. While the concept has traditionally denoted control of a physical entity, it can also refer to the ability to influence a decision, including psychological "ownership." It is this latter meaning that is most pertinent here.

When the NER was established, the first project manager was a local game warden who knew the community and its region. In addition, local community members had been important in lobbying for creation of the refuge. If not for the efforts of local residents, such as Stephen N. Leek, the refuge in its current incarnation might never have existed (Saylor 1970). Thus, when it was first established, it was a source of pride for local people, especially within the ranching community. They worked together to help the Jackson Hole elk herd, and at the same time they received benefits in the form of reduced depredation on their haystacks, employment (both from the production of hay and from jobs on the refuge), and a continued source of food from hunting.

As years passed and the mission of the refuge evolved, it was viewed less as a wildlife preserve "owned" by and managed for the benefit of a single, local clientele. As a management unit of the USFWS, the NER is technically the property of the citizens of the entire United States, not only those in Jackson Hole or Wyoming. However, decisions made on the NER may have a greater

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impact on local citizens than on those in distant places. Because the NER is adjacent to the town of Jackson and viewed daily by many residents, it is logical that people feel attachment to it. This historic sense of ownership still exists today, but it has been diminished in different ways in the community. While it is true that the residents of Jackson are not the sole “owners” of the NER, they are a segment of the larger U.S. population with a lot at stake in its management, and as a result, they are the segment whose values are most likely to be indulged or denied. It is this deprivation which can result in conflict over NER decisions. Because of this differential between national management responsibilities and the impact of local management actions, the decline in the sense of ownership by local residents may contribute to a contentious decision-making environment. As local residents feel increasingly powerless to affect management on the refuge in the face of national priorities, it is likely that they will assert their value demands through more contentious avenues, such as lawsuits.

There are several factors that have contributed to the decline in “ownership” by local people. As the population of Teton County rose, with a corresponding increase in the diversity of beliefs, the proportion of people with a direct connection to the creation of the NER dwindled. While the number of ways that local residents used the refuge increased, the overall sense of ownership was impaired by the large number of recent migrants to the area who are less attached to the NER (Teton County Planning Department 1994; U.S. Census 1990). Ownership grows from connections between the land and people, which generally require years of working and living in close contact (Keiter 1998). So while the families of early homesteaders and long-term residents maintained the sense of ownership of the refuge, which was developed over years of interaction, their feelings were diluted by the large influx of new people who lacked these connections.

This decreased sense of ownership was compounded by several technological factors. The advent of the automobile and the subsequent construction of roads into the valley have allowed people to move into and out of the valley with relative ease. It is this convenience that enables the tourist economy to flourish today. But at the same time, it contributes to the transient nature of the Jackson community. During both the summer and winter months, the human population swells with visitors and short-term residents (Teton County Planning Department 1994). The vast majority of these people come to the valley for recreation and are not interested in establishing direct or permanent relationships with the NER. It is likely that they do not seek or expect any form of “ownership” over the refuge. While the NER may serve as a source of recreation and even pride, the interactions that produce “ownership” do not exist.

Another technological change which altered the level of ownership was the shift from feeding hay to feeding alfalfa pellets. When the refuge was created, local cowboys were hired to operate and maintain the irrigation ditches to grow hay for the elk. Their efforts were recognized as being so significant that during World War II they were exempted from the draft so that they could continue

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producing hay for the nationally acclaimed Jackson elk herd (Wilbrecht and Robbins 1979). In addition, local ranchers were able to earn money by selling hay to the NER. People in the community felt a sense of pride and ownership because they helped feed the elk and, in turn, received values such as wealth, respect, and power for their efforts.

In the late 1960s, a decision was made to begin buying alfalfa pellets for the supplemental feed. Over the next decade hay was phased out in favor of pellets. There are many reasons for this shift, including the loss of permission to grow hay in Grand Teton National Park, concern about higher hay prices, and the ease of dispensing the pellets. Yet, as revealed in interviews with long-time residents, the shift represented a loss of “control” over NER management. Because local ranchers used to grow, harvest, and distribute the hay used by the refuge, they felt a sense of influence over the supplemental feeding program (Chambers-Gillette 1968). When the shift to pellets was completed, their efforts were no longer required, which resulted in a diminished sense of influence. In addition, money that was once used to purchase hay from local ranchers was now leaving the valley. Given the short growing season and limited agricultural lands in Jackson Hole, it is not feasible to produce pellets locally. They are purchased from producers in Idaho or Montana, depending on the lowest bid price.

Besides reducing income in the valley, this change was also significant because of the segment of the population it affected. The NER was established because of the efforts of local ranchers and farmers, who were trying to prevent elk depredation on their haystacks while also preserving the elk herd (Wilbrecht and Robbins 1979). Throughout the NER’s history these ranchers have represented some of the strongest supporters of the refuge and have been some of the most socially and politically powerful people locally. While this constituency continues to support the NER, one interviewee noted that, when the change from hay to pellets was made, many of these long-time supporters felt a decreased sense of control over refuge management.

None of this is meant to imply that the shift from hay to pellets was inappropriate. Rather, this change (in conjunction with the other factors such as diminished connections between people and the refuge and increased mobility) served to reduce the sense of ownership that the community felt for the NER. This is significant because, as conflict and dissatisfaction arise, there is a tendency to direct aggression toward people and organizations that are perceived as “outsiders” (McDougal *et al.* 1963). This attitude is evident in many ways. One example is the “Wyoming Native” bumper stickers that adorn vehicles around town, a clear statement of an “us vs. them” dynamic (Sahurie 1991). This dynamic partly explains the anti-federal sentiments that are expressed in many western areas, including Jackson Hole. Many people believe that the federal government and its land management agencies hold a set of beliefs contradictory to local sensibilities, and this perception increases the divisions between local residents and federal agencies.

Increasingly, the NER is perceived as “them” because of the decreased sense of ownership. This change has resulted from a smaller percentage of the local population with connections to the NER, the increased transience of the valley residents, and the anti-federal atmosphere in western states.

Increasingly, the NER is perceived as “them” because of the decreased sense of ownership. This change has resulted from a smaller percentage of the local population with connections to the NER, the increased transience of the valley residents, and the anti-federal atmosphere in western states. The change is significant because it will likely increase the level of conflict surrounding future NER management decisions.

TREND #3: INCREASING CENTRALIZATION, BUREAUCRATIZATION AND PROFESSIONALIZATION OF THE NATIONAL WILDLIFE REFUGE SYSTEM

Three significant organizational changes have affected refuge management since its establishment. Increasingly, important decisions have been made at the regional or national levels. In addition, local managers now spend a substantial amount of time completing paperwork to meet the demands of a complex, national bureaucracy. At the same time, land managers at all levels have become professionals who are highly trained in their fields. While these changes may not appear to be detrimental, one of the outcomes is increased distance between local communities and the NER, with a related rise in conflict.

Over the course of its history, management of the refuge has become increasingly centralized. While many decisions continue to be made at the local level, those related to budgets are often made at the regional or national level. While this is not necessarily negative, one detrimental outcome of this shift is budget inefficiencies because decisions made at the national or regional level often disregard the unique social and ecological context that affects NER management.

One prominent example of the problem with centralization relates to the supplemental feeding program. Because budget decisions are made by people who may not be familiar with the local context, it is difficult for the NER to obtain sufficient funds for the program. Regional and national managers view the concept of feeding a large game species as foreign to the mission of the National Wildlife Refuge System. As a result, there is a significant financial incentive to try to reduce the cost of the supplemental feeding program, even if the total expenses are increased. One such proposal is sprinkler irrigation, which may increase the overall financial burden even though it reduces spending for supplemental feeding. The use of sprinklers to improve forage is understood by managers at higher levels in the refuge system. Because decisions are being made at the regional or national level, there is a bias towards implementing a project that may not be financially prudent.

Since 1912 the federal government and the agencies within it have become increasingly bureaucratic. Often, significant resources are used to support and justify a bureaucracy, rather than the decisions it makes (Clark 1997). During interviews of NER employees, it was noted that paperwork and bookkeeping prevent them from dedicating as much time to management activities as they would like. In addition to requiring time and energy, bureaucratic organizations also tend to stifle the spontaneity and creativity of their employees (Clark

Three significant organizational changes have affected refuge management since its establishment.

1997; Daft 1983). On the NER, where complex problems are characterized by uncertainty and incomplete data, this tendency may impede effective solutions. For example, development of a bison management plan for the NER has dragged on more than a decade, in part because of bureaucratic constraints imposed on the planning process (Cromley, this volume).

Because of their complexity, bureaucratic organizations also tend to limit public participation in the decision-making process (Clark 1997). Since it may be unclear to the average citizen whom to approach or how to comment, the result is that public input is often diminished as the bureaucracy grows. Thus effective power is concentrated in a few hands (Daft 1983). For example, several people interviewed expressed confusion about who managed the refuge and how best to express their perspectives to the managers. The result was that these people were inclined to withhold their input from the management process until their value demands were significantly neglected.

An assumption underlying these comments by the public is that the refuge managers are best qualified to make decisions about the NER because they are professionals with specialized training. Professionals have come to dominate the National Wildlife Refuge System and natural resource management agencies in general. While individual professionals are indispensable to technical decision making, they can erect hurdles in terms of understanding participants' value demands (Clark 1997; Clark and Reading 1994). For example, managers on the NER are experts on elk ecology in Jackson Hole, and while local residents may have opinions about the optimal elk herd size, few can bolster their positions with scientific arguments. As a result, many people withhold their comments even though they may be critical to understanding predominant value demands in the valley. This dynamic may partly explain the lack of comments for the initial drafts of the irrigation program environmental assessment.

Another change related to the rise of professionals in the refuge system is that employees are now hired from within a national pool of experts, rather than locally. This protocol increases the number of potential job applicants, broadens managers' experiences, and reduces the chance that they will focus exclusively on the interests of one local community. However, it has drawbacks. Because of the value demands that affect refuge management, it is critical for managers to be aware of the local social dynamics. When managers are promoted horizontally from one refuge to another, many of their experiences specific to one community are lost. This trend is especially detrimental in natural resource management agencies because of the long time frame required to make, implement, and evaluate decisions. For example, the Bison Management Plan has been under development through the tenure of three refuge managers, and it has not yet been implemented (GTNP and NER 1996). No level of briefing can fully reconstruct the nuances and implications that were debated in earlier meetings. Yet it is exactly these details that are critical to working with local communities and understanding people's interests, positions, and values (Cromley on bison management planning, this volume).

The general impression gained from the increasingly centralized, bureaucratic, and professional decision making on the NER is that the organization is more isolated from the local social context than it used to be, and thus the task of identifying critical value demands has become more challenging.

The general impression gained from the increasingly centralized, bureaucratic, and professional decision making on the NER is that the organization is more isolated from the local social context than it used to be, and thus the task of identifying critical value demands has become more challenging. Important decisions about funding and project implementation are being made at higher levels within the USFWS, often without an understanding of the unique local context. At the same time, the complexity of the organization and the professional status of its employees result in fewer comments from local residents. In terms of understanding value demands, the result is that the amount of meaningful dialogue has declined and the potential for conflict has increased.

Recently, there has been a move to decentralize some decisions made by the federal government. While it is uncertain whether such a move is feasible or even prudent on a large scale, it does indicate an awareness of the problems of excessive bureaucracy. There is a growing number of examples of citizen efforts to cut short bureaucratic entanglements by managing federal lands at the local level, such as the Quincy Library Group and the Upper Clark Fork Watershed Steering Committee (Marston 1997; Mueller 1995). While factors specific to these examples have added to their success, the processes developed to build consensus can serve as models for decision making in other areas. Despite these changes, however, it seems unlikely that certain activities such as budget decisions will ever devolve to the local level. There is no indication that the role of professional experts in the National Wildlife Refuge System will diminish. While empirical, scientific data is critical to good decision making, it is only part of the picture. Social problems, which revolve around value demands, are intricate, dynamic, and subjective, and they often defy scientific description (Brewer and deLeon 1983). With these hindrances to an agency's ability to understand value demands and citizens' abilities to convey them, it seems likely that future decision making will result in conflict.

All three of these social, technological, and organizational trends have resulted in an increased level of conflict in the management of the NER. While the future is never certain, general projections can be made. The human population in Teton County is projected to continue growing (Teton County Planning Department 1994), and as it does, the frequency of value interactions will grow with it. This is likely to cause the contentious management environment to persist. In addition, as people move into the area, national organizations are also moving in. The Sierra Club, the Fund For Animals, and the Rocky Mountain Elk Foundation are examples of organizations with national and even international constituencies. As a result, people who live far away are increasingly making demands to have their interests served. This can only complicate refuge management.

While it is inappropriate for local residents to have complete say over the management of the NER, as the number of people and outside interests grows, it is likely that the feeling of local disenfranchisement will also grow and reinforce the "us vs. them" dynamic. Since locals are ultimately most affected

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by refuge decisions, they have the best reason to speak and act when their values are denied. Yet with bureaucratic complexity, they may be uncertain about the best way to do so. There are processes underway to take local interests into account, but given the historical trends, there is no indication that refuge management will become less contentious in the future. Rather, it is probable that conflicts will continue or even increase if the use of traditional public involvement methods persist.

HOW CAN VALUES BE INCORPORATED INTO REFUGE MANAGEMENT DECISIONS?

The goal of collecting data about human values is to inform decision-making processes. However, with values and uses growing, integrating and collecting this information can be a challenge. In an environment that is full of competing value demands, it may be unclear how to prioritize management objectives. For example, if one person values elk for the skill required in hunting and the well-being derived from the meat, while another values them for aesthetic or ethical reasons, it can be difficult for a manager to make a decision. One way to help set management priorities is through the concept of the “common interest.” As an agency within the federal government, the NER is responsible to the citizens of the United States. The refuge mission, in conjunction with the broader USFWS mission to manage the refuge system “for the benefit of present and future generations of Americans,” was developed in response to a broad array of value demands (NWRSA 1997). However, these directives are not static goals: their breadth and generality suggest that they are intended to be continuously updated with new information reflecting human values for each management decision that is made. This continuous process ideally clarifies and secures the common interest.

