PARK SCIENCE
Integrating Research and Resource Management

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NEGOTIATED RULE MAKING AS A RESOURCE AND VISITOR MANAGEMENT TOOL

A case study in the use of FACA

BY LINDA CANZANELLI AND MICHAEL REYNOLDS

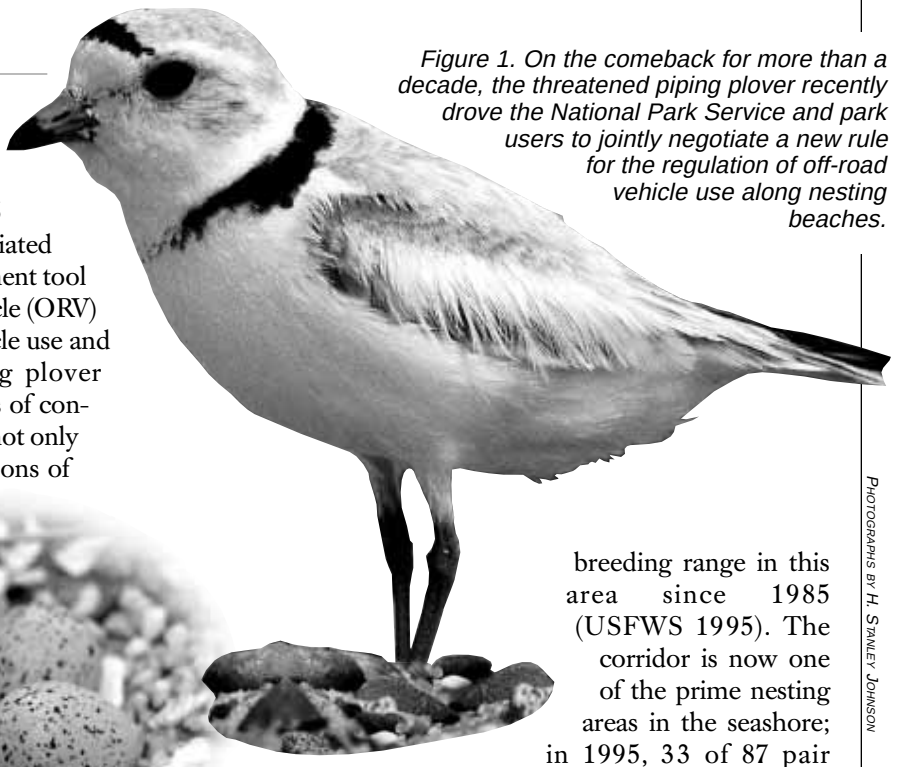

Figure 1. On the comeback for more than a decade, the threatened piping plover recently drove the National Park Service and park users to jointly negotiate a new rule for the regulation of off-road vehicle use along nesting beaches.

PHOTOGRAPHS BY H. STANLEY JOHNSON

CAPE COD NATIONAL SEASHORE, Massachusetts, recently tried *negotiated rule making* (per FACA, the Federal Advisory Commission Act, P.L. 92-463, 5 U.S.C. App. II Sec. 9(c), and the Negotiated Rulemaking Act, 5 U.S.C. Sec 561-570) as a management tool to resolve an ongoing contentious issue–off-road vehicle (ORV) use on the national seashore beaches. Off-road vehicle use and management of the federally threatened piping plover *(Charadrius melodus* [fig. 1]) has led to over 15 years of controversy, litigation, and different proposed rules that not only attempted to allow ORV access, but also close sections of beach for the plover in compliance with the Endangered Species Act.

BACKGROUND

In 1981, the seashore proposed a new ORV regulation that slightly reduced ORV use. Unsatisfied with the regulation, environmental groups challenged this proposed rule in court. The result was a rewrite of the regulation to what is called the "1985 regulation" (36 CFR 7.67). Environmental groups also challenged this regulation in court, but it was upheld.

The National Park Service would have been content with the 1985 regulation, which established a 13.6-km (8.5-mi) ORV corridor on the 64 km (40 mi) of outer beach within the park (fig. 2, page 16) , except that the piping plover has quadrupled its breeding range in this area since 1985 (USFWS 1995). The corridor is now one of the prime nesting areas in the seashore; in 1995, 33 of 87 pair nested in the corridor (Hoopes 1996). Primarily because of plovers in the corridor, seashore staff monitor every bird, nest, and egg daily to assess if the corridor should be closed or reopened to ORVs. As soon as a nest is identified, symbolic fencing is erected with true exclosures put up once the four eggs are laid; the ORV corridor is closed from the time the birds hatch until they fledge approximately 28 days later. During the past couple of years, on especially busy weekends such as the Fourth of July, we have only been able to open 0.6-1.0 km (0.4-0.6 mi) of the corridor (Hoopes 1996).

Continued on page 16

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CONTENTS

DEPARTMENTS

- Editorial 3
- News & Views 3
- Books in Profile 5
- Highlights 6
- Information Crossfile 8
- Meetings of Interest 32

FEATURES

- Negotiated Rule Making as a Resource and Visitor Management Tool 1
- The National Biological Service and NPS Science-Based Management 10
- NBS-USGS Merger Update 11
- Ecological Stewardship Workshop 13
- Ecosystem Stewardship: What Does it Mean? 15
- *Aster yukonsensis* Range Extension in Northern Alaska 18
- Landslides and Fossil Resources at Hagerman Fossil Beds 20
- Assessing Regional Economic Contributions from National Park System Units 24
- Why Assess The Economic Impacts of National Parks? 26
- Pseudoreplication Issues versus Hypothesis Testing and Field Study Designs 28

IN THE NEXT ISSUE. . .

Our look back at the first class of natural resource management trainees in 1984 will finally be featured next issue. Also, bald eagle surveys at Apostle Islands National Lakeshore, Wisconsin; the leave-no-trace camping ethics program; turfgrass research and use in eastern parks; and the successes and pitfalls of maintaining a water quality monitoring program at Sleeping Bear Dunes National Lakeshore, Michigan.

Managing Change

If not for change, we would have nothing to do. As resource managers, we spend most of our time trying to avoid change (of the resources) or bring it about. As scientists, comprehending change, investigating its causes, and determining options for dealing with it is paramount.

This issue features several articles that deal with change. One story examines the dynamic relationship between the NPS and the National Biological Service in the quest for research in support of resource management. The cover story on FACA demonstrates a recent management tool that integrates all park users more thoroughly into park planning.

Economic assessments are not new, but their slow proliferation in park management represents a change in the past decade. As two stories point out, economic assessments may help parks begin to see themselves as some park neighbors do–as sources of economic benefit. More importantly, park neighbors may relate the jobs and income derived from the park to the enduring nature of the resources themselves.

Finally, a pair of articles describes outcomes of the December ecosystem management workshop in Tucson. Managers can expect to see published in the coming year a compendium of scientific ecosystem management case studies that may help them adopt management practices pioneered elsewhere. Managers can also expect an era of change associated with taking this endeavor seriously. In this age, the story on page 15 asserts, human influences on park natural resources are undeniable and *natural process management* alone may no longer be adequate to care for natural resources.

This assessment is timely as the NPS begins to reexamine its natural process management philosophy. Often incorrectly called the "natural regulation" paradigm, the policy states that managers "will try to maintain all the components and processes of naturally evolving park ecosystems…." Its application in wildlife management has been hotly debated for decades, especially in parks where herd sizes of large mammals have been allowed to fluctuate naturally within park boundaries. The NPS will address this philosophy, and the criticism regarding its application, in a series of scholarly, collegial forums to be held in conjunction with several national science conferences over the next 2 years. The first will be Aug. 13 in Rhode Island (see Meetings of Interest on page 32) at the annual conference of the Ecological Society of America.

Many contend that the policy is not flawed, that how it is applied is what needs careful scrutiny. The upcoming review will examine the appropriateness of the policy, given the complexities of natural resource management today, and its application in three case studies: large mammals in Yellowstone, moose and wolf in Isle Royale National Park, and white-tailed deer in eastern U.S. parks. The forums will focus on the current and emerging science and the related human dimensions surrounding these case studies to set the direction of future park management.

News & Views

Park Science Now Online

Park Science is now featured on the World Wide Web at *"http://www.aqd.nps.gov/nrid/parksci"*. The home page describes the publication, the issues available online, article submission criteria, and instructions on how to download individual editions in portable document format (PDF) for subsequent viewing and printing. The web site also features an interactive article index that can search for a citation by keyword, park, title, or author, describes how to obtain back issues of the publication, and provides a simple way to get in touch with the editor. Give it a whirl.

Park Science Hard Copies Sought

The editor would like to bind several complete sets of *Park Science* for use as a reference. Needed are two copies of 7(4)–summer 1997. Additional reference sets can be bound if readers would care to donate an entire catalog of issues; most needed are complete sets of volumes 1-12. If you can be of help, please contact the editor (see page 2 for contact information).

Natural Resource Publications Program on Hold

As a result of restructuring, the former Natural Resources Publication Program is on hold indefinitely pending funds to hire a publications coordinator. Authors interested in submitting materials suitable for publication in the familiar Monographs, Natural Resource Report, and Technical Report Series will need to find other avenues for publication. Annual Science Reports, the Proceedings Series, and Highlights in Natural Resource Management have been discontinued; data from previously published Annual Science Reports is still available from the Investigators Annual Report database. A new report, described in the following article, will be initiated this year by the Natural Resource Information Division. *Park Science* will continue to be published.

Parties interested in receiving copies of reports may want to initially contact the authors of the respective reports. Alternatively, the NPS Technical Information Center (TIC) maintains copies of all NPS technical reports and drawings including all natural resource reports. For a fee they will make photocopies or microfiche copies of requested NPS reports for interested readers. Contact them at: Technical Information Center; National Park Service; P.O. Box 25287; (DSC-MS-TIC); Denver CO 80225-0287; through NPS cc:Mail at: "TIC- work orders/requests"; or by e-mail at: *"tic-_work_orders/requests@nps.gov"*.

New Natural Resource Report Needs Your Input

The Natural Resource Information Division of the NPS Natural Resource Program Center has begun preparing a new and comprehensive report aimed at building *outside* support for NPS natural resource preservation goals. Tentatively titled, *Natural Resource Year in Review*, the report will be published in early 1997 and will track the highs and lows of

Continued on page 4

natural resource management in the National Park Service during 1996. An easy-to-read, magazine-format publication, the report will relate stories of immediate interest, informing readers of the status of significant local and national natural resource issues. The report will be based in science, but written for a general audience that includes Congress, the public, and cooperators.

To be truly national in character, the report needs widespread input. Its contents will be developed with an eye toward comprehensive coverage of major and other current events, science and resource management happenings, and national and local issues that have a bearing on the state of the art of resource preservation in the national park system. *Park Science* editor Jeff Selleck is the editor-in-chief for the project and is now soliciting article ideas and editorial assistance.

Article ideas

Readers are invited to submit brief ideas for articles that relate to issues that are significant for both a park and the national park system this year. These synopses may be informal at this stage, but try to capsulize the central issue, problem, or resource management technique and describe how it relates to progress or lost ground in preserving national park system natural resources. Selected article ideas will be developed fully in the fall with the help of an editorial board and park authors. Following are two examples of what the editor is looking for now:

A local issue with broad implications–

Brucellosis, a bovine disease causing fetal abortions in cattle, is carried by Yellowstone bison. For more than a decade, park scientists, local citizens, and state veterinarians have debated the threat of disease transmission from wild, free-ranging bison to nearby cattle. In 1995, after years of controversial bison removals while government agencies tried unsuccessfully to come to agreement on a mutually acceptable bison management plan, Montana sued the National Park Service to try to speed resolution of the issue. The situation brings the lack of consensus concerning the NPS practice of managing for natural processes into question. The bison management debate necessarily requires the National Park Service and its neighbors to face the often conflicting social, economic, and political factors that influence natural resource management issues.

A national issue–

Since 1991, the network of long-term air quality trend monitoring stations has shrunk from 42 to 34 in class 1 airshed parks. Increasing operational costs without accompanying budget increases accounted for these shut downs and also resulted in suspension of baseline monitoring in other parks. These developments make it unlikely for the National Park Service to meet its goal of establishing baseline ozone and SO_2 levels in each of the 48 class 1 airshed parks by the year 2,000. Further reductions in the long-term monitoring network likely will continue as a result of government downsizing.

Forward your ideas to *Park Science* editor Jeff Selleck (see the bottom of the left column on page 2 for contact information) by e-mail, regular mail, or telephone as they come to mind.

Volunteers for advisory board

The editor is also interested in establishing an editorial board for article evaluation and development. If you are interested in serving on an editorial board and would have a few days this fall that you could devote to discussing the merits of the article ideas, prioritizing them, suggesting full treatment outlines for the articles, and possibly writing, please contact the editor. Editorial business will be conducted over e-mail and the telephone, rather than by travel. The editor would like representatives from a broad array of perspectives, including parks (park management, resource management, law enforcement and visitor protection, interpretation, and maintenance divisions), the Natural Resource Program Center, the Office of the Associate Director for Natural Resource Stewardship and Science, and partners.

Deadline

Please submit your preliminary article ideas and indicate your interest in serving on the editorial board by August 30.

In Closing

The *Natural Resource Year in Review* is an exciting prospect. It has the potential of unifying disparate stories from around the country into one message about the NPS role in the welfare of our treasured natural resources. While park visitors and political representatives alike flock to national parks to enjoy their grandeur, they may not understand as well or support as fervently the efforts of natural resource managers and scientists to maintain the health of the parks. The *Natural Resource Year in Review* will address this disconnect. Please give it your support.

Research Grants Available From the Center For Field Research

The Center for Field Research invites proposals for 1997 field grants awarded by its affiliate Earthwatch. Earthwatch is an international, nonprofit organization dedicated to sponsoring research and promoting public education in the sciences and humanities. Grants range from $10,000 to $100,000. Most of the funds contributed to the research projects come from the donations of Earthwatch members, who enlist for the opportunity to join scientists in the field and assist them with their data collection and other research tasks. Thus, nonspecialist volunteers must be integrated into the research design.

In 1996, The Center for Field Research made grants to several projects that had a direct bearing on national park sites: Resource Management Specialist John Roth researched cave formations and macro-invertebrate baselines at Oregon Caves National Monument, Oregon; NBS Research Scientist Judd Howell studied wildlife habitat relationships in Golden Gate National Recreation Area, California; Michigan Technological University Professor Rolf Peterson continued to look at moose-wolf ecology, and specifically the role of wolf predation, at Isle Royale National Park.

Information about Earthwatch field grants is available on the center's World Wide Web site *(http://gaia.earthwatch.org/WWW/gfr.html)* or you can contact: Dr. Andy Hudson, Director, The Center for Field Research, 680 Mt. Auburn Street, Watertown, MA 02172. Telephone (617) 926-8200; fax (617) 926-8532; e-mail *"ahudson@earthwatch.org"* or Sean Doolan, Science Officer, Earthwatch Europe, Belsyre Court, 57 Woodstock Road, Oxford OX2 6HU, United Kingdom. Telephone: (865) 311 600; fax (865) 311 383; e-mail *"ewoxford@vax.oxford.ac.uk".*

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SCIENCE AND ECOSYSTEM MANAGEMENT IN THE NATIONAL PARKS

A Timely Book by William L. Halvorson and Gary E. Davis

BY WILLIAM L. HALVORSON

SCIENCE AND ECOSYSTEM Management in the National Parks (ISBN 0-8165-1566-2) underscores that our national parks are more than recreational pleasuring grounds. They are repositories of the nation's biological diversity and contain some of the last ecosystem remnants needed as standards to set reasonable goals for sustainable development on a landscape basis. In the past, public pressure for recreation largely precluded adequate research and resource monitoring in national parks, and ignorance of ecosystem structure and function in parks lead to costly mistakes–such as predator control and fire suppression–that continue to threaten parks. This book demonstrates the value of ecological knowledge in protecting parks and shows how modest investments in knowledge of park ecosystems can pay handsome dividends.

