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FORUM

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Dedicated to the Protection, Preservation and Management
of Cultural and Natural Parks and Reserves
Through Research and Education

The George Wright Society

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On the Cover: A prairie dog (*Cynomys ludovicianus*). See, for example, Supernaugh, beginning on page 19.

Learning From the Past, Looking to the Future

The Fourth International Conference on Science and the Management of Protected Areas (SAMPA IV) will be held from May 14 to 19, 2000, at the University of Waterloo, Ontario, Canada. SAMPA IV is co-sponsored by The Parks Research Forum of Ontario (PRFO), with co-operation from the Heritage Resources Centre of the University. Make plans to attend and contribute to this conference that attracts a diverse group of parks and protected areas professionals, academics, researchers, managers and members of non-government groups primarily from Canada and the United States but also with representation from Mexico, South America, Europe, and Asia.

SAMPA IV offers international plenary speakers, a wide variety of presentations and posters on contemporary issues, and educational field trips before and during this conference to key parks and protected areas in southern Ontario such as the Niagara Escarpment Biosphere Reserve and Point Pelee National Park. Refereed proceedings will be published within a year of the conference.

Held every three years, this is a key global forum for the delivery of papers and for discussion and dialogue on a range of subjects impacting on the management of parks and protected areas. Two major themes within the conference are planned: Regional Approaches to Planning and Research on Protected Areas and Marine Protected Areas. Special attention will also be directed to topics such as ecological integrity, human dimensions, the use of science and research in decision making, the impacts of globalization on protected areas management, non-government organization research, stewardship and partnerships, and approaches to education, interpretation and community outreach. SAMPA IV urges potential participants to submit abstracts by November 30, 1999, on its two major themes as well as on a dozen other important sub-themes. Details on these and other aspects of the conference, its program, field trips, accommodation and registration are available on the SAMPAA Web site: *landscape.acadiau.ca/sampaa*, by contacting Stephen or Beth at *sampa.prioritygrow.on.ca.*or by calling 519-622-9362. To contact the Heritage Resources Centre at the University of Waterloo, e-mail: *hcr@fes.uwaterloo.ca* or call 519-885-1211.

GWS Participates in Meetings on Protected Landscapes, Africanisms

In June, Executive Director Dave Harmon represented the Society at a meeting on expanding the use of the protected landscape designation (Cate-

gory V in the IUCN classification of protected areas). The meeting was convened by the National Park Service's Conservation Study Institute and IUCN's World Commission on Protected Areas, and was held at Marsh-Billings-Rockefeller National Historical Park in Vermont. Protected landscapes try to combine the conservation of natural features in a particular landscape with the conservation of the cultural vitality that helped to shape that landscape. As such, it is not only open to, but practically requires, the presence of residents within the protected area. Furthermore, it calls for the administering authority to at least co-manage the area with the residents; in some cases, the residents may even assume primary managerial authority. This is a kind of protected area that, to date, has been confined almost entirely to Europe, where the long tradition of landscape appreciation makes the concept readily understandable. Now, IUCN would like to see the designation used elsewhere, particularly in developing countries where indigenous and other long-standing local interactions with landscapes are increasingly being disrupted by industrial and other kinds of development. Next year, a theme issue of THE GEORGE WRIGHT FORUM will focus on protected landscapes, drawing on presentations made at the Vermont meeting.

In August, Dave was invited to participate in a planning meeting for "Africanisms in America: A Conference on the Shared Heritage of Two Continents." Scheduled for September 2000, this will be a major international event bringing together scholars, activists, and others to consider the heritage of persons of African descent throughout the Western Hemisphere. The conference is being organized by the National Association for African American Heritage Preservation, whose president, Claudia Polley, was a plenary speaker at the Society's Asheville conference this past March. For Africanisms in America, the National Park Service is preparing a module on "Places of Cultural Memory," and the agency is assisting NAAAHP in preparations. The GWS was asked to share its logistical expertise in organizing conferences, and will continue to advise the conference organizers as the event unfolds. For more information, go to: www.africanismsinamerica.com.

GWS to Co-Sponsor Two Regional NPS Meetings

Along the lines of the Africanisms conference mentioned above, the Society is co-organizing two regional research and resource management meetings with the National Park Service:

- "Resource Stewardship: Meeting the Conservation Challenges in 2000 and Beyond" is co-sponsored by the NPS Northeast Region, the Society, and the Conservation Study Institute. It will provide an opportunity for information exchange among the resource professionals and superintendents in the Northeast Region by updating programs, gathering and

evaluating technical information, placing park resource management in a regional context, and highlighting successful management approaches. The conference has three themes: Conservation Issues, Regional Perspectives, and Integrated Planning. It will be held January 19-21, 2000, at the Radisson Hotel Valley Forge, adjacent to Valley Forge National Historical Park. For more information, go to www.portup.com/~gws/ner2000.html.

- In March 2000, the NPS Pacific West Region will hold its "West by Northwest" conference at the Hanalei Hotel in San Diego. The GWS will help with logistics. More information on this meeting will be in the next issue.

Environmental Research Information Exchange Service Launched

In July, the on-line National Library for the Environment launched its Environmental Research Information Exchange (ERIE) service, which provides a forum for researchers, educators, resource managers, agency decision-makers, foundation representatives, journalists and others in all environmental fields to share information and discuss issues. Both an information-sharing and research match-making service, ERIE will provide a bulletin board organized by environmental topics, a highlights page where selected research opportunities discussed by participants will be posted, links and lists of funding opportunities, and an outreach service where the host, the Committee for the National Institute for the Environment, will share selected requests with its network of thousands of scientists, managers, and others. Examples of how ERIE might be used:

1. A park manager is seeking a researcher to study management of a particular type of habitat. She can offer in-kind resources like accommodation at the park, but can't offer funding. A faculty member at a university may be looking for a suitable research project for a graduate student. Thus a match can be made.
2. A researcher is looking for study sites that meet certain criteria, such as the presence of certain species or contaminants. A federal, state, local, or private-sector environmental manager is responsible for an appropriate site and would be delighted to have research conducted at the site.
3. A journalist is writing an article about an environmental issue and is seeking a scientist to provide background information.

The bulletin board can also be used to discuss a wide range of research related issues. ERIE is located on the Web site of the Committee for the National Institute for the Environment: www.cnie.org.

— *from a posting by Kevin Hutton, Webmaster, CNIE*

The National Park Service's Management Policy in the 21st Century

GUEST EDITOR: RUTHANN KNUDSON

Michael A. Soukup

Introduction: Recommitting to Stewardship

The papers in this issue of THE GEORGE WRIGHT FORUM were presented at a symposium which took place in 1997 at a meeting of The Wildlife Society. That symposium marked the second in a series of forums designed to open and engage constructive scientific input, discussion, and scholarly debate regarding National Park Service (NPS) policy, science, and values for the management of natural resources, including wildlife. The first forum, held at the Ecological Society of America meeting in 1996, centered on case histories that discussed wildlife management issues and the science and institutional policies that surrounded them. The publication of this second set of policy deliberations is timely. It comes as NPS is embarking on what Director Robert Stanton has called a "recommitment to the stewardship of the natural resources throughout the National Park System." NPS's "Natural Resource Challenge," the formal title of its recommitment effort, was announced in August 1999. It came in response to the publication of Richard West Sellars' *Preserving Nature in the National Parks: A History* (Yale University Press, 1997). In that book, Sellars reviewed much of the history of NPS's approach to wildlife, as well as other natural resources. The conclusion I find in Sellars' writing is that the National Park Service is exemplary in making park resources available to the visitor, and has some successes in restoring disturbed park environments, but has a long way to go in integrating science into park management.

In this symposium, a wide range of scientists continues an examination of one of NPS's most controversial management issues: the management policies for the regulation of wildlife (animal) populations. Such scientific examination supports a significant part of NPS's recommitment to natural resource stewardship. It encompasses both obtaining the scientific information to inform our policies and decisions, and engaging the assistance of the greater scientific community in helping us meet the challenges of managing natural resources in the face of current and future complexities. This symposium represents both of those endeavors.

The idea of the symposium is to develop a dialogue on wildlife management that may offer a new and broader perspective in the area of NPS policy and wildlife management. Divergent scientific opinions on

values, science, and policy on wildlife management are discussed. These opinions focus on the agency's management policy at the national level, and interpretation and implementation of national-level policies at the park level. They also focus on the need to interface wildlife management policy with other mandates, policies, and the underlying science relating to invertebrate species, vegetation, landscapes, human values, and the paleoenvironments from which they developed. The National Park Service mission is to preserve the resources that visitors come to see. However, we have limited understanding or systematic measurement of how we are performing in the preservation of natural resources in parks, and we lack a systematic approach to accumulating, using, and translating an understanding of the resources we manage. This symposium will begin to provide a more systematic approach to understanding and managing our wildlife resources.

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John G. Dennis

National Park Service Management Policies for the National Park System

Introduction

National Park Service (NPS) policies for management of animals in units of the National Park System devolve from national park history, evolution of science, and changing human values. This paper summarizes the framework within which NPS animal management policies have developed, provides a brief statement of the content of today's Servicewide policy guidance, and suggests a stage for discussion of changes that might be made to that guidance in the future.

Framework Within Which Policy Has Developed

Today's animal management policies reflect the history of the National Park System, the legislative oversight applied to park management, and the administrative interpretation of that oversight.

Historical framework. History provides an important perspective. The first area of what are today called units of the National Park System was identified in 1790, at the end of the 18th century. The first place called a "national park" was created in 1872, toward the end of the 19th century. The creation of NPS as the manager of national parks and the emergence of ecology as a science useful to the management of national parks did not occur until part way through the 20th century. And now, at the approach of the 21st century, the explosion of scientific knowledge and burgeoning of the human population challenge us to learn from that history as we plan for the future.

National parks have no innate existence—they are solely the expression of human values. In the USA, national parks result from congressional decisions that integrate the human values, desires, and support extant at the time. As these values, desires, and support with respect to national parks change over time, so too does congressional direction about establishment, extinguishment, and support for parks. In turn, because the role of the administrative branch in our system of federal government is to carry out the directions provided by Congress, so too does the administrative policy for, and management of, national parks change over time.

Statutory development of policies for managing animals in national parks. Congress early in its

history established several areas that ultimately became part of today's National Park System. However, it was not until enactment of the Yellowstone Act in 1872 that Congress provided some statutory direction about how the animals of parks should be managed. This first direction responded to the concerns of the time—human harvesting of ungulates—by directing the manager of Yellowstone (the secretary of the interior) to protect "against the wanton destruction of fish and game" and to retain, in their natural condition, all timber, mineral deposits, natural curiosities, or wonders within the national park. At the same time, in recognition of an interest group that strongly supported creation of the national park, Congress also directed that fish in the park could be harvested by hook and line.

The 1872 Yellowstone Act thus established two basic principles regarding animal management in parks: protect animals from harvest and retain them in their natural condition. Subsequent statutes provided amendatory guidance as Congress both dealt with emerging circumstances at Yellowstone and also created additional national parks. The concept of surplus animals emerged, and some parks received authorization to remove surpluses of selected species of ungulates. The realization arose that some animal and plant life could be detrimental to the use of parks, and a general authorization was established to destroy such animal and plant life. Large-sized predators bore the brunt of this authorization for several decades and were exterminated from many parks. Today, exotic animals experience the application of this authorization. The anomaly of fish remains: for many decades exotic species of fish were freely planted—a practice which continues even up to today in some parks—even though such species have the capacity to be detrimental both to non-fishing uses of parks and to retaining native plants and animals in their natural condition.

The 1916 act which established NPS to administer national parks, monuments, and reservations chose different words for animals ("natural ... objects," "wild life") and added authorization for the new service to establish rules and regulations to guide use and management of parks. It also permitted livestock grazing as a possible use. Over time, subsequent legislation addressing the needs of individual parks added hunting and trapping as appropriate uses of animals in some parks, such as for managing elk populations in Grand Teton National Park or continuing the recreational use of game animals and fur-bearers in national seashores and lakeshores.

By 1970, Congress formally recognized that, although there was by then a large diversity of parks that had many unique purposes, there also is an underlying theme held by

all of the parks that warranted putting all of them into a single National Park System. Congress expanded this theme in 1978 by directing that "the protection, management, and administration of these areas ... shall not be exercised in derogation of the values and purposes for which these various areas have been established...."

Other, more broadly cast legislation provides additional guidance for NPS treatment of animals found within units of the National Park System. The Migratory Bird Treaty Act and the Eagle Protection Act protect these classes of birds wherever they occur, including within units of the National Park System. The Marine Mammal Protection Act focuses attention on conserving the marine mammals that occur in parks. The Endangered Species Act emphasizes preventing the loss of those animal species that are threatened with extinction. The Wild Free-Roaming Horse and Burro Act is worded carefully to not include units of the National Park System within its sphere of influence. The Clean Air Act Amendment focuses attention on air quality-related values, which can include animals.

The statutory framework thus developed over the past hundred years establishes that animals are important parts of parks and that, for the most part, these animals are to be conserved unimpaired in their natural conditions for the use of present and future generations of people.

Administrative development of policies for NPS management of animals. Over time, national park management policies for animals have reflected the statutory direction given by Congress, what was known about the biology of the animals being managed, and what human interests there were in having the animals be managed. In the early years, the management interest focused on a few species, primarily ungulates and fish, and the management effort focused on getting rid of predators, protecting habitat from fire, and adding new species of fish. Prodded by the new science of ecology, NPS's attitude toward predators changed, it developed a recognition that exotic species could be detrimental to maintaining natural conditions, it slowly evolved an antipathy toward planting of fish in park waters, it moved from equating fish and game or "wildlife" as animals to recognizing that all "wild life" in the animal kingdom are animals, and it came to recognize that fire is naturally a part of animal habitat in some circumstances.

While many early expressions of policy regarding animals were written by individual parks, NPS began publishing Servicewide expressions of policy by the 1930s in the publications of George Wright and his colleagues and in a 1933 article by the director which addressed exotic animals. The Leopold Report of

1963 provided the underpinning for a secretarial directive regarding animal management that ultimately became published in 1970 in the NPS's three-volume administrative policies. This version of policy was updated, revised, and expanded in three subsequent single-volume publications (in 1975, 1978, and 1988). The 1988 management policies received some degree of public review and comment before being formally adopted. In all cases from George Wright on, NPS scientists working in consultation with other government and academic scientists played active roles in the development and expression of agency policies for managing animals in parks.

The National Environmental Policy Act of 1969 (NEPA) added a significant new procedure to federal government decision-making by adding formal ecological assessment and public involvement to management planning. Although not directly applicable to NPS policy formulation, the NEPA procedures can influence agency policy when NEPA analysis of proposed management actions reveals that an underlying policy is flawed and needs to be amended to permit a resource-appropriate management practice.

Influence of an evolving science on NPS animal management policy formulation. Within the context of conserving natural objects for human use, early park animal management programs applied the science of the day to increase the supply of ungulates, decrease the populations of the predators that fed on them, and reduce the wildfire that destroyed their habitats, as well as to stock fish that humans would find enjoyable to catch. As experience with these animal management practices began to accumulate, the concept of retaining parks as much as possible in their natural condition stimulated an entry point for scientists to question the then-current wisdom of how parks were to manage park animal populations.

One early question raised by the scientific community concerned the practice of trying to eliminate predators from parks. The resulting discourse over a several-decade period led to a policy change and the recognition that predators are every bit as much to be protected as other kinds of animals. With further evolution of this thought, predators today are considered animals that are to be restored to, and maintained in, parks wherever possible.

Another early question of the scientists concerned the legitimacy of exotic species occurring in parks, a question that led to the conclusion that exotics do not belong in natural areas. This conclusion stimulated early action to eliminate exotic terrestrial animals, followed by actions to eliminate exotic plants and, ultimately, exotic fish.

Growth of the science of ecology stimulated thought regarding animal

population regulation, animal population carrying capacity, the role of lightning-ignited fire in natural areas, and the interrelationship of plants, animals, and the physical environment in ecosystems. Each of these lines of research has become incorporated into today's NPS management policies, principally in the fundamental precept that "natural resources will be managed with a concern for fundamental ecological processes as well as for individual species and features." More recently, the focus of the scientific community on habitat fragmentation and global change is reflected in policy developed to address migratory species, genetic resources, a biogeographic-area scale of focus for research, an increased emphasis on involving park neighbors in cooperative regional planning to integrate parks into their regional environments, and encouragement to engage in cooperative management of natural resources.

Current NPS Animal Management Policies

NPS has designed the current animal management polices to address the circumstances of all animals found in each of the 376 parks. The policies therefore provide general guidance together with specific advice on types of animal management concerns that could arise in each of the four major management zones into which parks may be divided. This general guidance and specific advice are constructed to accommodate the great diversity of park purposes as identified in general legislation, park enabling legislation, and park establishment proclamations. The guidance and advice also are constructed to fit within statutory and policy requirements that guide implementation procedures. In addition, the guidance and advice are intended to respond to the current precepts of science.

Policy elements. NPS seeks to perpetuate native animal species in natural ecosystems operating within the constraints of animal population dynamics as influenced by natural processes operating within evolving park ecosystems. These native animal species and natural processes are part of a recognized suite of natural resources and values that include plants, animals, water, air, soils, topographic features, geologic features, paleontological resources, and aesthetic values, such as scenic vistas, natural quiet, and clear night skies. NPS specifically recognizes that evolution of native species and natural change in ecosystems are integral parts of the functioning of natural systems and so seeks to ensure that natural processes are able to operate without human interference wherever possible. NPS considers native animal species to be those that as a result of natural processes occur or occurred on lands now designated as a park. In contrast, NPS treats as ex-

otic, or non-native, species those that occur in a given place as a result of direct or indirect, deliberate or accidental actions by humans, with the result that the manipulated species occurs in a place where it has not evolved with the species native to the place and therefore is not a natural component of the ecological system characteristic of that place.

NPS does not explicitly define "natural" or "natural processes." It does identify in its management policies the arena being considered and provides examples of natural resources. The 1906 Antiquities Act speaks of objects of scientific interest, the 1916 National Park Service refers to natural objects and wild life, and the 1970 General Authorities Act identifies the superb environmental quality of the parks. NPS management policies recognize the existence of tangible natural features (animals, plants, water, etc.) and intangible natural attributes (natural quiet, sounds of nature, scenery, etc.). The management policies provide examples of natural resources, such as a site that illustrates the characteristics of a landform, landscape, or biotic area, a diversity of ecological components, a refuge necessary for the continued survival of a species, an ecological or geological benchmark associated with research and scientific discovery, and the components of natural resources listed in the previous paragraph. The management policies also identify a number of situations in which the resource does not exist in a natural condition due to the effects of human actions, such as harvest, removal, destruction, harassment, or harm to animals, unnatural concentrations of native species, presence of exotic species, habitat damage, loss of appropriate levels of genetic diversity, extirpation of native species, loss of fire as a natural process, loss or decline in quality or action of water as a habitat and natural process, loss of natural shoreline processes, or loss of vegetation, wildlife, or water quality due to polluted air. These examples tie "natural" and "natural processes" to science, and, drawing from a dictionary definition of "natural," relate them to "pertaining to, in accordance with, or determined by nature," where "nature" is the "system of all phenomena in space and time, the physical universe," or, in another definition, "man's native, or original state, the condition of simple, primitive man," so that a "natural process" is "any phenomenon which shows a continuous change in time."