This section will elaborate on common interest concepts and decision making that is reasonable, politically practical, justified, and supported by the broadest constituency possible. It is first necessary to develop a working vocabulary of terms. Next, eight criteria will be offered to help decision makers set priorities that are in the common interest. Then a hierarchy of common interests will be explained to help differentiate between high- and low-order concerns. Throughout, examples from the NER will be provided to help clarify the concepts.

CLARIFICATION OF THE COMMON INTEREST

Interests consist of two parts: value demands and expectations that these demands are both advantageous and practical (McDougal *et al.* 1963; McDougal *et al.* 1981). Interests may be either common or special. Special interests are those demanded by specific segments of the community that benefit only those segments, with the rest suffering value deprivations. By contrast, common interests are demanded by broad sections of the community, and their enactment benefits this large population (McDougal *et al.* 1981). For example, zero tolerance for brucellosis is a special interest promoted by only a small part of

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the population; its enactment would benefit only a small portion of the community. By contrast, maintaining a healthy elk herd in Jackson Hole through the maintenance of critical winter range is a common interest that is supported by and benefits a broad constituency.

To complicate the process of differentiating between common and special interests, participants who promote special interests generally try to conceal their true motivations and mask or “justify” their interests as common. Interests that are easily classified as “special” are vulnerable to identification and dismissal by the majority of people (McDougal *et al.* 1963). For example, brucellosis eradication is often portrayed as critical to a broad range of participants across the country, from cattle growers to consumers to public health advocates. However, it is possible that the true brucellosis risks are minimal to many of these parties and that only a small part of the general population would benefit from the eradication program.

There are many policy designs, or structures, that can be used to make decisions. Lawsuits and other hard-line tactics are symptoms that the design in place may be fraught with pitfalls. While it is expected that people will disagree, a well designed process can help people to clarify what their common interests are. This is not always easy, but the difficulty does not negate the value of working toward common objectives. The following criteria can help to develop processes and outcomes that move toward a working definition of the common interest.

Because the common interest is rarely obvious, it is important to develop a process to help clarify what it is.

CRITERIA TO HELP CLARIFY THE COMMON INTEREST

Because the common interest is rarely obvious, it is important to develop a process to help clarify what it is. The criteria in Table 2 offer some measures to help judge whether an interest is special or common.

Table 2 Eight criteria to help clarify the common interest (adapted from Lasswell 1971: 96).

Value	Criteria
<i>Dependability</i>	Are the facts dependable? Is the participant credible?
<i>Comprehensiveness</i>	Is the demand pertinent to the full scope of the problem?
<i>Selectivity</i>	Does the demand relate specifically to the problem at hand?
<i>Inclusiveness</i>	Does the decision-making process include all participants? Do the demand outcomes include all participants?
<i>Timeliness</i>	Is the timing of the demand appropriate for the problem being addressed?
<i>Uniformity</i>	Is the demanded outcome applied uniformly across all participants?
<i>Rationality</i>	Does the demand address the problem to move toward the stated goal?
<i>Financial Efficiency</i>	Is the demand economically efficient? Is there another, more cost-effective way to achieve the same outcome?

Demands that are based on statements of fact may be assessed for dependability. Often data can be collected to determine validity, but in cases where this is not possible, credibility can be gauged by examining previous demands made by the same participant. Analysis of past trends and conditions can be very useful in determining credibility. For example, credibility of the Fund for Animals was tarnished by its attempt to entice young people from hunting on the refuge (Kerasote 1998). This action continues to shadow current demands that are made by the organization.

A demand can be evaluated based on its comprehensiveness and selectivity. Is the demand relevant to the full scope of the problem being addressed? At the same time, does it provide enough detail to be pertinent to the specific problem at hand? For example, the irrigation project is intended to alleviate some of the problems of the supplemental feeding program. If the problem is framed in terms of the best management for the elk within the ecosystem, then irrigation may be too selective. In general, "it is better to be approximately right than precisely wrong, to think about a complicated process in the large than to get bogged down in measuring only a few of its minutiae" (Brewer and deLeon 1983). This trade-off is difficult to judge exactly, but through careful analysis of the history of the problem, it is possible to reach a useful approximation of the balance.

Demands that are inclusive should be favored over those that try to exclude participants from the decision-making process. In addition, outcomes that benefit a wide range of participants are generally more favorable than those that only benefit a narrow group. The original decision about the size of the bison herd was controversial in part because it was made without any community input (GTNP and NER 1996). The plan became more acceptable as more participants were brought to the table.

Another criterion is the timeliness of a demand. It is possible that one participant is demanding an action that is completely valid except that it is either too early or too late. For example, a suggestion that the WDGf and NER enter into binding arbitration in the fall of 1998 might have been productive except that, with a court case pending, the timing was not appropriate.

The demands should be applied uniformly across participants. Cases where one segment of the population bears an uneven proportion of the burden should be examined carefully. The same is also true when one portion receives a significant percentage of the benefits. For example, a recent application to build a parking lot on the refuge would clearly benefit a narrow constituency while costing a much broader one in terms of lost open space and reduced elk habitat. Value deprivations and indulgences should be applied without discrimination across participants.

The demands being made should be tested for rationality. This standard should also be applied to the way the problem is defined. A rational solution should move the decision process from the identified problem to the stated goal. While this may seem obvious, it is very common for the problem and the

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goals to remain tacit. It is critical that both be explicitly defined. Only then can the rationality of the proposed demand be tested. For example, if the goal is to increase forage on the refuge, then irrigation may be a rational choice. If, however, the goal is defined as efficient management of the refuge, then irrigation may not be appropriate because it is costly in terms of human and financial resources, and it may increase the difficulty of reaching the target number of elk.

One final criterion is the financial efficiency of the demand. There may be multiple good solutions to a problem (i.e., they meet all the previous tests), but one may be more cost effective than the others. Irrigation might solve some of the problems associated with supplemental feeding, but acquiring additional winter range or reducing the size of the elk herd might also solve these problems. Given the high costs of the irrigation program, it is possible that one of the other options may be warranted. While it is not appropriate to make cost the overriding concern, it should not be ignored.

The previous criteria can help communities make decisions that will be supported by a broad constituency. While the common interest is an elusive concept, a working approximation can be achieved through the application of these principles.

PRIORITIZING MULTIPLE INTERESTS IN DECISION MAKING

The previous criteria can be used to determine whether a demand is a common or special interest. However, there are times when a decision maker is confronted by two or more valid, but conflicting, common interests. For example, hunters, outfitters, wildlife observers, and visitors may demand that the elk herd size be kept high to increase the chances for successful hunting or viewing. At the same time, Flat Creek anglers, environmentalists, and ranchers may demand that herd size be reduced to protect riparian habitat, increase trout populations, and reduce elk depredation on haystacks (Halverson, Matson, this volume). It can be difficult to determine which interest should prevail when both are supported by a broad constituency.

The following principles can serve as general guides to help rank multiple common interests. Common interests should always take precedence over special interests (Lasswell 1971). For example, a request to build a parking lot on the refuge is clearly a special interest that should be denied in favor of the broader common interest of protecting elk winter range. Common interests can be divided into high- and low-order concerns. For example, decisions about forage production are low-order concerns, whereas those about proper elk herd management are higher ranking. The National Wildlife Refuge System mission is another example of a high-order interest that should receive priority over low-order ones to avoid management conflicts. Often, decisions about high-order problems will also address lower order ones; thus it makes sense to work from the top down.

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Interests that include many people should take precedence over those that are exclusive and only involve a few people (Lasswell 1971). A demand by property owners on the refuge to increase their children's safety by closing the road to public traffic may seem valid, except that their interests would be subordinate to those of the much larger number of people who use the road for access to the national forest and refuge. When both interests pertain to a small segment of the population, precedence should be given to the interest whose values are most involved (Lasswell 1971). Bison hunting on the refuge is supported by a constituency of local hunters and conservationists who believe that the activity is ethical, ecologically sensible, and financially beneficial. It is opposed by a group of people from elsewhere in the country who believe the hunt to be unethical and unnecessary. In this case, the local constituency has more at stake in terms of values such as wealth, respect, skill, and rectitude. Some people feel that, as a result, given the narrow interests described here, the local interests should prevail.

The previous criteria and priorities offer useful guidelines to help clarify and secure common interests. There is no simple equation to help balance interests, however. Rather, these guidelines must be applied within a problem-solving framework that seeks to understand participants' value demands in the broader social context. By using these guides to address the historical trends and conditions, common interest outcomes can be achieved.

RECOMMENDATIONS

Three recommendations address the valuation issues raised in this paper. These include additional education about refuge management concerns, collection and analysis of relevant social science data, and development of practical skills to apply this information to decision making.

ADDITIONAL EDUCATION ABOUT REFUGE MANAGEMENT

Tours of the refuge, slide shows, and interpretive displays are all techniques that are used to inform the public about the complexity of refuge management issues. These efforts can be increased in several ways. Most public education currently focuses on low-order issues such as elk biology, the need for increased forage, and habitat improvements. While these are important topics, it is also necessary to initiate education and dialogue about higher order issues such as the mission of the NER, the role of refuge management in the Greater Yellowstone Ecosystem, and the optimal elk herd size. Workshops and informal gatherings can serve as fora to interact with the public. A 1998 "fireside chat" at the Teton Science School attracted a sell-out crowd. This type of gathering offers an opportunity to discuss a wide range of management issues, including high-order ones. Not only would this allow the refuge to disseminate information, it would also allow local residents to express their value demands. The new exhibits in the refuge visitor center are an important opportunity to explain high-level management concerns. While dioramas depicting running elk are

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aesthetically pleasing, other displays can educate visitors about management concerns such as herd size, the impacts of human development on wildlife habitat, and biodiversity. If these displays are high quality sources of information and debate, it is possible for the visitor center to attract local clientele in addition to tourists, just as the National Museum of Wildlife Art does.

Educating the public about high-order management issues can improve the dependability, timeliness, and rationality of value demands as people gain a better understanding of the larger management context. While residents may become frustrated if they perceive that management is focused on national interests, this need not be the case. High-order issues may be best addressed at a local level. For example, a high-order concern, such as determining the goals of management on the refuge, requires local input as well as national guidance. By including local communities in decision making, value demands can be clarified. In addition, dialogue with local residents about broad NER management concerns can convey respect as well as enlightenment. The community may begin to address the declining sense of ownership for the NER in the valley. While it may be difficult to reach every stakeholder, efforts can be made to contact leaders of different groups and organizations, since it is these people who are most likely to block consensus if their values are ignored or diminished. To accomplish this, it is critical to actively identify and contact these elites and engage them in dialogue.

COLLECTION AND ANALYSIS OF RELEVANT SOCIAL SCIENCE DATA
Collection and analysis of information about public attitudes can be accomplished in several ways. Community participatory processes, using a working group model, can be invaluable for identifying and polling the key stakeholders. In addition, they provide an ideal forum to discuss high-level refuge management issues. In establishing such a process, it is critical to define the objectives and expectations at the outset in order to maintain interest over the long term and to prevent participant frustration and disengagement. For example, if the goal of the process is to poll local opinions, the expectations will be different than if the outcome of the working group will actually be implemented on the refuge. If successful, a working group can be a practical way to increase community ownership in the refuge as well as to clarify common interests among participants. It is also a way to draw on financial and technical resources outside the National Wildlife Refuge System to alleviate the problems associated with the cumbersome federal bureaucracy.

Another way to collect information about human values and attitudes is through the use of surveys. These can be conducted either by computer at locations such as the visitor center or post office or by a trained surveyor. Each method has limits, but either could provide critical (and currently lacking) social data. Like the working group, collecting information about local residents' value demands will help clarify common interests, convey respect to these people, and increase their sense of ownership. It would also provide

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baseline data against which to measure the dependability, inclusiveness, timeliness, uniformity, and rationality of other value demands. For example, in some communities a demand to end all hunting on a wildlife refuge may be consistent with the interests of local residents and thus would be a feasible management objective. In Jackson Hole, such a demand may fail to meet several criteria, such as inclusiveness, uniformity, and rationality. This judgment can only be rendered if information is collected about the value demands of both residents and visitors.

The analysis of social science data requires people with special training and experience. Given the limited resources of the NER, this can be accomplished in several ways. First, partnerships with private entities can provide needed technical, financial, and organizational resources. Local and national universities offer a wide array of resources to undertake such a project. The NER represents a premier wildlife refuge in one of the most cherished ecosystems in the world. If the NER could offer simple incentives such as staff time and housing, professionals could be found to help with analysis. For example, the Teton Science School could collaborate in studies of the connections between biophysical and sociocultural phenomena on the NER. The Jackson Hole Community Foundation has also indicated a willingness to form a partnership with the NER, provided the project accrued benefits to the community of Jackson. If refuge managers marketed the NER assets wisely to career offices at universities around the world, it is likely that there would be many trained researchers interested in studying and analyzing the social dynamics that affect refuge management at a reasonable financial and organizational cost.

There are several ways to develop the practical skills necessary to incorporate value demands into management decisions.