Sponsored by the NPS Inventory and Monitoring (I&M) Program and recently published by the University of Arizona Press, this book presents 12 case studies of long-term research conducted in and around national parks. These case studies were chosen by a panel of NPS scientists and senior managers to address major natural resource issues. The cases show how the use of longer time scales strongly influence a manager's understanding of ecosystems and how interpretations of short-term patterns in nature often change when viewed in the context of long-term data sets. Most importantly, the cases illustrate conclusively that scientific research significantly reduces uncertainty and improves resource management decisions.

The cases offer a broad range of topics, including air quality at Grand Canyon National Park, Arizona, the moose and wolf interaction at Isle Royale National Park, Michigan, alien species at the Hawaiian parks, fire management in the Sierra Nevada (California and Nevada), and the impact of urban expansion on Saguaro National Park, Arizona.

Because national parks are increasingly beset with conflicting views of management, the need for knowledge of park ecosystems becomes even more critical with time–not only for the park units themselves, but for what they can tell us about survival in the rest of the world. This book demonstrates to policy makers and managers that decisions based on knowledge of ecosystems are more enduring and cost effective than decisions derived from uninformed consensus based on belief. It also provides scientists with models for designing research to meet threats to our most precious natural resources.

The I&M Program of the National Park Service was designed in 1992 as a phased program that would eventually include fairly complete resource inventories for some 262 national park system units with significant natural resources. To complete this work over the target 10-year life of the program, the National Park Service planned for annual funding increases that were projected to reach $20,000,000 by 1996 and $26,000,000 in the program's final year. Instead, though most agree with the importance of inventory and monitoring, the program dawdles along at about $6,000,000 annually. The importance of ecosystem level information, demonstrated so well by this book, has not yet been accepted by those that have the responsibility for providing guidance and funds.

The book has been sent to the inventory and monitoring parks, system support offices, field area offices, and the Washington offices of the National Park Service and National Biological Service. It is my hope that this volume will help bring added awareness and impetus to this seriously needed program.

I&M Inventory and Monitoring

Copies are available from the University of Arizona Press; 1230 N. Park Avenue; Suite 102; Tucson, AZ 85719;

(520) 626-4218 & (800) 426-3797; $40.00 hard copy; 364 pages.

William L. Halvorson is Unit Leader of the Cooperative Park Study Unit at the University of Arizona in Tucson. His phone number is (520) 670-6885. Gary Davis is a National Biological Service Marine Biologist at Channel Islands National Park, California; phone (805) 658-5707.

ROCKY MOUNTAIN

Bear Attractant Test of Biodiesel Fuel

In 1994, over 3 million visitors toured Yellowstone National Park, Wyoming. Along with NPS and concessioner vehicles, park visitor vehicles burned over 28.8 million liters (7.6 million gallons) of gasoline and diesel fuel in the park. Pollution from vehicle emissions can have harmful effects on both animal and plant life. In cooperation with the Montana Department of Natural Resources and Conservation and the U.S. Department of Energy, Pacific Northwest and Alaska Regional Bioenergy Program, Yellowstone is participating in a pilot project to evaluate the use of *100% rape ethyl ester* (*biodiesel*) as a low pollution alternative to diesel fuel in environmentally sensitive areas.

Biodiesel emits fewer hydrocarbons and particulates than fossil-based fuels and is derived from renewable resources. It contains negligible levels of sulfur and reduces emissions of sulfur dioxide, one agent responsible for acid rain. Biodiesel is part of the natural cycle (i.e., assimilation of CO_2 by plants for growth and development), and could lead to zero-net-gain in oxides of carbon emissions. The fuel is biodegradable and quickly breaks down, preventing long-term damage to soil or water if spilled.

Yellowstone preserves pristine wildlife habitat and is a premier wildlife viewing park. On occasion, animals, such as grizzly and black bears, may come into close proximity with humans. Biodiesel fuel is a vegetable oil derivative that smells like cooking oil. The exhaust from a biodiesel fueled engine smells similar to a french fry cooker and could attract bears. If bears were attracted to biodiesel powered vehicles, they could be drawn into park developments and roadside corridors resulting in increased bear-human conflicts (human or bear injuries and property damage). This could lead to potential removal of grizzly and black bears from the population. Concerned with this potential, the park conducted tests to determine if raw biodiesel fuel or its emissions were bear attractants.

As part of the tests, bears were exposed to ambient air, odor from raw biodiesel fuel, raw diesel fuel, a deer meat and dog food mix (known attractant), biodiesel exhaust, and diesel exhaust. Of five captive grizzly and five captive black bears tested, none displayed an attraction to ambient air and all displayed a significant attraction to the deer meat and dog food. All bears were indifferent to biodiesel and diesel fuel, but became agitated and aggressive when exposed to the exhaust from these two fuels.

Available at $8 per gallon, biodiesel is not presently a feasible alternative to gasoline and common diesel fuels. Because its use also requires a minor modification to fuel tanks, biodiesel is best suited to individual vehicle fleets, such as those operated by the park and its concessioners. Yellowstone plans to continue field testing the fuel and may be able to increase its use in more park and concessioner vehicles as biodiesel becomes more economical.

For more information on the experiment, contact Mark Biel, Kerry Gunther, or Hopi Hoekstra of the Yellowstone Bear Management Office at (307) 344-2162; e-mail *"k_gunther@nps.gov."*

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More Wolves for Yellowstone

Project biologists released 17 gray wolves in Yellowstone this past winter and early spring as a second phase of the wolf restoration efforts begun there last year. The 11 females and 6 males ranged in age from 9 months to 5 years, weighed between 72 and 130 pounds, and came from 6 packs in British Columbia. In April, following 10 weeks in acclimation pens, the wolves were released and joined 18 wolves already living in and around the park from similar releases in 1995.

The releases came after the late February through early March breeding season in the hopes that the wolves would den in April or May. Acclimated and released in four different areas of the park, two of the four packs scattered. Several wolves wandered to the Gallatin Range northwest of the park. A pregnant female appears to have denned in the Custer National Forest in Montana. Others from her group remained in the park, wandered to the Gallatin National Forest west of the park, and moved to Shoshone National Forest east of the park. A second known pregnant female, carrying six pups, died of hot spring water burns near Old Faithful; her mate remained in the south-central part of the park following her death. Five wolves released near Rose Creek in northern Yellowstone have generally remained in the park in the upper Slough Creek drainage.

Last year's releases of 14 wolves resulted in the birth of nine pups from two packs. Altogether, five wolves have died. A Red Lodge, Montana, man was convicted of killing a male wolf and given a 6 month prison sentence and $10,000 fine. Animal damage control agents dispatched a wolf north of the park after determining that it had preyed on sheep on two separate occasions. The final rule for managing the restored wolves provides for their removal in the event of livestock depredations, and the project biologists and cooperating agencies felt this action would most likely benefit the overall recovery effort. Defenders of Wildlife compensated the ranchers for their livestock losses. Two additional wolves have been shot outside the park in Wyoming. In one case, a rancher turned himself in to authorities when he realized he had mistakenly killed a wolf during a coyote hunt in calving season. Cooperative throughout the investigation, the man was fined $500. The other perpetrator is still at large. The fifth wolf was hit by a vehicle within the park.

Despite these setbacks, the restoration effort is generally thought to be going well. Three of the six original wolves from the Crystal Creek Pack remain generally in the Lamar and Pelican Valleys in the park; winter visitors reported seeing them chase and feed on elk. The Rose Creek Pack stays mostly in the Slough Creek and Hellroaring areas in the park. Last fall, the alpha female and her seven surviving pups were joined by a young male, formerly of the Crystal Creek Pack, who has now become the alpha male. The Soda Butte Pack ranges along the northern front of the Beartooth Mountains and in

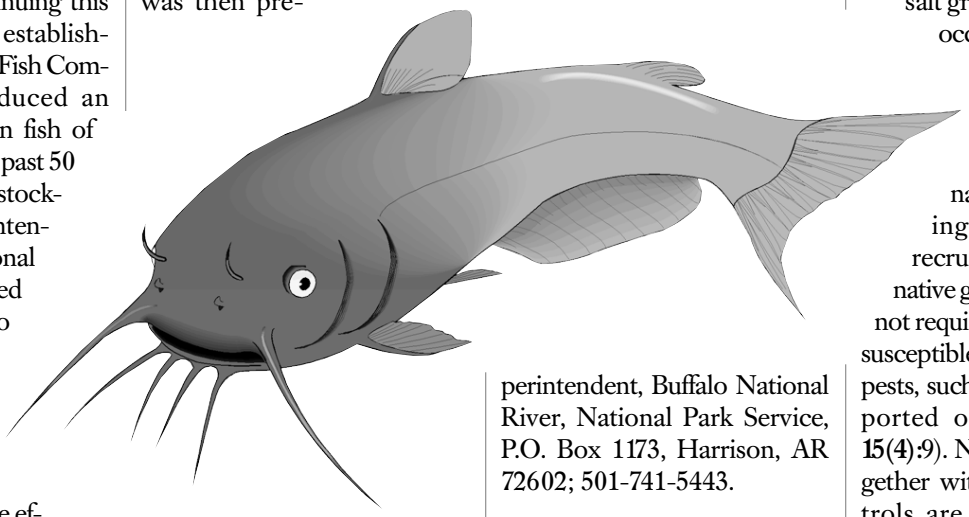
upper Slough Creek inside and outside the park. By late April, biologists noted signs that the alpha females from all three of these packs, and possibly some of the newly released packs, were denning.

Especially exciting is news that a male and female from two different 1995 release areas have paired, comprising the first naturally forming wolf pack in Yellowstone in more than 60 years. The pair has mated, appears to have denned, and could have a litter by summer.

GREAT PLAINS

Resolving "A (Fish?) Bone of Contention"

The Arkansas Game and Fish Commission began stocking catfish in the Buffalo River in 1951, long before the establishment of Buffalo National River in 1972. Continuing this practice after park establishment, the Game and Fish Commission has introduced an estimated 1.4 million fish of several species in the past 50 years. In 1988, the stocking issue became contentious when the National Park Service requested the commission to cease stocking catfish in the Buffalo River until adequate scientific data could be collected to assess the effects and results of stocking.



The National Park Service had a serious situation to address. The Game and Fish Commission considered the Buffalo River a *put-and-take fishery* and had a limited concept of NPS fisheries policy. The public was outraged at a misinterpreted newspaper statement attributed to park staff that "catfish probably never existed in the Buffalo River anyway." During this process the park lacked expertise in fisheries management to resolve many of the issues with the state biologists.

How were we to resolve this "bone of contention" as the Game and Fish Commission director described the issue? The park staff attacked the problem on three fronts: holding direct and informal discussions with state biologists, conducting joint fisheries research projects directed at the issue, and developing a cooperative fisheries management plan for the river.

We began by inviting a cadre of NPS, Forest Service, and U.S. Fish and Wildlife Service fisheries biologists to come to the park and develop goals, objectives, and an outline for a fisheries management plan. The resulting draft document was then presented to the state agency field staff for review and discussion before further review by their upper management. This gave us needed support at the field level and resolved many of the basic issues up front. Public meetings were held throughout the watershed for the draft plan review. We also engaged in discussions with the Game and Fish Commission regarding other issues and projects that helped to open dialog and promote better understanding of our mission.

Many benefits accompanied this approach to conflict resolution. Communication between us and the state improved, leading to cooperative projects in other areas of wildlife management. We had access to more complete expertise that the park lacked on its own. Most recently, a Game and Fish employee has been assigned to an interagency liaison post within Buffalo National River headquarters.

The resulting fisheries management plan has served as a nationwide NPS model of a warm water fisheries management plan. Copies are available upon request. Contact the Superintendent, Buffalo National River, National Park Service, P.O. Box 1173, Harrison, AR 72602; 501-741-5443.

GULF COAST

Salt Spray Alternative to Weeding

In the hot and humid summer months of years past, resource managers at Biscayne National Park, Florida, have labored many hours removing exotic, herbaceous weeds from landscaped areas within the park. The difficult task reduced the exotics, giving the native coastal plants a chance to come back in these areas. Funding constraints and the desire to explore an alternative to commercial herbicides caused resource managers to consider using a salt water treatment of the exotics on a trial basis; native plants are considered to be salt-tolerant, while exotic weeds are not.

The park tested an initial study plot 5 m x 5m (16 ft x 16 ft) in size. Staff applied salt spray to the exotics by attaching a pump to a transportable water tank. Applications thoroughly soaked the area and were repeated within 3 weeks of each other. After just two applications, not only did the exotic vegetation die back, but a natural recruitment of the native salt grass *(Distichlis sp.)* also occurred.

As a result of the test, the park will use the salt spray method as an alternative to costly weeding, and as a way to recruit low maintenance native grasses. Salt grass does not require mowing and is not susceptible to many turf grass pests, such as chinch bugs (reported on in *Park Science* **15(4):9**). Native salt grasses together with natural pest controls are low maintenance, ecologically sound environmental choices.

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New Journal Dedicated to Wilderness

The *International Journal of Wilderness*, the only journal to focus on wilderness issues worldwide, published its first edition last fall with contributions from around the world. Articles include new research findings, wilderness strategies, inspirational features, commentary, and reviews. The journal is designed to link professionals, scientists, and the public in a worldwide forum for discussing wilderness research, planning, management, education, and practical experience. John Hendee, Director of the University of Idaho Wilderness Research Center, is the managing editor. The National Park Service is one of 18 leading wilderness management organizations that has sponsored the new publication.

Subscriptions run $30 for individuals and $50 for organizations and libraries per calendar year; Canadian and Mexican subscriptions cost an additional $10. Outside North America add $20. To subscribe, contact the International Journal of Wilderness; the WILD Foundation; 2162 Baldwin Road; Ojai, CA 93023; fax (805) 649-1757; e-mail *"wild@fishnet.net"*. Include your name, address, city, state, zip code, country, and telephone number. For editorial communication, contact the managing editor at *"wrc@uidaho.edu"*.

Wild Horses and Fertility Control

Assateague Island National Seashore, Maryland, may have solved its predicament of what to do about its wild horses. Declared a desirable exotic species in the park enabling legislation, wild horses also damage the fragile ecology of the park. Faced with the dilemma of how to control population numbers in a humane and publicly acceptable way, the park began contraception research in 1985. The outcome is a practical, relatively inexpensive, and publicly acceptable humane management tool that may have far-reaching use.

Researchers initially experimented with administering steroid hormones to reduce sperm count in males and prevent ovulation in females, but the technique did not show promise. Later, they inoculated 26 mares with an immunocontraceptive vaccine (porcine zonae pellucidae or PZP) that was 100% effective. The glycoprotein-based vaccine produces antibodies that block fertilization and did not interfere with pregnancies in progress or social organization. After 7 consecutive years of treatment, the only effects noted were failure to ovulate and depressed estrogen concentrations; in 120 mare-years of PZP contraception, only four foals have been born. The vaccine is easily delivered remotely and a single annual booster is adequate to continue contraception.

John Karish, NPS Chief Scientist of the Allegheny-Chesapeake System Support Office, is distributing copies of the report, *Management of Wild Horses by Fertility Control: The Assateague Experience* (NPS/NRASIS/NRSM-95/26), by Dr. Jay F. Kirkpatrick. Contact him at 209B Ferguson Building; University Park, PA 16802-4301; (814) 865-7974.