The core of the NPS policy approach thus deals with what is the human role in nature and in the perpetuation of nature. Currently, this approach focuses on preventing modern humans from altering nature and natural processes in parks, on restoring those elements that humans in the recent past have altered, and, to a much lesser degree, on attempting to estimate how past, present,

and future human alterations will affect the future natural evolution of nature and natural processes in the parks. Despite a great deal of rhetoric available to it, NPS has not developed a comprehensive policy resolution for determining when to consider that humans and their actions occur within the nature and natural processes of parks and when they do not. To date, NPS has established informally, but not in its management policies, a more-or-less accepted policy inference that "technological humans"—generally, those who developed the country after the discovery of the New World by Europeans—are to be considered not part of the nature and natural processes that NPS is to perpetuate. NPS provides no formal policy assessment of the role of pre-Columbian Native Americans in the evolution of the nature and natural processes of today's parks, leaving an implication that, for the purposes of management today, the pre-Columbian Native American role may have been more within, than without, what was natural.

In applying this overall policy framework to today's management of nature and natural processes, the NPS management policies address animal, plant, genetic, extirpated, exotic, pest, fire, water, air, sound, light, weather, and geologic resource concerns. The management policies require similar management approaches to be taken in each of the four major management zones in parks ("natural," "cultural," "park development," and "special use") wherever appropriate and possible, but recognizes that the specific purposes of each zone may require some adjustments or exceptions. Parks are to perpetuate the native animal and plant life as part of their natural ecosystems. Individual animals may be removed where: (1) hunting and trapping are permitted by law; (2) fishing is not prohibited by law; (3) animal population control is required for park ecosystem maintenance; (4) animal control is necessary to protect humans, property, or landscaped areas; (5) animal harvesting is part of approved research projects; or (6) live removal is used to restore populations of the species to other areas. Animal and plant populations and landscapes are to be controlled by natural processes as much as possible. When natural processes are not effective due to interfering human activities that, themselves, cannot be controlled, or where other resource needs such as efforts to recover threatened or endangered species or to restore extirpated species require intervention, active management programs may be conducted to bring the native animal and plant populations to their desired conditions. Where harvesting of native terrestrial or aquatic animals is allowed, management generally is to focus on maintaining the populations of these species at a natural level and protecting the integrity of the natural

ecosystems that support them. Management of native migratory species is to focus on preserving their populations and habitats within the parks and cooperating wherever possible with other land managers to ensure their preservation outside the parks. Management may not introduce exotic species into natural zones, and may introduce exotic species into other zones only under very controlled conditions that meet the specified purposes of those zones. In general terms, management is to exert the least manipulation of native species and natural processes within natural zones, and in cultural, park development, and special-use zones may exert only narrowly selected manipulations of the components and processes of ecosystems according to the specific requirements individually established for each individual element of these three zones.

Implementing current management policies. NPS has developed a formal process by which parks implement the management policies. The overall guidance appears in the *Management Policies* book itself (NPS 1988). In recent years, this overall guidance has been interpreted in the NPS natural resource management guidelines, which provide greater detail and identify responsible officials for various levels of action.

Parks apply the NPS policies through a sequence of iterative planning steps, which often are developed out of synchronization because of different scheduled update cycles. The broadest planning activity is a given park's general management plan, which focuses on the broad purposes of the park, the mix of development and preservation emphases appropriate to the park's purposes, the preferable site locations for developments, and the preferred levels of intensity of human activities in the developments. The park resource management plan assesses the current condition of park natural and cultural resources, establishes what are the desired conditions for those resources, identifies management actions needed to bring substandard resources up to the desired condition, identifies information gaps and research and inventory actions needed to fill them, and prescribes actions needed to monitor the condition of the resources and to maintain those that require active management. The action plan provides detailed strategies for bringing specifically identified resource components up to their desired condition.

In preparing these plans and conducting the actions they prescribe, NPS management policies expect park resource managers to utilize the results of both applied and basic research, as appropriate, to determine causes of resource management problems, predict impacts of resource uses and related activities, develop methods to restore damaged resources, develop strategies to avoid

adverse impacts, and to further their understanding of the components, condition, and significance of park ecosystems. Further, the management policies expect NPS resource managers to cooperate with the research community within the overall requirements for resource protection and visitor use. Finally, the management policies require that the results of research conducted in parks be made available to park managers, the scientific community, and the public through technical publications and the popular media, including park interpretation and environmental education programs.

NPS draws on the guiding principles and statutory requirements of NEPA to produce an open, fact-based planning and decision-making process. Having sought to inform interested groups through park interpretation programs and interpretive and technical publications, NPS relies on scoping and document review activities to bring the interested parties into decision-making. The park resource management plan identifies the conceptual framework for the animal management program, identifies the priorities in which individual projects likely will be undertaken, and forecasts the level of NEPA compliance likely to be required for each. The park initiates the appropriate form of NEPA compliance shortly before, or in conjunction with, the allocation of funds to conduct a project, with the specific management action to be adopted being determined through the NEPA-guided analysis of alternatives.

Rarely, situations occur where NPS must institute an animal management action that is not consistent with the published policies. Because it is the NPS director who formally adopts the management policies, only the director may waive policy in such circumstances. The director issues such waivers only on a case-by-case basis, and only when the waiver request is well-supported with resource and park-use information and accompanied by an analysis of alternatives.

The Challenge to Scientists for Developing Future Management Policies

NPS management policies were last revised in 1988. Since then, NPS has adopted a streamlined policy and guidance promulgation system. The policies today are ripe for review and possible revision to incorporate new scientific information and newly emerging values of the American people. The evolution from the current management policies for the National Park System to whatever future policies will appear clearly will start from the body of law, science, and human values that exists today. Paramount in current law and resulting policy are the terms "natural condition," "unimpaired," and "non-derogation of the values and purposes" for which the parks were

created. The findings of current science regarding (for example) long-distance transport of pollutants, spread of exotic species, extirpation of native species, and fragmentation of natural landscapes support the belief that nowhere in the world is it possible to find ecological systems that truly are unimpaired by effects of human activities and that continue to exist in their natural condition. Further, it is likely that no unit of the National Park System is free of derogation of its values and preservation purposes while being developed for the enjoyment of present and future generations of people.

Given these realities, the future evolution of National Park System management policy would benefit greatly from continued scientific examination of fundamental park concepts, including "natural condition," "unimpaired," and "non-derogation." While such examination will require analyses in both the natural and social sciences, it is unlikely that any of these analyses can be constructed from the experimental approach characteristic of the scientific method. Despite the immediate unavailability of its principal tool (the experimental method) for directly exploring animal management in parks, the scientific community can contribute a great deal by focusing on how to identify and develop science-based standards for evaluating whether or not natural conditions, unimpaired states, and non-derogation of values and purposes are being advanced or not for any given change in policy. To achieve the capability for identifying and developing such standards, the scientific community can use the experimental method in surrogate locations to further understand how ecosystems work, how animal population dynamics are influenced by intrinsic and extrinsic factors, and in what ways human actions both within and outside parks are changing the natural environments within which park animal populations have evolved. Scientists can use this better understanding to construct models about park animal populations and the ecosystems that support them, and then to test the models and the underlying assumptions using the long-term monitoring programs that parks are establishing.

Thus, there is a significant and unique role for scientists to play in the evolution of park animal management policies. For scientists to exert that role effectively, they need to bring their knowledge of parks up to the same levels as their knowledge of their science. There are many ways for scientists to become involved that will increase their knowledge of the parks: designing and conducting research within the necessary constraints of working in parks, encouraging graduate students to perform their research in parks, using park animal management examples in their teaching, providing technical assistance to parks that are

preparing and revising resource management plans and project statements, designing and conducting research projects that directly respond to the research needs identified in resource management plans, regularly reviewing NEPA and interpretive documents from the scientific perspective, and providing technical assistance to employees.

There also is a role for scientists to play in policy development—a role that is not unique to scientists. Scientists, like all other citizens, bring their own value systems to policy decisions regarding parks and the animals they support. While it is important for scientists to express the management approaches that they prefer because of their own value systems, it is critical that they separate their value-based recommendations from their factual, scientific analyses of alternative future scenarios. The evolution of NPS management policies for animals reflects, and demonstrates the importance of maintaining, this separation. Scientists originally supported destruction of predators, introduction of exotic fish and other animals, and exclusion of natural fire because of the value they placed on other park resources and uses. As scientists learned more about natural systems through their studies in parks and elsewhere, their science unveiled the ecological roles and significance of predators, native species, and natural fire. That scientific revelation in turn informed value systems that underwent change, and ultimately induced changes in NPS management policies for animals.

Parks are for the Long Term

In developing science-based standards for future policy formulation, the science community can increase the value of its effort by focusing objective effort on identifying probable resource and human enjoyment outcomes of alternative policy choices for managing animals in parks. In creating this focus, it will be important for the science community to remember that parks are for future generations of people as well as for today. Furthermore, not only do some individual animals live for a hundred years or more, populations of animals may experience cycles in size that could span even longer time periods, and the vegetation within which the animals live may include plant species that have life spans of multiple centuries. In responding to this longer-term view of both human enjoyment of parks and the population dynamics of the animals inhabiting them, the scientific community can make a major by developing jointly with the parks an integrated, comprehensive, coordinated, and hypothesis-based program of long-term ecological monitoring.

Conclusion

National parks and the National Park System are human constructs that evolve as the interests and values of the humans that made them

change over time. NPS management policies evolve in response to these changes, as influenced by the changing human understanding, gained through science, of how park resources are structured and function over time and of how human activities influence them. Scientists offer two kinds of contribution to the evolution of NPS management policies: the injection of their personal interests and values (legitimate biases) into the selection of desired management outcomes, and the application of their unbiased scientific knowledge to improving the understanding of the structures and functions of park resources over time. The unique and important role of the scientist is this provision of unbiased information and analysis.

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William R. Supernaugh

Interpreting Wildlife Management Policy to Meet Individual Park Needs

When the National Park Service (NPS) released its current *Management Policies* volume (NPS 1988), it recognized that parks needed flexibility to apply prescriptive management techniques to wildlife residing within park boundaries for all or a part of their life cycle. Despite continued references in the media and some professional journals, NPS does not rely wholly on the principle of "natural regulation" when contemplating the long-term management of park ecosystems (NPS 1988, chap. 4:6). While preferring to manage holistically—that is, at the ecosystem level—park managers must, of necessity, adopt single-species management programs in some instances.

For a better understanding of the manager's options with regard to prescriptive management of a species, the following review of some of the wildlife-related policy statements is presented. As a first screening, faunal components of park ecosystems are noted as being either native or exotic (non-native) species (NPS 1988, chap. 4:5). Within the former category, NPS sets forth policies applicable to managing both resident and migratory native species, even going so far as to discuss the need to vary management practices for species with relatively short migration patterns, such as elk, versus animals having long migration routes which may only include park-administered lands for a short period of time, such as whales or butterflies. Providing a further breakdown of discretionary decision-making, NPS acknowledges that management of harvested species and their habitat may occur in those areas where Congress has specifically authorized hunting or trapping.

A second category within the management policies comprises non-native species, also called "alien" or "exotic" species. In general, NPS pursues opportunities to limit the establishment of species that were not a natural component of the ecological system characteristic of a particular unit of the National Park System. NPS policy allows different actions in response to non-native species that extend their range to parks (coyote and armadillo, for example), as opposed to zebra mussels, brown

tree snakes, and European wild boars. There is even a provision for the introduction of new exotic species when they may control previously established ones (NPS 1988, chap. 4:12). Leaf, root, and stemboring beetles that live on purple loosestrife are but one example of such introductions.

A third discrete emphasis of NPS's wildlife management policy is on the management of threatened and endangered wildlife (NPS 1988, chap. 4:11). Active management of such special-status species may be warranted under certain conditions, including but not limited to removal of targeted predator species, preconditioning of animals slated for introduction, and intense habitat manipulation to favor their success.

By now you should get the idea that wildlife management in the National Park System is not a single set of rules; rather, it constitutes broad guidelines designed to meet Servicewide objectives. Due to the diversity of areas (which now number over 370 sites; NPS 1997), their legislative history, their location within a larger ecosystem context, and the particular needs of a species or assemblage of species, park managers have a great deal of flexibility and discretion in designing wildlife programs. In 1991, NPS produced a guideline for natural resource management, *NPS-77,* which further amplifies the 1988 management policies with established or recommended practices and procedures for many aspects of the program (NPS 1991). Among these are more detailed discussions of native animal management; endangered, threatened and rare species; hunting and trapping; and exotic species management. These sections are designed to assist park managers in the development of resource management plans and action plans for specific programs. Just as important, they discuss the external concerns of managing native animals across park boundaries.

By way of illustrating policy interpretation and application in real situations, let us examine several recent events that have occurred at Badlands National Park, located in the southwest corner of South Dakota. Our first case study involves controlling the migration and establishment of black-tailed prairie dog *(Cynomys ludovicianus)* colonies on private and national grassland prairie communities adjacent to the national park. Within South Dakota, the prairie dog is designated a pest species and active efforts are maintained by the state to eliminate colonies when range managers complain (SDDA 1994). For the park manager, the policy is relatively clear: a native species to the badlands, prairie dogs are an important—and according to some (Kotliar et al. in press; Miller et al. 1994), a keystone—species within prairie ecosystems. (A keystone species has a large overall effect on community or ecosystem structure or

function, an effect disproportionately large relative to its abundance; see Power et al. 1996.) Seen as a competitor for scarce forage and a destroyer of rangeland, emotions run high when colonies expand outside the park boundary. The park has, on a case-by-case basis, prior to 1994, controlled colonies within one-half mile of private lands, using zinc phosphide, when requested to do so by adjacent land-owners. The *Management Policies* define an animal "pest" population as one which interferes with the purposes of the park (NPS 1988, chap. 4:13). While prairie dogs in and of themselves don't interfere with park purposes, they are a state-listed pest species and subject to control. The NPS policy statement goes on to say, "Native pests will be allowed to function unimpeded except where control is desirable ... to prevent outbreaks of the pest from spreading to ... other plant communities ... outside the park." The state, along with a private landowner, may take steps to control a population beyond park boundaries only to have it recolonized by animals migrating out of a heavy density on park lands, creating a chronic problem for the land-owner. In such a case, and using the exemption cited above, NPS would conduct a biological assessment, and, if disparate densities between NPS lands and private lands outside the boundary exist, control measures may be initiated. Further complicating any such action contemplated by NPS is the ongoing effort to reintroduce the endangered black-footed ferret onto park lands. While this may make control efforts more complex, the environmental impact statement for ferret management (USFWS 1994) did allow for the continuation of limited prairie dog removal even where the presence of ferrets was documented.

A second case study involves one of several species of native grasshoppers found within the prairie ecosystem. One, the migratory grasshopper *(Melanoplus sanguinipes),* is of economic interest as it is known to contribute significantly to crop and rangeland damage (APHIS 1997). Through emergency designation it has been declared a pest species in South Dakota in past years (SDDA 1997). In 1996 and 1997, populations increased dramatically, and agricultural land-owners adjacent to the south boundary of Badlands initiated a campaign to obtain funding for the Animal and Plant Health Inspection Service (APHIS) to conduct a preemptive aerial spray campaign on lands administered by NPS but held in trust for the Oglala Sioux Nation within the Pine Ridge Reservation. Using the same policy guidance as in the previous instance, APHIS was requested to initiate aerial spraying during the third instar of the species and at a time when visual counts with a sweep net were resulting in over 90 animals per sweep. A quarter-mile

buffer zone was established within the park boundary adjacent to cropland.

I believe that the Servicewide policies pertaining to the management of wildlife species do provide viable options for prescriptive manipulation of populations and their habitats. Both prairie dogs and grasshoppers, by nature cyclical and migratory, influence vegetation within an ecological context across political and ownership boundaries. Solutions based upon research findings and founded on common understanding and compromise among the several affected parties, using an integrated pest management (IPM) approach, can achieve results that meet each party's objectives without unacceptable long-term loss to park resources.

Parks do not exist in vacuums, but rather as islands among a sea of jurisdictional ownerships. Managing fragmented ecosystems with only part of the historic faunal component, policy must—and does—recognize the need to intervene at some definable threshold of tolerance.

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Michael A. Ruggiero

Wild Life is More than Wildlife:
Policy for Other Animals in the National Parks

I have been asked to speak about the "other animals" in the national parks, or pose the question, "Is wild life more than just wildlife?" During my presentation I will attempt to convince you of the importance of the "other animals," or, as I've also heard them called, "the spineless majority!" I will discuss National Park Service (NPS) policies and approaches for managing the invertebrates, and finally, provide my recommendations for the future.

Let me begin by pointing out that the "other animals" are most important for their contribution to ecosystem goods and services, or in other words, biological diversity and ecological processes, and in that importance they have economic value. This group contains the real resource managers of the national parks!

If we look at sheer numbers, the insects and other arthropods alone make up more than 75% of all described species. If we look at threatened U.S. species (Figure1), according to IUCN (Baillie and Groombridge 1996), we see again a dominance by the "other animals."

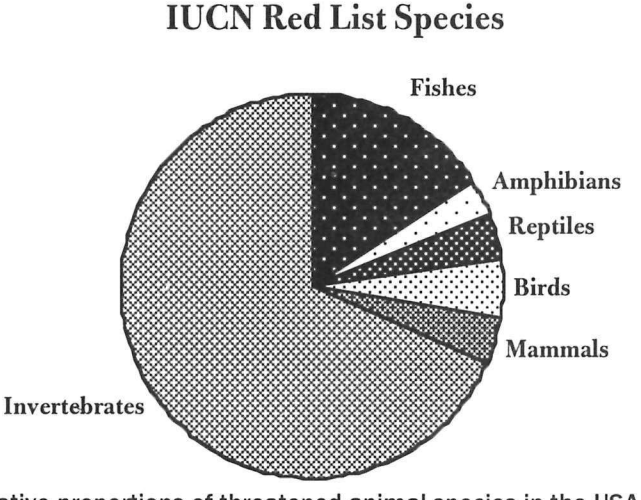

Figure 1. Relative proportions of threatened animal species in the USA

By now you're probably thinking, "So what about numbers—let's talk about importance!" Well, then, to use an old Washington adage, let's follow the money!

Costanza et al. (1997), tried to place an economic value on ecosystem services. They estimated 17 services on a global basis across all biomes, and arrived at an average annual value of $33 trillion. They also noted that, in comparison, the "global gross national product" is about $18 trillion per year. If we look at five of the services that involve a lot of activity by the "other animals" (Table 1), we can easily see their potential economic importance. While obviously dominant in pollination and biological control, the invertebrates are, at least, key players in nutrient cycling, food production (either as food or as food for food), and in recreation as part of and managers of the scenery.

So, other animals are important. How is this group treated and viewed by NPS? I would like to answer the question by looking at NPS policies, emphasis, and, yes, money devoted to studying the group.

From a policy standpoint, I think NPS has had a somewhat enlightened approach toward the group, and has been ahead of its time, for a long time in many respects. For example, NPS has long held that natural processes should be allowed to operate without management intervention. The NPS policy in 1980 of using integrated pest management was well ahead of its time (and has probably saved countless billions of "other animals" from the indiscriminate effects of broadcast chemical insecticides). These two polices, applied together, have been very favorable in conserving the enormous diversity of invertebrates in national parks. In this matter, NPS has been steadfast, even if it has meant defending mosquitoes, ticks, and black flies from time to time.