DEVELOPMENT OF PRACTICAL SKILLS TO INCORPORATE VALUE DEMANDS INTO MANAGEMENT DECISIONS

There are several ways to develop the practical skills necessary to incorporate value demands into management decisions. Current refuge managers have strong backgrounds in biological sciences, but are admittedly weak in the social sciences. One way to address the gap between biological and social science skills is to encourage refuge managers to attend or host workshops that teach such techniques. The problems on the NER are similar to those on other refuges. By hosting a problem-solving workshop aimed at refuge managers, the NER has the opportunity to establish leadership in developing a framework for participation that can be used throughout the country. In addition, bringing people to Jackson Hole allows problem-solving exercises to occur within the real context. People with the necessary social science and problem-solving analytical skills can come to the refuge to help organize and facilitate such a workshop. Skills can be learned by using a case study approach that examines actual problems that confront refuge management. Besides building a base of practical skills, this exercise can also help refuge managers address problems related to the government bureaucracy as managers from around the country offer insight and experience into the problems. By including regional and national

managers in the workshop, the NER would have an opportunity to illustrate to important decision makers some of the unique problems it faces.

Ultimately, it will be critical that all federal land management agencies, not just the NER, hire social scientists to help frame, analyze, and address the problems they face daily. This will require a paradigm shift in the way government does business. Because the problems on the NER are not about elk and feed, but rather human values, it is important to find people with experience dealing with these human dimensions.

CONCLUSIONS

Everyone has a unique blend of values that shapes every decision that he or she makes. As the number of people in Teton County grows and the uses of the NER grow with them, the management environment will become more complex and contentious. There is no indication that any of these trends will change in the future. To deal with this complexity, people often lump the value categories into “politics” and attempt to sweep it aside. Whether these values are explicitly addressed or not, they still exist. The rise in the use of lawsuits is a testament to the conflict that can ensue when important values are ignored. To address the problems associated with value conflicts and to develop understanding and insight into social processes, it is critical to acknowledge and understand participants’ value demands. This is the first step towards consensus building. While understanding values can add a large amount of information to the decision-making process, it is important to make the effort. Only through a better understanding can stakeholder perspectives be incorporated into decisions, and only then can a move toward the common interest be attempted.

Because the problems on the NER are not about elk and feed, but rather human values, it is important to find people with experience dealing with these human dimensions.

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Wildlife Resources: The Elk of Jackson Hole, Wyoming¹

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ABSTRACT

The Jackson Hole, Wyoming, elk herd lacks an effective “commons institution” for its management. Conflict over management is particularly intense for the segment of the herd that winters in the National Elk Refuge. The fundamental problem is that too many elk are concentrated in too small an area on the refuge in winter, leading to a high incidence of the disease brucellosis, vulnerability to tuberculosis, degradation of plant communities, loss of biodiversity, and high supplemental feeding costs. These substantive problems are accompanied by process or procedural problems: a large number of organizational participants, who have identified various problems in the situation, have been unable to resolve their differences. The decision process has been characterized by lawsuits, rigidification of opposing positions through the NEPA process, unclear goals, competing problem definitions, ineffective organizational mechanisms for addressing problems (including lack of public participation), and weak leadership. This situation can be attributed to institutional factors (such as the struggle for control and states’ rights), contextual factors (such as changes in the uses and values of the elk refuge and the role of the public in resource management), and leadership factors (such as the centralization, professionalization, and bureaucratization of management agencies). Three measures could help in clarifying and achieving common interests in the elk case. First, community-based participatory groups could build trust, skill, and civic knowledge. Second, government could establish a better decision process and leadership. Finally, a new goal of “restoring wild patterns” could alleviate many of the substantive problems of the current feed-ground concentrations of elk.

Wildlife is a common property resource in the United States and throughout the world, yet special interests typically make claims on its uses. The world-famous elk (*Cervus elaphus*) herd of Jackson Hole, Wyoming, is no exception. Like all natural resource management, managing elk can be reduced to questions of “How will they be used?” and “Who gets to decide?” Continuing conflict stems from these two issues. Government agencies that dominate the decision-making process seem to employ a “primitive power balancing” strategy in dealings with one another (see Brunner 1994), and while this dynamic plays itself out, elk management is negotiated through technical and legal language about the elk-feeding program, disease prevention, hunting issues, and states’ rights vs. federalism. The few officials and citizens who want to break this cycle find it difficult to change the politics. The absence of an effective “commons institution” to address wildlife management is evident in this case as in many others (Burger *et al.* 2000; Ostrom 2000).

The Jackson Hole herd of 16,000 migratory elk ranges over millions of acres in northwestern Wyoming annually. Between 8,000 and 10,000 animals typically winter on the 25,000-acre National Elk Refuge, although officials’ goal for some decades has been 7,500. Elk have traditionally been fed hay and cattle pellets in winter, and parts of the refuge are irrigated for hay production to support the artificially high herd size. Most of the remaining elk winter on feed grounds managed by the Wyoming Game and Fish Department and located on nearby national forest lands. Conflict over management is most intense about the National Elk Refuge herd segment. Basically, too many elk are concentrated

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in too small an area in winter on the refuge. Cattle grazing on public lands surrounding the refuge diminishes the forage available to migrating elk in the fall, thus encouraging their concentration on the refuge. High densities contribute to high incidence of *Brucella abortus*, a disease that attacks the reproductive organs and lymphatic system of its host, causing spontaneous abortion in elk, cattle, and other wildlife. The Jackson Hole elk herd is heavily infected; about 28 percent of elk on the refuge tested positive for brucellosis antibodies (Halverson, this volume). (East of the Continental Divide, where there are no feed grounds, only about 1% test positive.) Although there are no documented cases of wildlife transmitting brucellosis to cattle in the wild, Wyoming fears losing its brucellosis-free federal status necessary for interstate shipment and sales of cattle. The elk refuge herd segment is also vulnerable to catastrophic loss from tuberculosis, which also poses threats to humans and livestock. High densities of elk also degrade plant communities, especially willows (*Salix* spp.), resulting in a loss of biodiversity (Matson, this volume). Feeding costs remain high—nearly \$500,000 per year. Management responses to date have generally been to disperse the animals on the refuge by distributing feed pellets more widely and constructing irrigation systems at new locations (in both native and introduced vegetation).

These, however, are merely the substantive problems. This setting also contains process or procedural problems—in short, that a large number of participants see various problems in the elk situation, and they have not found an effective means to resolve the differences. Since goals for management of the Jackson Hole elk herd have not been agreed upon and since problems are defined only in relation to goals, different agencies and interest groups see different problems. Debates rage over the number and density of elk, the cost of feeding, the role of hunting, vaccination, irrigation, and other techniques in management, the loss of biodiversity, the role of the refuge in managing other species (specifically bison, *Bison bison*), the quality of the range, the risks of disease, and related issues. The questions generally boil down to these: Should elk be concentrated on winter feed grounds (following an “agricultural model”), or should we secure adequate winter range throughout the region and reduce or close down the feed grounds (following a “wild animal model”)? As the participants debate these issues, they must consider whose values are served or harmed by each model and which institutions are advanced or pushed into the background by each. Finally, the leadership is struggling to define these problems practically, to articulate and implement rational sound, politically feasible, and morally justifiable alternatives, and to transform the seemingly intractable situation into a new process that empowers people and increases problem-solving skills in the common interest.

Halverson (this volume) concluded that the substantive problems in the elk case cannot be resolved until procedural problems are at least partially resolved. After identifying the actors in this complex arena, I examine some of the weaknesses in the decision process, analyze the conditions behind these trends,

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and offer ways to improve the basic policy process. Data for this paper come from news articles, interviews, analyses since 1973, historic sources (Cromley, pers. comm.), and recent studies by Halverson, Cromley, Kahn, and Matson (this volume). Research and analysis are guided by the policy analytic theory and literature cited therein (Lindblom 1990; Lasswell and McDougal 1992; Bell 1997). My standpoint as an analyst is to help participants better organize the process through which they interact in search of their common interest in managing elk, especially those who want to participate but are currently excluded.

PROBLEMS IN MANAGING THE ELK HERD

PARTICIPANTS IN ELK MANAGEMENT

Management of elk on the refuge is formally the responsibility the US Fish and Wildlife Service, which has managed the refuge since its inception in 1912, and the State of Wyoming, which owns the elk in public trust as a commons resource. But other participants also have a say in management for various reasons—the National Park Service, the U.S. Forest Service, the Teton County Commission, private landowners, outfitters, and environmentalists (see Halverson, Cromley, Kahn, this volume).

The National Elk Refuge lies in southern Jackson Hole, a high-elevation valley centered in the 19-million-acre Greater Yellowstone Ecosystem (Clark 1999; Clark *et al.* 1999). This world-renowned landscape is experiencing dramatic environmental and human changes, and leaders at all levels are struggling to understand the changes and respond appropriately (Clark in press a; Primm and Clark 1998). Although the refuge has been managed for elk by the U.S. Fish and Wildlife Service, the refuge is broadening its mission in response to the 1997 National Wildlife Refuge System Improvement Act, which calls for the refuge system “to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.” This act mandates the Fish and Wildlife Service to “develop and implement a process to ensure an opportunity for active public involvement in the preparation and revision of comprehensive conservation plans.” The focus of the National Elk Refuge is shifting from single species management to biodiversity conservation. This reflects the national sentiment. Management is changing, as is the context of management, and federal officials generally embrace this change.

The chief state agency involved is the Wyoming Game and Fish Department, whose mandate is to provide “an adequate and flexible system for the control, propagation, management, protection and regulation of all Wyoming wildlife.” The department’s model of elk management is largely an “agricultural” one in which animals are fed on feedlots, vaccinated, and otherwise intensively managed like cattle in order to maintain the highest possible

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numbers for hunting since sales of hunting licenses brings in millions of dollars to the state annually and keeps its traditional constituents pacified. The Wyoming Department of Agriculture and many ranchers support this management philosophy. Controlled by a commission appointed by the governor, this agency's policies reflect the views of the governor, who espouses states' rights ideology and vehemently opposes the federal government (Thuermer 1995; Testa 1995). Wyoming is very conservative politically and maintains a local focus. The elk case is just one of many wildlife issues for which Wyoming Game and Fish—indeed many states in the West—contend with the federal government for authority and control.

The U.S. Forest Service, specifically Bridger-Teton National Forest, winters nearly all the elk that are not on the National Elk Refuge. The forest includes 1,460 square miles of the elk herd's annual range and 73 percent of the 120 square miles of essential winter range. The forest operates under the 1976 National Forest Management Act that requires it "to provide for adequate fish and wildlife habitat to maintain viable populations of existing native vertebrate species." The Forest Service is a multiple use agency, so Bridger-Teton is also used for recreation, logging, mining, and oil and gas drilling—activities that sometimes conflict with elk management. Most hunting of the Jackson Hole herd takes place on the Bridger-Teton Forest.

Grand Teton and Yellowstone National Parks contain 384 square miles of the herd's annual range. The National Park Service's mission is "to conserve the scenery and the natural and historic objects and the wildlife therein." Grand Teton is one of only two national parks that permits hunting. This controversial hunt pushes elk off fall range and onto the refuge earlier than otherwise would occur. Park officials and much of the public would like to eliminate hunting in the park.

The Teton County (Wyoming) Commission is responsible for public decisions in the county, which encompasses 2,000 square miles of annual elk range, including 26 square miles of critical elk winter range on private lands. The commissioners tend to favor land development in their decision making, and currently private land development is booming and the human population is growing rapidly. Moreover, the general sentiment is that, since the county is 97 percent federally owned, the county should not have to make special efforts to protect wildlife on the remaining three percent of privately owned lands. Nevertheless, the elk herd is recognized as a highly visible and desirable asset to the county.

A number of non-governmental participants also want a voice in how elk are managed. The Wyoming Outfitters Association and the Jackson Hole Outfitters and Guides Association are active in promoting their own economic and access interests of hunting and backcountry use. Both groups have been critical of the Fish and Wildlife Service's management on the elk refuge in the past. The Wyoming Wildlife Federation has called for phasing out the elk feedlots both on the refuge and elsewhere but remains strongly in favor of

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hunting. Numerous organized and unorganized hunters are also responsive to what happens on the National Elk Refuge. Although all these groups promote hunting, they are sometimes at odds over the number of licenses that are allotted to these businesses instead of being open to the general public. The Jackson Hole Conservation Alliance, Greater Yellowstone Coalition, and the Fund for Animals all seek a more comprehensive understanding of elk and other wildlife. The Fund for Animals opposes all hunting. All have been active in refuge management issues in recent years through the National Environmental Policy Act (NEPA) process and (in some cases) through the courts. Other groups, such as Trout Unlimited, also follow elk issues in the valley but are not major players. There is a growing consensus in the broad environmental community behind a new model of elk management that calls for reducing elk dependence on winter feed, restoring wild or historic patterns of elk movement, and making the decision-making process more open and participatory. Numerous businesses and the Jackson Hole Chamber of Commerce are also concerned about elk management, generally in support of the status quo, because of direct and indirect effects on the local economy.

WEAKNESSES IN THE DECISION PROCESS

Finding common ground has been an elusive goal in elk management and in natural resource policy and management in general (Langston 1995; Ascher 1999). In addition to discouraging trends in the substantive problems introduced above, there are significant problems—both in design and operation—in the process by which participants interact to make decisions and problems in the behavior of leaders and professionals. The decision process should ideally clarify and secure common interests. This is a legitimate purpose and a requirement of good governance (Kemmis 1990; Dahl 1989, 1994; Ostrom *et al.* 1999). Most simply understood, a common interest is an interest shared by members of the community (Lasswell and McDougal 1992). A common interest benefits the community as a whole. In contrast, a special interest is incompatible with the common interest and benefits (and is promoted by) only some members of a community at the expense of the whole community.

The decision-making process through which people interact to solve problems of mutual concern can be thought of as a three-part sequence of (logically) “pre-decision” (getting ready to make a decision), “decision” (prescribing new rules), and “post-decision” (carrying out the new rules). This process is generally considered to have seven functions: (1) intelligence gathering; (2) debate and promotion about the nature and status of the problems; (3) deciding on a plan to solve the problems (in other words, setting new rules); (4) invoking the new rules in specific cases; (5) applying the rules through administrative activities; (6) appraising progress or lack of it; and finally (7) terminating the rules when they no longer apply (Lasswell 1971; Clark in press b). Decision processes can be “mapped,” understood, and managed for adequacy by participants. This has not yet happened in the elk case, although outside

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researchers have examined various aspects of the case (Halverson, Cromley, Kahn, this volume). A number of weaknesses in the decision process have revealed themselves.