Global Change Research at Mount Rainier

David L. Peterson (NBS University of Washington CPSU) and Regina M. Rochefort (Mount Rainier National Park) have published the results of a Global Change Research Program study conducted at Mount Rainier. Entitled, *Temporal and spatial distribution of trees in subalpine meadows of Mount Rainier National Park, Washington, U.S.A.,* the study began in 1991 and examined the distribution and abundance of subalpine fir *(Abies lasiocarpa)* in five locations in the subalpine zone on Mount Rainier that represent variation in geography, climate vegetation type, and landscape position. They observed that the distribution and abundance varied during the past century in response to climatic variations at the micro- and mesoscale. Recruitment on the wetter west side of the park has been fairly continuous since about 1930, but has occurred only in short, discrete periods on the dry east side. Tree establishment is successful on the west side during warm, dry summers while cool, wet summers favor establishment on the east side. Vegetation type and landscape position also affect tree establishment. This dynamic relationship indicates that climate change could have a significant and rapid impact on regeneration of this and other high-altitude tree species.

Interested readers can find the 1996 article in Arctic and Alpine Research **28(1)**:53-59; reprints are also available from Rochefort; phone (360) 569-2211, ext. 3374.

Ferret Report Out

Biologists at Badlands National Park, South Dakota, have written a report on the black-footed ferret release program covering the period from May 1994 through September 1995. Nine chapters describe the restoration activities and include site preparation, release techniques, and post-release monitoring. Also included is the complete reintroduction protocol. A limited number of reports is available by contacting Badlands Wildlife Biologist Glen Plumb at (605) 433-2464 and asking for the report:

McDonald, P.M., P.E. Marinari, and G.E. Plumb, editors. 1996. Black-footed ferret reintroduction: Year one completion report, Conata Basin/Badlands, South Dakota. U.S. Forest Service. Wall, South Dakota. 136 pp.

Wisconsin CPSU Web Site Worth Checking Out

The Wisconsin Cooperative Park Study Unit (University of Wisconsin–Madison) now operates a fine World Wide Web site on the Internet *(http://www.emtc.nbs.gov/wicpsu.html)*. Its features presently include a list of the 1995 research projects undertaken by the CPSU in support of national park system areas of the Midwest Field Area, annotated flora references for 22 midwestern parks, searchable flora and lichens databases, and other related information.

Natural Resource Agencies and Social Values Explored

Craig Shafer, an ecologist with the NPS Natural Systems Management Office, recently enjoyed reading two papers by

Jim Kennedy, a professor of natural resource management at Utah State University. Presently serving a stint as Special Assistant to the Director of the Bureau of Land Management in Washington, D.C., Kennedy writes about natural resource management and social values, and has analyzed the integration of technically oriented natural resource managers into agency culture in the first paper. The second paper presents the results of a survey of several thousand employees of the U.S. Forest Service, probing their perceptions of agency priorities and its reward system. The analysis gives insight into what large organizations value most and how these values can be vastly different from those held dear by employees. The two papers are:

Kennedy, J.J. and J.W. Thomas. 1991. Exit, voice, and loyalty of wildlife biologists in public natural resource/ environmental agencies. Pages 221-238 *in* W.R. Mangun, editor. American Fish and Wildlife Policy: The Human Dimension. Southern Illinois Press. Carbonbale.

Kennedy, J.J., R.S. Krannish, T.M. Quigley, and L.A. Cramer. 1992. How employees view the USDA-Forest Service value and reward system. Presented at the 4th North American Symposium on Society and Resource Management, School of Natural Resources, University of Wisconsin-Madison, 17-20 May 1992. Unpublished.

Kennedy has written many other papers. Although he has not yet read them, Shafer suspects these will especially interest resource managers trained in the natural sciences, for Kennedy delves into social science issues in natural resource management. They include:

Kennedy, J.J. 1991. Integrating gender diverse and interdisciplinary professionals into traditional U.S. Department of Agriculture-Forest Service culture. Society and Natural Resources **4:**165-176.

Kennedy, J.J. 1988. Legislative confrontation of groupthink in U.S. natural resource agencies. Environmental Conservation **15:**123-128.

Kennedy, J.J., B.L. Fox, and T.D. Olson. 1995. Changing social values and images of public rangeland management. Rangelands **17:**127-132.

Kennedy, J.J. and J.W. Thomas. 1995. Managing natural resources as social value. Pages 311-321 *in* R. Knight and S. Bates. A New Century for Natural Resources Management. Island Press, Washington, D.C.

Kennedy spoke at the December Tucson meeting on ecosystem management (see the article on page 13) and recently presented two training sessions to new NPS resource managers at the Albright Employee Development Center. In the near future, he will be returning to Utah State University where he has worked for 25 years. Any potential readers who can not locate the papers are encouraged to contact Kennedy himself at (202) 208-3898; fax (202) 501-6718.

Indicators of Hydrologic Change Examined at Indiana Dunes

National Biological Service Research Scientist Doug Wilcox of the Great Lakes Science Center has published in the Natural Areas Journal **15(3):**240-248 a paper entitled, *Wetland and Aquatic Macrophytes as Indicators of Anthropogenic Hydrologic Disturbance.* Based on work conducted at Indiana Dunes National Lakeshore, Indiana, the paper discusses how hydrologic disturbances can affect wetland and aquatic macrophyte communities by creating temporal changes in soil moisture or water depth. Such disturbances are natural; however, human-caused changes in wetland hydrology may have negative effects on wetlands. Since plant communities respond to habitat alterations, observations of plant community changes may be used to recognize effects of hydrologic disturbances that are otherwise not well understood. A number of plants, including *Typha angustifolia* (narrow-leaf cattail) and *Lythrum salicaria* (purple loosestrife), are recognized as disturbance species; they are often found in roadside ditches, in wetland that have been partially drained, or in low areas that have been flooded. Other species commonly occur on mudflats exposed by lowering of water levels. In addition, wetland shrubs and trees invade or die as a result of draining or flooding. In more subtle terms, the relative composition of plant communities can change as a result of altered hydrology. Remote sensing (photointerpretation) and field vegetation studies, coupled with water-level monitoring, are recommended for gaining an understanding of hydrologic disturbances in wetlands.

Wilcox is also the editor of *Wetlands,* a quarterly journal concerned with all aspects of wetlands biology, ecology, hydrology, water chemistry, soils and sediment characteristics, management, and laws and regulations. Subscription and article submission information is available from the Society of Wetland Scientists; phone (913) 843-1235.

Environmental Software Described

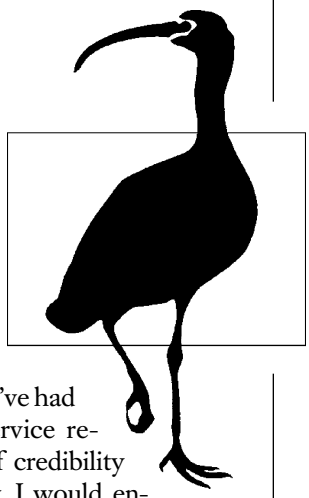
Environmental Software Systems (ISBN 0-412-73730-2) by R. Denzer, G. Schimak, and D. Russell, consists of articles on software used in environmental protection and research. The book addresses the themes of environmental information systems; modelling and simulation; environmental management; decision support; distributed environmental information; artificial intelligence applications; and environmental data visualization. Published by Chapman and Hall, 115 Fifth Ave. New York, NY, 10003, the hard copy costs $110.50. It is 304 pages in length.

Ecosystem Geography

Robert G. Bailey, the U.S. Forest Service senior geographer and developer of a well-known ecoregion classification system used by many land managers around the world, has published a new book. Available from Springer Verlag (800-777-4643), *Ecosystem Geography* (1995) is a landmark contribution that brings the geographers' tools–maps, scales, boundaries, and units–to the study of ecosystems. The author has distilled more than two decades of research on ecosystem mapping and classification. His work has had a growing influence on how government and academic scientists are using ecological data to monitor biodiversity, manage land holdings, and interpret the results of climatic change. *Ecosystem Geography* features spectacular graphics, including diagrams, photographs, and abundant maps. It will be welcomed by ecologists, geographers, land and resource managers, and anyone involved in the study or management of landscapes and ecosystems. The book has been released in both softcover (ISBN 0-387-94586-5; $34.50) and hardcover (ISBN 0-387-94354-4; $69.95), and is 204 pages long.

The National Biological Service and NPS Science-Based Management:

Examining a static need in a dynamic relationship



By Rich Bachand

THE NATIONAL BIOLOGICAL Service (NBS) was created in October 1993 by U.S. Department of the Interior (DOI) Secretary Bruce Babbitt to provide independent and objective science for department bureaus. The agency is "to work with others to provide the scientific understanding and technologies needed to support the sound management and conservation of our nation's biological resources" (NBS Mission 1995).

In creating the NBS, most biological research, survey activities, and personnel of the eight department bureaus (U.S. Fish and Wildlife Service, National Park Service (NPS), Bureau of Land Management, Bureau of Reclamation, Minerals Management Service, Office of Surface Mining, U.S. Geological Survey (USGS), and Bureau of Mines) were combined in the new agency leaving their respective parent bureaus without an internal biological research staff. The National Park Service found itself with 183 fewer scientists and staff (Ombudsman Committee Report 1994). This coincided with the publication of the National Academy of Sciences report on *Science and the National Parks* (1992), a report that strongly urged fundamental changes in NPS structure and culture to effect a greater emphasis on scientific research in parks.

It is easy to understand how these events left NPS officials uneasy. The National Park Service had a new and clear mandate to improve the quality of its research at a time when it would lose jurisdiction of its research staff. This crossroads is where the National Park Service and its former scientists would unfold a new partnership.

Expert Panel

At the George Wright Society meeting in Portland, Oregon (April 1995), I served as chairman of a panel session entitled, "The Role of NBS in Meeting NPS Management Needs." This session provided one of the first opportunities to explore the new alliance between the two agencies. The expert panel offered a variety of perspectives and consisted of individuals with broad expertise in park research and resource management. They included Craig Allen (Scientist–Bandelier National Monument, NM), H. Ron Pulliam (Director) and Charles van Riper III (Scientist–Colorado Plateau Research Station) from the National Biological Service; and Bob Moon (Regional Chief of Resource Management for the former Rocky Mountain Region) and Karen Wade (Superintendent–Great Smoky Mountains National Park, Tennessee and North Carolina) from the National Park Service.

With the imminent transfer of the National Biological Service to the U.S. Geological Survey, I have highlighted insightful observations made during that discussion for consideration as the former NPS science program undergoes further change. The issues discussed during that session remain pertinent to current discussions and serve as a reality check in an effort to continue providing scientific information to park managers.

Opportunities

Panelist Bob Moon tailored his comments to the complexities of the simultaneous creation of the National Biological Service with NPS efforts to reorganize and reinvent itself. "At the same time the Park Service is reorganizing itself, we're trying to figure out how we're going to do science with NBS." Moon saw these changing times as a chance to move forward in improving the quality and accountability of research. Although positive steps were made toward more closely tying quality research with science-based resource management, pre-NBS science conducted in house was not "the good old days," and he said "the movement still had a long way to go." Separating research from the National Park Service provided the National Biological Service with an opportunity to act independently and to establish its credibility by providing science for management. "One of the problems we've had with past Park Service research in terms of credibility was accountability. I would encourage the NBS to build in a lion's share of accountability," Moon recounted.

Layers of Reorganization

Many concerns dealt with the reorganization the National Park Service went through both before and after the creation of the National Biological Service. Moon noted that research and resource management in the NPS had been coming together (as called for in the Vail agenda). Quality research had been getting underway and lending itself to a more science-based resource management program. When the National Biological Service was created, all this forward movement came to an unexpected crossroads. The transition left the National Park Service without an internal structure for tactical research or technical assistance (it would depend on the partnership with NBS) at a time when it was going through its own reorganization. "This was a reorganization where NPS research was never part of the discussion." He quickly added that the National Park Service is still responsible for conducting research and carrying out science-based management and that the National Biological Service is an organization to help them reach this goal. Moon warned, "None of us (referring to NPS) can have the… attitude to let the NBS do it, so [that] *we* don't have to worry about it."

Progressive Steps

The departure of park scientists to the National Biological Service greatly concerns Great Smoky Mountains National Park Superintendent Karen Wade for

many reasons. In a proactive manner, the park and the NBS Southern Science Center entered into a memorandum of understanding in 1994 to ensure a continuing working relationship between the two organizations and obtain commitments from scientists for their continued park research. "Since our very modest biological research capabilities were changing hands, my desire was to partner with the NBS and to assure the ongoing consultative relationship so important to the future…." Superintendent Wade continued, "My belief is that together we can do better than what we were doing before this relationship began."

The memorandum addressed many park concerns and fears resulting from the transfer of NPS science capabilities to the NBS. The park wished to ensure that a reduction in tactical research assistance would never occur, especially in a hypothetical scenario where its former scientists were assigned to other NBS priorities. Next, both agencies committed to maintain the park's long-term monitoring program. The memorandum assisted in doing that through mutual agreement to cooperate, resource sharing to gain additional support for the program, and information sharing.

NBS Through the Eyes of a Park Manager

Superintendent Wade expressed concern that the NBS does not place high enough priority on field stations and (in a prophetic moment) that the NBS would be absorbed into another organization rendering the possibility of more distant ties between the agencies. She believed that field stations have been staffed with devoted scientists, and desired to continue the strong relationship with former NPS colleagues who could provide unbiased, non-advocacy science to park managers. "If the NBS is going to be absorbed into another organization, we must retain our scientists and the wonderful rich reservoir of knowledge that we currently have."

Too Focused or Not Focused Enough?

One question raised was how parks would sustain funding for park-specific needs if NBS concentrated its scarce resources on global, landscape-scale, multiagency research. Similarly, NBS must strike a balance and remain flexible enough to deal with tremendously difficult generic issues like air quality. Can NBS flex enough to have a unit located in the middle of the country that serves Shenandoah, Great Smoky Mountains, and the parks of the east coast? Bob Moon declared that for the NBS to be successful it must continue to do tactical research and provide technical assistance, "for NBS that's a given."

A Place-focused Approach

Based in Bandelier National Monument, NBS scientist Craig Allen championed the idea of a place-focused approach where a national park (or public land or natural area) served as a focal point for long- and short-term inventory, monitoring, and research. He quoted the 1994 ombudsman committee report, *Solutions to Problems faced by former NPS Scientists transferred to the NBS* (van Riper 1994), that stated, "Many [scientists] had a long-term tie to a specific park in which their role usually transcended basic research to encompass information transfer, science adviser, program facilitator, and activities fundamental to maintaining long-term integrity of the national park resources and ecosystems." He noted that what held this together was the focus on a place, the landscape, and the continuity of the relationships between the people and the place.

Dr. Allen stated that a positive aspect about the NPS research program, albeit small in pre-NBS times, was that researchers were on site in the parks working with managers. In these cases, scientists were closely integrated with management objectives. He also suggested that his role at Bandelier spanned a continuum between spending a quarter of his time monitoring, a quarter dealing with management issues including information transfer, a quarter supporting and catalyzing the work of other researchers, and a quarter conducting new research. "I can't think of just chopping and dichotomizing the individual [areas of work emphasis]; it's maybe more like a soil texture triangle, where for any given issue, you're in some interconnected place…," Allen stated. He continued that many scientists in a similar position assist in synthesizing the work of other people and serve as an interface between research and management.