Table 1. Annual global economic value of ecosystem services

- Pollination = US $117 billion / year
- Biological control = US $ 417 billion / year
- Nutrient cycling = US $ 17 trillion / year
- Food production = US $ 1.4 trillion / year
- Recreation = US $ 815 billion / year

That leaves us with emphasis and money to consider. Figure 2 shows what was reported by NPS for expenditures, from all sources, on natural resources research and studies during the six-year period from 1991 to 1996. The relatively small amount spent on the invertebrates is obvious. In fact, of the $10 million spent on invertebrates, $7 million came from sources other than NPS. There is obviously interest by others in the invertebrate fauna of national parks.

What do I recommend with regard to policy for the "other animals"? I believe that the largest threats to this group will stem from our lack of knowledge about them. NPS policies seem, in theory, robust enough to protect them, but in practice, ignorance and neglect of them could lead eventually to serious problems. I recommend the eight activities listed in Table 2 to put further emphasis on this group. These recommendations were developed largely at an NPS workshop in 1992 and subsequently reported by Ginsberg (1993).

As a final comment, I caution that as we rush to become more "active" managers of the environment, let's not forget about protecting those "other animals," already on the job, 24 hours a day, seven days a week. For if we remove them from the system, we inherit their work.

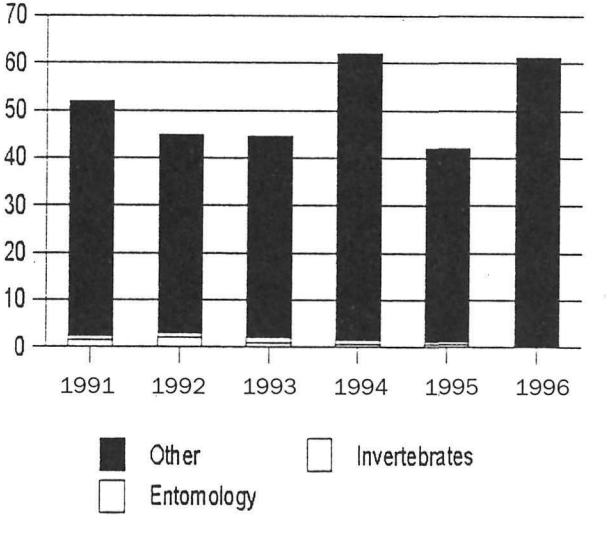

Figure 2. Funding for invertebrate studies in U.S. national parks, 1991–1996 (millions of dollars)

Table 2. Recommended activities to emphasize the study of invertebrates in parks.

• **Inventory historical information**
• **Inventory current collections**
• **Develop reference materials**
• **Target inventories**
• **Research inventory methods**
• **Foster use of outside talent**
• **Harmonize databases**
• **Educate and train**

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Linda L. Wallace

Evolution and Wildlife Management

All ecosystems contain multiple layers of information. These layers may coincide with trophic levels, or they may coincide with human usage patterns in the system. Additional layers are provided by the organisms living within the system as they interpret information concerning resource availability, mating opportunities, etc. When we manage an ecosystem, we place values on different forms of information. Some are extraneous to our management goals and are therefore considered to be unimportant. Other information may be used in various ways and interpreted differently depending on our management goals. However, managers must take great care not to dismiss information that may be critical to the survival of components of the ecosystem other than those directly affiliated with their management goals (e.g., non-target species).

This paper examines the role that information about vegetation plays in ecosystem management, when the goal of that management is the production of wildlife species. Frequently, "wildlife" is narrowly defined as being mammalian species, rather than including birds and fish. In this paper, this definition is narrowed even further to allow us to examine what role vegetation information has played in the management of herbivorous wildlife species. Four primary types of vegetation data have historically been considered to be critical in the management of wild herbivores. These include whether or not the system is overgrazed, the effects of grazing on community structure (usually defined as species diversity), information on exotic plant species and spread, and the effects of management on endangered plant species or habitats (e.g., riparian areas). I will examine each of these briefly and will conclude by encouraging managers to add a new data layer to their arsenal: that of the evolutionary responses of vegetation to herbivory.

Overgrazing and Wildlife Management

Implicit within the term "overgrazing" is the concept that ecosystems have an equilibrial level to which they will return if left unperturbed by humans. Different definitions of overgrazing exist depending upon the definition of this equilibrium (Coughenour and Singer 1991). The most relaxed definitions assume that ecosystems have multiple stable states (Caughley 1979) or exhibit chaotic behavior. The definitions which are least relaxed assume that there is a defined equilibrial

point for ecosystems, and that reductions of plant vigor, extinctions of species, and reductions in herbivore biomass can result in an irrevocable change in the system. This is analogous to the terminology introduced by Lauenroth et al. (1978) when they found certain combinations of perturbations to the shortgrass prairie that resulted in the formation of a new community structure that would not return to shortgrass prairie. This new structure was termed a "basin of attraction."

A great deal of interest has focused on the idea of irreversible ecosystem change in the management literature, particularly as it applies to the idea of carrying capacity (Caughley 1979). Strictly defined, carrying capacity is the number of organisms a given environment can support at a given time in a sustainable manner. This definition does not consider climatic variability. Climate is extremely important in regulating variance of biomass production between years, while shorter-term factors such as grazing are more important in regulating biomass production (both mean and variance) within a given year. In a meta-analysis of grazing literature, Dyer and Wallace (in prep.) found that grazers tended to increase mean production of monocots while reducing the coefficient of variation (CV) around that mean within a given year, resulting in a more stable or predictable mean. Dicots responded in a very different manner, with no general response in either mean or CV. Thus in monocot-dominated systems (e.g., grasslands) , it appears that grazers tend to control the mean biomass production and the stability of that mean within a year. To date, only one field test of this finding has taken place (Bell 1997), in which grazers were found to increase mean production and decrease its CV for monocots at the landscape scale. However, grazers had no significant effect on mean production and its CV for dicots, or for monocots at the community or individual-plant scales. Climate was found to be important for regulating the variability of biomass production between years. Of several factors examined, grazing had the greatest influence on production variability, decreasing it significantly at the landscape scale for both years of the study. Thus, our definition of carrying capacity has to be modified to realize that the interaction between herbivores and their forage base may be under different controls than we previously imagined. This does not come under our typical overgrazing definitions, but rather views grazing as having effects that may differ at different spatial and temporal scales (Brown and Allen 1989; Hendon and Briske 1997).

Grazing and Community Structure

Volumes have been written concerning the effects of grazing on plant

community structure (for reviews see Vallentine 1990; Heitschmidt and Stuth1991; Wallace and Dyer 1995, 1996). Much of the management literature describes the "climax" stage of a community and states that any change from this stage due to herbivory constitutes range degradation. Numerous examples have been found in which managed grazing by both wild and domestic herbivores has caused reductions in species diversity. Again, depending on the definition of ecosystem stability used, some of these changes could be due to the combined effects of climate and grazing and could be well within the natural range of variation experienced by the system and its multiple stable states or chaotic behavior (van de Koppel et al. 1997). Although there is considerable controversy surrounding the diversity–stability issue (Tilman and Downing 1994; Huston 1997), the potential for change in ecosystem functioning due to alterations in community structure is of great concern to managers.

Grazing and Exotic Plant Species

Grazing opens plant canopies (Heitschmidt and Stuth 1991; Escos et al. 1997) thereby increasing the amount of bare ground in many communities (Wallace and Dyer 1996). These openings can increase the relative availability of light and nutrients, both critical resources in grazed systems (Tilman 1990). Invasion of exotic plant species appears to be enhanced when such openings exist. Once such a foothold is gained, further movement of the exotic throughout the system can occur, either with or without the mediation of grazing. Examples of such invasions include Russian and spotted knapweeds, leafy spurge, Canadian thistle, cheatgrass, ox-eye daisy, and more. These exotics further their spread into communities primarily where they are not consumed by wildlife herbivores, while many of the native species are grazed. This sets up asymmetric competition in which the native species are at a disadvantage (Keddy 1989; Law et al. 1997). Exotic species may alter ecosystem function sufficiently to force the system into a new basin of attraction (Chapin et al. 1997). One example of this is cheatgrass invasion, in which the phenology of *Bromus tectorum* has altered the fire regime of much of the sagebrush grasslands of the intermountain western USA, causing the loss of many native species (Mack 1981; Brandt and Rickard 1994). It is interesting to note, however, that current livestock grazing is not always a prerequisite to the invasion by exotic species. Brandt and Rickard (1994) found that exotic species still readily invaded areas which had been grazed several decades prior to their study.

Grazing and Endangered Species or Habitats

Riparian areas and other critical habitats are particularly susceptible

to degradation by herbivore use (see Naiman and Rogers 1997 for a review). Large-bodied animals create paths, which increase soil erosion into waterways, compact the soil, and can greatly decrease vegetation growth in these sensitive areas. Browse species can be negatively affected either directly (through heavy browsing) or indirectly, due to animal effects on soils, overstory vegetation, hydrology, etc. When regulating animal usage of these areas, it is important to separate direct and indirect effects so that managers know whether solutions lie in reductions of animal numbers or some form of habitat modification to ameliorate damage. Other habitats which have been critically affected by wildlife grazing include arid grasslands. These grasslands can easily be shifted from a grass stable-state to a woody vegetation state (van de Koppel et al. 1997). If wildlife movements are restricted, or wildlife are somehow forced into these environments, or wildlife and domestic grazers both utilize the same area, desertification can occur.

Any wildlife management plan for a region including such habitats needs to take rare and endangered species into consideration. The primary cause of species being listed as threatened or endangered is loss of habitat. Wildlife grazing in fragile areas such as riparian sites or tundra may place unique species at risk. For example, *Philippsia algida* (icegrass) is a rare species that grows in wet alpine gravel below melting snowbanks (Clark et al. 1989) and is threatened by livestock grazing.

Shortcomings of Past Usages of Vegetation Information by Wildlife Managers

Wildlife managers are frequently faced with the issue of ecosystem management as well. If one was assigned the task of managing a typical engineering system, the task would be much more straightforward. Such systems typically have one or more definable inputs and equally definable outputs which not only need to be maximized in terms of the input variables, but also usually operate at only one spatio-temporal scale. On the other hand, wildlife managers are frequently faced with managing systems that do not have a simplistic input–output relationship. If a wildlife manager is to maximize the production of wildlife, would this place another portion of the ecosystem at risk? The typical usage of vegetation information in the past has been to yield data about ecosystem health. However, we are now finding that this issue is not as readily understood as we previously thought. Ecosystem health must be defined at many different spatial and temporal scales (Brown and Allen 1989; Allen and Hoekstra 1992; Dobson et al. 1997; Herendon and Briske 1997; von de Koppel et al.1997). Examining vegetative characteristics as static snapshots may lead to erroneous in-

terpretations in terms of the system's state relative to its long-term dynamics.

An additional, philosophical question that also depends on an understanding of system functioning at different scales is the idea of whether or not the system is "natural." Human influences on ecosystems are somehow considered to be "unnatural" or are felt to transform an ecosystem from its "natural" state to an "unnatural" one. Given that grazing ecosystems can have multiple stable states (von de Koppel et al. 1997), it is important to know what past ecosystem dynamics may be and whether or not human influences have pushed an ecosystem out of range of those preceding dynamics into a new basin of attraction. Complicating this further is the notion that potentially stable states may vary continuously with changing climate. Hence, wildlife managers striving to maintain a "natural" ecosystem that is defined according to some static ideal may not be allowing the ecosystem to express its full range of dynamic responses.

This lack of long-term knowledge of ecosystem dynamics can also lead to unrealistic expectations of herbivore behavior. Just as we have developed the myth concerning the role of Native Americans in "pristine" ecosystems (Schullery 1997), we also have a myth which states that free-ranging wildlife grazers will never have negative effects on an ecosystem. If these animals are constrained to stay in one area for any reason, if climatic variables change, or if the herd population age structure is altered, the effects of wild herbivores on the system may change over time. Again, this must be placed in context of long-term ecosystem dynamics to interpret just how seemingly novel grazing behaviors may fit within the realm of ecosystem behavior.

Grazing and Evolutionary Biology

The evolutionary history of most forage species in North America is not extremely long (Axelrod 1985; Gottlieb and Jain 1988; MacFadden 1997). The post-Pleistocene rise of the North American flora and fauna has led to some species being tightly coupled to grazing as an important disturbance element in their physiological, morphological, and reproductive development. By examining the responses of species to grazing intensity, frequency, and seasonality, we may be able to understand their evolutionary history more fully. This history then can tell us more about long-term ecosystem dynamics in ways which would be extremely informative to wildlife management.

Milchunas et al. (1988) eloquently express how the evolutionary role of grazing in a system may influence vegetation response to herbivory. In arid systems, plant community diversity will suffer with increased grazing intensity. However, this effect is more moderate in a system with an evolutionary history of grazing than

one in which there has been little grazing over evolutionary time (Mack and Thompson 1982). Similar responses are noted for ecosystems in more mesic climates, with those systems with a long grazing history showing responses to herbivory similar to what would be predicted by the intermediate disturbance hypothesis (Connell 1978).

How long does a system need to be grazed in order to have a "long evolutionary history"? A subset of this question might be, "How quickly can plant genotypes adapt to grazing?". This has been the subject of research examining the development of grazing ecotypes. Detling and his coworkers have found that the time frame for the "development" of ecotypes showing grazing-adaptive traits can be quite short. In studies in northern mixed grass prairie, differential responses were found in as short a time as 31 years (Detling and Painter 1983; Polley and Detling 1988).

Thomas and Wallace (in prep.) found that differential responses to clipping mimicking grazing could be found in a very short time in tallgrass prairie. *Andropogon gerardii* (big bluestem) showed different morphological growth patterns between clones growing either within a 25-year-old exclosure or outside of it (Figure 1). Interestingly, *Schyzachrium scoparium* (little bluestem) showed no such response. However, this species is seldom grazed by large-bodied herbivores (e.g., bison, cattle, elk).

These types of studies show that there is sufficient genetic variation in grazed systems (even those in which vegetative reproduction predominates) such that grazing-adaptive ecotypes can exist. Tonielli (1995) found sufficient genetic diversity (Table 1) between two populations of *Phleum pratense* (timothy), an exotic grass species growing in Yellowstone National Park, to correlate with the differential response of these two populations to the combined effects of grazing and drought (Figures 2 and 3). The population from the more mesic, deeper soil location was unable to maintain high rates of gas exchange in the face of drought and grazing while the population from the drier, shallow-soil site was unaffected by drought and grazing (Figure 2). Greenhouse experiments on the two populations indicate differential responses of biomass accumulation in dry rather than moist conditions as well (Figure 3). This, again, points to the critical role played by climate variability in vegetation responses.

Therefore, grazing ecosystems can maintain a wide range of genetic variability, capable of different responses to different levels of herbivory. Given this, it is an important source of information to wildlife managers in terms of what the long-term history of the system in question may be. For example, carefully

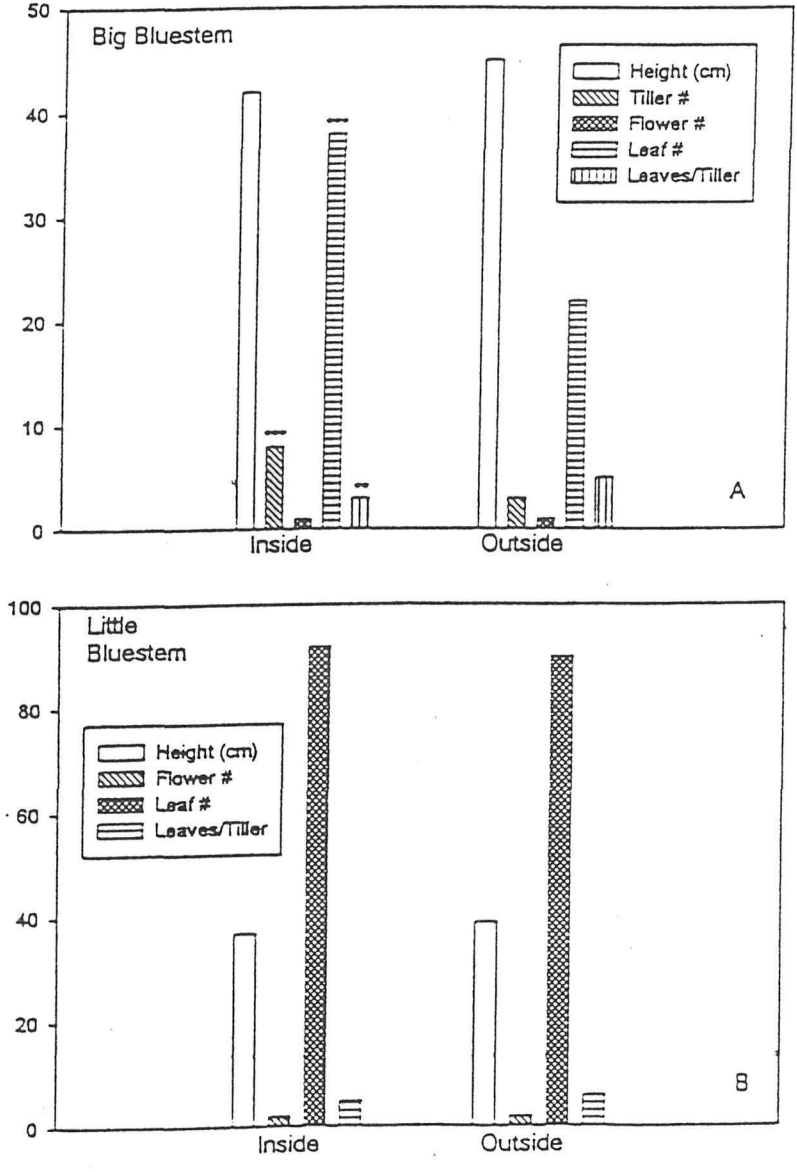

Figure 1. Morphology of *Andropogon gerardii* (big bluestem) (A) and *Schizachyrium scoparium* (little bluestem) (B) populations collected originally from inside and outside a 25-year-old exclosure in the Wichita Mountains Wildlife Refuge, southwestern Oklahoma. *Schizachyrium scoparium* is not usually grazed, while *A. gerardii* is a preferred forage species. Therefore, we can see significant differences between clones exposed to or protected from grazing in the latter species, but not the former.

Table 1. Indices of genetic variation in two populations of *Phleum pratense* in Yellowstone National Park. Means are given for each population with standard errors in parentheses, where applicable. Between-population indices (I and D) are also presented (Tonielli 1995).

	Upper Norris	*Lower Cache Calfee*
Mean sample size / locus	23.6 (0.6)	53.7 (0.4)
Mean number of alleles / locus	1.4 (0.3)	1.4 (0.3)
Proportion of polymorphic loci	21.4	21.4
Mean number of alleles / polymorphic locus	3	3
Mean observed heterozygosity	0.068 (.038)	0.061 (.035)
Mean expected heterozygosity	0.087 (.052)	0.094 (.054)
Nei's (1978) genetic identity (I)	0.997	
Genetic distance (D)	0.003	

crafted experiments can show which frequencies and intensities of grazing could optimize the growth of different genotypes (Oesterheld and McNaughton 1988, 1991). These studies could also be coupled with timing of precipitation, and different soil types (Georgiadis et al. 1993; Hicks and Reader 1995; Tonielli 1995; Varnamkhasti et al. 1995), to show what seasonal levels of grazing may have resulted in optimal growth in the past and how these levels interact with soil types (Molvar et al. 1993). These data could be collected from clones located across a landscape or across resource gradients on the landscape. Then, by taking this information and organizing it within a spatial and temporal model of the landscape, the manager could develop an evolutionary model of herbivore grazing intensities. If the movement patterns and grazing intensities found in the extant landscape do not fall within these bounds (allowing for interannual variability), the manager may wish to take additional actions to modify herd movements, herd size, etc. The choice of forage species to study is extremely important. Both currently dominant species as well as rare species need to be examined, because rare species may be rare due to their response to herbivory, rather than a response to competitive pressures (Hartnett 1989; Hulme 1996).