Lawsuits

Weaknesses in the elk decision process itself are becoming more problematic as the agencies and the public continue to rely on a design that has not resolved problems in the past. Several lawsuits have been prosecuted in the 1990s over elk management, caused in part, by the design of interagency interactions. Legal claims have been initiated by an animal rights group, a rancher, an association of hunters, a conservation group, and the Wyoming Game and Fish Department (Halverson, this volume). Although the courts settle disputes in an authoritative and controlling manner, settlements are ephemeral. Addressing both substantive and procedural problems in elk management in court is time consuming and financially costly. Judgments are rendered on the basis of evidence submitted by two factions in conflict, usually over narrow issues such as whether to vaccinate or not. Court intervention breeds ill will and distrust, further drawing down the ability of participants to work together in the future. The courts seldom resolve fundamental, underlying problems. As one Game and Fish biologist put it, “You wind up with someone [the judge] who doesn’t know anything making decisions about how to handle the herd” (Bohne cited in Halverson, this volume).

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NEPA

The federal government is required to use NEPA and the preparation of environmental assessments and environmental impact statements (EIS) to address management and involve the public. NEPA has come under intense criticism in recent years because it is a linear process that does not work well in practice to clarify and secure the common interest. As organized groups proliferate in the EIS process, it becomes more difficult to integrate them through politics to secure the common interest. Each interest group tends to focus on narrow demands as a means to best use its limited resources and maximize its effectiveness. An EIS typically mobilizes divergent interest groups to use their scarce resources to promote narrow and inflexible demands, and seek other rigid allies that do not compromise their demands. Opposition groups respond in kind to each other, utilizing their resources to block opponents, creating a power balancing process (Brunner 1994). In such situations, NEPA serves as a substantive and procedural constraint to clarify and secure common interests. The federal government continues to use the NEPA design almost exclusively to address natural resource problems. The state, however, does not use NEPA, a NEPA-like process, or any other public participatory problem-solving mechanism to address complex management issues.

Goals

The goals sought by the extended community concerned with elk conservation are unclear. The recent spate of lawsuits and divergent values and views expressed in the media are evidence that the decision process in the Jackson Hole elk case has yet to find common ground (see Halverson, Cromley, Kahn, this volume). This is nothing new; elk management has been problematic since Jackson Hole was first settled. Olaus Murie, who studied elk on the National Elk Refuge with the U.S. Biological Survey, recounted a prolonged debate among local residents in the 1930s on “what to do about the elk” (Murie and Murie 1966). The citizens insisted that the government feed more hay to solve the problem of having too many elk on private lands each winter. But for Murie and others, supplemental feeding was part of the problem. His solution was to secure additional elk winter habitat against human encroachment. He recorded that “People do not want to provide enough natural range for wildlife. Sportsmen demand bigger and bigger game herds but do not trouble to provide living space for them in the way nature intended. They want to simply stuff the animals with hay, the easy way—and that is supposed to settle all problems. That’s what’s the trouble with the elk!” (Murie and Murie 1966: 177). The goal and the management means required to achieve it remain troublesome to this day.

Problem definition

Because participants do not agree on the goals and the means to achieve them, each side sees itself faced with a different set of problems (which usually includes other participants’ perspectives). This situation was succinctly stated by Tom Toman (1996), Wyoming Game and Fish District Supervisor, who noted that “the biggest problem that I can identify is that agencies often derive solutions to problems before the problems have been clearly identified or defined.” From a substantive standpoint, Halverson (this volume) attributed all problems to the winter feeding program on the refuge, which concentrates animals at 4,000 per square mile (compared to 15 per square mile on summer range), and which in turn exacerbates diseases, habitat degradation, loss of biodiversity, and consumption of half a million dollars annually. From a procedural or process standpoint, Halverson (this volume) detailed problems that have prevented government agencies from resolving the substantive problems, including over-reliance on “experts” (biological professionals) to define and address the problems and, as a result, an exclusively technical conception of the problem, bureaucratic orthodoxy, and weak strategic leadership. Other problem definitions in circulation are based largely on utilitarian, economic, or bioethical standpoints, many of which compete with one another. In short, state and federal officials, who are jointly responsible for elk management, and other actors, who seek to influence the process to serve their own interests, are attempting to solve the substantive management problems in divergent ways through a poorly designed decision process (Cromley, this volume). According to Barry Reiswig, refuge manager (cited in Halverson, this

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volume), elk management has become more problematic because of this interagency conflict and conflict with the public and special interest groups.

Design

The mechanisms employed to integrate the perspectives and strategies of the two principal agencies, U.S. Fish and Wildlife Service and Wyoming Game and Fish (and their constituencies), have frustrated resolution of substantive problems. Halverson (this volume) described the historic designs used in interagency relations. The first mechanism, which ran from 1927 to 1935, was the Commission on the Conservation of Elk of Jackson Hole, Wyoming, created by the President's Committee on Outdoor Recreation. It included a diverse set of government and non-government participants. During the 1940s and '50s the agencies discussed elk management in a less formal design. But after years of conflict, the agencies set up a new design, the Jackson Hole Cooperative Elk Studies Group, in 1958. This group, which is still active, seeks to "coordinate plans, programs, and findings of studies, and to provide an exchange of ideas, information, and personnel to study the elk herd and its habitat" (Wilbrecht *et al.* 1995).

Both Fish and Wildlife Service and Wyoming Game and Fish sources report that the group's effectiveness has been limited in recent years by internal disputes over fundamental policy issues, including who has authority and control over the elk, herd management objectives, and the vaccination program (Halverson, this volume). Wyoming Game and Fish wants to vaccinate more elk against brucellosis, while the Fish and Wildlife Service wants clear scientific evidence that vaccination is efficacious before it permits more intensive and costly management intrusion on the National Elk Refuge. The recent lawsuit by Game and Fish against the Fish and Wildlife Service to permit the state to vaccinate elk has clouded interagency relations. In addition, no public participation is permitted in the current official program, except through environmental assessments under the 1969 NEPA. This mechanism for decision making about elk follows the bureaucratic model of operation under the assumptions—roundly criticized in recent years—that government can efficiently manage natural resources, that government should direct the process, that the locus of needed work should be the agencies, that discussions should be largely technical, and that natural resource professionals (who believe that, by definition, they serve no special interests) should control the process (Moseley 1999). The Elk Studies Group, involving a mix of groups, diverse forms of reasoning, and contradictory ideologies and goals, has tended to be conventional (rather than functional) in its problem-solving approach (see Miller 1999).

In summary, the elk decision process has produced a highly controversial and tenuous approximation of the common interest at best, and it has been unable to resolve competing claims about how the elk should be managed and who should decide. But rather than appraise and revise it, many key participants continue to use the same design, causing or aggravating problems.

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LEADERSHIP

The role and effect of leadership in the elk case has clearly been evident over the last twenty-five years. Overall, effective leadership, both in and out of government, has been lacking. However, this is changing, and a few leaders have come to the forefront who are open to understanding and solving interrelated substantive and procedural problems inherent in the elk case. Some of the leaders of the key agencies in past decades tended to be narrowly bounded, technically focused, and authoritarian. Some relied on old models of leadership wherein the technical expert knew best, power was what mattered, and defense of agency position was paramount. Others ignored or avoided actual problems and focused on biological or technical aspects of elk management. A few played “hard-ball” power politics. Recruitment of leaders in the past seems to have relied on people moving up the ranks who were selected for their loyalty to agency norms and policy preferences and skill in promoting them. They behaved defensively and seemed to believe that the best defense was an aggressive offense. These older styles of leadership supported and enhanced the centralization, bureaucratization, and professionalization of wildlife management and transacted the government’s business in traditional, status quo ways.

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FACTORS THAT EXPLAIN THE CURRENT SITUATION

These several problems can generally be understood in terms of three classes of factors—institutional, contextual, and leadership.

INSTITUTIONAL FACTORS

Agency perspectives on the elk situation reflect the constituencies and different cultures of each organization as well as the organizational form used to carry out operations. The conflict in the elk decision process is a consequence of the clash of different philosophies (value outlook and cognitive perspective) and operating designs. Much of the controversy in elk management involves one value—power (Cromley, this volume). This is not unexpected since the “central myth in the maintenance of any social system is the myth of authority” (MacIver 1947: 42), and that myth is at stake in the elk case. Power struggles abound in situations where authority and control are fragmented, unclear, and in flux—as in the West where federal agencies have typically managed land while the states manage wildlife, and in the case of migratory species like elk that range across lands under multiple jurisdictions. People who are predisposed to power and its modes of operation are drawn to leadership and professional positions, and people with like perspectives tend to gravitate together and to develop a common, mutually reinforcing, cultural outlook based on similar core beliefs. Change, if it comes at all to people and organizations that are motivated by power, is costly and slow and is usually met with resistance and conflict.

With regard to elk in northwestern Wyoming, Wyoming Game and Fish Department in particular seems to seek more control. Seeing threats from

animal rights groups (Thuermer 1990), and other “outside” forces (including a declining hunting population), Wyoming Game and Fish has adopted a largely defensive policy stance and is inclined to concede nothing to its perception of opponents. Conflict reached a new level of polarization in a 1998 lawsuit in which the state asked the court to order the U.S. Fish and Wildlife Service to allow the state to vaccinate elk on the refuge against brucellosis. (This case was decided in 1999 in favor of the federal agency.) The Fish and Wildlife Service had refused to grant the state’s original request for both political and management reasons. In a conservative, bureaucratic organizational system such as Wyoming Game and Fish, attention to the agency’s own underlying assumptions about contextual factors and standard operating procedures is minimal compared to defense of the organization’s core philosophic values and demands for more authority and control (Clark 1997). These institutional factors set up an “us vs. them” mentality which is predisposed by the states’ rights vs. federalism conflict that dates to the constitution of our nation and is promulgated by many Western state governments and agencies. This outlook can be an obstacle to solving complex societal issues because it promotes a rigid, exclusive, and confrontational mode of interaction. The proliferating lawsuits and continued wrangling over goals, problem definitions, and models of management all indicate institutional rigidities, intractable routines, non-adaptiveness, and failure to “bridge” or create linkages. Ideally (seldom approximated in practice), each participant in the elk case would be aware of his own outlook, understand how it directs his behavior and that of his employing organization, and take this knowledge into account in his actions.

CONTEXT

The context of wildlife conservation in northwestern Wyoming is rapidly changing, as it is throughout the nation (Kellert 1996; Clark in press a). Contextual changes include changes in peoples’ values (Kahn, this volume). As new people move into the region, their values and perspectives clash with those held by long-term residents. The National Elk Refuge, for instance, is currently used for hunting, fishing, wildlife observation, a sleigh-ride concession, jogging, and biking, among other uses, but, commonly, decisions about use that benefit one group deprive another of important values. The decision to end hunting indulges one group but deprives another. Many different values are at stake in the interpersonal and interorganizational interactions surrounding elk management. (Power, wealth, rectitude, respect, well-being, affection, enlightenment, and skill are the eight generalized categories of values [Lasswell 1971].) A number of groups are jockeying for power, and most have at least some financial stake in elk management. But additional values are at play as well, even in such interactions as lawsuits. Individuals and organizations seek respect, they seek to demonstrate the “rightness” of their positions, or they seek to exercise their skills and knowledge in management actions. All these values are open to gains or losses in the elk decision process. Kahn (this volume)

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characterized value dynamics over time, noting that as more diverse people utilize or become interested in elk and the refuge, the interactions and value-transactions among these people also increase. His analysis of trends in values showed a decline in community “ownership” of the refuge and increased centralization, bureaucratization, and professionalism in the agencies as the human population increases. Because of these trends, value decisions about elk are difficult to make and often result in conflict. In general, people’s values are changing from utilitarian uses of wildlife to more conservation-oriented values, but these shifts are often not reflected in agency management.

Another contextual factor is that the role of the public in management is changing dramatically. Citizens and interest groups are no longer content to be passive bystanders who ratify (or rail against) predetermined agency policies (Berry 1999). They demand a more active role in wildlife conservation. Public involvement in management processes is now a challenge that agency officials must address successfully. But, as Magill (1994: 295) noted, many natural resource professionals and managers are “academically and psychologically ill-prepared to acknowledge the legitimacy of public demands.” This is especially difficult when the public—at local, regional, or national scales—strongly asserts values that conflict with agency objectives or with each other.

LEADERSHIP

Leadership has always been important in wildlife conservation. In the elk decision process many people have cited the importance of individual personalities and leadership styles (e.g., Bohne, Curlee, Griffin, Harvey, Lichtman cited in Cromley, this volume). In response to the historic conflict in the elk case and other factors in society at large, leaders in the agencies, including professional experts, have centralized, bureaucratized, and professionalized elk management (Kahn, this volume). Important decisions today about the National Elk Refuge and the Jackson Hole elk herd, in contrast to several decades ago, are made in state level or regional offices and sometimes even in Washington, D.C., all far removed from the local, place-based community closest to the elk. The federal land management system overall has changed over the years (Moseley 1999). Bureaucratization of state and federal agencies has increased staffs and budgets as well as rules, roles, and regulations. Land managers at all levels have become professionalized and highly trained in their fields, often in a narrow sense. Schneider and Ingram (1997: 172) observed that “where science and professionalism have come to dominate, goals are utilitarian, and no distinction is made between what is good for science and professional groups and what serves the public interest.” It is difficult for government agencies to produce leaders with the knowledge and skills to keep their organizations current, adaptable, and effective. Too often, organizations fail to recognize and support good leaders.