Lending evidence to Wade's earlier comments regarding the commitment and allegiance of a scientist to the "place"

Continued on page 12

NBS-USGS Merger Update

On March 22, 1996, NBS Director Ron Pulliam announced that the NBS-USGS merger was in progress and would be completed on or before October 1, 1996. At that time, NBS biological science and related activities will become the Biological Resources Division (BRD), a fourth division within USGS (USGS currently consists of the Geologic Division, Water Resources Division, and the National Mapping Division).

A transition steering team composed of NBS and USGS representatives established four issue subcommittees (science, management, administration, and information and technology) that worked toward a June 1 final report that will serve as a final plan for the NBS-USGS consolidation. Under the flag of USGS, the BRD will continue serving the biological research needs of DOI agencies with the potential for increased funding in fiscal year 1997 to address priority science needs of the DOI land management bureaus. This new initiative would expand research assistance by means of tactical research, inventory, monitoring, mapping, and data support. Combined with a commitment by the National Park Service to provide matching support for NBS NRPP (Natural Resource Protection Program) work, hope for a continued emphasis on a strong science-based approach to land management is foreseeable.

(i.e., park, monument, natural area), Allen noted that through time, and perhaps by default, he had become "the local expert" on the ecology of not only Bandelier, but also of the larger landscape around the monument. To a degree, each scientist becomes the institutional memory and source person for a variety of information concerning local natural resources. He emphasized that he did not think his situation was unique, because it was not uncommon for many park based researchers to spend a good part of a career in a given park producing similar local expertise.

National Biological Service Director H. Ron Pulliam emphasized his strong belief in the importance of having NBS scientists in the parks, though he did not feel it would be possible in the near future to cover each national park in the country. His rationale for increased focus on parks was the lack of basic information concerning the resources in national parks and monuments. He cited a recent publication by NBS scientists (Stohlgren et al. 1994) that examined the status of biotic inventories in parks. "It really pointed out our fundamental ignorance about park resources. We don't have a reasonable inventory of even the birds, mammals, and vascular plants in the parks, much less the [reptiles and amphibians] and other less charismatic organisms." He noted that there is even less understanding of the changes affecting the biological resources.

As an indication of the NBS commitment to providing science in national parks, Director Pulliam intends to continue implementing the recommendations of the 1994 ombudsman committee report. The report proposed establishing a network of long-term NBS research sites including national parks as focal points, dedicating a portion of NBS funding to deal with NPS research issues, continuing to waive NBS overhead on NPS funded projects, and other park oriented initiatives.

Research Grade Evaluation

Dr. Allen brought up one issue that was not addressed in the ombudsman report. He discussed how research grade evaluation status puts pressure on park-based NBS scientists to think more narrowly about their roles. "Within NBS, we could receive less credit for doing the things the park wants us to do." He spoke of an experience where one NBS scientist was told by the chair of his research grade evaluation panel that the kinds of local interactions with management (information transfer, coordinating research, etc.) were "serving as anchors to a career with otherwise great potential," clearly highlighting the tradeoff between management support and publishing activities. "I think it's a very real problem. There is persistent tension between how you're evaluated under research grade evaluation status (i.e., a publishing record) and the realities of a park-based scientist." Although all would agree that publishing builds scientific credibility, some balance must be made that realizes the realities of a park-based scientist. Some of these concerns are being discussed as part of the current transfer of NBS scientists to USGS.

Final Thoughts

In closing, the panelists called for leaders to ensure that the National Park Service and National Biological Service take active roles in making the partnership work. Charles van Riper suggested that "the parks should take their planning documents down to [the] local NBS office, wherever it may be, and say 'Here's what I need done, do you have anybody that can do this?'" He felt that when the next call for NBS research proposals would come out, those scientists could show an identified research need, and leverage that in a way where one could say, "Look, I'm meeting a client need," thus aiding in getting the project funded. Van Riper insisted that parks use their planning documents and was adamant that the National Park Service not be charged overhead. Park officials express hope that positive trends like this will continue as NBS merges with the USGS.

Perhaps one of the most important points to come out of the discussion was the need to solidify the NBS-NPS partnership. "How do we make visitors aware of the research challenges that directly relate to wise management?," Superintendent Wade asked. She expressed that research programs need more visibility so that the public could take that awareness to their representatives and make them realize that we need more research to more wisely manage and protect our nation's resources. "NBS needs to become a household word. If we can make a positive connection between the NBS as the organization in parks doing our research, we will have overnight visibility for our research needs and both organizations will benefit."

It is hard to predict what the most appropriate or even practical model is for science in the parks and science-based park management. Prior to the NBS, science in parks was on an upswing through the National Academy of Sciences report, issuance of the NPS-75 Inventory and Monitoring Guideline, and the beginnings of nationwide ecosystem research initiatives like the Global Change Research Program. However, as Bob Moon noted earlier, "Pre-NBS research was not the good old days."

As 1996 progresses with change and uncertainty swirling about us, the relationship between science and the parks has become as dynamic as the changing research needs. However, the need itself remains constant. Often, times of change present the greatest opportunity to reinvent, improve, or create something positive. As the NBS (soon to become the Biological Research Division within USGS) undergoes its transfer to the USGS and the new relationship to the NPS continues to unfold, each agency must assume the responsibility of procuring a sound, science-based management of natural resources in our parks. PS

Literature Cited

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Stohlgren, T.J., J.F. Quinn, M. Ruggiero, and G.S. Waggoner. 1995. Status of Biotic Inventories in U.S. National Parks. Biological Conservation **71:**97-106.

Van Riper, C. 1994. Ombudsman Committee Report: Solutions to Problems Faced by Former NPS Scientists Transferred to NBS. A Report to the Director of the USDI National Biological Service. 14pp.

Rich Bachand is an Ecologist studying climate change in forested ecosystems with the National Biological Service. Stationed at Rocky Mountain National Park in Estes Park, Colorado, his research interests also include landscape ecology and dendroecology. His phone number is (970) 586-1211; fax: (970) 586-1392; e-mail "richardb@niwot.cnr.colostate.edu".

ECOLOGICAL STEWARDSHIP WORKSHOP

The National Park Service takes a step toward ecosystem management

BY CRAIG L. SHAFER

LAST DECEMBER, 400 PARTICIpants from numerous federal agencies and nongovernmental organizations took part in a bold workshop entitled, "Toward a Scientific and Social Framework for Ecologically Based Stewardship of Federal Lands and Waters." The groundbreaking gathering, held on the outskirts of Tucson, Arizona, sought to develop a framework for implementing an ecosystem approach to managing federal lands and waters. Hosted by the University of Arizona, the U.S. Forest Service explained that the meeting aimed at shortening the 10-15 year development time historically needed to make routine use of scientific information in the management of federal lands. The product will be a compendium that outlines the options and alternatives and documents the scientific foundation for ecosystem management. According to the Forest Service, the framework is not intended to provide prescriptive solutions for individual sites or places, but will provide the foundation for the development of agency implementation plans and strategies.

PLANNING THE WORKSHOP

The workshop was a logical step in the progression toward ecologically based land and resource management. In 1994, the Congressional Research Service, the President's Commission on Sustainable Development, and the Interagency Ecosystem Management Task Force each added to the development of ecosystem management approaches on federal lands. This gathering built upon these earlier efforts.

This event was the brainchild of the U.S. Forest Service Chief Jack Ward Thomas, with planning and logistics carried out by Robert Szaro and William Sexton, also of the agency. Many agencies participated in planning sessions around the country to devise how the conference should be organized and what it should cover. This included the National Park Service, which fully endorsed the event. The NPS involvement was coordinated by Natural Systems Management Office biologist John Dennis and Agate Fossil Beds Superintendent Ruthann Knudson; additionally, the National Park Service held periodic meetings at the conference to assess its involvement. Many sponsors also contributed to the success of the conference. They included the National Fish and Wildlife Foundation, Kendall Foundation, Pinchot Institute for Conservation, and Pew Charitable Trusts, to name a few.

PRODUCTS

The 10-day workshop centered on synthesizing existing scientific knowledge (including social sciences, economics, and legal considerations) and corresponding practical management experience on 30 key topics related to ecosystem stewardship. Each morning, selected *science team* authors delivered summaries of key points in the development of their papers. In the afternoon, *management team* authors focused on the successes, promising options, and failures related to the corresponding science topics. Participants contributed ideas in the afternoon management breakout sessions for the benefit of the management team authors. The result will be two parallel papers on each topic: a synthesis of existing scientific knowledge of the topic and a practical treatment of management experience in implementing these concepts on federal lands. The book containing these papers is being written and is expected to be published by a major university press.

EXPERIENCED PARTICIPATION

A diverse group including the U.S. Fish and Wildlife Service, U.S. Geological Survey, National Biological Service, Boise Cascade, Weyerhauser, Woods Hole Oceanographic Institution, Oak Ridge National Laboratories, and the Conservation Fund, and many others, participated in the workshop in hopes that they could make a difference in furthering ecosystem management. The science team authors included many luminary figures from academia, government, conservation organizations, and industry. The management team authors came mostly from the U.S. Forest Service, Bureau of Land Management, and National Park Service. As the lists in tables 1 and 2 on page 14 attest, the National Park Service is participating in more than two-thirds of the 30 writing teams by providing both management and science team authors.

Agency heads also attended portions of the workshop. For example, the NPS Director and Deputy Director addressed participants, and ten top managers, including members of the NPS National Leadership Council, attended the end of the gathering. Near the close of the workshop, many agency heads, including those from the Bureau of Land Management, U.S. Geological Survey, National Biological Service, U.S. Forest Service, and National Park Service, signed a joint agency statement reflecting common ground. Deputy Director John Reynolds in a talk and subsequent memorandum to the National Leadership Council outlined immediate NPS follow-up to the agreement. More specific recommendations derived from the meeting will continue to be adopted.

CONCLUSION

Miraculously, this all happened within 8 months of the first major workshop planning session. Those involved in its planning thought it could never happen in such a short time–but somehow, it did! Why? Probably because it had to. The Forest Service said that this was the only timetable available to them. We also feared the possibility of political interference. Fortunately, no problems of this nature occurred.

The event helped demonstrate how natural and social science, history, and law are all components of ecosystem management. Such insights and integration will

Continued on page 14

Workshop continued

be provided on paper and although much work lies ahead to produce the final volume, the process is in motion. Managers will be able to use the detailed reference of over 60 scientific, management, and case study papers. However, the real test of the conference will come later as federal agencies and other land holders begin to implement some of the ideas discussed in Tucson.

Getting Involved

The process being used to exchange ideas and compile the written reports is provided on the Tucson workshop home page on the World Wide Web. The page may be accessed through the U.S. Forest Service home page or directly at *http://www.fs.fed.us/eco/workshop*. It includes a summary of the process, list of science and management topics, operating plan (including author team members), and both the science and management chapter outlines developed in Tucson. Many science topic papers were already in draft at Tucson and are available for review and comment.

PS

Craig Shafer is an ecologist with the WASO Natural Systems Management Office. His phone number is (202) 219-8934 and his e-mail address is "craig_shafer@nps.gov".

Table 1. NPS Management Team Authors

Author	Affiliation	Topic
William Anderson	National Capital Field Area Office (202-342-1443)	Cultural values/resource use
Jennifer Bjork	Cumberland Island National Seashore (912-882-4336)	Decision support
Steve Cinnamon	Great Plains SSO (402-221-3437)	Shifting human use
Brien Culhane	Everglades National Park (305-242-7700)	Regional cooperation
Muriel Crespi	Archeology and Ethnography Program, WASO (202-343-8156)	Cultural values/resource use
Joan Darnell	Alaska SSO (907-257-2648)	Legal perspectives
John Dennis	Natural Systems Management Office, WASO (202-208-5193)	Ecological functions; Scale phenomena
Mary Foley	New England SSO (e-mail—"mary_foley@nps.gov")	Land condition over time
Rick Harris	Curecanti National Recreation Area (970-641-2337)	Ecological classification
Ron Hiebert	Midwest Field Area Office (402-221-3461)	Population viability; Uncertainty & risk assessment
Anne Hitchcock	Museum Management Division, WASO (202-343-8138)	Data management, collection, and inventory
Dan Huff	Intermountain Field Area Office (303-969-2651)	Human role
A. Trinkle Jones	Western Archeological and Conservation Center (520-670-6501)	Heritage management
Donna Kostka	National Center for Recreation and Conservation, WASO (202-343-3669)	Social system functions
Ruthann Knudson	Agate Fossil Beds National Monument (308-668-2211)	Human role; Ecological economics
Jean McKendry	University of Idaho CPSU (208-885-7129)	Case study—Columbia River
Susan Mills	Alaska SSO (907-257-2573)	Stewardship, consensus processes
Earl Neller	Kalaupapa National Historical Park (808-567-6802)	Cultural values/resource use
Kathleen Picarelli	Chesapeake & Allegheny SSO (215-597-1628)	Regional cooperation
Richard Ring	Everglades National Park (305-242-7700)	Restoration & maintenance; Case study—South Florida
Dave Ruppert	Rocky Mountain SSO (303-969-2879)	Heritage management
Ray Sauvajot	Santa Monica Mountains National Recreation Area (818-597-1036)	Ecosystem and landscape diversity
Craig Shafer	Natural Systems Management Office, WASO (202-219-8934)	Ecosystem and landscape diversity
Page Spencer	Alaska SSO (907-257-2625)	Disturbance and temporal dynamics
Howie Thompson	Denver Service Center (303-969-2461)	Public expectations/shifting values
Gary Williams	Natural Resource Information Division, NRPC (970-225-3539)	Monitoring and evaluation

Table 2. NPS Science Team Authors

Author	Affiliation	Topic
Don Calloway	Alaska SSO (970-257-2408)	Social/cultural classification
Steve Cinnamon	Great Plains SSO (402-221-3437)	Shifting human use
Muriel Crespi	Archeology and Ethnography Program, WASO (202-343-8156)	Cultural values/resource use
Dan Huff	Intermountain Field Area Office (303-969-2651)	Land condition over time
Rebecca Joseph	New England SSO (617-223-5056)	Social/cultural classification
Ruthann Knudson	Agate Fossil Beds National Monument (308-668-2211)	Human role
Gary Machlis	University of Idaho CPSU (208-885-7129)	Human ecosystems introductory book chapter; workshop summary

ECOSYSTEM STEWARDSHIP

WHAT DOES IT MEAN?

By Ron Hiebert

CRAIG SHAFER DESCRIBED the format of the Tucson Ecosystem Workshop. As he stated, we do not know what the benefits or outcomes of this exercise will be. We hope written products will communicate to scientists what managers need and encourage managers to engage scientists in the decision making process. All National Park Service participants share the responsibility to incorporate what was learned into everyday park operations, planning, environmental education, and training. Following I give my impressions of what the Tucson workshop was all about, the lessons I extracted, and how I feel it applies to the way in which the National Park Service conducts business.

To me, the message of the workshop was change. Not so much change in what we do but change in how and why we do it. Ecosystem management certainly is not a new concept for the National Park Service. We have long professed that we manage for the whole system rather than for individual components. We say we recognize humans as an integral part of the systems we manage and that societal, cultural, and natural resources are interrelated. But, how often do we approach problems on this premise? Treating these parts separately often does not the whole make.

Ecosystem stewardship is about scale, both spatial and temporal. The National Park Service recognizes that parks are not islands and that they must be managed within the context of their regional landscape. It is less routine to strategically consider the role of a group of parks in a regional scale such as the Ozark Highlands or the Great Lakes Basin, the role of the park system in preserving national biodiversity or the role of parks in providing habitat for neo-tropical migratory birds in North America. On a temporal scale, the National Park Service has put forth a concerted effort through such endeavors as the Vail Agenda to look at our changing role and how we must change to meet new challenges into the future. This kind of thinking needs to be scaled down to the cluster and individual park level more consistently and objectively.