Experiments such as those described above examine the evolutionary history of the entire ecosystem. They do not discern the mechanism for the range of responses shown by either the herbivores or the plants. This has been an area of great controversy (e.g. Brown and Stuth 1993; Cebrian and Duarte 1994; Post and Klein 1996). How-

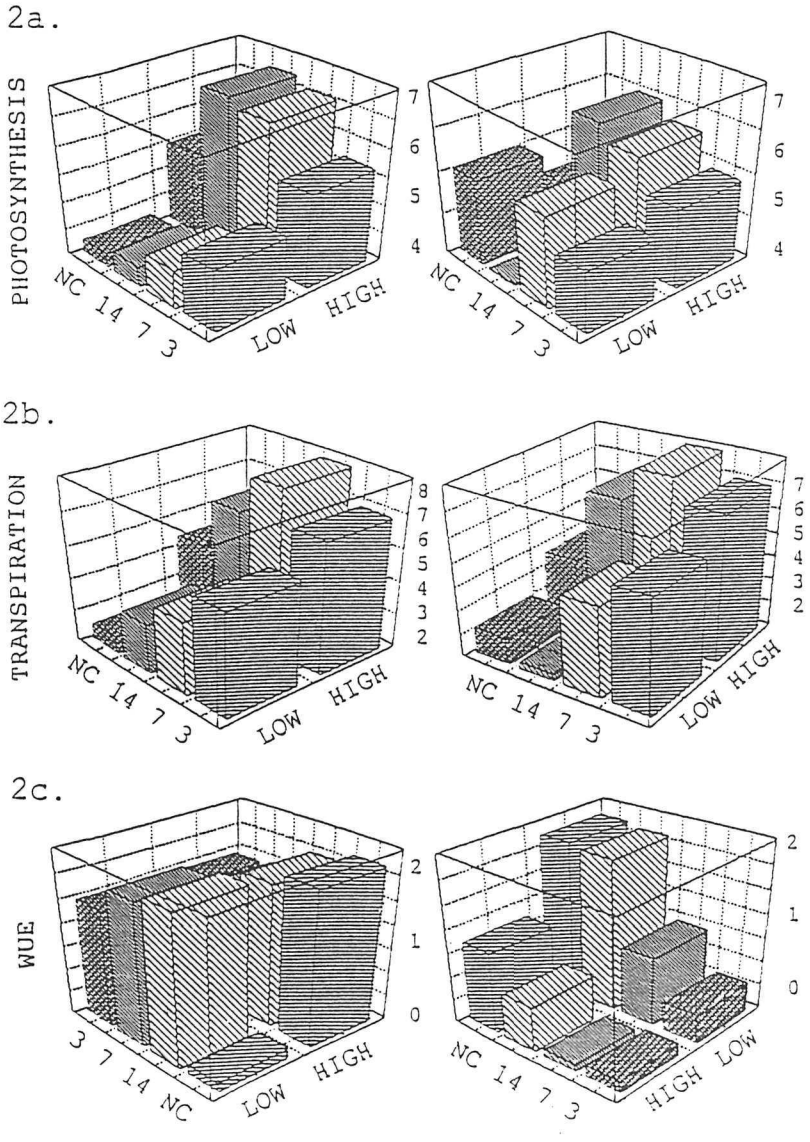

Figure 2. Physiological responses of two populations of *Phleum pratense* from Yellowstone National Park. The populations were collected at two sites, Upper Norris (UN) and Lower Cache Calfee (LCC) and were exposed to daily watering (HIGH) or weekly watering (LOW) and different clipping frequencies. NC = not clipped, 3 = clipped every 3 days, 7 = clipped weekly, 14 = clipped every other week. Data for UN are shown in the left column and for LCC are shown in the right column. Note that the population from the LCC site shows little difference in responses between high and low watering regimes. Large differences are noted for the other population.

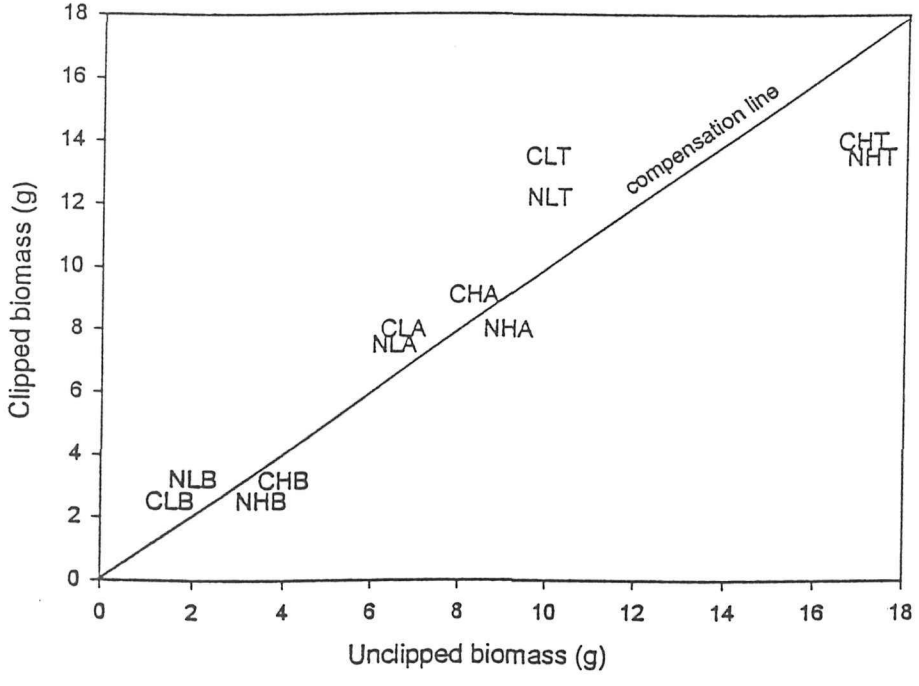

Figure 3. Comparison of clipped and unclipped treatments at the end of the experiment described in the legend of Figure 2. Legends for the points on the graph contain three sets of information. The first letter designates which site plants are from (N=Upper Norris, C=Lower Cache Calfee); the second letter describes the watering regime (L=low water, H=high water); the third letter describes which plant component was weighed (T=total biomass, A=aboveground biomass, B=belowground biomass). Note that plants which received less water tended to overcompensate regardless of the site of origin. This is important evidence for the differential effect of climate on ecosystem response to herbivores.

ever, in terms of understanding if the extant dynamics are sustainable, this question is not immediately germane. If it is determined that grazing levels are indeed not sustainable, then determining the causal agent will become critical to the manager's response.

In summary, ecosystems are dynamic entities which are capable of maintaining multiple stable states. Rather than manage for a static entity, it is critical that wildlife managers use the vegetation response to different frequencies, intensities, and timing of grazing to understand what the long-term dynamics of the system may have been. Given these boundaries of system behavior, the manager can then monitor the system to de-

termine if those boundaries have been exceeded and whether or not this excess may lead to system degradation. It is critical to attempt to do this analysis in a predictive rather than in a *post hoc* manner so that predictive models of ecosystem behavior can be developed (Nichols et al. 1995). Integrative models would also allow managers to use the large number of data layers available to them, rather than focusing on only a few output parameters. These models would, I hope, reflect the evolutionary history of the system in question more than short-term economic considerations or the biases of the system's political constituents.

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Using the Past to Shape National Park Service Policy for Wild Life

NPS Natural Resource Management Policies and Paleoecological Research

To understand modern ecosystems and the wild life in them, and manage these and future ecosystems, one has to know about past ecologies and the complex interrelationships among their biological, geophysical, and sociocultural components. In drafting its statement of ecosystem management within the National Park System (NPS 1994), the National Park Service (NPS) recognized that "living things exist in complex, interconnected systems within a broad landscape" and that cultural systems are and have been part of ecosystems (NPS 1994, 5), though this is not clearly recognized in Halvorson and Davis's recent book *Science and Ecosystem Management in the National Parks* (1996).

I manage a park with Miocene mammalian fossil beds, and I suggest that paleontological and paleoecological information from throughout at least the past 20 million years is useful to understanding modern ecosystems (Knudson 1999). Certainly we ought to understand them throughout the 100,000 or so years of the Wisconsinan period of the Late Pleistocene, and certainly we need to understand the paleoecology of the last 15 to 25 millennia in North America, the terminal Late Pleistocene and Holocene period, when people were living in the American hemisphere.

Current NPS policies for managing wildlife are set forth in the agency-wide *Management Policies* (NPS 1988, chap. 4), which are consistent with the Leopold Report's recommendation (Leopold et al. 1963) that NPS landscapes should generally represent pre-Euroamerican panorama (cf. Huff 1993, 1997; Sellars 1997; Wagner et al. 1995). The more recent *Natural Resources Management Guidelines* (known as *NPS-77;* NPS 1991) retain this approach. Natural and social science research are an integral element in supporting NPS natural resource management program planning and implementation. However, as Porter and Underwood (1996) have pointed out, NPS reacted to the Leopold Report, and the various policies based on it, by seeking ecological constancy rather than equilibrium. As NPS has developed new understanding of the fluctuations in natural processes and worked at developing more responsive resource manage-

ment programs, it has had problems communicating the value of the new concepts in contrast to the publicly understood goal of maintaining the status quo.

NPS's 1993 sustainable design guidance (NPS 1993) includes requirements for a basic understanding of natural behavior within an ecosystem, cumulative human demands, an initial definition of the acceptable limits of change, and routine monitoring and evaluation. Understanding the dynamic nature of ecosystems over the past 100,000 years and formally recognizing this in policy and guidance would add significantly to the Service's ability to plan and monitor its natural resource management activities and gain public support for those.

Academic and government scholars have been conducting paleoecological research in the national parks throughout the past century, especially during its second half. Most of these paleoecological studies (e.g., Fryxell 1930; Heusser 1972; Mehringer 1977; Waddington and Wright 1974; Wright and Frey 1965; cf. Beaudoin and Beintjes 1994) have focused on biological or geophysical contexts, but there has also been a century of archeological and historic studies that provided paleoenvironmental data. These began on what were to be NPS lands as early as Bandelier's 1880 research at Pecos (Lee 1970; cf. Rothman 1989) and continue today with projects such as those by Kuehn (1995) and Fredlund and Sundstrom (1996). Together, these constitute some of the most significant contributions to Late Quaternary studies.

Until recently (e.g., Whitlock et al. 1991) NPS has not consciously incorporated the collected data into its natural resource management programs. The terms "geomorphology," "paleoecology," "palynology," and "pedology" are not mentioned in the 1991 natural resource management guidelines, and much less is there recognition of the baseline data available in cultural resource studies. NPS now recognizes that the systematic evaluation and synthesis of the known paleoecological data from its park units and their regional contexts, and programmatic collection of new data, is a critical element in managing the dynamic ecological communities within the agency's lands and waters. There is also an opportunity for the NPS, particularly in partnership with the U.S. Geological Survey's Geological Resources, Water Resources, National Mapping (McClelland 1997), and Biological Resources (Selleck 1997) divisions, to provide leadership in building models for the practical application of these scientific data about past ecosystems. The Sierra Nevada Ecosystem Project (CWWR 1996) incorporated sociocultural, biological, and geophysical information and evaluations into its management planning. Yellowstone's

northern range studies (YNP 1997) are a pivotal recognition of the interrelationships of the sociocultural, biological, and geophysical components within ecosystems and the utility of diachronic information about all these relationships in wildlife management planning.

Climatic Change Over 110,000 Years

We now have information about 110,000 years of climate and climatic changes leading up to the present time in North America, including scientifically acceptable information about the presence of people in the American ecosystem in the Late Pleistocene.

Radiocarbon (^{14}C) dating of organic materials up to about 40,000 years in age was introduced to the archaeological and geological world in January 1948 (Taylor 1987, 155), and our understanding of paleoecology has developed immensely since. There is a variety of methods for dating organic and inorganic Quaternary deposits and materials (Rutter and Catto 1995) that provides us with chronological data to build models of past climates and ecosystems.

For generations people have been trying to figure out how climates and weather come to be, probably since people relied on hunted and gathered wild foods and certainly since they began to rely on cultivated crops. In his introduction to the recent publication on the COHMAP project (Cooperative Holocene Mapping Project; Wright et al. 1993), Wright (1993) notes that it was Milankovitch's post-World War I computations of variations in the Earth's orbit around the sun that was the key to the scientific understanding of climate and climatic variability. Milankovitch had documented the Earth's "precession," or seasonal changes in the Earth–sun orbital geometry due to solar and lunar gravitational forces upon the Earth. When ocean cores and glacial features could be radiocarbon-dated, there was an apparent correlation of major climatic changes and the precession cycles.

On the basis of this information, and with increased computer capabilities, the CLIMAP (Climate Mapping, Analysis and Prediction) modeling project was initiated in the 1970s by a group of paleoceanographers. Computerized models of Milankovitch cycles were compared with ocean core data, and the CLIMAP reports proved to be strong evidence supporting Milankovitch's theories. In the late 1970s, the COHMAP project was initiated to model climates over both land masses and ocean bodies. COHMAP models include global January and July temperatures, surface wind/sea-level pressures, precipitation, annual precipitation minus evaporation, wind speed, and surface storm tracks at 3,000-year intervals over the past

18,000 years (Wright et al. 1993). Broecker (1995, 1997), who has modeled the ocean's thermohaline circulation system, notes that it is very sensitive to freshwater additions and may be a key to global climatic shifts that can jump from one mode to another in a decade. Bryson (1988, 1993) has been a leader in modeling climate change in the Northern Hemisphere, and has highlighted the influence of volcanic ash in affecting solar budgets and weather patterns. It should be noted that not all scholars (e.g., Muller and MacDonald 1997) accept the primacy of Milankovitch cycles in regulating glacial cycles, but the Milankovitch model prevails at present.

Any model is only as good as the data supporting it. A problem linking the models and real-world data was pointed out recently in an overview of general circulation models by Sellers et al. (1997), who note that the global carbon cycle is intricately linked to the physical climate system and that, therefore, radiocarbon determinations must be calibrated against some other dating system to accommodate the climatic changes being documented (cf. Eglington et al. 1997; Freeman 1997; Schindler et al. 1997).

Since the modeled COHMAP data have been developed, researchers around the world have used datable sediment core materials (e.g., pollen, dust, volcanic ash, invertebrates, soils) to test the hypothesized data triggered by precessional concepts. Past paleoecological information collection from national park lands is important to evaluations of these models, and new research designed to provide a more systematic understanding of the paleoecology of individual park units would provide comparative information for testing the modeled hypotheses, as well as support more informed natural resource management planning and public education.

In the 1990s, several deep cores were taken from the ice in Greenland (Zielinski and Mershon 1997) and Antarctica (Mayewski et al. 1996), and these give annual climatic data for the past 110,000 years. The Greenland GISP2 core and evidence from ostracod and disseminated organics and seeds in pluvial Lake Estancia, New Mexico (Allen and Anderson 1993), indicate significant climatic changes between 20,000 and 13,000 years ago at decadal intervals.

Researchers are learning a lot about global patterns, and are refining it and regionalizing it with data from specific landforms, cores, estimated ice volumes, etc. Recently, a working group of zoologists and archeozoologists has developed the FAUNMAP database, collecting information on the fossil mammal faunas from nearly 3,000 localities across the USA (Graham et al. 1996). The data document that mammalian range shifts were a complex response to climatic change,

habitat reorganization, biological interactions, and stochastic events, and the researchers concluded that models for future change must rely more on individual species and their requirements than on species associations. In complement, Pitelka et al. (1997) have used a COHMAP-like approach to model the distribution of plant communities over periods of climatic change, and comparison of these and the FAUNMAP data may aid in explaining faunal distributions over time. Holman (1995) has synthesized the existing knowledge of Quaternary herpetofaunas in North America, and notes that no genera became extinct at the Pleistocene–Holocene transition. The concept that glacial cycles and related climatic changes have had a dominant role in influencing vertebrate genetic adaptations during the Quaternary is not supported by songbird genetics (Klicka and Zink), which document a five-million-year history of speciation.

While the traditional U.S. professional archeological hypothesis is that people settled the Americas from Asia, bioanthropological documentation of that is ongoing, and several scholars are questioning the hypothesis (e.g., Bonnichsen et al. 1995, 41-44; cf. Deloria 1995). The preponderance of the morphological, genetic, and mitochondrial DNA evidence collected to date from Native Americans supports an Asian-origin hypothesis. Recent geological investigations at the archaeological Diring Yuriakh site on the Lena River in northeastern Siberia support dates of from 366,000 to 240,000 years ago for humanly made choppers and scrapers (Waters et al. 1997, though see Rink 1997), which provides evidence of an adaptation to northern latitudes older than that which was previously believed. At this point, the possibilities are open as to the earliest movement of people into the Americas and what would be recognized as evidence of their presence.

There is well-accepted archaeological evidence from the Monte Verde site in Chile (Dillehay 1997) that people were established in the Americas by 12,500 years ago. Native American population estimates in 1492 vary. Dobyns (1983) estimates that the population north of Mexico then was 18 million, and this is generally supported by Ramenofsky (1987); in contrast Verano and Ubelaker (1992) estimate under 2 million people. I am more comfortable with Dobyns' and Ramenofsky's research.

Many of the local geophysical, biological, and cultural data continue to come from NPS lands and waters (e.g., Kuehn 1995; Romme and Turner 1991), and the relatively unmodified properties could be an even greater source of paleoecological information to use in managing resources and providing public education.

Paleoecological Data Collection and Analysis

We know North American ecosystems of the past were dynamic, and that people were part of them from at least 12,500 years ago, and perhaps as much as 30,000 years. What are the methods of collecting information about what the past ecosystems were like and how people, fauna, flora, weather, and Earth resources interacted?

Information can come from archaeological sites with associated paleoecological data, or from sites with no cultural evidence. In additional to the paleoecological information, archaeological sites often provide direct evidence of human use of natural resources or the landscape. Physical remains that provide paleoecological information include the following: geomorphology and stratigraphy; soils, with humic acids for dating; pollen; malacology; plant macrofossils, including peat; vertebrate remains; core materials, including oxygen isotope data, dust, volcanic ash, and diatoms.

Information is also available in historical records and archival materials, including comments from early Euro-American explorers, such as Lewis and Clark (Moulton 1983, 1986-1993), Ogden (Cline 1974), and Culbertson (1952); artists and draftsmen such as Bodmer (Hunt and Gallagher 1984); and early photographers such as Curtis (Andrews 1962) and Jackson (Hale 1984). There are extensive comments about vegetation and marker trees in the records of the General Lands Office that date to 1812 (since the 1940s, the records have been held by Division of Lands of the Bureau of Land Management; see Harrison 1962). There are 6,000 volumes of cadastral survey notes (a major source of vegetation data) and 100,000 survey plats. There is also information about flora, fauna, weather, and landscapes in diaries and letters in local, state, and national archives (e.g., Bustard 1992).