Another contextual factor is that the role of the public in management is changing dramatically. Citizens and interest groups are no longer content to be passive bystanders who ratify (or rail against) predetermined agency policies (Berry 1999). They demand a more active role in wildlife conservation.

RECOMMENDATIONS

If past trends and conditions continue in the elk case, then the decision process and substantive management in the future will be similar to the past. But certain trends that suggest opportunities to improve elk management are discernible. If participants can capitalize on these, it may be possible to institute a more flexible, integrative, and effective approach to elk management in the common interest. First, public interest in the elk and the refuge has risen in recent years, many participants are growing tired of the endless conflict, and there are increasing demands for more inclusive participation and for opening a “civic dialogue” on management goals. Second, a few leaders are emerging who recognize the need and opportunity for change. Third, the 1997 National Wildlife Refuge System Improvement Act calls for preparation of a long-term management plan. Fourth, the recent decision by the Department of the Interior to undertake a multi-year multi-million dollar EIS on management of the National Elk Refuge also offers an opportunity for new approaches to improve the decision process and address substantive problems.

Three measures can help improve decision making in the elk case. First, community-based participatory groups can address some problems in decision process (Cromley, this volume; Moseley 1999). Such groups must be inclusive and develop have a community-wide reputation for honesty. They can help disparate groups to find and clarify shared interests that all participants agree on, beginning, perhaps, with something as fundamental as “the health and sustainability of the elk herd” or “ending the conflict” and then adding more specific and realistic goals and objectives. This would help reduce some of the narrow and rigid demands promoted by the NEPA process and facilitate agreement on goals and problem definitions. Participatory groups are also a way to stay in touch with changing public values. Public inclusion is a process of bringing citizens into the management, science, and decision making of elk conservation. It offers managers a tool and a strategy to understand public values better, to create a constructive management environment, and to develop plans that integrate social and natural conditions (Berry 1999).

One citizens’ group is currently organizing itself in the elk case (Hoskins 1999). It operates on the assumption that elk management will best be accomplished through a participatory process that includes people with diverse perspectives and takes into account complex interactions among ecological, social, and economic systems. Such a process does not presently exist. If this citizens’ group is to participate successfully, several practical requirements must be met (Moseley 1999). It must build social capital, or a stock of trust, skill, and civic knowledge. High capital is required to create community-based collaborations that can act as governance structures to effect change (Lasswell 1971). It must be a skilled, genuine, problem-solving exercise, not just an interest-based, negotiated (or facilitated) effort. Collaborative norms and habits must come to dominate all interactions. People with varying levels of knowledge, distinct values, roles, perspectives, and skills must be able to come

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together in meetings to discuss, analyze, and make meaning of complex information. Such groups also need linkages to their larger communities to gain acceptance for their work, to mobilize labor and financial resources, and to undertake collective action. These kinds of groups need the capacity for planning and some implementation, which requires administrative and substantive skills (Moseley 1999). Finally, the harmful effects of government must be minimized. Scott (1998), for instance, argues that governments have a tendency to try to simplify and structure society and nature in an effort to control people and their use of natural resources.

Second, government, which is mandated by law to manage land and wildlife, must design, operate, adjust, and lead a better decision process. This effort might involve changes in the membership, operations, or scope of the Cooperative Elk Studies Group, changes in the NEPA-derived public input process, new cooperation with a citizens' group, a series of civic dialogues, or other mechanisms to achieve a more problem-oriented and contextual way to solve problems. The goal is to help communities identify their common interests and secure rational, politically workable, and morally justifiable decisions. This will require a special kind of skilled, strategic leadership. Because the elk problem is fundamentally one of people and their values, leaders are especially needed who are skilled in creating the kind of intellectual and political environment in which good decisions will be made (Westrum 1994). This requires skills both in technical matters and in "the process skills that promote interdisciplinary teamwork" to serve the common interest (Clark *et al.* 1994: 427; Clark in press c).

Several agency managers in the elk case appreciate the need for better leadership and are already openly experimenting with new leadership methods and problem-solving approaches, including community-based exercises. This kind of "transformational" leadership, according to Burns (1978), brings more effective modes of interaction and decision making into practice. It engages people in such a way that leaders and followers are raised to greater levels of motivation and morality. The best modern example is Gandhi, who aroused and elevated the hopes and demands of people and in the process enhanced his own life and personality. Leaders in the elk case are leaving behind maintenance of the bureaucracy, perpetuation of the status quo, and "transactional" leadership styles that merely facilitate exchanges of valued items (e.g., economic, psychological, political) among people (Burns 1978). These progressive leaders are seeking new knowledge and skills to be more effective problem solvers. Their goal in resource management should be to bring about "ways and means for blending wisdom and science, for balancing free association and intellectual discipline, for expanding and refining information, and for building a problem-solving culture that balances 'permanent' with 'transient' membership, thereby remaining open to new participants and to fresh ideas while retaining the capacity for cumulative learning that refines, clarifies, and simplifies" (Burgess and Slonaker 1978: 1).

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If one or more agencies or interest groups maintains a strong power orientation, however, it will remain difficult to create a cooperative climate, focus on the problems at hand, or establish open, inclusive processes. Power can distort the way in which agency leaders or community-based efforts explore new goals, and it can thwart even the best-designed problem-solving structures.

Third, a new goal is needed that moves away from the “agricultural model” of elk management. This idea needs to be explored by the agencies, the technical experts, the citizenry, and the interest groups as a means to solve the substantive problems caused by the crowding of elk onto winter feed grounds. Hoskins (1999) outlined the goal and management challenges and suggested that the new goal ought to be securing extensive, quality winter habitat off the feed grounds to lower elk population densities by redistributing them. This initiative (or policy innovation), which he called “restoring wild patterns,” would seek more protection, acquisition, and conservation of habitat in strategic, novel, more effective ways to sustain wild, free-ranging wildlife. This goal is supported by an unknown percentage of the public. For significant habitat to be conserved, changes in elk management and human land uses must be secured in a manner that is appropriately timed and minimally disruptive ecologically, socially, economically, and politically. One way to begin to test whether the initiative to restore wild patterns has support (from the government and the public) is to decommission one of the smaller, state-operated feed grounds to learn how such an operation can be done in a logical and least disruptive fashion and to learn how people, institutions, and elk (and other species) respond. If this effort is undertaken using a community-based approach and supported by transformational leadership, much can be gained in terms of building social capital and improving elk management. Such a prototypical effort can then be sustained, expanded, modified, or abandoned in response to what has been learned.

Taken together, these three options constitute key parts of a sound, long-term strategy for improving elk conservation in the common interest (see Brunner and Clark 1997). It will require building social capital, skilled leadership, and a better decision process through which government, experts, special interests, and citizens can learn and interact successfully. These recommendations are consistent with democracy and opened-ended problem solving. They constitute adaptive management at its best.

CONCLUSION

All concerned parties share an interest in the future of the common property resource that is the Jackson Hole elk herd. In practice, though, there is little agreement on how realistically to specify goals, carry out needed management, and especially, answer basic questions like who should decide management policy. There are many beneficiaries of the current decision process and the “agricultural model” of elk management, including the state of Wyoming and

Third, a new goal is needed that moves away from the “agricultural model” of elk management. This idea needs to be explored by the agencies, the technical experts, the citizenry, and the interest groups as a means to solve the substantive problems caused by the crowding of elk onto winter feed grounds.

WGF, hunters, and outfitters and related businesses. But these interests are being challenged in court and in the media by people who want to modify this model to encourage elk to move freely throughout western Wyoming. These challengers, largely the environmental community, academics, and some non-hunting segments of the public, demand broader conservation goals and more participation in the decision-making process. At the heart of the growing elk management problem is a chronically weak decision process that withholds from many groups the opportunity to participate meaningfully. Reconfiguring the decision process to make it more inclusive, open, and honest; more comprehensive and integrative; more creative, rational, effective, and timely; and non-provocative and ameliorative—all standards recommended by Lasswell (1971)—offers the best vehicle to address this common property management problem. This can be achieved via a well structured and operated, community-based, participatory process combined with skilled “transformational” agency leadership, and the restoration of elk to a free-roaming ecology via an adaptive management approach.

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Appendix

Interdisciplinary Problem-Solving: Next Steps in the Greater Yellowstone Ecosystem¹

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and Northern Rockies Conservation Cooperative

ABSTRACT

The Greater Yellowstone Ecosystem, a 7.6-million-hectare region in the Central Rocky Mountains of the United States, is used to illustrate both the challenges and means to improve problem solving in the natural resources arena. The challenges in this world-famous region are contextual (rapid change, growth, pluralism, complexity, state/federal conflicts, and lack of a common perspective), institutional (multiple organizations with overlapping authority and control and disparate mandates, uneven leadership, lack of creativity in problem solving, and resistance to change), and human (diverse perspectives and values and epistemological limitations). To overcome these challenges, an interdisciplinary method that integrates knowledge to improve policy making is briefly described. It provides a framework with a comprehensive set of categories to use in investigating and analyzing problems and inventing alternatives for substantive, process, and structural improvements. Five programs or interventions, all of which are based on this method, are suggested to address the challenges facing Greater Yellowstone: (1) workshops for "capacity building;" (2) leadership, staff development, and student internships; (3) case analyses and appraisals for policy learning; (4) problem-solving exercises and decision seminars; and (5) prototyping exercises to improve interdisciplinary and interagency coordination. These are described, examples given, and benefits outlined.

All nations face the challenge of developing and applying effective problem-solving strategies to manage their natural resources for the common interest of their citizens. Strategies that integrate knowledge to improve policy and on-the-ground action are being demanded by many sectors of society. In universities calls for interdisciplinary problem solving are growing, in natural resources arenas the new emphasis is on comprehensive ecosystem management, and in business the focus is on integrating environmental concerns to modernize operations. Interdisciplinary problem-solving is the means by which knowledge integration can take place.

But a number of problems limit interdisciplinism. Complex dynamic social and political contexts focus people's attention on immediate concerns. Fragmentation of knowledge is pervasive and institutions are inflexible. The epistemology of positivism and professional training philosophies are among other variables that underlie many failed problem-solving efforts (see Lasswell 1970). Although disciplinism, positivism, and other forms of institutionalized knowledge production have many advantages, we must also develop our capacity to integrate across disciplines, epistemologies, organizations, and policies. We must therefore find or create opportunities to use integrative methods explicitly and systematically, describe and teach them, and diffuse and adapt them widely (Brewer 1992, 1995).

This paper uses the policy arena of the Greater Yellowstone Ecosystem (GYE), a nineteen-million-acre (7.6-million-hectare) region in the Central

¹ Originally published in *Policy Sciences* 32: 393-414. Reprinted with permission of the publisher and editors. Paper prepared for a Conference on the Theory and Practice of Interdisciplinary Work, Stockholm, June 1998. Convenor: The Swedish Foundation for Strategic Environmental Research and The Council for Planning and Coordination of Research.

Rocky Mountains of the United States, to characterize the challenges of integration, introduce a method to facilitate interdisciplinary problem solving, and describe ongoing (or planned) efforts to facilitate knowledge integration, build skills, and improve policy and action for the sustainable use of resources.²

CHALLENGES IN THE GREATER YELLOWSTONE ECOSYSTEM

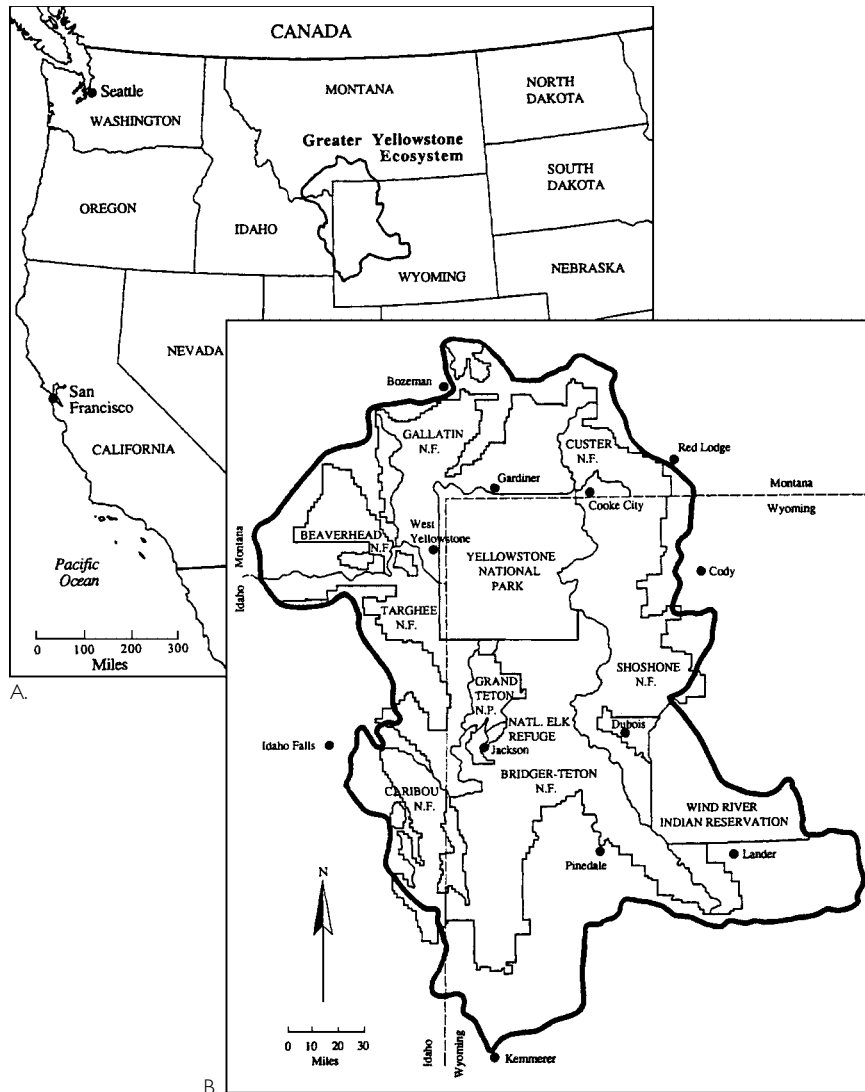
Ideally, effective, group-based problem-solving must include “ways and means for blending wisdom and science, for balancing free association and intellectual discipline, for expanding and refining information, and for building a problem-solving culture that balances ‘permanent’ with ‘transient’ membership, thereby remaining open to new participants and to fresh ideas while retaining the capacity for cumulative learning that refines, clarifies, and simplifies” (Burgess and Slonaker 1978: 1). This ideal is seldom approximated in practice in the GYE, and the region’s decision makers, managers, and citizens face numerous difficulties of context, institutions, and people before they can achieve it.