The workshop also forced me to reexamine the meaning of stewardship, what it means to the federal land manager and specifically to us in the National Park Service who have been entrusted with stewardship of the nation's crown jewels for future generations. This is an awesome responsibility. We must, on a routine basis, find and apply the best information available in making management decisions. All of us must continue to hone our skills and keep abreast of new tools and technologies. Finally, we must involve the public in a meaningful way in park management. After all, they are who we serve.

The meeting also reemphasized the need for effective teamwork between managers and scientists and adoption of adaptive management principals. Managers need to engage scientists in the decision making process in ways that do not compromise their objectivity. Scientists need to be open to engaging in decision making to bring the best information to the table. This is a real challenge in our present structure with our former researchers now being transferred to the U.S. Geological Survey.

Further, we must recognize that "nature is dead." That is to say that the concept of systems uninfluenced by humans is now a myth. Therefore, it is up to us to define what we want the future condition of each park to be, develop a plan on how to get there, and apply evaluation criteria to see how we are doing. Simply saying our goal is to manage to protect "natural processes" will not do anymore.

Finally, management of parks will never again be as it was in the past. The public is no longer satisfied with the answer that we are doing it this way because "that's our policy." If it is perceived that a proposed action may be controversial, we must make the effort to explain to park users the rationale of the policy and why we believe that action should be taken. We must also be armed with solid scientific data to support our decisions. For example, if one wishes to remove feral horses, which park users love, the park must effectively communicate the NPS policy concerning exotic species and have solid scientific data to document the impacts the feral horses are having on park resources. Then, we must be prepared to seek a mutually acceptable solution to the problem (see the cover story on FACA).

The Ecosystem Stewardship Workshop was about change. Not so much change in what we do but in how we do it. As stated by the Director of the U.S. Forest Service in his opening remarks at the conference, we must "change or die."

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Continued from cover

The Issue

To generalize, ORV user groups feel strongly that they should be able to drive the entire outer beach when the plovers are not present as they did before the seashore was establish in 1961 (fig. 2). Conversely, the environmental groups feel that all ORVs should be banned from the beaches altogether. Many groups feel the answer is somewhere in the middle. The National Park Service, using the existing limited science on ORV use and resource impacts, and previous legal actions, feels that controlled, regulated use of ORVs on limited sections of the outer beach is not inappropriate, but that the majority of the outer beach should be vehicle free and that ORVs are not appropriate in sensitive resource areas (inner dunes, wetlands, marsh).

The objective of negotiated rule making is to *front-load* controversy by getting everyone involved in the decision from the beginning, and acknowledging (if not resolving) all issues and concerns. The process brings all interested organizations into the process and charges them with developing a common solution. This process is used by many federal agencies, most notably the Environmental Protection Agency (EPA), but this was the first time the National Park Service used it to make a rule that will be published in the Code of Federal Regulations (CFR). With recent criticism that federal land management agencies are facing for making isolated decisions, for example, we see this process as an important and growing tool.

The Process

Negotiated rule making is authorized under the Federal Advisory Commission Act, which provides for formal meetings to be open to the public. Meeting notices are published in the *Federal Record*. A public comment period at the end of each day is required as part of the process and those not in attendance can submit letters to be included in the record.

We began by identifying 23 groups (the maximum allowed is 25, although 6-7 is more common) that had a long-term interest and involvement in this issue. The organizations included state agencies, the six towns that the seashore is located within, ORV user groups, environmental groups, federal agencies, and tourism and preservation groups. Each organization selects one person to represent them at the table. These representatives are the only participants in the formal discussions, and all are equal, including the NPS representative.

Figure 2. The negotiated rulemaking sessions resulted in a new regulation that closed a significant portion of the plover nesting beaches to off-road vehicle use. Elsewhere, ORVs are still restricted to a nonsensitive corridor, marked with stakes.

To avoid unbalanced votes, we managed the negotiated rule making as a consensus process giving each representative a veto). This approach helps get people out of their entrenched positions, pushes them toward the edge of what they can agree to, and gets them thinking creatively. A "threat" can also be used to create a further incentive to participate. In our case, we made the initial statement that the NPS would be developing a new regulation for off-road vehicles if negotiation failed. Either the regulation would be developed by the group, or it would be developed by the National Park Service with the ideas, information, and creativity gathered from the group.

The advantage of this process for the National Park Service, regardless of whether the group reached consensus on a regulation or not, was that every issue, idea, and concern was heard by all sides. Furthermore, the National Park Service was no longer the enemy, but was a participant just like the others. If we were to reach consensus, we made a commitment to publish that regulation in compliance documents and the *Federal Register* as our preferred alternative.

The Federal Advisory Commission Act not only facilitates the process, but also in our case created some challenges in getting it underway. For example, our rulemaking sessions began only after the process had been cleared, some 2-3 years after the idea was first proposed. Another delay was that all organization representatives (as opposed to the organizations party to the process) had to be appointed by the Secretary of the Interior. After the first meeting, one organization removed its original appointee and selected a new one who they felt better represented their views. This created a scramble, for the Washington staff had to get the new appointee approved within a very small window of opportunity. If the National Park Service is going to use negotiated rule making regularly, it would be very beneficial if the process and paperwork associated with it could be streamlined.

Professional negotiators, contracted through an EPA *indefinite quantities* contract, ran both the formal sessions and the advance meetings with each organization. The $64,000 budget limited the formal sessions to just three, 2-day meetings. These were spaced a month apart to allow the representatives time to make sure that they were committing to things that their organizations could support and, very importantly, to allow time for behind-the-scenes interactions and negotiations. This is where much of the real work happens.

Preparation Vital

The most difficult NPS decisions and thinking had to be done before the process began. We used the time between meetings to refine philosophies, determine our boundaries on issues, and consider new suggestions. It is important that every angle and approach be explored, even undesirable ones, so that the NPS position, at least in public, is unified. The NPS representative must be sure of these boundaries during the sometimes heated and demanding exchange that takes place in the negotiation room. Thus, preparation is key to the process.

Normally, the process would start from ground zero. However, because of the limited number of meetings, the professional facilitator asked us to be prepared to share a *straw dog* or unofficial position to initiate discussion. To develop this, we first assembled a wide variety of park staff. We analyzed every aspect of the existing regulation and brainstormed possible rewrites. This included considering alternatives that would not have been in our plan, if we had been developing it independently. Finally, we threw out all the options we could not live with.

While developing the position document, we needed to keep it to ourselves until we could formally present it in the first session. We did not want the plan to get out, have an attack developed opposing this plan, then find ourselves in the very human position of defending a plan that we had developed specifically to provoke discussion, rather than to identify our idea of the best solution. This was easier said than done. The very need to keep the document private prevented the entire staff from participating in these first discussions. This was a problem and we should have done a better job of getting the staff to understand the process and how they would be involved.

We also needed to collect and organize relevant data, files, decisions, and past research on the issue in advance of the meetings. This information had to be synthesized, analyzed, and distilled so the staff was aware of the history of the issue. The scientific reports and data helped identify what separated the acceptable options from the unacceptable. The representative had to be able to explain to the committee the important points and ideas contained in these documents so that everyone could understand them.

Despite our preparation, we found that data often got in the way of the negotiation process. It was easy to get into a battle of "my expert" versus "your expert." Mountains of data and reports can overwhelm the group and the process, because some participants do not have access to expert information or may not understand the science behind the information; also, the claims of who has the better information, the correctness of the scientists, or the interpretation of the works can come into question. This creates the danger of raising tempers, because there is no way of resolving these issues among laypeople, and moves the discussion away from the central negotiation points. Our approach was to quickly disseminate scientific information, but only when necessary.

Between the second and third sets of meetings we put forward our first draft proposal, which was developed by a much larger circle of staff. This process was very much a parkwide, and in some respects a servicewide, effort. While just one person spoke for the National Park Service at the table, an enormous support team was behind the proposal. The team participated in numerous discussions between meetings, developed draft rules, reported the institutional knowledge on issues, and served as the reality check on the feasibility of different scenarios. Washington staff moved along the mountains of paperwork and requirements associated with FACA and reviewed draft proposals; the regional solicitor's office reviewed draft proposals and legal issues. Phone calls, e-mail messages, and discussions with other NPS areas around the country looked at their ORV issues and concerns.

Summary

The National Park Service has been accustomed to making decisions, plans, and policy after consulting staff or other federal agencies; however, we must improve our ability to communicate with state and local agencies, critics, and supporters, and learn to listen to their concerns and issues. We need to involve and be involved with our local communities and agencies, and we need to work together on issues of mutual concern rather than always seek public comment in traditional forums that keep us separate and above our critics. Although it promotes listening to our critics and involving them in the decision making process, negotiated rule making does not suggest that we abdicate our responsibility to protect resources or ignore the NPS mission. It simply requires that we not let resource preservation become a way of eliminating input or ignoring solutions developed by others. It requires us to be up front about our boundaries and to clarify a range of acceptable solutions. We found it to be a useful tool.

Epilogue

On the sixth and final day of negotiations, the ORV user groups and the environmental groups had a private 6-hour caucus. In the end, all 23 groups agreed to a new ORV regulation that closes a significant portion of the current ORV corridor, which is a prime plover nesting area from April 1 through July 20. The regulation also opens both a section of outer beach not currently available for ORV use (for night fishing only) and another small section of beach for general ORV use. Some small (two to three car) undeveloped parking lots will be established behind the primary dune for parking to accommodate fishing access. The new regulation also formalizes and recognizes the role that ORV users, serving as volunteers, play in education and resource monitoring and preservation.

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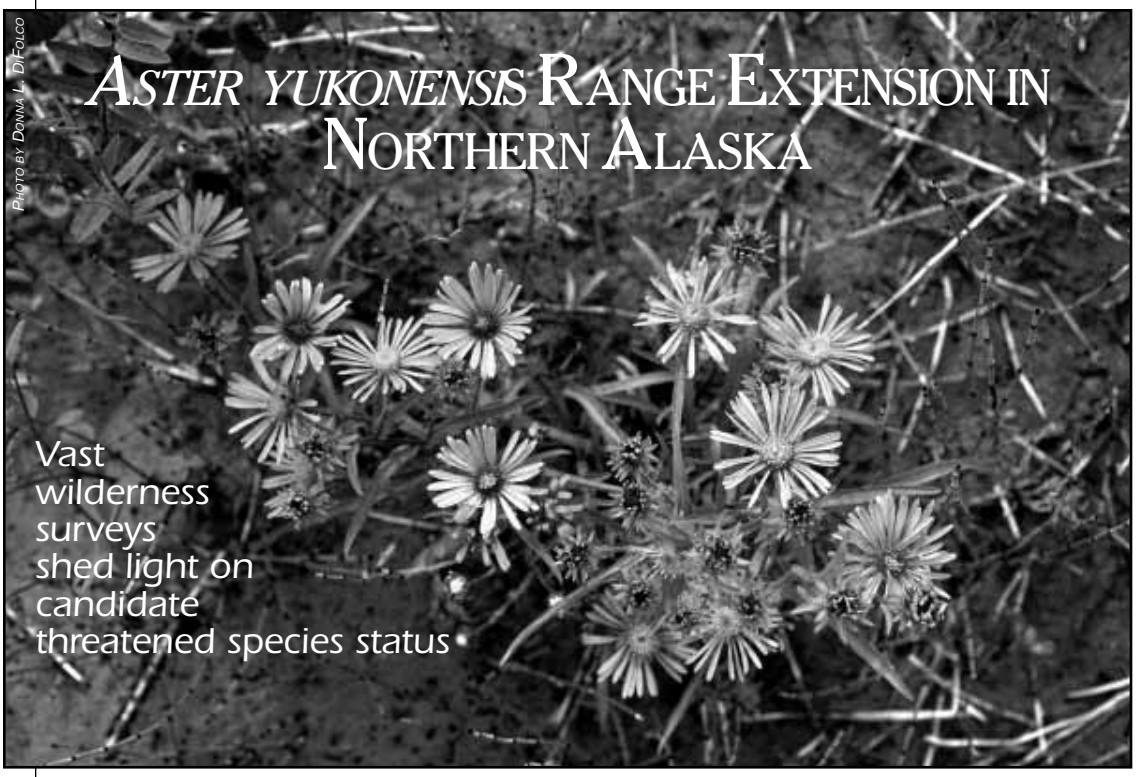

PHOTO BY DONNA L. DIFOLCO

ASTER YUKONENSIS RANGE EXTENSION IN NORTHERN ALASKA

Vast wilderness surveys shed light on candidate threatened species status

Figure 1. Yellow centers and violet petals characterize the Yukon aster, a candidate threatened plant species in Alaska. Recent surveys in Gates of the Arctic National Park and Preserve revealed that the plant is more widespread than previously thought.

BY DONNA L. DIFOLCO

IN JULY 1993, NPS RESOURCE managers discovered a small population of *Aster yukonensis* (fig. 1) on an island in the Middle Fork of the Koyukuk River in northern Alaska, within several miles of the only documented location of the plant in the United States. This discovery spurred interest in searching for more populations of the plant in neighboring Gates of the Arctic National Park and Preserve (fig. 2). The NPS staff at Gates of the Arctic have since found more populations of the Yukon aster along the Middle and North Forks of the Koyukuk River. Resource managers have also identified the plant in the Kobuk Sand Dunes in Kobuk Valley National Park.

The Yukon aster, a violet petaled, thin leafed aster of the Composite family, is currently listed as a candidate species, category 2, for the threatened and endangered species list. Knowledge of the plant's range and status is not yet fully understood, hence its classification as a category 2 species. Until recently, the Yukon aster had been known to occur only in southwestern Yukon, Canada, and at one location on the Koyukuk River, Alaska. The National Park Service is mandated by the Endangered Species Act to protect threatened, endangered, or candidate species of plants and animals within the areas it manages; Gates of the Arctic National Park and Preserve has undertaken the task to locate and map *A. yukonensis* within its borders to meet this mandate.

In late July, 1994, a resource management crew surveyed approximately 58 km (36 mi) of the Middle Fork Koyukuk River, searching for the plant on every gravel bar (fig. 3) on the park side of the river (generally the north bank) and each island that was mostly on the park side. For the first day-and-a-half of the survey, we searched in vain. Finally, we came across the first population of *A. yukonensis* on a gravel bar of the park border.

Once we located the first specimens, we walked from one end of the gravel bar to the other in parallel transects. We counted each *A. yukonensis* seen on the gravel bar, from the thick organic mat of the forest edge to the sparsely vegetated strip nearest the river. The first specimens located were examined carefully by looking for the densely glandular phyllaries (the narrow, leaflike bracts at the base of the flower) to confirm identification. After this, we used macroscopic features, such as the long, narrow clasping leaves, to identify the species more quickly, and to distinguish it from other species (mainly *A. sibiricus*).

Some river bars harbored so many of the Yukon asters that it was impossible to count them all. In these high density areas, we dispersed across the gravel bar, each person searching a different section and counting asters. Then the individual counts were combined into a minimum estimate for the total site count.

The search turned out to be much more successful than expected, as we found Yukon asters growing on nearly every gravel bar in a 40-km stretch (25 mi) of the river bordering the park. Most sites had from 50 to over 400 plants on the gravel bars. Two sites supported at least 1,000 plants each. The plants seemed to prefer sites mainly where river silt had accumulated at the upper and lower ends of gravel bars and along sloughs.