There is a wealth of natural resource information in ethnographic reports and frontier autobiographies, particularly those from the late nineteenth and early twentieth centuries when Native Americans were still practicing many of their traditional subsistence patterns (e.g., Schultz (1962) about life in the Northern Plains between 1878 and 1915; see also Glenn 1992). Schlesier (1994) has linked the prehistoric archeological record of the Plains to modern Native American tribes and groups, but these associations are tenuous given the amount of time which has elapsed and the sparseness of the data.

NPS, Paleoecology, and Natural Resource Management

In the past decade, especially since the 1992 Earth Summit in Rio de Janeiro, land managers and the general public have come to better understand the linkages among the geophysical, biological, and so-

ciocultural components of ecosystems and realize that few diachronic baseline data are available from which to monitor future changing conditions. Collection of such data, including its description as scientifically useful information, is labor-intensive; the availability of computers has assisted in cutting analysis time and supporting more sophisticated linkages; still, the data first have to be collected. There is little immediate public return for data collection, and hence funds for it do not compete well with (for example) primary and secondary education programs and policing needs. Information about the past, especially the distant past, is often difficult to find—dynamic geophysical erosion and deposition processes have not left that many readily available and well-preserved deposits. There is no law protecting peat bogs and significant Late Quaternary landforms, unless they are within managed public lands. Archeological sites with their embedded paleoecological information are more frequently seen by land managers only as a compliance issue—something that has to be inventoried and treated in compliance with legal mandates before the *real* resource management activity can be accomplished.

In 1997, the Institute for Environmental Education's Annual Environmental Forum was entitled "Reality is What Goes on Between the Disciplines," focusing on the disciplines within the life and earth sciences. I suggest that that paradigm be taken one step further, to look at what goes on among all the disciplines and constituencies that represent the major components of ecosystems as that concept is defined by NPS (NPS 1994).

Given the limited availability of funds, both within NPS and outside of it, we need to be smarter with what we have.

Within NPS, there has been a great variety of projects that have collected paleoecological data. Here is a selection of references. The Sierra Nevada Ecosystem Project (CWWR 1996) included multidisciplinary information about traditional Native American land-use practices and ecological impacts (CWWR 1996; Anderson and Nabhan 1991) and historic settlement patterns. In Olympic National Park, ethnographic, ethnohistoric, and archeological data have been used to understand the distribution of mountain goats over time (ONP 1995; Schalk 1993; Schultz 1994). The role of ancient hunters in Alaskan ecosystems has been described (Birkedal 1993). Various natural and cultural paleoecological data have been described in Yellowstone (e.g., Barnosky 1994; Cannon 1998; Cannon and Phillips 1993; Conner 1991; Greiser 1994; Janetski 1987; Johnson 1997), but until recently (YNP 1997) have not been integrated to provide a truly interdisciplinary dia-

chronic perspective (cf. comments in Boyce 1991; Coughenour and Singer 1991; GTNPNER 1996; Singer 1996). Lynott (1993) has collected natural and cultural paleoecological data for the Ozark National Scenic Riverways, and Richner (1993) has evaluated the role of Native Americans in the Voyageurs National Park ecosystem (cf. Bonnicksen et al., forthcoming). I have described the various paleoecological data sets currently or potentially available for Agate Fossil Beds National Monument lands (Knudson 1999). There are dozens of NPS archeological reports available (e.g., Alex 1991) that include important natural paleoecological information useful to wildlife managers.

Paleoecological information has been collected from NPS lands for a century, and much of this can make a contribution to the agency's wildlife management by providing an interdisciplinary diachronic baseline. Several activities would support development and use of this baseline.

- Available specific and regional paleoecological information should be compiled and interpreted for each NPS unit by an interdisciplinary team.
- Data gaps should be identified.
- Missing information should be actively sought.
- The use of interdisciplinary paleoecological data should be supported by managers, without being bounded by traditional NPS barriers between natural and cultural programs. This should include funding and staffing decisions and revisions to *NPS-77*.
- Managers and resource specialists at all levels should be trained in the use of multidisciplinary paleoecological information in developing current policies and programs.
- As new multi-resource ecological data are collected, they should be integrated with previously collected information and the whole combined with natural resource monitoring information to understanding developing processes.

Under NPS's compliance with GPRA, the Government Performance and Results Act (Public Law 106-62, 31 U.S. Code 1101; NPS 1997a), NPS has developed a national strategic plan (NPS 1997b) and the natural resource stewardship and science program has its own strategic plan (NPS 1997c). At present, none of these is consistent with the NPS draft ecosystem management statement (NPS 1994), but each rather reflects the strong disciplinary-specific programs sustained in the agency's recent reorganization. NPS's GPRA response and current long-range planning do not provide opportunities for the kind of interdisciplinary integration of paleo-

ecological information that has provided such a strong basis for the Sierra Nevada ecosystem management plan (CWWR 1996) and Yellowstone's northern range evaluations (YNP 1997). We need to search out those opportunities and the policy support to implement them.

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Values, Science, and Policy: How Best to Serve the National Parks

What is Policy?

Thanks to John Dennis, Mike Coffey, and Mike Soukup, this is a session about policy. We wildlife biologists talk energetically about and advocate policy, but often without stopping to think about what policy is, how it is and should be set, and by whom. So in order to make sure that we are all communicating, it seems desirable to start this discussion with a bit of Political Science101 before talking about national park policy.

The several dictionaries around me vary slightly in their definitions of "policy," but converge on an amalgam something on the order of, "A statement or stated plan of how an organization will operate to achieve some goal."

So a policy is a stated plan or course of action, and most of the discussion about policy tends to focus on this aspect. The discussion frequently overlooks, or simply fails to address, an extremely important part of the process: the goal or goals. Consequently, most of the policy discussion focuses on means rather than ends. A major point that I will develop in this paper is that policies, and the management programs they prescribe, cannot be meaningfully designed without clear and explicit goals which they are designed to achieve.

Point 2 in this 101 discourse, probably obvious to all, is that policies set for public or common-property resources, such as public land, are public policies. And needless to say, they are therefore carried out by some governmental entity.

Finally, numerous authors (cf. Hendee 1974; Giles 1978; Kania and Conover 1991; Wagner 1994; Kennedy and Thomas 1995) are now pointing out that public resources are managed, not for the resources themselves, but to satisfy societal values. Hence, management goals are the satisfaction of those values, and an oversimplified model of the policy process is sketched in Figure 1. The implications of this model are: societal values are the basis of the whole process; goals are articulated to satisfy those values; policies prescribe management programs to achieve the goals, and thereby satisfy the values; and science is not part of the direct causal sequence that sets policy.

Figure 1. A model of public policy-setting which originates with societal values.

Goal-Setting for the Parks

If we apply our Poli Sci 101 principles to the on-going debates on wildlife policies in the National Park System, it becomes clear that the arguments over culling animals, prescribed burning, elimination of exotics, restoration of absent species, and such variants of no management as natural regulation and natural-process management are debates over means, not ends. Very little of the discussion focuses on the ends box—the "goals" of our model—which, for national parks, are their purposes or reasons for being.

The goals we do have in place, and which officially guide park policies, come from a diverse and disjointed array of sources that fall into two general categories. One is legislation: the 1916 Organic Act and the enabling acts establishing each national park. The latter are commonly pushed by local congressional delegations, typically with different agendas in different biophysical settings, and with the result of different purposes and policies among the parks (Huff 1996, 1997).

The second category is a spectrum of goal statements set within the federal executive branch. At one end of the spectrum are presidential proclamations establishing national monuments that later become national parks. Grand Canyon and the current Grand Teton national parks are examples.

In the middle of the administrative hierarchy, the National Park Service (NPS) itself has prepared and published a series of policy statements over the years variously termed "administrative policies" (NPS 1968), "management policies" (NPS 1988a), etc. The 1968 document states that the agency's administrative policy dates back, with only "minor modifications," to a May 13, 1918, letter written by Interior Secretary Franklin Lane to NPS Director Stephen T. Mather (NPS 1968, 14). The letter is sometimes called the Magna Carta of the national parks.

In a number of cases, these System policies have been influenced by external, professional panels or committees, such as the 1963 National Academy of Sciences–National Research Council Advisory Committee to the National Park Service on Research (Robbins et al. 1963), and the concurrent Secretary of Inte-

rior's Advisory Board on Wildlife Management, the Leopold committee (Leopold et al. 1963). That this committee influenced general, System policy is shown by Secretary Stewart L. Udall's May 2, 1963, memorandum to NPS Director Conrad Wirth stating: "You should, accordingly, take such steps as appropriate to incorporate the philosophy and the basic findings [of the Leopold Committee] into the administration of the National Park System" (NPS1968, 88).

The current policy document, issued in 1988, stresses the differences between units of the System, and pronounces only very broad charges that give great flexibility within which park goals can be set:

> Park managers should ascertain park-specific purposes and management direction by reading the park's enabling legislation or proclamation and determine general management direction, not inconsistent with enabling legislation, from the organic act (NPS 1988a, chap. 1:2).

This very general charge facilitates independent goal-setting within individual parks—the other end of the goal-setting spectrum. The result, according to Huff (1997), is a range of goals so varied as to "preclude the development of explicit, forceful management objectives for all System units." In some cases, goals or policies articulated in individual parks have become goals for the entire system. Thus, the natural-regulation policy adopted in Yellowstone in 1967 (NPS 1967) for the management of ungulates was contrary to System policy at the time, but eventually spread to become the System's prevailing policy (Wright 1992, 78-79).

In addition to the goals officially in place for individual parks and the System, a variety of goals are advocated by non-NPS resource professionals, environmental organizations, and other devotees (cf. Rolston 1990; Boyce 1991; Brussard 1991; Frome 1992, 231), usually on the basis of their own personal values. Some of those have been proposed at this conference.

The result of all this action is a wide and confusing array of officially adopted and proposed goals that can be generalized into a number of categories which overlap to varying degrees:

1. De facto museums (1916 Organic Act, Leopold Committee's "vignettes of primitive America");
2. Ecological experiments: natural regulation (Despain et al. 1986), natural-process management (Boyce 1991);
3. Ecological reference systems for comparison with contemporary human-modified ones (Wagner and Kay 1993; Boyce 1996);
4. "Playgrounds" (cf. the 1872 Yellowstone Act's "pleasuring grounds"; Sax 1980; Foresta 1984);
5. Cathedrals for spiritual renewal (Sax 1980; Rolston 1990; Frome

1992);
6. Venues for education (NPS 1992; Frome 1992);
7. Refugia for protecting biodiversity (Brussard 1991) and threatened and endangered species (NPS 1988a, chap. 4:11); and
8. Nation building: to "... preserve, protect, and convey the meaning of those natural, cultural, and historical resources that contribute significantly to the nation's values, character, and experience" (NPS 1992).

And one can see management procedures that are assiduously avoided in some parks while being carried out routinely in others: animal population control, prescribed burning, etc.

Huff (1996), as mentioned above, has stressed that the biophysical settings and enabling acts of the parks are so varied that this type of diversity is inevitable. But one then wonders whether there is any but the vaguest overall purpose to the System, or whether it is largely a collection of miscellaneous, ad hoc entities. As Carol Aten, former chief of the NPS office of policy development, commented, "at the park level, there is no System view" (personal communication, 1992).

Numerous authors, both inside and outside NPS, have argued that the national park goals we do have from this diverse range of sources are too ambiguous or ill-defined to give clear policy and management direction. Johnson and Agee (1988), two NPS employees who convened a symposium on "Ecosystem Management for Parks and Wilderness" in 1987, commented that "park and wilderness goals will have to be stated in more precise terms, depending on the values represented by the individual area," a theme expressed repeatedly during the symposium. The Gordon Commission study (Gordon et al. 1989), sponsored by the National Parks and Conservation Association, recommended that NPS "install and refine the concepts of ecological management ... [including] establishing preservation and visitor impact management goals." One member of the Commission commented, "They've got to decide what it is they want" (personal communication, 1989).

In November 1991, the Renewable Natural Resources Foundation and Utah State University co-sponsored a workshop on fire policy in the national parks. After two days of discussion, the participants (53 NPS employees and a similar number from other federal and Canadian agencies and academia) concluded that the System's biggest need is a clear statement of goals (Wagner 1993). Other authors have commented in the same vein (Foresta 1984, 1; Bonnicksen 1989; Bonnicksen and Stone 1982a, 1982b; Porter 1991; Underwood and Porter 1991; Porter et al. 1994).

I believe that it is at least in part because of this lack of clear and explicit goals or sense of purpose that the parks are experiencing significant impacts on their natural resources. One has to consider these impacts to be "problems," depending on what the System and park goals are. A 1986 internal, agency-wide survey identified 101 categories of "threats" to the natural resources of the System (NPS 1988b). In the survey's list of major natural resources "issues," the first three were:

- Degradation of park resources due to native animal species overpopulation;
- Impacts on threatened, endangered, and other sensitive animals; and
- Loss of threatened, endangered, and other sensitive plants.

Wagner et al. (1995) summarized a number of cases in which high populations of white-tailed deer in eastern parks, elk in western parks, and feral or exotic species throughout the System were profoundly altering park ecosystems, reducing native biodiversity, stimulating invasion of exotics, and affecting threatened and endangered plant and animal species. If park goals are the maintenance of healthy and intact ecosystems, preservation of biodiversity, and protection of threatened and endangered species, these alterations again have to be considered "problems." In my opinion, they are caused, or exacerbated at least in part, by lack of clarity or agreement on System and park goals.

If park goals are unclear and ambiguous, it is not possible to formulate precise policies within the sequence illustrated in Figure 1. In turn, ambiguous policy cannot give a clear prescription for management programs. We heard Exhibit A from someone in the audience for this session. In his very fine review of NPS policies, John Dennis stated that NPS policy for managing biological resources is natural-process management, a policy also set forth in the current *Management Policies* document (NPS 1988). When asked by someone in the audience if NPS has a definition of "natural," Dennis's prompt response was "no." I submit that without explicit definition of the policy, it is impossible for park managers to know exactly how to proceed. The end result is risk of damage to the resources.

For these reasons, I maintain that the most immediate need regarding national park policies is to develop a set of succinct goal statements for the entire System, and for individual parks. Perception of the need is not unique with me. The authors cited above, both within and outside NPS, obviously conclude the same. And while Huff (1997) takes issue with this view in Wagner et al. (1995), he contradicts himself by stating in the close of his article "I suggest we start with some common-sense revisions

to our Servicewide and park-specific policies, clearly iterate our purposes...."

I understand the logic in Huff's argument, and that of NPS's own Vail symposium (NPS 1992), that the diversity of units in the System makes it difficult to articulate any System-wide goal or purpose. But without one, the System is merely a random array of independent operations. And, after stating the difficulty, the *Vail Agenda* did set forth a general purpose, the "nation-building" one listed above. Moreover, it is certainly possible, and there is an urgent need, to define explicit goals for the individual units.

Who Should Set Goals and Policies for the Parks?

The parks belong to the American people, and I contend that goal-setting should be a public process, addressing societal values. This process is achieved to some degree when goals are articulated in legislative action. But as we have seen above, goals and policies to a substantial degree are set internally by the agency at levels ranging from the central administration down to the individual superintendents. This internal goal-setting is a legacy of the turn-of-the century Progressive Era (Nelson 1995; Freemuth 1997), when technically trained professionals thought they knew what was best for the public, and designed and implemented policies themselves.

Progressivism incurred two problems. One was the inertia of agencies in changing policies as societal values changed. This has been less of a problem for NPS, which has retained high public-approval ratings, than it has been with the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM). The latter two have been cajoled out of Progressivism by public pressures and resulting legislation, and have adopted more public-sensitive, policy-setting procedures. Lacking such pressures, NPS has not moved with the other agencies.

The second problem is what (in the eyes of some observers) amounts to mismanagement. With an accepting public, lack of critical scrutiny, and client capture in the early 1900s, USFS has been charged with excessive or ill-advised logging (Hirt 1994) while BLM has been accused of allowing excessive grazing (Jacobs 1991). And NPS does not escape this one: the resource problems described above must be attributable in part to internal decision-making by an agency operating with ill-defined goals, and without strong scientific (Risser et al. 1992) or professional (Freemuth 1996) underpinnings.

For all of these reasons I consider it extremely important that NPS develop new, public-sensitive mechanisms for goal setting and policy making. The parks do now engage in the National Environmental Policy Act process for specific management

actions proposed in their resource management plans. Olympic developed a lengthy environmental impact statement for proposed mountain goat management, as did Yellowstone for wolf restoration. And they do enter into ad hoc policies under public pressures when particular problems arise, as with the recent Yellowstone bison situation, and earlier over the Fishing Bridge incident (Freemuth 1989).

But there is no formal, System-wide legislation for setting goals at both the System and park levels, such as USFS has in the National Forest Management Act, which prescribes forest planning with significant public participation in each of the national forests. Nor does NPS have standard administrative procedures, such as BLM's coordinated resource management planning and Interior Secretary Bruce Babbitt's resource advisory councils. These collaborative approaches have virtually become the norm in natural resources policy-setting, and are given a number of generic titles such as "interest-group pluralism" and "collaborative decision making" (Wagner 1994).

I am not alone in advocating such procedures for the National Park System. The Gordon Commission (Gordon et al. 1989) recommended "national, regional, and park Ecosystem Management Advisory Panels." A 1992 joint workshop between NPS employees and members of the Ecological Society of America recommended "science cooperative groups" (Risser and Lubchenco 1992). And NPS's own *Vail Agenda* (NPS 1992, 133) recommended that NPS "greatly expand the role of the public in resource stewardship activities and eliminate the barriers to public participation."

One would hope that such procedures would be adopted administratively within the organization, stemming from the recognized need alluded to in the Vail Agenda and which I contend here. But students of bureaucracy generalize that bureaus are conservative and seldom initiate significant change internally (cf. Downs 1967). Hence, the change might require new legislation—perhaps a new organic act.

In total, the parks are facing a number of management dilemmas and resource impacts which I believe are not receiving adequate attention because of ill-defined goals, and because of insufficient participation in goal articulation and management planning by concerned publics that would support resolute action.

The Role of Science

I pointed out above, as an implication of my model of policy-setting, that science is not a part of the causal sequence connecting societal values to management programs designed to satisfy those values. Policy-setting is a sociopolitical procedure, and science itself does not set policy.

However, science has an indispensable role in the overall process if policy-setting is to be enlightened and rational. That role is to provide an environment of fact and truth within which policy deliberation can take place, and without which policy-setting is largely a process of power politics, often without empirical knowledge of the implications of policy alternatives. Thus we can now elaborate the above policy-setting model with the role of science, both social and natural (Figure 2).

The social sciences have the important role of ascertaining and portraying the value profile of the affected publics, and the social, political, and economic implications of alternative goal, policy, and management options. The natural sciences similarly evaluate the biological and physical implications of those options, assist in the development of management programs, and evaluate how well they achieve the goals. In the process they clarify, and where appropriate quantify, such terms and concepts looming large in national park management as "natural," "natural regulation," "natural-process management," "ecosystem integrity," etc. Wagner et al. (1995) have discussed at some length the ambiguity associated with these terms, and the problems of translating them into clear-cut management directions.