CONTEXTUAL CHALLENGES

The GYE, a global model for natural resources conservation for over a century, is a relatively intact block of national parks, forests, and wildlife refuges interspersed with state and private lands (Figure 1A). Yellowstone and Grand Teton National Parks are at its heart. Presently, the context is changing rapidly because of a great influx of new residents and tourists, associated developments, and diverse demands on public lands management. Modern populations and uses are threatening unique features such as scenery, wildlife, and geothermal features. Ironically, the very institutions and people who manage and enjoy the GYE are also part of the problem. Rigid bureaucratic and interorganizational relationships and over-reliance on traditional disciplinary problem-solving frameworks and standard operating procedures have produced this situation. In recent years, however, some officials, managers, and citizens have sought to improve intergovernmental coordination, democratic responsiveness, and adaptability (e.g., Lichtman and Clark 1994; Primm and Clark 1996). Ultimately, the GYE’s institutions and people must also be the source of innovations for its improvement.

Since the region’s discovery by Euro-Americans almost two centuries ago, human occupancy and use have increased dramatically. There was little white settlement prior to the establishment of Yellowstone in 1872. From 1872 to 1916 the GYE was sectioned into territorial jurisdictions (i.e., states and departments) and private interests (i.e., ranches, mines, and logging). The years from 1917 until the 1980s saw heavy resource extraction; although well established by World War I, ranching, mining, logging, and related activities spread inward rapidly and intensively from the GYE’s periphery. In the last fifteen years there has emerged a more integrated or ecosystem management approach involving many scientific, policy, and organizational changes; non-governmental organizations (NGOs) have been instrumental in calling for

² A word on my standpoint: I have been interested in these subjects and have worked in the GYE for thirty years. Although I began work in the GYE as a field ecologist and ethologist, I refocused my interest after about fifteen years on making organizational and policy improvements in endangered species and other natural resources systems, and today spend nearly all my time on interdisciplinary conservation efforts. I teach policy sciences as related to natural resources at Yale University and in workshops to government, nongovernmental, and citizens. I also research diverse substantive natural resources policy issues in the GYE, elsewhere in the U.S., and internationally.



The last decade, for instance, has seen more lawsuits than ever before on public land management, and citizens, NGOs, and government are seeking “conflict resolution” and “public participation” means to address some problems.

Figure 1 A. Location of the Greater Yellowstone Ecosystem in the Central Rocky Mountains of the United States. B. Administration of the Greater Yellowstone Ecosystem showing major jurisdictions.

these changes. Today, the GYE’s unique assemblage of geological, geothermal, and biotic features attracts about ten million visitors annually, while about 250,000 permanent residents live in the GYE. These people express a growing demand for a better quality of life, a trend that reflects global and American demands in general (see McDougal *et al.* 1988), but also signals accumulating stress (Brunner 1994). The last decade, for instance, has seen more lawsuits than ever before on public land management, and citizens, NGOs, and government are seeking “conflict resolution” and “public participation” means to address some problems.

Change in the GYE will likely accelerate and the context will become more complex. There will be growing pluralism, more diverse value demands, more

organized interest groups, increased demands for market solutions to problems, more calls for private/public partnerships, and growing tension between state and federal governments. At the same time, there will be more pleas for effective conflict resolution and increased citizen participation in public policy processes. At present, there is no comprehensive contextual map that outlines key trends in the GYE, reasons for the trends, or projections of future conditions. This lack of a common, shared contextual map perpetuates unproductive dialogue, conflict, and fragmentation in perspectives and value-institutional divisions.

INSTITUTIONAL CHALLENGES

The institutional makeup of the GYE is also dynamic and complex. Responsibility for management of the region's natural resources has changed over the last 150 years. Today, about twenty-eight governmental agencies at national, state, and local levels administer the region, resulting in a highly bureaucratically organized and territorial arena (Figure 1B; see Clarke and McCool 1985). The National Park Service's job is to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (see Winks 1997: 575). The U.S. Forest Service operates under multiple-use policies that manage for timber, watersheds, range, wildlife, and outdoor recreation. Mining and oil and gas extraction also occur. Three state governments also manage various aspects of the GYE's resources, including wildlife. They variously embody conservative, states'-rights perspectives about authority and control, and they often conflict as well as cooperate with federal agencies (e.g., Davis and Lester 1992). Many private organizations, especially businesses, also operate in the region; some, such as commodity extraction interests and the tourism industry, are loosely organized. Other organizations play important roles, including county and town governments, business associations, the media, as well as state governors and U.S. congressional representatives. NGOs play various roles, including critiquing government at all levels. Probably the largest and most influential is the Greater Yellowstone Coalition, a conservation group whose mission is "to preserve and protect the Greater Yellowstone Ecosystem and the unique quality of life it sustains." Many of these organizations support one another cooperatively, but others conflict directly and indirectly in a shifting mosaic of issues over time.

Interdisciplinary problem solving will come about only if these organizations facilitate it. Few organizations in the GYE have demonstrated a knowledge of how to find common interests in a genuinely interdisciplinary, cooperative way. Few motivated and skilled individuals have surfaced to carry out interdisciplinary problem solving and provide strategic leadership. Within organizational contexts, problem solving is a dynamic process that is part of a complex set of cultural, social, political, and other practices, all of which are focused on

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particular values. The scientific disciplines as well as government and private organizations are sites for constructing and sustaining disciplinary and conventional social and cultural identity in relation to other institutions. Interdisciplinary problem solving will require changing these patterns of social and cultural identity.

Mixed trends in value-institutions will likely continue in the GYE. Few of the region's organizations currently strive for integration as they struggle to adapt to a rapidly changing context, including new patterns of value demands by citizens as well as special interests. Many public agencies have not only down-sized staffs and budgets, but their influence is also diminishing as a result of declining public respect. At the same time, however, many opportunities exist to develop interdisciplinary skills through workshops and forums, individual and cooperative problem-solving exercises, and improved leadership.

PEOPLE CHALLENGES

Diverse people with complex and shifting perspectives live in the GYE and staff its organizations. Many dedicated people in government, friends of the agencies, and citizens work hard to perpetuate the conservation ideals of the national parks, forests, and wildlife refuges and to improve natural resources policy. However, the problem-solving methods and cognitive styles of both individuals and groups are often less than fully effective (see Miller 1985; Doob 1995). Because the world is complex and uncertain, individuals need to simplify it in order to comprehend the myriad factors and forces that shape problems and social processes (Simon 1983). Each person uses a framework to abstract, organize, and understand experience and to guide future problem solving. These models, maps, or metaphors vary in sophistication, comprehensiveness, and practicality, and as Einstein noted, how we see things determines much of what we see. Some ways of seeing and thinking are justifiably better than others (Brunner 1997 a, b). Interdisciplinary problem solving is a "better way" that can be taught, learned, and applied and can eventually replace less effective methods (Clark, in manuscript a)

At the heart of all problem solving, individual or social, are various epistemologies or systems of knowledge. Epistemology deals with "the whole range of efforts to know and understand the world, including the unrefined, workaday practices of the layman as well as the refined, specialized methods of the scientist or scholar" (Goldman 1995: 13). Some frameworks and epistemologies permit interdisciplinary problem solving, while others prevent it. The framework widely shared in technical fields in and out of government is "positivism," or experimental science, which is defined as "rational inquiry into nature in terms of logical inference aimed at finding universal laws, preferably written in the language of mathematics, and the prediction of new empirical facts deducible from theory confirmed by observation and experiment" (Lenoir 1997: 4). The crucial assumptions of positivism—realism, objectivity, disinterestedness, and autonomy—have been criticized by many

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people (e.g., Torgerson 1985; Dryzek 1990; Appleby *et al.* 1995). Despite its limitations, though, it is still deeply entrenched in many individual and group problem-solving frameworks and in the practices of many organizations. Positivism is the social epistemology that dominates in the GYE, and despite the sincere efforts of many people in the region to improve their own problem-solving methods, individually and collectively, their primary difficulty in this struggle is epistemological. These trends are expected to continue.

A FRAMEWORK FOR INTERDISCIPLINARY PROBLEM SOLVING

Facing these challenges, natural resources policy in the GYE could benefit from the knowledge and skill to synthesize diverse disciplines and perspectives into a common program. Interdisciplinism requires disciplined rationality—clarity, accuracy, precision, consistency, relevance, depth, and breadth. It demands a commitment to fair-mindedness and the ability to understand others' thinking, to use a framework for reasoning across diverse knowledge holdings, and to critique one's own thinking (see Brunner 1997c). Becoming an interdisciplinary problem solver may require partially unlearning what one already knows.

The first requirement of interdisciplinary problem solving is a framework that can accommodate, conceptually and practically, diverse data, epistemologies, and disciplines. The policy analytic framework of Harold Lasswell (1971) meets these criteria. This method is part of a global professional movement to improve policy decisions and quality of life through genuinely comprehensive and integrated inquiry. The framework seeks to generate practical and theoretical insight and action (Lasswell 1971; Lasswell and McDougal 1992). Its comprehensiveness, yet clarity, helps users find, analyze, store, recall, and relate important information for use in creating realistic policy alternatives. Social processes are very complex, but rather than avoid or deny complexity, the framework seeks to organize information about it in manageable ways to improve problem solving (Burgess and Slonaker 1978). Other "approaches may appear to offer simpler or easier solutions, but each usually turns up lacking in important ways—not the least of these being their relative inability to help one think and understand, and hence to become a more humane, creative, and effective problem solver" (Brewer and deLeon 1983: 22).

Table 1 illustrates the four main dimensions of the framework—problem orientation, social process mapping, decision process mapping, and observational standpoint—and offers a series of questions to guide readers in its use. Empirical data about each category must be gathered, organized, and interpreted in actual situations. Each category contains an investigative checklist to guide attention to procedures as well as content (see Clark *et al.*, in press a; Table 1).

Problem orientation is a strategy to analyze problems and invent solutions. It focuses on the rationality component of problem solving. Goals that people seek must be specified in relation to the problems at hand, and thus problems must be identified and defined. Historic trends must be described to see if events are moving toward or away from goals. Factors or conditions that have

Facing these challenges, natural resources policy in the GYE could benefit from the knowledge and skill to synthesize diverse disciplines and perspectives into a common program. Interdisciplinism requires disciplined rationality—clarity, accuracy, precision, consistency, relevance, depth, and breadth.

Table 1 An interdisciplinary problem-solving framework showing integrated categories designed to guide research and management decision making.

PROBLEM ORIENTATION

(after Lasswell 1971; Burgess and Slonaker 1978; Clark, in manuscript b)

- 1) **Goal clarification:** What outcomes or future states do the participants prefer?
- 2) **Trend description:** To what extent have past events approximated the preferred goals? What discrepancies exist between goals and trends? What problems hinder achievement of the goals?
- 3) **Analysis of conditions:** What factors or conditions have affected or caused the direction and magnitude of the trends described? How do these contribute to the problem?
- 4) **Projection of developments:** If current policies are continued, what are the probable future trends with regard to goal realizations and discrepancies? How will these affect the problem?
- 5) **Invention, evaluation, and selection of alternatives:** What other policies or practices might achieve the goals and solve the problems? How should these be evaluated with regard to past trends, conditioning factors, and projected trends?

SOCIAL PROCESS MAPPING

(after Lasswell 1971; Willard and Norchi 1993; Burgess and Slonaker 1978; Clark, in manuscript b)

- 1) **Participants:** Who are the relevant participants, both individuals and groups? Who ought to participate? Who is demanding to participate?
- 2) **Perspectives:** What do the participants think, believe, feel about the policy, problem, or issue? What values, institutions, people, ideas, etc., do the different participants identify with? What are their expectations about what will happen? What demands are they making and on whose behalf?
- 3) **Situations:** Where are they and what are the occasions for their interaction with other participants? What is the geographic setting and time frame? Is the setting organized or not? To what degree are current policies institutionalized? Have any crises affected the participants?
- 4) **Base Values:** What assets (capabilities, perspectives, values, or resources) do the participants have? Power is to make and carry out decisions. Enlightenment is to have knowledge. Wealth is to have money or its equivalent. Well-being is to have health, physical and psychic. Skill is to have special abilities. Affection is to have family, friends, and warm community relationships. Respect is to show and receive deference. Rectitude is to have ethical standards.
- 5) **Strategies:** What strategies do participants employ in their efforts to achieve their goals—diplomatic, ideological, economic, or military? How do they manage and how are they likely to manage their assets (base values)?
- 6) **Outcomes:** What outcomes are achieved in terms of values in the ongoing, continuous flow of interactions among participants? Outcomes can be considered in terms of changes in the distribution of values. Who is indulged in terms of which values? Who is deprived in terms of which values? What outcomes do the participants seek? Outcomes also refer to changes in practices or institutions in society.
- 7) **Effects:** What net distribution of values is likely to be realized by the interactions of the participants? How are institutions and practices changed in the long run?

DECISION PROCESS MAPPING

(after Lasswell 1971; Burgess and Slonaker 1978; Clark, in manuscript b)

- 1) **Intelligence (planning):** How is information that comes to the attention of decision makers gathered, processed, and disseminated? Is intelligence being collected on all relevant components of the problem and its context and from all affected people? To whom is intelligence communicated? Is the intelligence process factual, reliable, complete, selective, creative, and available to everyone?