Directly after the confluence with the North Fork Koyukuk, we found only a few Yukon asters. The sudden disappearance of the large populations was puzzling. A change in soil type could be one reason for the decline. Less silt accumulates just below the confluence than along other parts of the river because the sedimentation regime has been altered by North Fork river water. Farther down river from the confluence, population sizes increased again, with counts in the 50-150+ range. These populations were made up of scattered individuals, much like the popula-

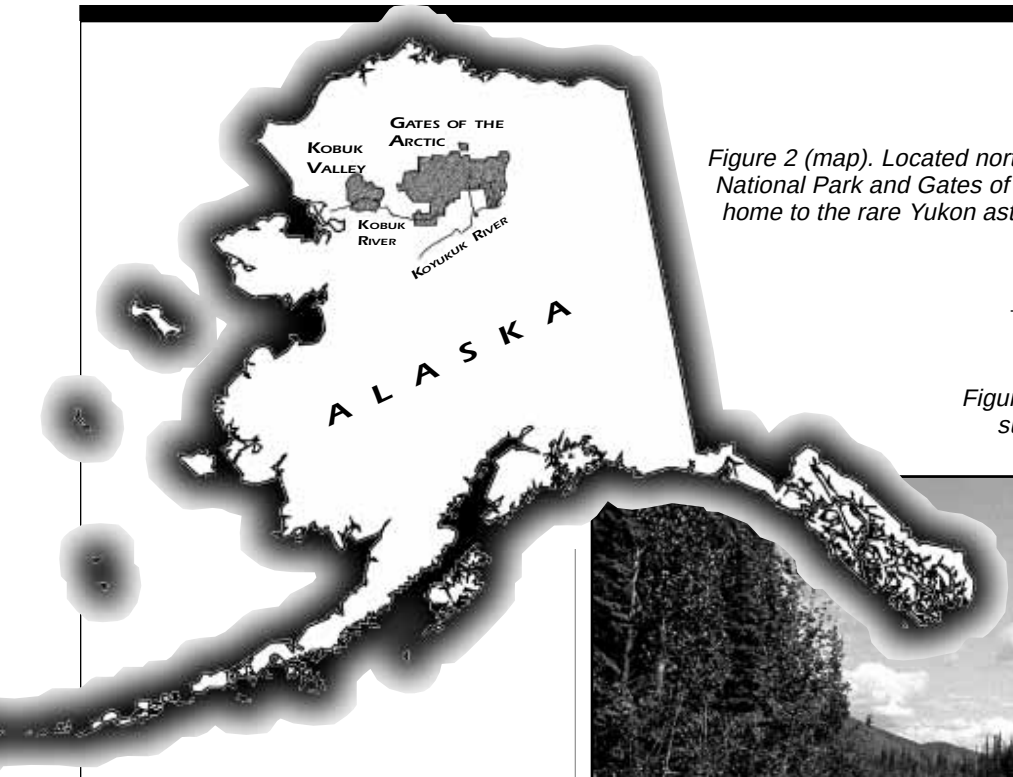

Figure 2 (map). Located north of the Arctic Circle in Alaska, Kobuk Valley National Park and Gates of the Arctic National Park and Preserve are home to the rare Yukon aster.

Figure 3 (photo). The aster grows along gravel bars, such as this one located on the Koyukuk River in Gates of the Arctic.

PHOTO BY DONNA L. DIFOLCO

tions where the first flowers were discovered. This type of distribution suggested that either the species was just getting established on the gravel bar or the soil type was not optimal.

About a month after the survey, a flood swept through the area, rivers swelling high above the 100-year flood water line. Concern that the flood wiped out the tenuous population of Yukon aster along the Middle Fork Koyukuk was relieved when biologists on a bird survey the following spring confirmed that some plants had survived the big flood.

In 1995, staff surveyed the North Fork Koyukuk River for the species, mapping more, albeit few and scattered, populations of the Yukon aster. Resource managers found 13 populations along the North Fork, totalling less than 300 individuals. We do not know whether more substantial populations existed before the 1994 flood or not. A second survey of the Middle Fork to reexamine gravel bars that supported sizeable populations of the aster might reveal whether the flood affected the flowers. If major floods have deleterious effects on populations of these rare plants, then this may explain why the plant is uncommon.

While *A. yukonensis* was being mapped on the Middle Fork Koyukuk River in 1994, it was also being discovered in the Great Kobuk Sand Dunes along the Kobuk River in Kobuk Valley National Park (fig. 2). National Park Service personnel in Kobuk Valley found 23 populations of *A. yukonensis,* totalling about 1,500 individuals (Hunt, NPS, personal communication). The habitat types where the Yukon asters were found in the Kobuk Sand Dunes were similar to the silty-sand gravel bars they seemed to prefer along the Koyukuk River. The Kobuk Sand Dunes populations, found mainly in dune depressions, were not as robust in terms of density and numbers of individuals as some of the Middle Fork Koyukuk populations, but seemed to be better developed than the North Fork populations. Differences in soil type and the length of time since the last environmental extreme (e.g., flood or drought) may be reasons for variations in population densities.

The past two summers of field work have greatly expanded the known range of *A. yukonensis* in northern Alaska. The plant is likely to occur in other areas as well. In summer 1995, Yukon asters were reportedly seen far into the mountains along Agiak Creek, a tributary of the Hunt Fork John River. As we gradually survey the vast areas of Gates of the Arctic National Park and Preserve and inventory its resources, we will begin to more clearly understand the distribution of rare plants such as *A. yukonensis*.

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Landslides & Fossil Resources at Hagerman Fossil Beds:

A case study in landslide factor assessment

By Lawrence P. Growney

LOCATED 64 KM (40 MI) west of Twin Falls, Idaho (fig. 1), Hagerman Fossil Beds National Monument preserves abundant and diverse Pliocene-epoch fossils embedded in the banks of the Snake River. The quantity, quality, and variety of these 3-3.4 million year old fossils distinguish the monument internationally. Over 150 species, including mastodon, giant ground sloth, camel, bear, and the world famous Hagerman horse, have been preserved and identified in the Glenns Ferry Formation, which rises in cliffs to over 153 m (500 ft) above the Snake River.

Authorized in 1988, the park preserves the fossils and provides for paleontological research. However, landslides regularly disturb the fossils and endanger the safety of visiting researchers. Since 1983, landslides have decimated more than 2.7 million m^3 (3.6 million yd^3) of fossil-bearing material (Table 1 and fig. 2).

Concerned about this serious resource threat, park staff hypothesized that the landslides were the consequence of oversaturation of the Glenns Ferry Formation resulting from leaking, unlined, irrigation canals on the plain above the Snake River. Ironically, the park enabling legislation states that the preexisting water delivery system, which crosses the park, is "compatible and consistent with park purposes." However, for the monument to become a premier location for scientific study, we must be able to assure visiting researchers of a reasonably safe and productive research experience and preserve a coherent stratigraphic and depositional setting conducive to interpretation. To meet these goals, the park began a detailed landslide assessment process in 1993 to determine the factors resulting in the landslides and recommend solutions within the bounds of the legal mandates.

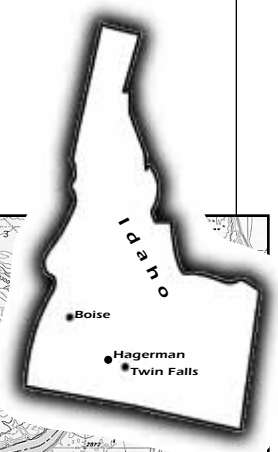

Figure 1 (inset). Hagermann Fossil Beds National Monument, Idaho, located 40 miles west of Twin Falls.

Figure 2 (right). Topographic map of Hagerman Fossil Beds National Monument. Numbers identify the year of major landslides. The Horse Quarry site, Shoestring Road Basalt flow and Fossil Gulch canal are visible at the top center. The abandoned Bell Rapids canal location can be seen in the left center.

Geologic Setting and Background

The fossil-rich Glenns Ferry Formation in the Hagerman area is composed of ashfall units and sediments deposited in lakes, rivers, and swamps during the Pliocene epoch 3-3.4 million years ago (Malde and Powers, 1972). A thin (<4.6 m or <15 ft) basalt flow crops out at the north end of the monument and is visible in the hillside northeast of the world famous Smithsonian Institution Horse Quarry (fig. 2). Known as the Shoestring Road Basalt, this flow is interbedded with the Glenns Ferry sediments about 122 m (400 ft) above the river.

The Desert Entry Act of the early 1960s, opened the plateau adjacent to what is now the national monument to farming (fig. 2). The Bell Rapids Irrigation District was created by the farmers to supply water for their needs. For more

than a decade, two pump stations moved nearly 51,000 acre-feet of water from the Snake River uphill 152 m (500 ft) through 48" diameter pipes to the plateau for distribution by canal (Anderson, 1995). Since a 1987 landslide that buried the Bell Rapids pump station (fig. 2), water to the irrigation project has been supplied by the Fossil Gulch pump facility. The pipeline from this pump station lies adjacent to the Horse Quarry and crosses over an extensive seepage zone.

From the Horse Quarry site, over 100 skulls and 30 complete skeletons have been recovered through past excavations. It is the most productive and scientifically significant locality for the species *Equus simplicidens* in the world. While the Horse Quarry site is open to visitors and researchers at the present time, this could change. Each year, nearly 500 acre-feet of seepage, and sporadic slope movement, occurs within a radius of 610 m (2,000 ft) of this site.

Assessing Landslide Factors

In 1994, we began a 3-year assessment effort to find a solution to the landslide threat. Using NPS NRPP (Natural Resource Preservation Program) funds, we first identified the fossil areas at greatest risk, and have begun to characterize the rocks, study the hydrology, and examine the soil strength of these areas. A key to accomplishing the work within the 3-year time frame has been to involve other public and private parties that have an interest in the Hagerman landslide issue (Table 2). Together we have shared our strengths and made quicker strides toward achieving our goals of minimizing landslides and their effects.

Results

Studies examining the rock types, and their interlayering, support the Malde and Powers findings (1972) that the local Glenns Ferry Formation is composed of layers (beds) of ashfall, lake, river, and swamp deposits, which dip gently to the south-southeast at about 3 degrees. It is important to note the distinction between dip of the beds and slope gradient. Dip of the beds is about 3 degrees while the slope gradients near landslide-prone areas are between 30 and 90 degrees. This is why seeps (and the landslides) occur on south- and east-facing slopes.

Nearly 75% of these beds are composed of very fine-grained particles, such as clay, which retard the downward flow of groundwater through the bed (Lee et al. 1995). When the water finds it easier to flow across the top of a bed, rather than through it, the bed is referred to as an *aquiclude*. The water held above an aquiclude forms a *perched aquifer*, or a body of groundwater occurring above the true water table. Young (1984) and Reidel (1992) have identified at least 4 perched aquifers within the monument.

Geophysical investigations of the perched aquifer system involved the use of geoelectric and seismic methods. Data gathered by a private firm under NPS contract demonstrated a tie between canal leakage and both the seeps near the Horse Quarry and the 1991 landslide scarp. Furthermore, the contractor found that approximately 5,000 acre-feet of water, or about 10% of the total canal flow, leaks into the subsurface each year (Anderson 1995).

In the course of drilling six new monitoring wells, we learned that one of the perched aquifers occurs in the open fractures of the basalt flow (Young 1994; personal correspondence). Water supplied by this perched aquifer is the cause of the 1991 landslide (fig. 2), a small slump and pond, and the wide zone of seepage and instability occurring around the Horse Quarry site.

Groundwater monitoring has identified a cyclic pattern to the groundwater flow in the Horse Quarry area. Combined read-

Continued on page 22

Table 1. Major Landslides

Year	Scarp Location	Attitude	Height m	Height (ft)	Displacement Volume m^3	Displacement Volume (yd^3)
1983	Bell Rapids	South	31	(100)	995,000	(1,300,000)
1987	Bell Rapids	East	62	(200)	918,000	(1,200,000)
1989	Bell Rapids	East	46	(150)	765,000	(1,000,000)
1991	Fossil Gulch	South	18	(60)	38,250	(50,000)
1993	Bell Rapids	East	no change		369	(482)
1994	Fossil Gulch	South	no change		84	(110)
1995	Bell Rapids	South	9-31	(30-100)	49,725	(65,000)
1995	Fossil Gulch	South	20	(65)	459	(600)
Total volume					2,766,387	(3,616,192)

Table 2. Contributions to the Landslide Assessment Effort

Organization	Contribution	Staff Experts
Idaho State University	Stratigraphy, lithology, & soil analyses	Geologists
Boise State University	Seismic refraction	Geophysicists
USGS Water Resources Division	Monitoring, drilling, logging	Hydrologists
USGS Earthquake & Landslide Branch	Soil strength testing, mapping, monitoring	Geologists
USGS Photogrammetric Laboratory	Landslide volume quantification	GIS technicians
Private consulting firm	Geoelectric assessment	Geophysicists
Bell Rapids Irrigation District	Trenching, pipe laying	Equipment operator
Idaho Power Company	Monitoring, mapping, assessing hazards	Geologists, GIS support, ecologists

ings from the two monitored seep locations below the Horse Quarry vary from 416-1,022 liters (110-270 gallons) per minute; the lowest readings were recorded from May to July and the highest readings were from October to December. The seepage increase in the fall coincides with elevated groundwater levels in the study wells that tap the basalt aquifer (Young 1995; personal correspondence). Water is piped into the canal from May to September for use during the summer growing season. The rise in the groundwater table, and increase in seepage discharge volumes, consistently mirror canal usage with a lag response time of around 5 months (Young 1983, 1984, 1985; personal correspondence).

The key factors in understanding why the Glenns Ferry Formation has a tendency to slide are slope gradient and the strength of the soils relative to their moisture content. Samples taken from landslide scarps and landslide-prone areas, have been classified as high plasticity clays and silts (Chleborad and Schester 1995; personal communication). With these types of materials, as soil moisture increases, and with slope gradients of 30 degrees and more, the ability of the beds to maintain their cohesiveness is slowly overcome, culminating in a landslide. This process is responsible for all of the landslides within the monument and is occurring most notably within 610 m (2,000 ft) of the Horse Quarry.

Solutions

Dewatering provides immediate relief to slopes under stress where this stress is the result of increased saturation. A seismic refraction survey of the Shoestring Road Basalt (fig. 2) helped us understand the probable subsurface pathways for groundwater migration in areas underlain by the basalt, by delineating the margins and general structure of the flow. This information allowed us to identify six drilling sites that appeared to offer the best probability of encountering groundwater. Of the six wells drilled, three contain enough water to allow dewatering. Initial results suggest that an amount equivalent to 20% of the groundwater currently being discharged at the seeps in the Horse Quarry area could be intercepted at these wells. However, not all of the water intercepted at these three well sites is being discharged at seep locations in the vicinity of the Horse Quarry, so the overall effectiveness of dewatering activity on the Horse Quarry area is approximately 14% of total discharge. Based on the limited number of dewatering locations, this effort is inadequate to stop the landslides. At best, it should reduce the frequency of failures and marginally improve the stability of affected areas.

Monitoring is essential in consistently and accurately tracking changes in slope behavior. Surface monitoring is critical for detecting movement in unstable areas for both visitor safety and research opportunity reasons. Subsurface monitoring is needed to track changes in groundwater levels, seepage discharge volumes, and soil moisture, all factors that contribute to landslide inception. While monitoring protocols implementation has begun, funding limitations have greatly slowed this process. By demonstrating the effectiveness of this monitoring program, we hope to encourage the financial participation of private parties in a joint, long-term monitoring effort.