Thus science illuminates every step of the policy and management

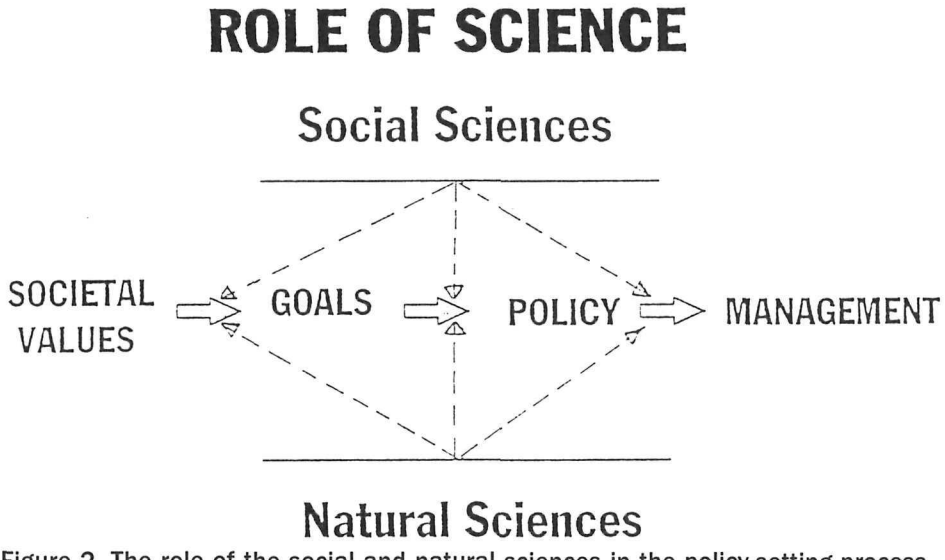

Figure 2. The role of the social and natural sciences in the policy-setting process. Science is a service to policy-setting, illuminating the process by analyzing the societal value profile; elucidating the consequences of goal, policy, and management options; assisting in the design of management programs; and analyzing the degree to which those programs achieve their goals.

process. But if it is to do so effectively, it must be competent and objective and have the trust and credibility of all concerned interests involved in the situation. It is for these reasons that I believe scientists should avoid policy advocacy. When a scientist advocates in favor of a given position in policy debate, he or she risks damaging the image (if not the reality) of objectivity, and credibility and trust fade.

This becomes a problem in a resource management agency which has the charge of advocating for and protecting the resources. But somehow the scientists must distance themselves from the policy positions of the organization. Some observers have charged that science in some areas of the System has been biased to support the agency's policies, and I have seen evidence to that effect. One of the purposes for Secretary Babbitt's formation of the National Biological Survey was to distance the researchers from the management agencies in order to move the scientists away from policy and administrative coercion. We all hope that the change will have this effect, but I have not yet seen much evidence of it. It may take generation turnover.

Conclusions

In my judgment, the numerous natural resources problems identified both by NPS insiders and outside observers result at least in part from the lack of clear and precise goals, both for the System and for individual parks, that would give clear direction for management programs. I and numerous other observers believe that the System urgently needs articulation of such goals.

Since the parks are a public resource, I contend that goal-setting should be a collaborative public process involving concerned interests, much like the other resource agencies have adopted. Developing such procedures might be achieved administratively within the organization, or require new legislation.

Science does not set policy, but it is an indispensable service to rational policy-setting by illuminating the process. In order to do so effectively, it must be competent and objective, and have credibility and trust. Scientists should avoid advocacy in policy debates in order to maintain both the image and essence of objectivity, and to retain credibility and trust. To achieve this, they need some measure of administrative separation from management and management administration in order to escape policy and administrative coercion.

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John Freemuth

Absolutely American and Absolutely Democratic: National Parks and Policy Change

But ever since I was old enough to be cynical I have been visiting national parks, and they are a cure for cynicism, an exhilarating rest from the competitive avarice we call the American Way.... Absolutely American, absolutely democratic, they reflect us at out best rather than our worst.

Wallace Stegner

Unless the scientist reads outside her/his field, or takes a sociology class and learns how such Kuhnian paradigms as "cultural baggage" lead humans by the nose in all they think and do, one can go through life ignorantly believing that science is detached, objective, factual, unmythic, and withal goal-setting.

Michael Barbour

Most of us are familiar with the above observation of Wallace Stegner on the importance of the national parks. In that observation are some important clues as to how we might need to think about the parks, and hence policy, as we discuss wildlife policy in the national parks. The parks, as Stegner's comments should remind us, are creatures of a democratic society. That society, both in its "American" form and its "democratic" form, affects the making of our national park policy.

The Environment of National Park Policy-Making

It would seem obvious that any attempt to change, or defend, wildlife policy must pay attention to the factors, both within and outside of the National Park Service (NPS), which might impinge on that attempt. Two of the most serious, and intertwined, arguments over park policy occur over which *side* of the (in)famous "dual mission" ought to emphasized, and over *who* gets to "make" park policy (Freemuth 1989, 278-286).

There are number of actors who clearly favor or support the "enjoyment" side of the NPS mission. Among them one can find park concessionaires, members of Congress and their staff who have heavily visited units of the National Park System in their districts, various presi-

dential administrations, local park-dependent communities, and interest groups who support recreation and tourism. These actors are most likely to be in favor of wildlife policies which support wildlife as a resource to be enjoyed by park visitors, as long as those policies don't create other unresolvable conflicts. Perhaps the reintroduction of the wolf in Yellowstone would fall into this category.

Conversely, other actors can be found on the "resource protection" side of the ledger. Environmental groups, congressional park policy specialists, and some academics, for example, have often urged NPS to better protect park resources, promote resource management, and develop a stronger research program. These groups and individuals would seem obvious allies for a wildlife policy which sought to protect park wildlife resources.

One obvious point about all of the external interests is that they pay attention to national park policy and will often intervene to attempt to countermand agency policies and decisions with which they disagree. Of course, they are no more "right" about park policy than any one else, but their potential opposition is a factor that must be taken into account in the making and implementation of policies. It cannot be enough to dismiss these interests as either ignorant or "political," as often seems the case. These external groups may, or may not, represent the view of the public regarding wildlife policy, if such a "public" actually exists.

It would do well at this point to introduce a brief observation about the proper meaning or "interpretation" of the 1916 Organic Act's stated purpose of national park management to "conserve [not preserve, as is often assumed] the scenery and the natural and historic objects and the wildlife 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."

It is striking how much time and ink has been spent trying to determine, argue, or prove what aspect of the NPS mission is the dominant one. While such discussions can be enjoyable, they seem, at the end, a waste of time. Neither conservation or enjoyment is dominant, for that would have led NPS and the parks to be different than they are. Of course, that would seem to be the point of those arguing for a dominant mission or policy change which would view parks as either wildlife preserves or tourist-oriented theme parks.

What is rarely discussed is the premise that park visitors understand (or would understand) the need for limitations on use if resources or park experiences were threatened. There are examples of such an approach that could be used as policy experiments to learn from. Zion Na-

tional Park, for example, has just instituted a limitation on how many visitors per day can use a popular side canyon in the park. The key here is how the public responds to use limitations in the name of resource protection and the experience of the park visitor. Such an approach might have merit, as it would move all of us away from the stale debate over the "trump" in the Organic Act.

The second point about national park policy is about control: Who makes policy? In a sort of Progressive-era vision of the world, NPS would be the dominate entity when it came to the making of park policy. This, however, is not the case. Consider the following categorization of public-sector agencies. Barbara Romzek and Melvin Dubnick once described the National Aeronautics and Space Administration (NASA) as having had what they term a "professional accountability" system during the 1960s. Under this system, "public officials must rely on skilled and expert employees to provide appropriate solutions" (Romzek and Dubnick 1986, 229). Under a professional accountability system, the general public also shows deference to expertise and thus there is not nearly as much outside interference in agency decision-making. This type of accountability system is relatively rare. In land management policy, only the U.S. Forest Service ever approached this ideal. Samuel Hays caught the spirit of that ideal at the turn of the century when he noted that—

> Conservationists were led by people who promoted the 'ra tional' use of resources, with a fo cus on efficiency, planning for future use, and the application of expertise to broad national problems. But they also promoted a system of decision-making con sistent with that spirit, a process by which the expert would decide in terms of the most efficient dovetailing of all competing resource users according to criteria which were considered to be ob jective, rational, and above the give-and-take of political conflict (Hays 1980, 7).

NPS is not an expert-centered agency, but more a responsive one. A "responsive agency," in the words of Romzek and Dubnick, is concerned with questions of representation, access, and responsiveness to public demands.

> The potential constituencies include the general public, elected officials, agency heads, agency cli entele, other special interest groups, and future generations. Regardless of which definition of constituency is adopted, the ad ministrator is expected to be re sponsive to their policy priorities and programmatic needs (Romzek and Dubnick 1986, 229).

These constituencies are the groups and individuals discussed above who are external to NPS and who influence park policy.

The notion of agency responsiveness to other political actors fits our expectations of democratic theory.

We do not relish our public bureaucracies making policy without taking the opinions and values of others into their decision calculus. This does not enshrine public opinion as unerring truth, but it does mean that agency judgements are constrained, as they should be, in a system which celebrates, however fitfully, the checking of power and the notion of value diversity. What compounds the problem is that many natural resource professionals have been trained within a model of decision-making that assumes that the expert "knows best" and does need to seek out other views regarding the management of natural resources.

However, the 1916 Organic Act also charges NPS to manage parks "for future generations." The clause gives NPS a focus which is different from all of the other actors who claim to have an interest, or power, over agency policy. NPS can act in the name of park resources, and in the name of visitor experiences with a long-term "public interest" perspective. But, NPS must speak in those terms, rather than solely in the language of expertise or of science. There is no guarantee that NPS perspectives on park management issues will prevail, but such a public interest perspective is different from a perspective which looks out for constituents or is based on political ideologies and agendas currently in play. The future generations who will visit the parks could become a benchmark for whom parks are managed today, and thus this long-term perspective can legitimately be inserted into debates over park management. Expertise, and science remain *necessary* tools, however, in this debate. NPS might then present to its public(s) and other interests management decisions framed with a long-term perspective and designed to help those interests deliberate over choices NPS must make. It seems that wildlife policy choices are suited to perform in this role of public deliberation.

NPS Organizational Culture

NPS is not a monolith, and questions of who decides agency policy must also be looked at from an internal perspective. There is surprisingly little information available on the internal culture of the NPS. What does seem apparent, however, is that there are a number of "world views" within the agency. One example, told to me anecdotally, is the so-called Yosemite Mafia, employees with formative experiences in law enforcement gained at Yosemite who are now in positions of influence throughout the agency. For the purposes of wildlife management, one can discern differences between superintendents, resource managers, and scientists. There may be vital disagreements between what a scientist might view as a "correct" policy and the "art of the possible" as seen from the position of park superintendent. These differences matter.

They matter when it comes to the concerns of those who argue for more spending for park resource management and scientific research. A recent General Accounting Office (GAO) report noted that recent funding increases for NPS "have mainly been used to accommodate upgraded compensation for park rangers and deal with additional park operating requirements, such as safety and environmental regulations" (GAO 1997a). The increased funds were not apparently used then, for resource management and scientific research.

A closely related issue is the expectations and reward system for the scientific endeavor within the National Park System. Put simply, more thought may have to be given to encouraging, listening to, and rewarding park science which helps with a management issue facing the agency. NPS scientists cannot expect to have the freedom of their academic colleagues in the choice of research topics, but they need rewards which compensate for that loss of freedom.

Students of organizations know that the two examples above are explained by in part by NPS culture. Any attempt to change or refine wildlife policy must pay close attention to how NPS culture would affect such change. To put it another way, agency culture could also frustrate policy change. If the role of science and resource management has yet to receive proper attention or "respect" from those in management, then a clear strategy would need to be developed to change that aspect of NPS. Such a change would seem to need a commitment from top levels of the agency.

The Roles of Science

Another issue which influences the development of areas such as wildlife policy is the sociology of science. It is of immense interest to students of natural resource policy that science is not a monolith. There is an argument going on in ecology that has striking implications for how we should think about managing the national parks. Put simply (that is the only way I can do it), the argument centers on whether nature is "simplistic and deterministic" or "complex, fuzzy-edged, and probabilistic" (Barbour 1995). The debate centers on the work of Frederick Clements and Henry Gleason and reflects an ongoing discussion on holism and reductionism in science. (NPS's arch-nemesis, Alston Chase, has a very readable discussion of this debate in his 1995 book *In a Dark Wood.* The book does a good job of showing how the debate has entered into political discussions over such issues as the northern spotted owl.) What is so interesting about the debate is that "the language and perceptions of many of today's nature conservationists are considered to be 'unnatural' by most ecologists" (Barbour 1995, 233). Thus, it becomes

problematic what a concept like "natural-process management" actually means.

One must add the increasing use of such popular terms as "making decisions with the best science" or the "learning the lessons of ... (fill in the blank, with "nature," "conservation biology," etc.). What is presented to be "scientific," I argue, is more a set of values masking as science. What is left is an overt political act. "Letting science decide" (or some alleged fact) is actually letting scientists decide, which, of course, excludes non-scientists from the decision. This is not science; it is politics. Scientists, too, have values: as J. Stan Rowe has said, "We're all strongly influenced in our science by our political beliefs. Look at the emphasis we put on competition. If one is trying to see nature holistically and integrated, you tend to see cooperation more than competition and aggression" (cited in Barbour 1995, 251). If we are not careful with this logic, we end up in the silly position of arguing that a political scientist's vote should count one hundred times more than that of everyone else, because, after all, they "know more" about what a correct vote should be.

It seems obvious to this writer that science is a necessary but insufficient condition for the making of wildlife policy. For example, my research into the politics and policy of visibility protection offers one case study of this latter role for science. It is hard to see how the Navajo Generating Station near Page, Arizona, would have had to install retrofit technology without the source identification work of the NPS air quality division and others. But the work that went into identifying that power plant as a source contributing to impairment at Grand Canyon could not "force" anything on its own. That required the teeth of the Clean Air Act and political coalition-building. Yet, without the work of the air quality scientists and specialists, nothing would have happened either. (Freemuth 1991).

The linkage of agency policy with scientific knowledge can get confusing when it comes to wildlife policy. NPS's *Management Policies,* in the section on biological resource management, have this to say about "population management":

> Natural processes will be relied on to control populations of native species to the greatest extent pos sible. Unnatural concentrations of native species caused by human activities may be controlled if the activities causing the concentrations cannot be controlled. Nonnative species will not be allowed to displace native species if this displacement can be prevented by management (NPS 1988, chap. 4:6).

One can imagine the questions of those who pay attention to agency policy. How can native species be controlled by natural processes while non-native species are to be actively

managed? What principle or goal allows for this differentiation? Would active management also affect the native species too? What is a native species? Isn't this a completely arbitrary term? What does the term "unnatural" mean? In short, what is the basis for this policy? Science? The Organic Act? A personal value system of those who wrote it or of the democratic society of which NPS is a part?

Finally, we remain caught up in a confusing debate about "nature." It is clear that the term refers to something observable in the physical world, but it also used as a metaphor to describe the type of world we ought to desire. Thomas Hobbes referred to nature as where life was dangerous, in order to set up his argument for strong government. Darwin's nature was bastardized by the view that life was competitive, so why worry about the poor? What needs to be disentangled is the observable natural world from the use of nature as a metaphor to prescribe normative public policies (cf. Cawley and Freemuth 1993, 41-53).

Yellowstone and Wildlife: Reflections of a Grumpy Political Scientist

Wildlife policy implemented for specific units reveals that many in NPS and outside the agency have struggled with questions like those above. It seems an impressive struggle, a battle where new ideas about policy are being articulated. Yet from a policy perspective, it is Yellowstone, once again, that appears most visible and most insightful when it comes to the making and possible alteration of NPS wildlife policy.

To a student of policy, politics, and organizational processes, the Yellowstone experience is a fascinating one. The Yellowstone policy of "natural regulation" has been likened to an ongoing "experiment" some twenty-nine years old. There is harsh criticism of this experiment, which calls for more active management of the Yellowstone elk; the response to that criticism is to allow the experiment to continue. There is evidence to support both the critics and proponents of the current policy. The nature of the debate, has, at times, taken on all the trappings of a high war in academia: charges and countercharges fly. Yellowstone's biologists are "dogmatic and defensive," and restrict who gets to do research in Yellowstone, while critics are said to support some sort of "Ecosystem Oz." One can only imagine the *perception* outsiders must have about this affair (even if there are some people who deserve a lot of the blame) and the capacities of professionals and academics in our society to carry on an civil debate about national park wildlife policy.

Let us assume that the debate over natural regulation remains a debate, and that the evidence on the success of the policy remains ambiguous.

What remains vital is the process by which we argue out natural regulation as a policy. It seems that this process is what has become unhealthy and "overgrazed," as it were. Perhaps Congress has allowed for a way out by calling on the NPS to "initiate a review by the National Academy of Sciences of all available science related to the management of ungulates and their ecological effects on the rangeland of Yellowstone" (GAO 1997c, 10). What would remain unanswered by the study, however, would be how, whether, and why management would respond to its conclusions. These questions are as important as the Academy's study charge.

One more point need to be made. In a recent edition of *The George Wright Forum,* John Varley and Paul Schullery wrote a fascinating article on public involvement at Yellowstone. They laud a strategy which "smothered the opponents, proponents and the undecided in information" about wolf restoration. The point was to use fact inundation, "the most science, the best science ... the only science" to overwhelm people. This was all done to "advance a cause" (Varley and Schullery 1996, 68-75). There is nothing wrong with this strategy as long as it pays attention to what the various publics are telling the agency about its policy. When we enter the area of the Yellowstone northern range, however, things become more complicated.

The GAO has noted that "supporters and critics of the Park Service's policies have scientific evidence that supports their points of view" (GAO 1997c, 8). One of the criticisms of the "great experiment" at Yellowstone is that it uses selective science and discards evidence that contradicts the so-called success of the experiment. What Varley and Schullery have done, paradoxically, is leave the door open to continued criticism by essentially admitting that their defense of natural regulation could be a massive public relations campaign designed to sway public opinion towards the conclusion that the policy is a success.

NPS Policy-Making: The Problem of Goal-Setting

Current debate over NPS wildlife policy moves in two directions. One direction leads towards the search for the evidence of policy success or failure—an all-too-rare example of policy evaluation. Last year's symposium had several papers which took that approach. The other direction leads towards a review of the process of developing wildlife policy. Here, the debate appears to center on whether it is desirable to have clearer policy goals, with management prescriptions designed to meet the goals, and able to be evaluated for success, failure, and redesign.

The process of setting NPS wildlife policy has been, and will be, developed and implemented in a legal environment fraught with ambiguity.

The overall management mission of the agency is unclear, as reflected in the Organic Act. Park units have enabling legislation which often creates exceptions, if not more ambiguity, regarding the 1916 act. Many units have had grazing, mining, and hunting authorized within them.

As another example, should national recreation areas be managed the same as the national parks, even though both have natural zones within them? At one time the answer to this question was "No," according to George Hartzog, former NPS director. He has asserted that wildlife management under the natural, recreational, and cultural area policies of the 1960s was different for each of the three areas (Hartzog 1988, 253). Under later policies, all the units in the park system became co-equal jewels in a crown, guided by the Organic Act and the unit's enabling act. The Organic Act and a unit's enabling act became the only guides to policy. The question, then, is the relationship between a *national* wildlife policy, and a policy based on *specific* circumstances in an individual unit of the System—units which often ironically still bear a close relationship to the discarded three-tier policy.