- 2) **Promotion (open debate):**How are policy decisions recommended and promoted? Which groups (official or unofficial) urge which courses of action? What values are promoted or dismissed by each alternative and what groups are served by each? Is the promotional process rational, integrative, comprehensive, and effective?
- 3) **Prescription (setting rules or guidelines):** How are general rules of a newly adopted policy developed/ prescribed? Will the new prescriptions harmonize with rules by which participants already operate, or will they conflict? What prescriptions are binding (these are easier to determine if they are written down)? Is the prescription process effective in meeting people's expectations, is it rational, is it inclusive and open, and is it future oriented? Does the prescription have appropriate content and authority, and is it adequately communicated?
- 4) **Invocation (enforcing):**How are general rules of the policy prescription provisionally invoked in reference to people's conduct? Is implementation consistent with prescription? Who should be held accountable to follow the rules? Who will enforce the rules? Is the enforcing function prompt, dependable in characterizing facts, non-provocative? Is it open to abuse by individuals? Does it serve the common interest?
- 5) **Application (dispute resolution):**How are general rules applied? Will disputes be resolved by people with authority and control? How do participants interact and affect one another as they resolve disputes? Is the dispute resolution process rational in meeting the rules, is it contextual, unbiased, and workable, and is it constructive in mobilizing consensus and cooperation?
- 6) **Appraisal (reviews):**How is the working of prescriptions appraised? Is the program or policy evaluated fully and regularly? Who is served by the program and who is not? Who is responsible and accountable for success or failure? By whom are one's own activities appraised? Is the appraisal process realistic, continuing, independent (unbiased), and contextual in terms of taking many factors into account, including matters of rationality, politics, and morality?
- 7) **Termination (ending and succession):**How are the prescriptions, programs, practices, or policy arrangements brought to an end? Who should stop or change the rules? Who is served and who is harmed by ending a program? Is termination timely, comprehensive, dependable, ameliorative, respectful, and consistent with human dignity?

OBSERVATIONAL STANDPOINTS

(from Willard 1997, personal communication)

- 1) **Roles:** What roles are you (and others) engaged in—student, teacher, advocate, advisor, reporter, decision maker, scholar, facilitator, concerned citizen, or others?
- 2) **Intellectual Tasks:** What intellectual tasks do you carry out when performing your roles—clarifying goals, determining trends, analyzing conditions, projecting trends, and inventing and evaluating alternatives?
- 3) **Shaping Factors:** What factors shape how you carry out your tasks and roles—culture, class, interest, personality, and previous experience?
- 4) **Conditioning Factors:** What conditioning factors shape your “contemplative orientation” in general and in reference to particular subjects of inquiry? Which orientations or roles are you predisposed toward or against, and how are you predisposed to conduct observation from each orientation?
- 5) **Contemplative Orientation:** How does your contemplative orientation shape how you carry out the intellectual tasks associated with your roles? For example, what is the impact of your contemplative orientation on the goals you clarify and how you specify them, the trends you identify and describe, the conditions you analyze and how you analyze them, the projections you make and how you make them, and the alternatives you invent, evaluate, and select?

influenced trends must be determined; projections of future trends are possible if past trends and conditions are known adequately. Finally, potential solutions or alternative actions must be invented, evaluated, and selected (assuming projections are viewed as harmful). If these five tasks are carried out comprehensively, yet selectively and realistically, a practical solution is most likely.

Social process mapping is an effort to comprehend the social context in which all problems are embedded and which affects every detail. Social process focuses on the political and moral components of problem solving. A set of conceptual categories develops awareness of both the larger context and the details of particular situations. Every problematic setting, regardless of its subject matter, is made up of participants with perspectives interacting in particular situations. Participants employ whatever values, or assets, they have through different strategies to obtain desired value outcomes, which have additional effects (e.g., power, well-being, respect, affection). Values are both the things that people strive for and the assets they use to get them (e.g., wealth, enlightenment, skill, rectitude). They are the medium of exchange; values are used and exchanged, or shaped and shared, through social interactions to gain more values. In any social and decision process, participants are both indulged and deprived of values. Eight value categories are recognized: power, wealth, enlightenment, skill, well-being, affection, respect, and rectitude.

Decision process mapping is the analysis of the decision-making process integral to all policy problems. Decision process focuses on the political and moral components of problem solving as well as the problem at hand. Decision processes consist of seven interrelated functions, or activities. In actuality not all these are always carried out. Intelligence must be gathered about the problem at hand and its context. In turn, intelligence must be debated, discussed, and solutions recommended, advanced, and promoted. Rules or guidelines must then be established to solve the problem. Subsequently, these must be initially specified or enforced. Eventually, the rules must be fully enforced and disputes resolved. All these functions must be appraised. Finally, the process will be terminated. Standards have been recommended for the adequate completion of each function, and preferred outcomes for each have been outlined to assist participants (Lasswell 1971; Lasswell and McDougal 1992).

Observational standpoints are held by all people who engage in policy analysis. Standpoint consists of one's value orientations and biases stemming from personality, disciplinary training, parochial/universal experiences, epistemological assumptions, organizational allegiances, and other sources. People should seek to be clear and realistic about their own standpoints and the perspectives of others.

Empirical study can yield data on problem orientation, social and decision process variables, and standpoint. These few sets of categories must be considered repeatedly in interdisciplinary problem solving because information is cumulative (Table 1). Diverse methods—qualitative and quantitative, observational and experimental, intensive and extensive, contemplative and ma-

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nipulative—are required to obtain empirical data on all the framework’s categories. This process thus serves as a disciplined, self-corrective device, the utility of which can best be appreciated by applying it to actual problems. One way is to array data (by categories in Table 1) in a matrix of social process x decision process and fill in the cells based on research. Other possible 2 x 2 matrix combinations can also guide research and decisions, such as decision process x base values and social process x problem orientation. This exercise quickly tells the problem solver which cells he has data about and which he does not. It identifies what he knows and where the gaps are in his knowledge of problem orientation, social process, and decision process.

Diverse methods can improve insight, understanding, and control of the problem environment. Among the techniques designed to cope with complexity and the future-oriented aspects of problem solving are “decision seminars,” “prototyping,” and “developmental constructs,” according to Lasswell (1971). Other more familiar methods include program budgeting, operations research, systems analysis, forecasting, linear and dynamic programming, brainstorming, risk assessment, and computer simulation and gaming (Brewer 1986). Dryzek (1990) suggests conflict resolution, management by objective, arbitration, and others. These and other methods can be extended, adapted, or integrated as needed in solving problems.

SOME SUGGESTIONS FOR SUCCESSFUL PROBLEM SOLVING

Goldman (1995) listed several components of problem solving that should be considered in any interdisciplinary problem-solving exercise. First is how the problem solver understands, formulates, or “represents” the problem to himself and others. Different conceptualizations may make it harder or easier to solve. The importance of this “framing” issue cannot be underestimated, and much study has gone into identifying the variables that influence representation, including what stimuli prompt one’s representation and the difficulties of revising one’s initial representations. The rule is to avoid commitment to initial representations, which tend to structure subsequent thinking and may confine it to rigid “loops” in which the person (or group) keeps recycling the same themes. Experts and novices represent problems differently. What enables experts to solve more problems more quickly than novices seems to be how they conceptualize the “domain” of the problem; experts tend to have more global, or abstract, categorizations of the problem space.

Second is how well people can abstract general ideas from particular circumstances. Some people are very good at distilling “macrostructural” representations of problems and devising analogies necessary to solve problems. Breakthroughs in problem solving often occur when the problem solver discerns an analogy between the target problem and previously encountered problems, possibly from different domains. An appropriate level of abstraction is necessary even before analogies in different domains can be discerned.

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The third consideration in problem solving is its social setting: problem solving is a group as well as an individual exercise. Groups of diverse kinds—communities, government agencies, scientists, and whole societies—share an interest in finding answers to questions about natural resources policy. Groups vary in their practices and structures; some promote while some inhibit problem-solving power. Collective problem solving can outstrip that of individuals in many ways. People can pool their factual information, yielding more facts for each individual to work with. Their ideas, hypotheses, and insights can also be multiplied so that each person profits from a larger menu of candidate solutions. Critical assessment of alternatives is also facilitated, since an isolated problem solver may be easily seduced by the allure of his own ideas, while defects are easier to detect and weed out when they come from others. Complex solutions often need many skills to refine and test, and a division of labor among group members can facilitate several testing tasks at once. The group can offer incentives to make intellectual specialization possible, which may be needed for the long-term investment required for solving complex problems, and it can impose sanctions for behavior inimical to truth (lies, fabrications, and the like).

Table 2 A matrix of five activities to improve interdisciplinary problem solving in the Greater Yellowstone Ecosystem by challenges and targets or kinds of improvements sought. The five activities are: (1) Workshops for “capacity building,” (2) Leadership, staff development, and student internships, (3) Case analyses and appraisals for policy learning, (4) Problem-solving exercises and decision seminars, and (5) Prototyping exercises to improve interdisciplinary and interagency coordination. Numbers in bold are areas of primary improvement.

CHALLENGES IN THE GREATER YELLOWSTONE ECOSYSTEM			
Targets (kinds of improvements)	Context (rapid change, growth, pluralism, conflicting value demands, complexity, lack of common outlook)	Institutions (multiple groups, overlapping authority and control, uneven leadership, institutionalized problem-solving approaches, resistance to change)	People (diverse perspectives, differences in base values, epistemological limitations, bounded rationality)
Substantive (e.g., outcomes)	2, 3, 4	3 , 5	1, 3
Process (e.g., patterns of interaction, governance)	2, 3, 4, 5	1, 2, 3, 5	2 , 1
Structure (e.g., designs for research, practice, and education)	4	5 , 1, 2	2

INTERDISCIPLINARY PROBLEM SOLVING IN THE GREATER YELLOWSTONE ECOSYSTEM

There are a number of ongoing cases in the GYE in which officials, professionals, and citizens are already trying to integrate knowledge to improve policy, although these are generally understood in terms of conflict management, improved governance, and various substantive issues. Additional opportunities exist or can be created to find rational and practical solutions to the problem of knowledge fragmentation. The “Governance and Natural Resources Management” project by Ronald Brunner and Tim Clark is but one example. I would like to recommend five possible activities or programs that can help integrate knowledge and policy. The underlying approach in all five programs is to infuse interdisciplinary problem solving into the GYE’s management and policy dynamic (see Brunner and Clark 1996). The precise mix of projects will be determined by interest, opportunity, and funding.

The five activities (described below) can be used singly or jointly to address substantive problems, process or governance problems, and structures for research, practice, and education (Table 2). First, substantive issues might include improving wildlife management (e.g., grizzly recovery, wolf restoration, bison management), human growth management (e.g., winter recreational use, road building, ranching), and management of other natural resources (e.g., rivers, biodiversity, air and view sheds). Resolving substantive problems could bring to light new ways to address process problems. Second, process or governance issues might include improving patterns of participation, data acquisition, open debate, planning, implementation, and evaluation. These might best be addressed by prototyping exercises (e.g., decentralizing the planning function), cooperation and conflict resolution (e.g., improving open debate), coordination of official and non-official policy (e.g., finding better rules or guidelines for management), management (e.g., better implementation, monitoring, and appraisals), and learning (e.g., better reviews and evaluations, easier succession to new policy and programs, and improved knowledge integration). Third, improving interpersonal and organizational structures for research, practice, and education might include decision seminars, and workshops or lectures on specific or general problems on a scale and frequency currently lacking.

The principal task for participants is to sharpen their focus on applied goals within the primary goal of common interest natural resources policy and management. Leadership is key to the success of all three activities and must be supported to become more skilled and effective. A multi-year effort to improve the GYE’s natural resources policy and management has been initiated among Yale University, University of Colorado (a cooperative project on governance and natural resource management with Ronald D. Brunner), and the University of Michigan (a cooperative project on interdisciplinary problem solving with Garry D. Brewer), U.S. Fish and Wildlife Service, U.S. Forest Service, National Park Service, and the Northern Rockies Conservation Cooperative

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(Jackson, Wyoming). Other national, state, and local public and private partners may also join in.

(1) WORKSHOPS FOR “CAPACITY BUILDING”

Workshops would teach knowledge and skills for interdisciplinary problem solving to the staffs of government agencies and NGOs as well as community leaders and interested citizens. The goals would be to upgrade knowledge, standards, and skills by articulating new ways to gather, array, and synthesize information, develop critical thinking, and avoid technical, parochial, or special outlooks. A workbook is needed and will be written.

Two well-received workshops have already been conducted. In the fall of 1996 the Teton County (Wyoming) Commissioners and about twelve citizens convened to discuss sustainable planning and review previous county planning. They were introduced to interdisciplinary problem solving and the framework’s categories and applied them to issues of concern. They concluded that the methods and range of human values they had used in planning and public process were too narrow and that this was a major reason why past planning had been less than fully successful. Through the workshop, they developed skills in thinking more comprehensively about future planning and public problems. In the other workshop in September 1997, twenty-three government and NGO participants compared their experiences using the framework. They systematically analyzed the decision processes of several GYE policy issues, including management of grizzly bears, wolves, bison, and elk, ecosystem management, tourism, the Yellowstone to Yukon biodiversity project, planning, private land issues, professional effectiveness, and others. Similar workshops have been held in other countries and at the Yale School of Forestry and Environmental Studies, and additional exercises are planned (e.g., Clark *et al.*, in press a, b). Comments from participants from the 1997 workshop suggested that they had learned new skills: (1) A government biologist wrote, “I have gained very practical ideas on how to concretely proceed to start to resolve a complex, highly-conflicted real-life situation.” (2) An NGO conservationist concluded that “the workshop was helpful primarily in opening new possibilities for action.” (3) An independent biologist and educator said, “I think anyone interested or affected by natural resources management would benefit from this workshop.... More people need to be thinking and analyzing with this perspective.”