The ultimate solution to the landslide problem involves keeping the groundwater away from the hillsides. Based on the geotechnical and hydrological data collected, a number of remedial methods are currently under consideration. Current plans call for the selection of a preferred alternative sometime later this year.

Gravity of the Problem

Landslides destroy the stratigraphic and depositional relations needed to interpret prehistoric ecosystems. Furthermore, in-place material is buried beneath

Figure 3 (left). The scarp below the Bell Rapids Canal demonstrates the severity of the landslide problem at Hagermann with two slides showing clearly. The 1987 slide is just out of view in this image, obscured by the bluff.

Figure 4 (below). In the vicinity of the 1995 slide, author Larry Growney leads a crew to rescue a peccary fossil in danger of being compromised by additional slides. Water still seeps out of the hillside near the Bell Rapids pump station although the canal on the bluff has been abandoned for years.

the landslide debris making it inaccessible and lost to study. The hazards that landslides present to researchers and visitors may result in area closures, further impeding research and resource enjoyment. To understand the true impact of a landslide, consider the following figures approximated for the 1991 landslide:

Volume of failed material
38,228 m^3 (50,000 yd^3)
Area buried by landslide debris
4,180 m^2 (5,000 yd^2)
Area of new scarp
1,338 m^2 (1,600 yd^2)
New restricted zone above scarp
836 m^2 (1,000 yd^2)

This example clearly shows that the total amount of land lost to paleontological exploration is much greater than just the volume of the landslide debris. Most park landslides occur at or very near the top of slopes. This means that the three-dimensional space (volume) lost to paleontological study can be much greater than the numbers from the above example suggest. Moreover, the soil strength of the debris pile is much less than that of the original hillside prior to the landslide. As a result, the debris piles are likely to remain unstable, creating a long-term threat to field research and exploration on and below these features.

Time and Preservation

We continue to inventory both long established and newly discovered fossil sites. Through the implementation of a monitoring protocol, which helps us set excavation and study priorities, many specimens have been recovered rather than lost to landslides. The combination of monitoring and fossil site inventory control gives us the ability to quickly identify threatened fossil sites, and respond before the scientific value of the resource is lost. However, even with these efforts, the landslides often beat us to the fossils. For example, a 3.2 million year old, still organic, log (see *Park Science* **14(1):7**) was covered by a small landslide before it could be adequately sampled for study.

By taking steps to inventory fossil sites, use hydrologic, lithologic, and geotechnical assessment techniques, and implement monitoring protocols, we have built the foundation for improving a very bad situation, and we are well on our way to developing an ultimate solution. However, until the source of the groundwater recharge is stopped, major landslides, and resource degradation, will continue to play a role in the development of Hagerman Fossil Beds National Monument.

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A social science tool for regional planning

Assessing Regional Economic Contributions from National Park System Units:

Figure 1. Manassas National Battlefield Park, with its popular stone house, was just one of 13 Virginia parks recently analyzed for its economic contributions to the regional economy. Park operations and visitor expenditures play a substantial role in local economies and can help leverage park preservation issues.

By Kevin L. Gericke and Jay Sullivan

Editor's note: *"A Handbook for Assessing the Economic Contributions of National Park Service Units" (Sullivan et al. 1993b–as listed in the literature citations at the end of this article) contains further explanation of information presented in this article.*

According to its mission, the National Park Service must make resource decisions seeking a balance between use and preservation. The tools of economics are useful in making these decisions, helping to justify investments, and allocating resources to national park system units. A simplified economic assessment tool known as the *money generation model* or MGM may be familiar to some readers as it has been circulated to parks to help managers and park neighbors gauge the economic impacts of the park on regional economies (see the companion article, "Why Assess The Economic Impacts of National Parks?, on page 26"). In a more detailed economic assessment of park contributions, three types of benefits occur: regional income and employment, resource values, and contributions to a community's sense of well-being. This article presents major issues to consider when conducting an economic assessment of park contributions and examples from a case study of national park system units in Virginia (Shenandoah National Park, Colonial National Historical Park, Manassas National Battlefield Park, etc.–see fig. 1) (Sullivan et al. 1993a).

Income and Employment Values

National Park Service operations often generate substantial income and employment in the surrounding region as a result of spending by visitors, the National Park Service itself, concessionaires, businesses, and other government agencies. The fundamental principle that guides the assessment of income and employment values is the *with and without* principle. That is, the analysis should identify only the income and employment effects that occur as a result of NPS operations in the region.

Two types of income and employment effects, direct and multiplier, must be considered. Direct income and employment effects are immediate economic activities generated by NPS operations. For example, direct effects include money spent by visitors to the park or jobs created in local restaurants to serve visitors. Multiplier effects are additional rounds of economic activity set in motion by direct effects. For example, to provide a meal to a visitor, local restaurants require groceries, energy for lighting and cooking, and many other purchases in the region. This purchasing activity can occur in many rounds, until the initial money has "leaked" out of the region through purchase of goods and services beyond the region.

A multiplier describes total economic activity in an area (direct + multiplier effects) in terms of business output, income, or employment in a region. The multiplier "expands" direct effects to the rest of the regional economy. Individuals often use the phrase "money turnover" to describe how many times a dollar changes hands in an economy before it leaves through payments made outside the region. This definition is not the same as a multiplier, however. For example, a multiplier is not *seven* just because a dollar changes hands seven times in an economy. With each transaction,

the regional economy loses a portion of the original dollar through payment of taxes, purchases of goods outside the region, and in many other ways. This leakage may cause the original dollar to dissipate quite rapidly in a region. Multipliers greater than 3.0 are unusual, and are not likely to be credible with outside groups.

Depending on the detail of analysis, a variety of information is needed about park visitors: number of visits, average daily visitor spending, average length of stay in the area, visitor origin, and destinations. Information is also needed about NPS spending (payroll and operating expenses), other government spending, state and local taxes and in-lieu-of tax payments, associated business investment, and multipliers. An analyst can obtain much of this information from monthly public use reports, state tourism boards, travel organizations, visitor services projects (CPSU-based social science programs that serves NPS social science needs) reports, state tax commissions, and universities.

Commonly Asked Questions

A common question about income and employment values is, "Do I include in my analysis those visitors who are residents of the region?" Income and employment effects often exclude spending by resident visitors. This approach is used because it is difficult to determine whether those visitors would have spent their money within the region if the park were not available (the with or without principle). Another question is, "Do I include the spending by visitors who stop at many attractions on their trip, with this unit being only one part of their trip?" It is only appropriate to consider the time and money spent in the vicinity of the park unit by these multiple-destination visitors. A third commonly asked question is, "Do I include concessionaire spending?" If the daily visitor spending estimates do not include purchases from concessionaires, then concessionaire spending is considered; otherwise, concessionaire spending is not considered, to avoid double-counting.

A study of the economic contributions of NPS operations in Virginia estimated that total contribution to business output in the state from national park system units was $474 million in 1993. Also, an estimated $117 million in personal income and 9,000 jobs in Virginia resulted from NPS operations. These results indicate a substantial contribution to regional economies as a result of NPS operations (Sullivan et al. 1993a).

Resource Values

A resource value is the amount individuals are willing to pay for the ability to enjoy the many goods and services that the National Park Service provides. While not as widely recognized as income and employment values, resource values are also significant contributions, because they may be more than what an individual pays as an admission fee or travel expense, thereby contributing to overall national wealth.

Resource values arise from the use and preservation of an area. The value from using an area may come from a consumptive activity (e.g., fishing), a nonconsumptive activity (e.g., learning about the history of an area), or an indirect activity (e.g., reminiscing with family who have visited park system units). The value for preserving an area may come from visitors knowing that they will have an option to see the resource in the future if they choose, or that the resource is a bequest for future generations.

The travel cost and contingent valuation methods are commonly used approaches for estimating resource values, and they require extensive visitor surveys. Economists have conducted hundreds of site-specific studies, resulting in a wide range of values for numerous activities (see Walsh et al. 1988 for a summary of studies). Other types of information are also indicative of the resource value individuals hold for units of the national park system, including membership in local conservation and historical societies, number of volunteer hours at a park, or the amount of public involvement in political and management decisions.

While it is difficult to conduct surveys for all parks in the national park system, an analyst can use previous studies to provide a first estimate of resource values. Information on visitation, travel costs, and visitor trip destinations are needed to calculate resource values. Park staff considering conducting an economic analysis may find local universities to be helpful in determining resource values.

Estimated resource values for units administered by the National Park Service in Virginia range from $2,000 to over $51,000,000 per year.

Estimated resource values for units administered by the National Park Service in Virginia range from $2,000 to over $51,000,000 per year. Other information collected also provides an indication of the value related to preservation of natural areas in Virginia: over 1,200 people are members of the Committee to Preserve Assateague Island; the Sierra Club serves over 12,000 Virginia members; and 1,200 people belong to the Virginia Native Plant Society (Sullivan et al. 1993a). With information of all

Continued on page 26

kinds about resource values, decision makers will be able to better understand why individuals desire certain management actions, provide for their needs, and maintain the integrity of the resource.

Community Values

The National Park Service also contributes to the sense of well-being in communities by providing ecological, cultural, and recreational services. For example, open space provided by national park system units may contribute to the quality of life in an area. In Roanoke, Virginia, commuters often use the Blue Ridge Parkway, despite the fact that it is a slower route than interstate highways. However, the parkway offers individuals a chance to unwind after a busy day at work.

Several methods can be used to assess community values, including personal interviews, monitoring media coverage, and examining written visitor comments. We interviewed local governments, chambers of commerce, and NPS personnel in the Virginia study. Respondents indicated how important the services provided by the parks were to them. These services included education programs, regional economic activity, cultural and historic preservation, natural environments preservation, social opportunities, and various recreational activities. The results indicate a range of perceptions about the importance of parks. For example, respondents from rural areas near national park system units tended to place a high level of importance on the effects to local business by the National Park Service. In urban areas, respondents placed a higher importance on the open spaces the units provide than the local business effects (Sullivan et al. 1993a). Assessing NPS contributions to community values is as important as resource values or income and employment values in fully understanding the relationship between the National Park Service and people in the surrounding region.

The National Park Service also contributes to the sense of well-being in communities by providing ecological, cultural, and recreational services.

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Why Assess The?

By Ronald R. Switzer

For many years traditional park managers have done remarkably good jobs of protecting park resources and serving park visitors. Unfortunately, some stopped managing at park boundaries. That is to say, although they may have interacted with communities in their spheres of influence, too little time was dedicated to convincing those communities that the national park was an important neighbor, not just as a resource steward, but as a driving force in their local and regional economies. As such, the parks heavily influenced the quality of life over large areas, and needed to be recognized and brought to the table as equal players in long-range opportunity planning and economic development discussions, discussions that set the tone for compatible development, and that have the potential to reduce unwanted threats to the parks.

Many park managers grew their careers under the notion that those who visited national parks were just *visitors,* people who passed briefly through the resources and left no impact on the resources or the economy. In truth, the National Park Service has been in the tourism business since before it was officially designated in 1916, and what we do has dramatically affected local development and economics adjacent to all parks. Seldom have we taken stock of our contributions, and less frequently have we let our neighboring communities know the extent of those contributions.

While serving as tourism coordinator for the 13 national parks in Texas in a collateral duty capacity to the

ECONOMIC IMPACTS OF NATIONAL PARKS?

Figure 1. Mammoth Cave National Park, Kentucky, is the single largest resource attraction in the state. Assessments of economic impact applied in positive ways can draw the national parks closer to the communities they serve.

position of Superintendent of Big Thicket National Preserve, the Texas superintendents began helping me assemble economic impact information on an annual basis. This information was made known to the local communities, and synthesized as educational information for the Texas Departments of Commerce and Transportation. The significance of the economic contributions of the parks became a catalyst for the formation of a federal-state tourism coordinating committee involving more than a dozen agencies. Eventually, this group split into the Federal Tourism Council and the State Tourism Council, both of whom signed a memorandum of agreement to participate as partners in the Texas strategic tourism plan and to work toward accomplishing mutual goals and objectives.

At the local level, Big Thicket National Preserve assumed the leadership of a potent group of federal and state agencies, local chambers of commerce, tourism bureaus, and businesses in the private sector, to further resource-sensitive tourism and outdoor recreation, economic development, and environmental education. This same approach is currently being pursued in Kentucky, and while it is too early to assess whether it will succeed, indications are positive. The current Kentucky tourism master plan calls for the formation of a federal tourism council, and one is in the making.

Assessments of economic impact applied in positive ways can draw the national parks closer to the communities they serve. While past and current assessments in Texas and Kentucky have been based largely on the NPS *Money Generation Model* (contact Ken Hornback of the Washington Office Socioeconomic Studies Division at (303) 969-6977), the results tend to be very conservative because they are based on low multipliers, and do not take full account of all economic factors. State generated models (and the one described in the preceding feature article) generally yield much higher impact figures, higher by 25-40%. Whatever model is used, the results are extremely important as barometers of the economic worth of the national parks locally, regionally, and even statewide. Because Mammoth Cave National Park is the single largest resource attraction in Kentucky (fig. 1), the impacts it generates are noticed at the highest levels of state government. When the impacts of the four Kentucky national park units are considered, our worth to the economic well-being of the commonwealth is fully appreciated.

We have made good use of the Money Generation Model, but you should be aware of some of its shortcomings. As already mentioned, the multipliers are applied very conservatively, probably under-estimating economic benefits by a considerable factor. Furthermore, the full impacts of concessioners are not taken into account because of the danger of counting visitor impacts twice in the same model. The calculations do not recognized that concessions operations contribute more than the capital improvement expenditures used in the formula for "other" expenditures when concessions operations *do* contribute more. Similarly, it fails to fully assess the impacts of employee expenditures for housing, health care, education, recreation, and living expenses locally. In addition, most models do not take into consideration the contributions of the National Park Service in funding and grants for urban park and recreation projects executed under statewide plans.

If the Money Generation Model does not fulfill your needs, I encourage you to work with your nearest cooperative park study unit, university department of park or outdoor recreation planning, or state department of travel development to develop one that measures critical economic impact. This helps assure that the information becomes a visible and appreciated part of growing partnerships with your local constituencies. Trust me, this works. PS

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Pseudoreplication Issues versus Hypothesis Testing and Field Study Designs

Alternative study designs and statistical analyses help prevent data misinterpretation

By Roy Irwin and Lynette Stevens

Editor's note: *Pseudoreplication issues are complex, and space constraints allow only an introduction here. A more detailed recap and a related summary of impacts considered* de minimis[1] *(small enough to be trivial) is available through e-mail from Roy Irwin, "roy_irwin@nps.gov".*

PSEUDOREPLICATION HAS become a popular buzzword that has attracted considerable interest, controversy, and confusion. The debates over pseudoreplication began with Hurlbert's introduction and definition of the term pseudoreplication as:

> *The use of inferential statistics to test for treatment effects with data from experiments where either treatments are not replicated (though samples may be) or replicates are not statistically independent (Hurlbert 1984).*

Since 1984, many papers have attempted to refute, better explain, and expand on the issue of pseudoreplication. Pseudoreplication occurs when classical hypothesis-testing treatments are not technically replicated or statistically independent. Pseudoreplication often involves (but is not limited to) situations where investigators extrapolate site-specific statistical inferences beyond the situation that was studied. Pseudoreplication does not describe just a particular type of experimental design, but rather a particular category of misinterpretations or incorrect analyses.