These caveats aside, there is ample opportunity to rethink national park wildlife policy. Recent congressional action has provided a framework for those interested in better policy evaluation.

A Window of Opportunity to Develop Wildlife Goals?

In 1993, Congress passed the Government Performance and Results Act (GPRA); NPS is beginning to implement it. GPRA is a congressional mandate to link the mission of an agency to outcome-related goals, statements on how the goals will be achieved, and program evaluations of whether the goals are achieved or not. For example, one goal of the NPS mission has already been clearly stated through GPRA procedures as "protect park resources" (NPS n.d.). From this goal statement, a number of park-specific actions that can be documented and evaluated through quantitative measures of performance are supposed to follow. The congressional intent of the GPRA is to measure and evaluate outcomes rather than outputs. In this example, one would evaluate "results" (e.g., was a resource protected) rather than "processes" (i.e., money spent, personnel activities, and so on).

There are, of course, problems with GPRA. In the field of education we might term this the "teach the test" problem. Let us suppose a board of education mandated a similar approach to measuring teacher success by requiring a certain percentage of students to score above the 70th percentile on a standardized test. If the percentage is not reached, then the teacher has not met the required outcome measure. One way for a teacher to increase the percent-

age would be to spent a lot of time focusing on passing the test by essentially teaching the test to students. We would likely be able to see a higher student success rate, but we would have no way of knowing whether the students were actually "better educated." More fundamentally, it has never been clear that tests can measure all attributes of an education, or that what is measured is what ought to be, but cannot be, measured. Thus, NPS might find ways to measure certain attributes of resource protection, but will that be because those attributes are easier to quantify? Or, will agency personnel be compelled to manage to meet preordained outcome measures, while disagreement remains whether the measures actually signify much? One way to avoid falling into this trap too easily is to rely on both NPS and external scientists (and others) to help decide what appropriate measures might be, as suggested by Wagner et al. in their discussion of wildlife policy in the parks:

> Specifying these ecological pa rameters for all of the parks in the system with natural resources involves an aggregate of ecological knowledge beyond that held by ecologists formerly in NPS and now in NBS [the National Bio logical Service, now subsumed under the U.S. Geological Survey Biological Resources Division], or any other agency. It must draw on the experience and insights of the entire ecological community (Wagner et al. 1995, 167).

These GPRA-related outcome measures are all actions that appear as though they are under NPS management control. Cross-boundary issues and actions related to them, such as air pollution or intergovernmental coordination, may also be able to be documented, but they also relate to another aspect of GPRA. Under the act, each federal agency is to have a strategic plan, which, among other things, requires an "identification of those key factors *external to the agency and beyond its control* [emphasis added] that could significantly affect the achievement of the general goals and objectives" (such as protecting park resources, or more specific wildlife management policies) (Public Law 103-62, amending U.S. Code 3; quotation from section 306-a-5). This is clearly a fortuitous time for NPS to document what aspects of protecting park resources are beyond its control, since this law requires such documentation. NPS should seize this opportunity to clarify the scope and extent of the "external threats" problem, an action which might help clarify what is or is not resolvable by its wildlife management policies.

The Problem of Policy Conflict

It is also striking how NPS is dealing with this new law and its relationship to the agency's ecosystem management efforts, which, of course, is another federal policy initiative of huge scope and import.

This comparison provides insight into the complexity of coordinating and making agency policy.

The "cooperative" or "collaborative" aspects of ecosystem management may not fit well with GPRA. NPS training materials have already interpreted actions such as "forge strong collaborative relations with all partners and integrate them in all operations" as being *not* appropriate GPRA criteria (NPS 1996). Compare this statement with the following one from a NPS ecosystem management document which is very similar to some government-wide ecosystem management definitions: "Ecosystem Management is a collaborative approach to natural and cultural resource management..." (NPS 1994, 3).

By GPRA standards, it is hard to show how such collaboration has been accomplished, and what the *measurable outcomes* would be. The difficult question for NPS is whether it ought to spend more time on process (collaboration) or on results (outcomes), because Congress has asked one thing and the Clinton administration another. Yet, until a better definition of ecosystem management is achieved, it may make sense for NPS to pay more attention to GPRA. There are several reasons why the agency might wish to do so.

First, there is a growing critique of ecosystem management from a number of directions and perspectives, which illustrates that the term is amorphous and somewhat questionable scientifically (Chase 1995, 401-405; Lackey, forthcoming). Allan Fitzsimmons has made the following scathing observation about USFS's 1995 rule calling for the implementation of ecosystem management throughout the National Forest System. The rule "calls for the Forest Service to oversee the National Forest System in order to sustain undefined conditions on undefined landscape units that exist in limitless numbers in undefined locations and that are dynamic and constantly changing over time and space in unclear ways.... This is an unintelligible basis for managing the National Forest System" (Fitzsimmons 1996, 221).

Put simply, because of fundamental vagueness in key parts of its definition, ecosystem management is becoming a target, and one possibility would be to move slightly and subtly away from the line of fire, rather than spend inordinate agency resources and energies trying to define and implement a policy that many view as both ill-defined and without necessary public support at this time. Or, NPS might at least begin to link ecosystem management with the outcome-oriented procedures of GPRA.

Second, GPRA, while flawed, sets out a process that appears a bit more specific; a process that the agency as well as its interested publics might be able to use to get a better under-

standing of what actually is being valued as well as accomplished by NPS. GPRA might even provide NPS a way to define what it means by terms such as "ecosystem management" and how the agency will measure whether it is successful. Given the huge public disagreement over the goals and purposes of much of the federal estate, this understanding would be no mean accomplishment.

What is most intriguing about GPRA for wildlife policy is that it might provide a way to resolve the sometimes acrimonious debate over that policy. To this observer, many of those who write about wildlife policy clearly would like to see better goal specification and the development of measures of whether those goals were being achieved or not. GPRA appears to offer a process for doing just these things, but caution is in order for a number of reasons.

First, goal-setting will, and should, occur, within the democratic system discussed at the beginning of this paper. There are many people who will, and should, have some voice in the determination of the goals of national park wildlife policy. We might complain that there will be political influence on the setting of wildlife policy. We must remember, though, that the national parks are embedded in the human world, and they mean different things to different people. They are a place, said Stegner, that is "nothing in itself. It has no meaning, it can hardly be said to exist, except in terms of human perception, use and response" (Stegner 1989, 169). Stegner's phrase suggests that parks have appeal to people. As Ronald Foresta reminds us about a national park: "It strikes people grand or sublime, or it just makes people happy to be there, for whatever reason" (Foresta 1984, 268). The various meanings we find in the parks will be a constraint on unfettered setting of wildlife policy. There is opportunity here, but it should be in the form of persuasion and conversation.

Second, there appears to be need for clarity regarding the balance between universal NPS wildlife polices, and the needs and requirements of individual units of the system. Many observers, both within and external to NPS, have argued for a clear and focused System-wide set of policies on wildlife management. At the same time, the notion of "adaptive management" would argue for discretion at the unit level in order to better promote policy "learning" that could then be used to make necessary alterations in the System-wide policies. Such discretion, however, exposes one of the primary issues facing NPS. As GAO put it, "superintendents exercise a great deal of discretion in setting operational priorities" (GAO 1997b, 4). There is nothing wrong with a system so organized, and there are many strengths associated with it. Yet, as GAO goes on to note, there is

weak accountability system in place, because

> ... key components needed to hold superintendents accountable are missing. Without expectations about the goals that are to be achieved in the parks, a means for measuring progress toward these goals is not in place. As a result, the agency's ability to determine or ensure that the desired results are achieved is diminished (GAO 1997b, 7).

Those who argue for System-wide wildlife policy goals need to pay attention to this observation. For example, if such goals are developed, should they be done with the input of park superintendents? Are there problems with that approach?

There remains the question of how best to address the forum for wildlife policy-making in the parks. The history of NPS wildlife policy suggests that the agency has sometimes made policy changes on its own, while at other times Congress has chosen to intervene. To some, political intervention, and NPS sensitivity to that intervention, has characterized wildlife management policy, a charge undoubtedly true. But what do we do about that? NPS will find it difficult, if not impossible, to insulate itself from political influence. But NPS can lead, too, by presenting to Congress and the American people some of the difficulties in managing wildlife in the national parks. Such a presentation might well cause people to back up a step and see that some of these difficulties stem from the mission of the agency. Regardless, the dialogue is needed and it must be between NPS (and within the agency) and those it seeks to serve and respond to. From this dialogue could then come both the ideas and the support for policy change. Congress is the appropriate forum for resolution of conflict over wildlife policy, but it is NPS which has been charged with protecting parks for future generations. What NPS may really be up against is our society's uncertainty about the role of the public administration during this era of increasing distrust of all institutions of government. How we puzzle this out is the major challenge facing agencies such as NPS.

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The Partnership Between Park Wild Life Management Policy and Landscape Wild Life Management Policy

How Shall We Then Manage?

Introduction

Resources management practices are changing in North America, not only based on greater understanding of the resources that are being managed, but also on some critical sociological relationship changes between human beings and between humans and nature. The entire way that humans look at the natural world and our own society is changing dramatically as we come to the end of the twentieth century. Managers are changing from making belief-based decisions to making informed knowledge-based decisions through better science programs. Society appears to increasingly be making a shift to a community mind-set, a mind-set of connectedness and interdependence, and away from strict individualism. Managers appear to be ready to embrace the concept of unity and wholeness; to understand that humans and nature are inextricably tied to each other's well-being.

North American land and wildlife ownership has its roots in eighteenth-century western Europe where land, wildlife, and trees were owned by the royalty who would vest some of their land ownership in loyal noblemen. In developing the "new world," framers of the United States of America decided to reject that notion for one that would allow everyone who could afford it to be able to own land—except that they stipulated that the wildlands and wildlife would be owned by all in public trust until it be deemed appropriate to turn them over to private owners.

This idea of lands and wildlife being owned by the public was initially of little concern (at least to those newly coming to the continent). As the continent was populated with Europeans, however, it became abundantly clear that "public responsibility" for the lands meant that little responsibility was being taken; lands that were owned by all were being cared for by none. Prime examples of this are the forestry practices in New England that nearly completely denuded the landscape and forced the population to expand westward to find wood, and the great

buffalo slaughter associated with the westward expansion. Further, it became clear that some lands were of such great public value that they should always remain in public ownership and not be allowed to become privately controlled.

Beginning in the late 1800s and into the twentieth century, the federal government began, through a series of laws and the development of agencies like the U.S. Forest Service (USFS), National Park Service (NPS), and Bureau of Land Management (BLM), to take control of the public lands. The initial tendencies were to administer these public lands for some fairly narrowly focused uses: forest tree production, scenic pleasuring grounds, and cattle and sheep production. The management perspective was that Euro-Americans were separate and apart from nature and that natural resources were put on the Earth solely for people's use and benefit. In a sense, Americans went from the king's ownership of public lands and wildlife to government agency ownership, both federal and state—the term "ownership" here meaning that government agencies had authoritarian control. It was NPS land or USFS land and the park superintendent or forest supervisor was, to a very large extent, the authority for control of those "public" parcels.

In the past few years, an increasing variety of public pressures has brought us to an interesting juncture in history. Today, we find ourselves looking at another new world, one in which the public is no longer content to let the agencies control use of lands. There is a growing outcry to let the public decide what is done with public lands. It is a cry to hold managers of public lands accountable for maintaining healthy systems and for long-term viability of those systems. It is also a cry to take power away from these managers and to let the public have a heavy hand in deciding how the land will be managed.

In many ways, the shifts that are being seen in land management parallel the changes in our social structure, in personal, business, and political lives. People were once content with, and even expected, an authoritarian decision-making process. Authority figures were never questioned, and were always approached with a certain amount of awe and fear. Today, individuals are less willing to remain quiet while being told what to do, how to act, and how to think. Today, the public is much more actively involved and less willing to trust that government land managers know what they are doing or trust that they have all the public's interests at heart.

The result of this is that resource managers can no longer be just biologists, or scientists; they now must be trained in new "people" skills. They must have skills in understanding interpersonal relations and interactions of all sorts; they must

have skills in consensus-, team-, and community-building; and they must have skills in methods associated with cooperative, interactive, and participatory decision-making. All this in order to deal with their own staffs, and also to deal with "stakeholders" and "interest groups" as well.

The number of lawsuits relative to land and wildlife management is testament to the fact the transition is not going all that smoothly. Some days it seems as if the courts are making more resource decisions than the agencies. At best, the transition is a slow, painstaking process that causes great frustration and long pauses in action. We are interested in two aspects of this change: 1) research and the need for higher quality and better sharing of information, and 2) the sociopolitical conditions that accompany this change.

The Need for Research and Information Management

In a recent compilation of case studies involving research application to management in NPS (Halvorson and Davis 1996), five lessons emerged which have direct application to the issue of how society can better manage large, landscape-scale areas.

Lesson 1: Resource managers need more information than they have and they need that information in a more useful form. There are a number of issues related to this lesson.

Issue 1A. Absence of information leads to management based on beliefs, which in turn often leads to false conceptual models and costly mistakes. This type of management leads directly to lack of public trust because managers are perceived as not caring or not knowing what they are doing.

The earliest conceptual models of NPS areas considered them to be scenic places to be used by the public as pleasuring grounds. Managers were not too concerned about obtaining knowledge about what they were managing as long as it looked good (Likens 1989; Risser 1991). This conceptual model resulted in practices like predator removals to assure deer in the meadows, and total fire suppression to keep the "politically correct" green forest. These practices, however, led to massive disruptions in naturally functioning ecosystems. Armed with better ecological understanding and information from a long-term view of the consequences of these actions, managers later revised their conceptual models and set a new course—one that included structure and function of biological systems along with scenic beauty. This change to a new, scientifically based course of action has been slow and cumbersome, being pushed from outside the agency and in many ways causing turmoil on the inside (National Research Council 1992; Wright 1992).

The shifting paradigm of cutthroat trout management at Yellowstone National Park (Varley and Schullery 1996), for instance, has been based on long-term studies providing information to managers who have been periodically revising their concept of how that complex system works. The goal is to keep adding information until enough is known that management of the lake can be done with complete understanding of the roles of trout, predators, and fishing. Fire in the Sierras (Parsons and van Wagtendonk 1996), as elsewhere, is one of the more publicized changes in management strategies. Early understanding that there were "climax" communities which were stable and that fire was a "disturbance" to that stability led to the unfortunate belief that, to protect our forests, we had to totally suppress fire. It was only after years of gathering information on the dynamics of forest systems that the understanding came that fire is an important environmental parameter in many systems, and that total fire suppression was actually the disturbance that targeted these systems for some rather dramatic changes.

Issue 1B. Long-term monitoring of resources, though costly, is actually cost-effective for protecting resources because it allows for interactive resource management; that is, course corrections can be made during an action program instead of waiting for a crisis to see if the action worked or not. It is "penny wise and pound foolish" not to monitor, as it keeps agencies consistently in crisis-management mode.

An active program to regularly assess the condition of resources facilitates problem identification and suggests solutions at an early development stage. This is analogous to regular physicals for individuals. In Hawaiian national parks, early detection of some alien species (Stone and Loope 1996) has allowed the parks to remove them with minimum effort and cost. By monitoring backcountry use, the Sierra Nevada parks (van Wagtendonk and Parsons 1996) are able to adjust use in such a way as to minimize damage and, therefore, ameliorate the need for large-scale restoration projects. The use of monitoring protocols at Ozark National Scenic Riverways has allowed the park to effectively set carrying capacities on river use. This is as important as the business concept that it is more cost-effective to do the job right the first time, or to do preventative maintenance, in order to avoid the cost of doing something over, correcting a mistake, or suffering through unscheduled down time.

Issue 1C. Long-term data sets not only provide good information, they are politically and legally powerful and assist greatly in the decision-making process, whether it is a management, political, or legal decision.

Managers of natural areas and natural resources regularly need to

do battle in legal and political arenas. This need is actually increasing as parks become more and more affected by surrounding human developments. In order to effectively uphold the rights of natural resources, managers need to have data and information that are sound (in both the public and legal sense) and can refute the desires of those who want to use natural features for human activities which will adversely affect resources.

By monitoring air quality (Shaver and Malm 1996), Grand Canyon National Park was able to prove the impact of a nearby power-generating plant on visibility in the canyon. The Devil's Hole pupfish (Williams et al. 1996) was saved only because of research that showed the relationship between regional groundwater use and the habitat of this endangered species. Saguaro National Park (Shaw 1996) actively pursued the issue of the impact of urbanization on species within its boundaries. Understanding all the species interchanges between the park and the surrounding housing developments helped the superintendent in sensitizing the public to the effects of developments near the natural area. This led to changes in zoning close to the park boundaries—changes that assist in protecting the park's biological resources, not just its scenic values.

Lesson 2: Natural areas are not the static entities that they were once believed to be (one of the more serious false conceptual models under which NPS was managed for many years). Managers now have a clearer understanding that changes occur no matter what actions are implemented, including no action.

Through studies like those highlighted by Halvorson and Davis (1996), as well as a number of other problems that park managers have had to deal with in the last three decades, NPS management has recognized the need for a change in attitude. A change has pretty much taken place from "All we have to do is put a line around it and protect it" to "We better find out what's inside the park's border and check periodically on how conditions are changing."

Lesson 3: Studies to understand the characteristics and dynamics of natural systems need to be undertaken, and need to be long-term, consistent, and multifaceted to address a broad range of temporal and spatial scales.

Issue 3A. NPS areas need active programs to provide managers with information on the long-term dynamics of ecosystems. There is no area in the National Park System that can do without information on its resources. Every area should have a monitoring and research program in place, with scientists regularly available to the staff. This information should be available to all divisions of the park, including interpretation, protection, and maintenance.

One of the most troubling problems in managing long-term research is the fact that research sites are continually being lost to development as society marches across the landscape. NPS areas can provide stable sites for long-term studies, where threats to the research site are minimized.

There have been instances in the past in which agencies such as the National Science Foundation have been reluctant to fund long-term research in any NPS areas because of a lack of sensitivity for such research on the part of NPS managers. While this has been a problem, a new relationship is possible, as managers change the way they view monitoring and long-term resource management (see also Risser 1996). With continuing agency support through an operations-based program in resource monitoring, there can be a better cooperative relationship between NPS and research in the national parks. This will not only benefit park resources through increased information about those resources, it will also benefit the understanding of landscape and ecosystem ecology in general.

Issue 3B. Consistency is absolutely necessary in long-term studies. There are many reasons why there are so few long-term ecological studies. In order to develop information useful to managers, all the impediments must be overcome. Reasons for the paucity of long-term data sets in NPS areas include inconsistent support from park management and funding sources, lack of a dedicated leader with a personal stake in the project, lack of support from the research community for promoting and rewarding such studies, and the lack of support to maintain a database management system in an environment of regularly changing personnel.

The dynamics of population interactions are extremely complicated and our understanding of such interactions is still very shallow at best. The long-term studies of moose and wolf populations on Isle Royale (Wright 1996) is a good case in point. Through them we have come to understand that defining interspecific population interactions is arrived at only with great diligence. Even after 15 or 20 years, the changes from year to year can be puzzling.