Workshops could be particularly useful in development of leaders and staffs and in building skills for carrying out decision seminars or prototyping exercises.

(2) LEADERSHIP, STAFF DEVELOPMENT, AND STUDENT INTERNSHIPS

A special kind of strategic, policy-oriented leadership is needed in the GYE to aid heterogeneous (pluralistic) communities in clarifying and securing their common interests. Considerable experience already exists in the leadership of

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diverse organizations in the GYE that could be “harvested” and diffused widely. But even experienced leaders and public officials could explicitly and systematically upgrade their practical, policy-oriented outlooks and interdisciplinary problem-solving skills through workshops and exercises (see Brewer and Clark 1994). Models for support of leadership already exist at the Yale School of Forestry and Environmental Studies and elsewhere (see Berry and Gordon 1993) and in previous workshops. In the GYE, top-level managers of Bridger-Teton National Forest and the National Elk Refuge as well as other leaders are open to exploring ways to be more effective. Additional opportunities also exist, and there are several coordinating groups and leaders who could be approached to inquire about their interest in implementing interdisciplinary options.

At the staff level, agency and NGO personnel could take “sabbaticals” to work on interdisciplinary team-efforts or ecosystem-wide projects or to attend Yale University or other academic programs. Professionals would then return to their employing organizations with new knowledge, skills, a practical policy orientation, and especially an ability to use the framework. For agency staff and other professionals, fellowships exist for study at Yale, for example. More opportunities need to be made available for practicing professionals to aid one another and to improve their knowledge and problem-solving skills in cooperative settings and with the public.

It would also be beneficial to the agencies and NGOs in the GYE to have students who are knowledgeable about interdisciplinary problem solving to participate in management and policy programs. One effort currently underway on the National Elk Refuge is a partnership of the University of Michigan, Yale University, National Elk Refuge, and the Northern Rockies Conservation Cooperative. Students will use the framework to analyze ongoing management processes and recommend improvements. These projects will include: (1) a review of past and ongoing elk management, which is costly and problematic; (2) finding lessons from nearby situations directly applicable to the refuge, such as elk management in Yellowstone National Park and bison management in the region; (3) and assessing the full value of the refuge, incorporating all eight value categories, to understand the diverse benefits; and (4) other projects are planned to further the goals of sustainability and biodiversity conservation.

This effort would directly address the human challenge of diverse perspectives and base values, epistemological characteristics, and bounded rationality among a select number of potential participants. It would improve process or governance issues by helping leaders, staff, and interns to develop the policy orientation needed by individuals and by organizations to deal with complex, dynamic contexts and institutional settings.

(3) CASE ANALYSES AND APPRAISALS FOR POLICY LEARNING

We should look to the experience of individuals and organizations in the region for lessons to improve our collective performance. Greater Yellowstone could provide an even more powerful exemplar if its programs and policies were

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described and analyzed in ways that could be generalized to other situations. Constructive reviews of selected management and policy efforts could be carried out to find and promote successful methods. Comparative case studies, widely used in professional education, seek to describe actual policy dynamics and make practical recommendations. Similar appraisals have been conducted for endangered species conservation in Australia (Stephens and Maxwell 1996; Clark 1996). Wolf reintroduction and recovery, grizzly bear conservation, and northern Yellowstone elk management are three programs that will likely furnish useful examples.

The interdisciplinary, problem-solving framework provides a basis for sophisticated appraisals and policy learning. As a stable frame of reference, it provides a systematic basis for finding, describing, and communicating lessons. The framework's integrated categories can be used as an analytic lens to guide these studies, which could be published and disseminated widely. The utility of the framework as an interdisciplinary tool can be illustrated in this way and its broader use encouraged.

One recently completed case is a study of grizzly bear management focused on a high-profile incident in Grand Teton National Park in summer 1996. Cromley (in press) examined the killing of bear #209 and the history that led to this incident to understand the perspectives of various participants in the ongoing debate about bear management. She used the framework to research the case, analyze it thoroughly, and recommend future management. Results are being published. In another ongoing project, Rutherford (1997) will employ the interdisciplinary framework to examine ecosystem management efforts in the GYE to find out how best to devise and implement such efforts in the GYE and elsewhere. Ecosystem management has been recommended as a science-based innovation to improve management of public and private lands and resources (see Grumbine 1994), it has been nominally adopted by many federal and state agencies, and a multitude of ecosystem management projects are underway (e.g., Yaffee *et al.* 1996). Additional ongoing GYE projects can be studied to learn how to improve practices and programs, among them co-planning efforts between the Forest Service and county governments just west of Yellowstone National Park and a variety of citizen-based, problem-solving initiatives, such as the Conflict Resolution Group in Teton County, Wyoming.

By harvesting the lessons of experience in systematic, understandable ways and thereby improving policy learning, case analyses and appraisals can make substantive improvements in institutions and, secondarily, in the complex and rapidly changing contexts and participants in the GYE. Such analyses and appraisals can be useful to the overall program by building a knowledge bank of case material on which to base prototyping exercises, capacity-building workshops, and problem-solving exercises.

(4) PROBLEM-SOLVING EXERCISES AND DECISION SEMINARS

Joint problem-solving exercises of government, NGOs, and citizens would seek

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to develop “common interest” solutions to specific management and policy problems. A decision seminar could be used—a cooperative, genuinely interdisciplinary approach that can generate practical insights for decision making, fully explore problems and methods of analysis, assess proposed solutions, clarify institutional responsibilities, and manage data (Lasswell 1971). The power of the decision seminar rests on its unique methodological integration (Brewer 1986). A decision seminar in the GYE would consist of selected agency leaders and others in the region as well as qualified people outside the region. Such exercises could be added to efforts already underway or set up as parallel efforts closely allied to ongoing formal programs.

Leaders can use decision seminars as a strategy to develop effective problem-solving routines (Burgess and Slonaker 1978). This design has three characteristics that “enable” problem solving. First, it demands a contextual approach that permits movement between the parts and the whole and back and forth among the past, the present, and the future. Second, it requires multiple methods to ensure a healthy diversity of approaches to problems and to encourage cross-field investigations. Ideas, creativity, and novel hypotheses are fostered by the use of multiple, aggregative, interpretive, and projective methods. Third, it requires the initial specification of the objectives or purposes of the problem-solving activity in a way that allows for refinement while promoting consensus. Brewer (1986) reviewed methods for synthesizing information for policy purposes through decision seminars. Bolland and Muth (1984) offered one application of this method to solving urban problems; to date no decision seminar has been used in GYE.

There are a number of long-standing management issues that could greatly benefit from a directed, problem-solving exercise like this. Among the high-profile possibilities are bison, grizzly bear, and wolf cases, all of which have been underway for decades, and, despite some advances, show continuing weaknesses in decision making. More broadly, a decision seminar could also be carried out at the ecosystem level for the fundamental purpose of constructing a comprehensive, realistic “map” of the changing context of natural resources policy and management in the region. Such a map, continuously updated, would be immensely valuable in day-to-day decision making on both small and large scale issues.

One long-contentious issue in which interdisciplinary problem solving was encouraged was large carnivore conservation in the northern Rocky Mountains of Canada and the United States (Clark *et al.* 1996). Diverse participants, including social and biological scientists from various organizations, were asked to contribute articles to a special journal section to develop a broad understanding of the large carnivore conservation challenge and offer ways to improve matters. Resources were not available to bring all contributors together, but the editors sought to integrate the contributions throughout the publication. A similar interdisciplinary, large-scale effort on Australian koalas is underway (Cork *et al.*, in press). Again diverse participants are working

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together to construct a reliable, broad overview of the challenges confronting koala conservation. Recommendations include various substantive, process, and structural improvements. Again, limited resources have precluded convening the contributors early in the process, but a concluding conference was held in July 1998. The editors seek to integrate knowledge, perspectives, and recommendations using the policy sciences framework to the extent possible.

Problem-solving exercises and decision seminars help create new structures for tackling the difficult problems of context in the GYE by widely useful contextual maps. These efforts could reinforce the capacity-building workshops and professional development of leaders, staffs, and interns.

(5) PROTOTYPING EXERCISES TO IMPROVE INTERDISCIPLINARY AND INTERAGENCY COORDINATION

A prototype is a small-scale, trial intervention in a social or policy system. Its main goal is to gather information about what factors are relevant to solve problems, especially in highly uncertain, complex, and conflict-laden situations. Successful elements can then be repeated, adapted, and improved in other policy systems and institutions. In other words, it is a way of finding out what practices work and why and how to diffuse them. Prototyping has been used in endangered species recovery (Clark *et al.* 1995) and in community development (Dobyns *et al.* 1971), and similar efforts are common elsewhere (e.g., Miller 1996; White *et al.* 1996; Pye-Smith *et al.* 1996).

The potential exists to set up trial interventions in policy systems in partnership with agencies, NGOs, businesses, and citizens. One place to begin might be the coordinating committees that have been established for many GYE species and resources, including grizzly bears and elk. The overarching one is the Greater Yellowstone Coordinating Committee (GYCC), which seeks to coordinate federal management and policy. These coordinating groups vary in structure, creativity, deliberativeness, and effectiveness in clarifying and securing common interests. To build on their accomplishments to date, new problem-solving approaches and organizational arrangements could be introduced to aid their management and coordination activities. These approaches could be designed to help them better understand and address challenges of context, institutions, and people. In addition, some committees might welcome constructive appraisal—a sort of “business plan”—as well as direct support to improve their effectiveness (see Clark and Cragun 1994). Comparing and sharing experiences among committees can diffuse successful efforts and restrict or eliminate unsuccessful practices.

In addition to the coordinating committees, there are other interorganizational or “transboundary” projects that are trying to achieve co-planning and are moving toward interdisciplinary problem solving involving different stakeholders, reliable science and data collection, and facilitated civic discourse (Glick and Clark 1998; Knight and Clark 1998). Four such programs are: (1) Beaverhead County partnership, an ecosystem planning effort in

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Montana between county government and the U.S. Forest Service; (2) Madison Range Landscape Assessment and Adaptive Management Project, a landscape assessment between Forest Service and local residents; (3) Henry's Fork Watershed Council, an NGO and the Fremont-Madison Irrigation District (1,700 members) working together on water management issues; and (4) Greater Yellowstone Coalition Stewardship Program, an NGO working with private landowners in a twenty-county area to address public and private land management issues. The "Cooperative Resource Management" efforts in the Big Horn Basin of Wyoming and on the National Elk Refuge in Jackson Hole, Wyoming, are two other examples.

Prototyping to improve interdisciplinary and interagency coordination offers great promise in creating structural and substantive improvements in institutions. It can also improve patterns of interaction within institutions and contexts in the GYE. Prototyping exercises can support leadership and staff training as well as substantive problem-solving efforts. It can also provide case material for analysis and appraisal.

Creating, finding, and promoting the successes and lessons from the GYE is the "innovation-diffusion process." All five of these activities require education and outreach activities to complete the mission of integrating knowledge to improve natural resources policy and management in the GYE. Conferences, publications, electronic teleconferencing, and issue and leadership forums may be useful in this regard. The format of these forums may include organized, facilitated, and open designs depending on the target audience, technical or general nature of the issues, and the problems at hand and their contexts. Specific issues will be covered, in-depth case studies will be analyzed for lessons, and leadership forums will be featured. Experienced people can share their experience with others. Participants in all aspects of this undertaking are expected to disseminate their results to colleagues, co-workers, the public, and people on other sides of the issue.

Although they do not focus on the GYE, two books are currently in progress that will detail the interdisciplinary framework and illustrate its application. *The Policy Process: A Practical Guide for Natural Resource Professionals* (Clark, in manuscript b) is an introductory book, while *Foundations of Natural Resource Policy and Management* (Clark *et al.*, in press a) contains several in-depth case studies, as well as background and theory.

CONCLUSIONS

Creating an arena for effective interdisciplinary problem solving in the common interest should be a high priority in the GYE and elsewhere. U.S. Secretary of Interior Bruce Babbitt called for development of an "interdisciplinary science" to meet today's natural resources challenges. Achieving this will require terminating certain aspects of conventional, discipline-based education, institutional boundaries, and standard operating procedures. Clearly, there are tremendous difficulties in making such changes, including contex-

Prototyping to improve interdisciplinary and interagency coordination offers great promise in creating structural and substantive improvements in institutions. It can also improve patterns of interaction within institutions and contexts in the GYE.

tual, institutional, and people challenges. But human dependence on the sustainable use of natural resources requires that we meet the challenges with new tools and concepts. The five activities outlined here can improve problem-solving skills, upgrade integration of knowledge, and guide development of natural resources policy in the common interest. The GYE, long cherished by the nation and emulated by the world, is worthy of all our efforts to build common interest policies and practices. The benefits can be enormous—in perpetuating our natural heritage, in building democratic processes, in cooperating toward common goals, and in providing a model for improved problem solving everywhere. Commitment, leadership, and resources are required to develop interdisciplinary problem solving within institutional and policy processes in the GYE. The challenge is clear, the opportunities exist, and the means are known.

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Acronyms

APHIS	Animal Plant and Health Inspection Service
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
FTCA	Federal Tort Claims Act
GTNP	Grand Teton National Park
GYE	Greater Yellowstone Ecosystem
JHCEG	Jackson Hole Cooperative Elk Studies Group
NEPA	National Environmental Policy Act
NER	National Elk Refuge
NGO	Non-governmental organization
NWRSAA	National Wildlife Refuge System Administration Act
NWRSIA	National Wildlife Refuge System Improvement Act
TCNRD	Teton County Natural Resource District
USFWS	U.S. Fish and Wildlife Service
WDGF	Wyoming Department of Game and Fish