Although many NPS studies involve routine inventory and monitoring rather than experiments to document effects of various stresses, staff doing inventory and monitoring studies should be aware of pseudoreplication issues. In many cases, others will eventually compare past and present data in an attempt to get insight as to whether or not a trend is developing or whether or not some impact (a treatment) is causing resource deterioration. Therefore, inventory and monitoring studies should be designed to maximize their utility for future trend or injury analyses.

Pseudoreplication does not describe just a particular type of experimental design, but rather a particular category of misinterpretations or incorrect analyses

Example

A common example of pseudoreplication occurs when repeated observations of a subject are substituted for replicated applications of a treatment on different subjects. In this situation, the sample design calls for taking measurements over time, but uses only one control and one treated site (subject); data are not spatially replicated. For example, consider a common before-and-after study to determine effects on aquatic biota from some point source effluent entering a stream (e.g., a power plant on a river). The study design consists of two sample points: one above the input and one below. Although several samples may be collected above, and several below, these are not true "replicates" for purposes of hypothesis testing coupled with inductive (from specific case to general case) inference, since there is only one treatment (the power plant effluent) and one experimental unit (the specific river). Due to lack of true replication, inductive statistics should not be applied. In other words, you cannot use the results of this study to generalize about any other power plants or other stream systems, or even to conclude that the power plant caused the difference seen in this one situation.

A key point to keep in mind is that Hurlbert's original definition concerned pseudoreplication with respect to testing effects of treatments. By common (mis)usage, some have also used the term pseudoreplication more broadly to include such things as no replication or inappropriate replication, even in the absence of an effort to examine treatment effects (cause and effects) through the use of inductive statistical inferences. Examples would include the following: (1) taking three sediment samples from one area, thoroughly mixing the three in a pan, putting portions of the mixed sample in three separate jars, and then calling the three jars three "replicate" samples; or (2) taking three samples so close together in time or space that they are really more like one sample than three samples.

In routine monitoring, these examples of questionable replication, in the absence of treatment effects testing, may be considered unwise or inappropriate, but would not be considered pseudoreplication under Hurlbert's original definition. Although often done, criticizing a data set as "pseudoreplicated" is usually inappropriate unless statistical inferences are made for cause and effect.

[1] The phrase *de minimis* is an abbreviated form of the Latin phrase "de minimis non curat lex," which translates to "the law cares not for small matters;" in risk assessment, de minimis impacts are those that are so small (and not related to special resources such as endangered species) that one can disregard them.

Pseudoreplication Issues in Ecology

Due in part to large amounts of natural variance, lack of baseline ecological data, and lack of adequate funds for complete replication of studies (or treatments), occurrence of pseudoreplication is especially high in ecological research. Pseudoreplication is not inevitable if an experiment lacks treatment replications, but occurs only if the researcher misleads the reader by applying inappropriate statistical analyses or misstating the strength of the evidence obtained (Hargrove and Pickering 1992).

Field situations are often uncontrolled, unreplicated, and typified by so many confounding variables that cause and effect is difficult to establish.

However, lack of true replication should not be portrayed as an evil to be avoided in all situations. Often pseudoreplicated (or unreplicated) studies cannot be avoided in disciplines such as medicine, regional ecology, observational field ecology, and astronomy, but the state of "scientific" knowledge or site-specific or issue-specific understanding of issues still slowly progresses to new heights, mostly through weight-of-evidence approaches. Just as astronomers cannot directly manipulate stars, and therefore are prone to pseudoreplication, regional ecology research is difficult or often impossible without pseudoreplication (Hargrove and Pickering 1992). While population studies of animals with large home ranges may not be appropriate for experimentation, sample surveys and demographic studies may still be used to assess population effects (Skalski and Robson 1992).

The following are red flags for potential pseudoreplication problems (Meyer et al 1994):

Red flag #1–Use of more than one data point from given random or systematic plots or locations. **Solution**–Use one datum per sampling unit in statistical procedures. **Illustration**–If you measured the length of 97 plants in a quadrate, report one number, (the average or median, for example). Avoid the temptation to say N=97; instead, say N=1.

Notes: Many contaminants and biology effects data sets are not normally distributed, so it is often preferable to use nonparametric methods, to dispense with means and variances altogether, and to utilize alternative descriptive measures of central value and variability for skewed data, such as the median and interquartile ranges–IQR (Heisel 1990). In epidemiology work, a common practice is to compare only three groups: those with clearly high doses, those with clearly low (or no) doses, and an intermediate group. Even random selection of study sites from assessment and reference areas is "subsampling" or pseudoreplication if statistical conclusions are extrapolated beyond the assessment and reference areas (Meyer et al 1994).

Red flag #2–Use of the same plots or locations over time (OK for determining what happens to that one plot but not for larger universes).

The problem is often triggered when the investigator uses a classical null hypothesis testing analysis and overstates conclusions related to the causes of the differences

Red flag #3–Multiple observations on same animal (OK for determining what happens to that one animal but not for determining what happens to populations).

Red flag #4–Measurements on the effects of a single point source on a river, up- and downstream. Limiting the statistical inference to that unique location above and below is not pseudoreplication. **Note:** It is safest not to expand your inferences beyond that one site and situation and not to pretend that your significant levels or various statistical inferences prove the cause of any differences noted.

Statistics Applied to the Scientific Method and Risk Assessment

The ideal way to build scientific knowledge is to use the scientific method in true experiments. A typically recommended scenario would be to combine genuine replication with random assignment of treatments to experimental units or probabilistic sampling from a study area (personal communication, Lyman L. Mcdonald, West Inc., 1995). However, while genuine replication is a powerful tool that should be used when possible, the scale of ecological research should not be dictated by statistical constraints (Hargrove and Pickering 1992).

In the absence of truly random samples, convincing evidence of an effect requires the effect to be demonstrated consistently at different times in different places (Meyer et al 1994). Consistent effects of incidents comprise a non-statistical type of inference. Such inferences are deductive (general case to specific case) or nonstatistical (Meyer et al. 1994). Although difficulty in replicating large-scale field manipulations makes quantifying

Continued on page 30

cause and effect relationships difficult, this loss of statistical inference to pseudoreplication may be offset by carefully developing ecological inferences (Hargrove and Pickering 1992).

Pseudoreplication can be avoided by applying truly replicated treatments or by restricting the generality and comprehensiveness of one's conclusions.

Ecological (deductive, weight-of-evidence) but not statistical (inductive) inferences can be made even when treatments are not replicated (personal communication, Lyman L. Mcdonald, West Inc., 1995). For example, normic statements (i.e., statements of what usually or normally happens that are generated by the collective outcomes of repeated experiments) can be the result of pseudoreplicated experiments. Although these statements are not universal, probability based, or predictive, they represent generalizations with exceptions. Even so, the information content of normic statements is high in terms of explanatory power (Hargrove and Pickering 1992).

Some of the problems related to pseudoreplication in field studies arise because the investigator is conducting an observational study rather than a manipulative experiment. The problem is often triggered when the investigator then uses a classical null hypothesis[2] testing analysis and overstates conclusions related to the causes of the differences. This has become common partly because most standard textbooks dealing with statistics and biological study design do not adequately distinguish between statistical conclusions drawn from manipulative experiments and statistical conclusions drawn from observational studies (Meyer et al 1994). The arithmetic analysis is often the same for both types of design, but the statistical conclusions of a manipulative experiment extend to the protocol by which the study was conducted while the statistical conclusions of an observational study are limited to the specific assessment area, reference area(s), baseline conditions, and assessment period in the study (Meyer et al 1994).

Hypothesis Testing and Pseudoreplication

Pseudoreplication problems are often partly the result of inappropriately trying to force non-replicated data into classical null hypothesis testing molds. Descriptive statistics, predictive methods, or various other observational data analysis methods are often more appropriate than classical null hypothesis testing schemes for environmental observational studies, injury assessments, many before-and-after (BACI) applications, upstream-downstream studies, and ecological risk assessments.

At least some hypothesis testing assumptions are typically violated in field studies. A thorough discussion of the pitfalls of using hypothesis testing in field study applications would require a separate article, but the following notes from Suter regarding hypothesis testing versus risk assessment and field studies are helpful in understanding pseudoreplication issues. The following points were presented briefly in Suter's Ecological Risk Assessment Text book (Suter 1993) and expanded in a platform session paper presented at the National SETAC meeting in Denver, November 3, 1994: entitled "The abuse of hypothesis testing statistics in ecological risk assessment." A paper of the same title and basic content was in press as of January 1996, in *Human and Ecological Risk Assessment.* A synopsis of the information is presented here with permission of Glenn Suter):

"In ecological epidemiology there is no random assignment of populations or communities to treatments and treatments are almost never replicated so we cannot use statistics to test the hypothesis that populations or communities treated with a pollutant are different than those that are not.

There is no truly random assignment of treatments. The investigator cannot randomly assign some reaches to be treated with an effluent and others not to be treated. In other words, while hypothesis testing requires random assignment of treatments, the investigator has typically had no role in where the effluent pipe was placed.

In field studies there is often only one treatment (an effluent, for example) rather than replicated treatments. Multiple biological samples (for example, benthic macroinvertebrates) are often taken above and below the effluent. However, the downstream samples are taken from one community affected by a single effluent and the samples are pseudoreplicates from that one treatment. In other words, samples from above and below a discharge pipe are not true replicates, they are pseudoreplicates since there is only one treatment.

The question often arises: can't we use hypothesis testing if we do it right? There have been heroic efforts to do so (for example, the Stewart-Oaten, BACI design which nevertheless does not totally solve the problem).

Since there is an inherent bias in favor of the null hypothesis, hypothesis testing places disproportionate burdens on environmental protection. Those who would protect the environment are required to prove with 95% confidence that effects are occurring. This bias is defensible in pure science but indefensible in risk assessment; it rewards polluters who perform poor studies with few replicates and high variances due to sloppy techniques. Hypothesis testing provides less protection for organisms less abundant or more difficult to sample.

[2] The null hypothesis is the hypothesis that an observed difference (as between the means of two samples) is due to chance alone and not due to a systematic cause.

Polluters love hypothesis testing since it can be done with poor data…. They can then fail to reject the null hypothesis and the environment is not cleaned up…. Our real problem is often defining real significance…. Often we should use descriptive rather than experimental statistics."

Some Solutions

Two study sites in a single area, for example, just up- and downstream of a discharge, can properly be sampled and compared using descriptive statistics relating to magnitudes, variances, and trends. Some would say they could also be compared using a classical null hypothesis testing scheme, while others would say a null hypothesis testing scheme should not be used. Both would agree that no matter which statistical methods are used, if a difference is shown, the investigator only knows that they are "different," has not proved why they are different, and should be careful not to generalize the results to other sites, times, or conditions that were not studied. Although field researchers have sometimes determined that the samples are "different" using hypothesis testing, conclusions as to why they are different often cannot be drawn (Suter 1993).

Some experts say the results (that the samples are different) of hypothesis testing at one site could be used as one of several clues making up a weight-of-evidence argument related to effects at that one site. Other experts would argue that it is better to use descriptive statistics to suggest that the samples are "different" and thereby avoid any hint of an incorrect conclusion that cause and effect has been "proved" at any given significance level.

A key point to keep in mind is the importance of properly limiting inductive inferences or conclusions. Pseudoreplication can be avoided by applying truly replicated treatments or by restricting the generality of one's conclusions (i.e., not overstating results) (Dixon and Garrett 1994). Some would argue that restricting the generality of one's conclusions might sometimes involve stating that you do not know why the samples are different.

Instead of hypothesis testing, using descriptive statistics and a weight-of-evidence approach to link potential relationships is often better (Suter 1993). Field situations are often uncontrolled, unreplicated, and typified by so many confounding variables that cause and effect is difficult to establish. The weight-of-evidence approach (which often includes statistical data from both field and lab sources) is often safer in ecological, risk-injury assessment, and contaminants field work (Suter 1993, Chapman 1995).

It is sometimes acceptable to set up the analysis in terms of tests of bioequivalence in the following manner: Assume the treatments will result in a difference in bioequivalence, including variation up to de minimis amounts of acceptable natural variation. The investigator determines the level at which there can be a change without exceeding bioequivalence thresholds (for example, a percentage change in an endpoint such as biomass or number of taxa). If the effect does not exceed a certain percentage previously chosen by the investigator as a trivial or de minimis change, the change has not exceeded a bioequivalence threshold. Such an approach requires the investigator to deal with issues of natural variation and confidence.

Conclusions

Understanding the intricacies of pseudoreplication and hypothesis testing versus field study design issues is not an easy task. The importance of proper determinations of the interrelationship between study objectives, study designs, data analyses, and statistical inferences in field investigations cannot be stressed enough (Skalski and Robson 1992). Those lacking expertise in statistics, may find it wise to first consult a statistician familiar with pseudoreplication and the study design issues discussed herein (not just any handy statistician or book). It is also wise to develop a written (and defendable) statistical design plan prior to beginning the study.

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Meetings of Interest

July 7-10 To be held in Keystone, Colorado, the 51st Annual Conference of the Soil and Water Conservation Society will address conservation and ecosystem science, ecological decision making and management, and sustaining ecosystems. For more information, call 1-800-THE-SOIL.

August 11-15 The Ecological Society of America will hold its annual conference in Providence, Rhode Island. The National Park Service will host a panel discussion on its natural process wildlife management policy. For more information, contact the society at 2010 Massachusetts Avenue, NW, Suite 400, Washington, DC 20036; e-mail: "brian@esa.org".

August 19-22 The 15th annual North American Resource Modeling Conference, Evolutionary Consequences of Resource Management, will take place in Lutsen, Minnesota. Sessions will address the potential for evolutionary biotic and ecosystem change as a result of global human impacts. The conference will bridge the gap between theoretical ecology, evolutionary ecology, and natural resource management (including the idea of sustainable yield) in examining issues that involve natural resource modeling. Contact Julie Karels of the Department of Fisheries and Wildlife, 200 Hodson Hall, University of Minnesota, St. Paul, MN 55108.

September 9-20 Front Royal, Virginia, will be the venue for the technical conference, Biodiversity Monitoring at Permanent Plots. Contact the Smithsonian Institution/MAB Program, 1100 Jefferson Drive, SW, Suite 3123, Washington, DC 20560; fax (202) 786-2557, for more information.

September 14-19 Florence, Italy, will play host to the 17th International Meeting for specialists in air pollution effects on forest ecosystems. Entitled, Stress Factors and Air Pollution, the gathering will focus on recently discovered effects of air pollutants on forest ecosystems, with special reference to the interactions between environmental stress factors. Sessions include: interactions between air pollutants and abiotic and biotic stress factors; impacts on wildlife and ecology; air pollution and global change; and biodiversity conservation. For more information, contact Dr. E. Paoletti; C.S. Patologia Specie Legnose Montane; CNR, Piazzale delle Cascine 28; I-50144 Firenze; Italy; phone 39-55-368918; e-mail: "raddi@cspslm.fi.cnr.it".

October 19-21 The American Society of Landscape Architects will hold its annual meeting in Los Angeles. This exposition will focus on compelling evidence of landscape architecture work in planning, design, and technology that contributes to societal well-being. Contact Cheryl Wagner (Fax: 202-686-1001; e-mail: "cwagner@asla.org") for more information.

October 25 Bandelier National Monument, Santa Fe National Forest, and the Los Alamos National Laboratory are co-hosting a no-fee Symposium of Biological Research in the Jemez Mountains, New Mexico, in Santa Fe. Contact Stephen Fettig ("stephen_fettig@nps.gov"; 505-672-3861, ext. 546), NPS Wildlife Biologist at Bandelier, by July 1 if you are interested in making a presentation; abstracts are due September 15.

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