Having gaps in data collection is often a cause of databases losing their functionability. It is important that any resource data-collection program be set up to be in operation for a reasonably long term, but with built-in reviews at given intervals. Such programs should not go on unquestioned for years, but neither should it be possible for a new staff member to come and shut down a project because of personal preference. Likewise, a program should not be lost because a particular scientist happens to move on to another area (Al-

exander 1996). The means must be found to institutionalize an active program of data collection, storage, summary, and analysis, and reporting of results, and to maintain it with changing personnel.

Issue 3C. Research in NPS areas should address management issues of varying temporal and spatial scales. Early research efforts in NPS were on single species, and studies with short temporal scales. These types of studies are still needed as each NPS manager is daily faced with problems that require quick, short-term solutions. Research must respond to such problems as efficiently as possible. Managers should also support long-term monitoring and research on their park resources to have a more complete set of data and understanding of their systems so that day-to-day decisions are made in the context of this more complete understanding.

In most cases, the best attitude to take when managing resources or carrying out a resource management project is that there is an experiment taking place. The need is to have every action followed by the collection of data that will help evaluate that action.

Lesson 4: No longer can we afford to treat any land management unit as an island unto itself. All areas, natural or otherwise, are connected in a myriad of ways to surrounding lands. Managing any piece of landscape in the future will involve cooperation and coordination with neighbors.

As more information is accumulated about ecosystems, it becomes clearer that all areas are very much connected to and influenced by the lands that surround them. This inevitably leads to placing emphasis on landscape-level research and monitoring. This is demonstrated well at Mammoth Cave National Park (Alexander 1996) and Ozark National Scenic Riverways (Chilman, Foster, and Aley 1996), where karst topography results in waterway connections far beyond the boundaries of the NPS units. Initially, NPS managers were slower than researchers to understand this. Tensions were high as new data were developed which led everyone to understand that problems were more complex, and involved people and situations outside the park boundaries. It is easy to see why some managers would come to the point of saying, in frustration, "Don't give me any more information, I have more problems than I can deal with now." Not having the resources to deal with it, many managers did see new information as another problem, and did work toward slowing down the numbers of "problems" that were coming at them by not supporting research or, in some cases, being more aggressive in restricting research.

Most managers today understand that they need to be involved in the management of areas that surround

them. They welcome the gathering of information that will help them deal with their neighbors. This understanding will be increasingly important in the future and will be necessary for NPS and other land management agencies to see their areas as part of interconnected resources and not as isolated "islands." Though usually not as dramatic as buffalo at Yellowstone National Park walking outside the fence and being shot, every NPS natural area today deals with wild life issues at its boundary.

Lesson 5: A good relationship between scientists and park staff is crucial.

Issue 5A. There is a need for recognition, support, and leadership in understanding the value of long-term ecological research in national parks from both scientists and NPS managers. The official statement of the Cary Conference on Long-term Ecological Research of May 1987 (Likens 1987) concluded that there needed to be, because of common long-term goals, a new partnership between scientists and resource managers. This partnership needs to include 1) an agreement by scientists to answer the questions put to them by managers, making clear the level of uncertainty that exists and what additional research needs to be done; and 2) an agreement by managers to give serious consideration to scientists' answers and to support continuing research toward better answers.

Data are important, but they must be in a form that is understandable by the managers who need information in making day-to-day decisions. It is necessary that scientists and managers work cooperatively in the development of this information. A scientist–manager partnership requires a change in attitude in both the manager and the scientist; to understand and respect the value and needs of the other. Without such respect, there will be constant struggle in any research program. Narrowly focused and obstinate scientists are often as troublesome to the search for truthful information as are superintendents who feel the need to impose their authority on and begin to direct research.

Issue 5B. Research in national parks should be jointly supervised by local superintendents, regional scientists, and the scientist's research supervisor. There has been a long history of individuals, committees, commissions, and task forces that have advised the NPS to increase its science capability, up to and including the establishment of an independent research branch of the organization (Leopold et al. 1963; Robbins et al. 1963; Orians et al. 1986; National Research Council 1992). All of that advice has had little effect on Congress, on the Department of the Interior, on NPS, or on the research program. This is still a major need and one that will be even more complicated to solve because of the

reorganization of research in the Department of the Interior.

However research is to be organized, it is clear from the case studies in *Science and Ecosystem Management in the National Parks* (Halvorson and Davis 1996) that supervision of research must be done cooperatively. Scientists require input from superintendents so that the individual park needs get met, and from scientist supervisors who can assure that NPS research needs are being met, which the scientists' standing in the scientific community is protected and enhanced.

Issue 5C. Each NPS-area research program should be related to a university peer group or the larger research community. This can be done either through a Cooperative Park Studies Unit or an advisory group, and is for the purpose of assisting a park's research program from becoming so in-house that it does not relate to regional knowledge bases or becomes insensitive to theories and concepts being developed by other researchers. In the case of studies of the saguaro cactus (McAuliffe 1996), for example, interested superintendents got bad information and advice from researchers who failed to use available information, to involve a review process, and to use a holistic approach in planning their specific research projects.

Of primary concern should be that the resources of NPS areas are managed in such a way that sustains ecological processes and provides for the enjoyment of future generations. All involved must work more cooperatively to get this job done. They must get beyond the personalities and the personal agendas of researchers and managers and become more in tune with working with committees and looking at resources on a regional or landscape level.

Sociological Changes in Resource Management

The change taking place in the way federal agencies do research and obtain information, and share that information, is related to and brings us to our second major point: that of the sociopolitical changes in the field of resource management.

The following are lessons, not that have been learned, but that we believe are being learned, both from the perspective of the agencies and society as a whole.

Lesson 1. A shift in social consciousness of humans relating to nature is taking place. This shift is from a consciousness which says that nature is totally separate from people and is there for us to use and abuse with impunity, to one which says that humans and nature are integral to each other and that we need to be protective of natural processes and find the way to live in a sustained manner as part of the landscape.

Lesson 2. In order to more successfully manage "public" lands, there will need to be better coordination among neighbors, partners,

and stakeholders (Howe et al. 1997; Sonoran Institute 1997). Resource management will come to be seen as a landscape-scale issue into which many "publics" will have input. The days are over in which a few individuals in one agency decide what is best for a particular property. Land management agencies will need to develop training programs in participatory decision-making and community-building to have managers more fully capable of interaction with their neighbors.

Outside the boundaries of any land management area, there continue to be increasing activities in the development of citizen groups or collaboratives: watershed associations, watershed councils, "friends" groups, and other assorted, variously named comings-together of people on a particular piece of landscape. These groups will more and more be demanding a say in how that landscape will be managed. The leaders of these groups will also benefit from taking the time and expending the effort to obtain training in community-building and decision-making.

It is not only that NPS managers are being asked for participation by the local populace interested in the park, the NPS manager is finding it necessary to participate with local and county groups to raise consciousness about wild life and to influence development near the parks. A couple of important programs in this regard are the United Nations Man and the Biosphere Program's biosphere reserve initiative and the Gateway Communities Program of the Conservation Fund and the Sonoran Institute (Howe et al. 1997).

Lesson 3. The various publics need to have additional and more usable information than they presently have. A library full of books and journals doesn't cut it in the fast-paced world of the 1990s. The doubling time for gathering information is decreasing exponentially and is causing us to become dependent upon computerized geographic information systems (so that everyone is using the same maps and data), quality control and quality assurance of data, and computer networks.

If managers are going to have effective partnerships, society will need to find ways that all groups—federal, state, and local agencies; nongovernmental organizations; and interested citizens—have access to the same information. This was one of the major reasons given by Secretary of the Interior Bruce Babbitt in his creating of the National Biological Survey. As yet, little has been done to solve this problem, as we are moving in that direction slower than a desert tortoise.

Lesson 4. In order to more successfully coordinate with all stakeholders in any landscape-scale area, new governance structures and new institutions will need to be developed. It is problematic that this can be accomplished without going

through chaos. Along with the new governance structures comes the need for new decision-making processes—processes that are cooperative and participatory.

Lesson 5. Social structures in how we view private versus public lands are shifting to a community mind-set: one of interconnectedness and interdependence, and moving away from strict individualism.

We believe that the days of "It's mine and I'll do whatever I want to with this land" are going away for all ownership categories, including federal agencies, state agencies, and private land-owners as well. As society begins to manage landscapes, all owners will be brought—some kicking and screaming—under an umbrella plan that gives everyone a set of rules to live by, much like the home-owner association rules of some of today's more progressive home developments. This new structure will lead to a new level of "local" governance. Land managers will be actively working with planning programs of neighboring agencies and with the counties and municipalities that are adjacent to and near to their borders.

Lesson 6. A shift from commodity-based management to ecosystem-based management strategies is taking place. It is becoming necessary to manage all aspects of ecological systems, whether they be natural areas, timberlands, or grazing lands. The whole system must be considered from a long-term sustainability perspective, not simply any one parameter, whether that be biodiversity, water, productive soil, cattle, timber, or one of the many charismatic or endangered species.

Discussion

Early NPS wildlife management took the flavor of managing a game preserve: intensively managed areas that focused on the preservation, and enhancement, of a few selected species. The management methods used in these areas, such as artificial feeding, control of predators, fire control, and habitat enhancement, were designed to protect species considered to be desirable. Having enhanced the good species, NPS then faced problems associated with overpopulation, and management was forced to start culling herds to prevent habitat destruction and large-scale die-offs. NPS then actively entered a time when management meant deciding how many of the good species were appropriate and variously feeding and killing to maintain that number. This made it difficult for some outsiders to understand how this "park" was somehow so different that hunting would not be allowed. It began to look like hunting was allowed, but only for a privileged few.

Later approaches to wildlife management were in the realm of "hands off," where "natural" processes were left to function as they would. This approach is also not without its

problems, and required a shift away from the belief that there are good and bad resources and good and bad processes. NPS actually began to really get to know its neighbors at this time as it was often difficult to make park neighbors understand this "let nature take its course" management style when that management causes an impact on their property, in the form of fire, or deer browsing, or disease, or some other form of destruction. A major difficulty with this approach is that the world is drastically different today, with no freedom to roam for the herds, no Native Americans hunting, changed fire regimes, and fewer numbers of predators. So what "natural" processes are operating? Further, it is very difficult for the American public, and for many managers, to watch wild fluctuations that natural processes can cause to occur.

For most of us, it is more comfortable to see consistency in numbers and in habitat condition year after year, but is this natural? Our collective world view (belief) won't let us get comfortable with massive die-offs and wild fluctuations. Collectively, we still believe in the concept of carrying capacity and believe that the way it is supposed to be is a gentle variation around that carrying capacity. Even though there is a lot of information to support the contrarian view that nature is full of drastic, powerful, stochastic fluctuations, many continue to cling to a belief in succession, climax and long-term stability. Thus it is that there is still too much management based on belief, even while not understanding why our natural systems don't behave the way they are supposed to and not mentally coping with wild swings in population numbers or health conditions of our natural systems. Since there is not yet a sufficient monitoring program to aid us in understanding the dynamics of natural systems, management continues to fall back to beliefs on which to make decisions. In the coming world of partnerships, wild life management will need sound information in order to overcome struggles over differences in beliefs of the various groups at the decision table. Management will be forced to make knowledge-based decisions.

No matter what we call it—"ecosystem management," "landscape management," or something else—society is now moving into an era of cooperation; a time when many in our society will no longer look at interactions from a win–lose, competitive perspective, but one in which there is a realization that health, peace, and sustainability demand a win–win, cooperative attitude. This will drive our future resource management programs. It seems to us that: 1) government and private institutions will have to be reorganized and in many ways reconstituted by new laws and regulations in order to accomplish this coopera-

tion efficiently; 2) we will need close partnerships in the gathering, use, and sharing of information; and 3) we will need close partnerships with neighbors and "stakeholders" in the decisions of what we do with our management units and programs.

For many, this entering into partnerships is a painful and difficult time. Some want to continue to say, "It's my land and I'll do what I want with it," some want to say, "We're the professionals, *they* are not going to tell us how to do our business," and some want simply to say, "It's too hard, I can't (or I'm not going to) do it."

We must, however, do it. We must move away from an NPS wild life management strategy and get to a landscape wild life management strategy. To do this will require better science and better sharing of information, as well as policies and goals that reflect the needs and desires of an entire protected landscape (Jackson 1984), and it may even require NPS to revisit issues of culling (hunting), fire management, timber harvest, joint or cooperative management, and others. We must now work toward managing resources inside the park's boundary in the context of landscape, toward supporting (and sometimes changing) the desires and beliefs of the parks' neighbors, and toward developing full partnership involvement of those who live and manage at the parks' borders.

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Thomas M. Franklin

Key Differences in Thought in Science and Values Regarding National Park Service Wildlife Management Policies

In his opening remarks, Michael Soukup described the current conditions on park lands and the challenges to managing wildlife conservatively under visitor and budget pressures. He acknowledged that changes in policy are made by the National Park Service (NPS) as the bureau's understanding of ecology progresses. He expressed an openness to modifying park policies objectively and professionally, based on increased understanding of natural systems. And Soukup expressed an awareness of the criticism of NPS management and the agency's use of science in decision-making. He acknowledged the legitimacy of concerns in the scientific community and expressed a willingness to re-examine current policies in light of ecosystem-level needs, diverse public values, and contemporary scientific theory and practice. He explained that the budget for natural resources and science is very limited in relation to the needs of a huge visitorship. Therefore, policies are very cautious to assure that if errors are made, the bureau will err on the side of conservatism.

In response to a question from the audience, he said NPS needs to find innovative ways to supplement technical expertise available to them; perhaps by recruiting assistance from retired experts.

John Dennis described the history of federal legislation that created and guides NPS as it strives to conserve wildlife for the enjoyment of future generations. Dennis remarked that national parks are solely the expression of human values. Policies have evolved from the early days to the present based on available knowledge. Congressional direction also has changed over time as has administrative policy that implements it. Dennis described the flexibility of NPS management policies to achieve species conservation needs. He described park resource management plans and challenged scientists to provide technical input for the plans. He urged the scientific community to help the agency by focusing on how to identify and develop standards for evaluating whether or not natural conditions, unimpaired states, and non-derogation of values and purposes are being advanced for any given change in policy. He challenged wildlife scientists to study how ecosystems work, how animal population dynamics are influenced by intrinsic and extrinsic factors, and

what and how human actions are or are not changing the baseline environments within which park animal populations have evolved.

He further challenged the scientific community to take a long-term view of both human enjoyment of parks and the population dynamics of the animals. However, he cautioned that scientists should avoid advocacy of their personal values. He suggested that wildlife professionals develop jointly with the parks a comprehensive and coordinated program of long-term ecological monitoring in the parks.

William Supernaugh discussed individual park management needs from a biologist's perspective. He emphasized how unique conditions in each park may require flexibility in policies to address social and biological concerns. NPS policy accommodates needed management actions in parks within fragmented ecosystems that contain only a portion of the original faunal component after a definable threshold of tolerance is reached.

Michael Ruggiero emphasized that NPS policy has focused on a few charismatic species to the neglect of invertebrates which make up three-quarters of all described species—the so-called spineless majority. Invertebrate species have significant economic value. They provide trillions of dollars in services. NPS policy has recognized the value of conserving invertebrates, but invertebrate research has received relatively little funding. NPS needs to: (1) inventory invertebrates and establish collections, (2) develop reference materials and collections, (3) do research on inventory and monitoring methods, (4) hire entomologists to collect data, and (5) aggregate data.

Linda Wallace expressed concern that NPS policies focus on vegetation management as it relates to the level of ungulate grazing, that is, whether or not vegetation is overgrazed. Vegetation responses to herbivory should be viewed more broadly to include how communities might be grazed and look after considering the evolutionary history of different grazing regimes. Scientists can then better understand how ecosystems may have functioned in an evolutionary context. She suggested that policy-makers should recognize that plant behavior does not necessarily respond to policy-based timetables, but integrates across a range of conditions over evolutionary time.

Ruthann Knudson believes NPS wildlife policy needs to take into account cultural history as well as biological factors. Native Americans may have affected wildlife and habitat conditions many thousands of years ago. Understanding long-term past relationships, including the bilateral impacts of natural and cultural events and activities, can help the NPS make more scientifically based and publicly acceptable wildlife management decisions.

Frederic Wagner believes that the NPS needs to identify clearer goals for the National Park System and individual parks. The public needs to be involved actively to identify social and biological goals. Science should neither prescribe goals nor set policies. It should be a non-advocating service to the goal-setting and policy development processes, pointing out the consequences of alternative goal options, assisting in the design of management programs, and evaluating their effectiveness. In the process it should clarify, and in some cases dispel, ecological theory and practice. The entire ecological community should be involved in this process.

John Freemuth told us that NPS wildlife policies should be critiqued with particular attention to assumptions, constraints, and opportunities that are rooted in the political system and in NPS organizational culture. He raises some important questions about how to resolve policy conflict—through a collaborative approach or through the quantitative approach established by the Government Performance and Results Act.

William Halvorson and Chris Eastin suggested that national parks policy must be considered in the context of ecologically sensitive management of the surrounding landscape. They believe it is no longer feasible to manage NPS units as if they were islands in the age of computers and information proliferation. NPS wildlife management policies must take into consideration the management practices of agencies surrounding them.

NPS needs to move from management by belief-based directives of the few to management by scientific understanding and broad consensus. But they acknowledge that this change will create a new set of sociological problems. They believe NPS must now work toward managing resources more effectively through educating, cooperating, and involving its neighbors in wildlife management decisions.

Discussion

A stimulating open discussion occurred following the presentations. Key points made by the audience included:

1. Judicial influences have led NPS to initiate more collaborative processes.
2. NPS needs to engage the public more effectively by presenting them with management dilemmas from which to choose.
3. Parks are a long-term public good that need to take into account how to meet the needs of future generations.
4. Scientists should communicate directly to a larger public rather than filtering their science through agencies.

Addressing Differences in Thought in Science and Values

Existing wildlife policies of NPS are an artifact of past politics, biological theories, public values, and perceptions of agency administrators and scientists. Advances in science and ecological theory, constantly changing public values, and stakeholder interests suggest an innovative approach to establishing goals and objectives for wildlife management in national parks.

The answer to existing policy conflicts should be addressed through informed and careful public scrutiny of NPS practices at both the national and individual park levels. All Americans, wherever they reside, should have the opportunity to express their opinions about park issues in a formal public process in which their wishes are carefully considered by NPS. Scientists both inside and outside of the agency should have reasonable access to the parks and the entire body of scientific literature to test theories empirically. The diversity of viewpoints about park wildlife issues should be discussed openly in forums such as we are enjoying here in Snowmass.

NPS should consider adopting a formal planning process for public input into decisions affecting the National Park System and individual parks. There may be an opportunity to better use existing resource management planning processes. The Government Performance and Results Act may be a useful tool. A modified land planning model, such as exists in the Resource Planning Act and the National Forest Management Act for the U.S. Forest Service and perhaps in the new National Wildlife Refuge legislation before Congress, is worthy of consideration—especially if it includes an effective adaptive management requirement. Although not perfect, such a process could encourage thoughtful consideration of all aspects of resource management for the National Park System as well as at the landscape level for each park. Such a process could lead to better public acceptance of NPS actions. Certainly such a process does not eliminate conflicts, but it would help illuminate conservation options, ensure that the concerned public has an opportunity to affect the natural resources conditions in the parks, and set the stage for implementing state-of-the art wildlife management practices that will benefit the resource as well as present and future generations of American citizens.

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