PARK SCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT
Volume 19 Number 1 February 1999
U.S. Department of the Interior • National Park Service

The application of a solar "Hot Box" to pasteurize toilet compost in Yosemite National Park

By Paul R. Lachapelle and John C. Clark

Land managers today are continually searching for methods that promote sound and sustainable backcountry management techniques while decreasing costs and use of human resources. The public is also increasingly concerned over great expenditure for backcountry infrastructure projects including the construction of innovative toilet facilities (Voorhees and Woodford 1998). Past research has documented composting toilet technologies as a low-cost, efficient, and sustainable method of backcountry human waste treatment (Davis and Neubauer 1995; Land 1995a, 1995b; Yosemite NP 1994; Mount Rainier NP 1993; Weisberg 1988; McDonald et al. 1987; Jensen 1985; Cook 1981; Leonard et al. 1981). While considerable research has demonstrated the operation and maintenance of composting toilets in the backcountry (fig. 1), few studies have explored proper methods and disposal of composting toilet end-product.

In 1996, the USDA Forest Service, San Dimas Technology and Development Center and the USDI National Park Service, Yosemite National Park, conducted a cooperative study in the development and operation of a passive solar insulated box (termed the "Hot Box") to treat the end-product from composting toilets used by hikers in the backcountry (fig 2, this page, and fig. 3, page 20). The study demonstrated that the Hot Box could consistently meet U.S. Environmental Protection Agency heat treatment requirements and produce a class-A sludge that could be surface-applied as outlined in 40 *Code of Federal Regulations* (CFR) Part 503 (Lachapelle et al. 1997). According to the regulation, this heat treatment is a function of time and temperature (fig. 4, page 21). The study demonstrated that the time-temperature requirement could consistently be met in Yosemite, an area that proved ideal because of high ambient air temperatures and consistent sunlight throughout much of the summer.

Field staff at the park tested the application of the Hot Box to pasteurize large quantities of end-product during the summers of 1997 and 1998. Field staff report that the Hot Box operated well and required minimal labor under optimal conditions. Previously, all of the end-product removed from backcountry toilets in Yosemite was sealed in plastic bags, deposited into designated dumpsters and then thrown away in a local landfill.

Fig. 1 (above). A convenience to backpackers, the composting toilet represents a problem for resource managers: How to safely dispose of the human waste? The authors offer a solution based on their research of the box-type solar cooker (fig. 2, right), which they tested to pasteurize the end-product from public composting toilets used by hikers in the backcountry.

See "Hot Box" on page 20

PARK SCIENCE

Integrating Research and Resource Management

Volume 19 – No. 1 • February 1999

Published by
U.S. Department of the Interior
The National Park Service

Director
Robert Stanton

Associate Director, Natural Resource Stewardship & Science
Michael Soukup

Editor
Jeff Selleck

Park Science (ISSN-0735-9462) is a research and resource management bulletin that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Content receives editorial review for completeness, clarity, usefulness, basic scientific soundness, and policy considerations—materials do not undergo anonymous peer review. *Park Science* is also available on-line (ISSN-1090-9966).

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Make check payable to National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to invite contributions for the Highlights column. Please refer to the guidelines in 16(3):5-6 and on-line, or contact the editor:

National Park Service
Natural Resource Information Division
WASO-INFO
P.O. Box 25287
Denver, CO 80225-0287
Phone 303-969-2147
FAX 303-969-2822
jeff_selleck@nps.gov
www.nature.nps.gov/parksci

Printed on recycled paper

Contents

Departments

Features

In the next issue...

Park Science will host a guest editor next time with an issue primarily devoted to the social sciences. Among the anticipated articles is one originally planned for this issue that explores the carrying capacity issue on the carriage roads of Acadia National Park (Maine). Also look for reports on a study of visitor satisfaction with transportation at Denali National Park (Alaska), a managers perspective on the Fee Demonstration Program, and politics and parks.

Size and Scope

This issue is our longest since 1986. At 40 pages, it clearly demonstrates the awesome scope and complexity of preserving natural resources in the parks. Several articles describe resource disturbances: gizzard shad at Chickasaw NRA exhibit malignant tumors, and the cause remains a mystery; hiking within a popular river canyon at Zion alters the habitat of aquatic organisms; and biodiversity associated with eastern hemlock stands in two mid-Atlantic parks could be at risk if an exotic insect infestation continues to take its toll on the forest. Conversely, at Point Reyes the elephant seal is making a comeback, albeit with such fervor that several new management issues have arisen. The stories also remind us that ingenuity, determination, and teamwork aid success. This is evident in reports on the ambitious watershed restoration activities at Whiskeytown, the desert tortoise population studies in the Mojave Desert, and the development of plant propagation programs in several parks. Our cover story goes to the heart of a nearly universal management issue: what to do with composted human waste from backcountry toilets, and the authors offer a relatively simple treatment option that is sensible, sustainable, and has broad applicability. Finally, Superintendent Karen Wade shares a personal account of the value of science in making management decisions. Her uplifting comments speak of hope and the need to keep the momentum going toward the preservation of park natural resources. This issue contributes in that vein.

Jeff

Letters from the past year

Snowmobiles

I write in response to the article "Exposure of snowmobile riders to carbon monoxide" [17(1):1, 8-10]. As a backcountry ranger and winter caretaker at Kenai Fjords National Park [Alaska], which allows snowmachine access, I feel that *Park Science* failed its readers in not taking a strong stance against snowmachine access in the national parks. If the NPS mission involves any semblance of preservation thinking, it must condemn snowmachines. Anyone who has witnessed snowmachine use in the national park system must attest to: disturbances of wildlife, noise pollution, groundwater pollution, and destruction of any aura of wilderness.

Michael O'Brien
Seward, Alaska

Science?

I received my copy of *Park Science* and the book review of *Preserving Nature [in the National Parks: A History*–17(2):1, 8]. [Since] I have not read the book, I will limit my comments to the short editorial and book review.

It is truly shameful that NPS revisionists are attempting to demonize past park managers for making parks accessible to generations of American recreationists, while promoting the new biocentric "myth" that science will lead park managers to abandon human values in favor of ecosystem preservation. In fact, to the extent that future NPS management strives to maintain or restore "pristine" wilderness ecosystems in parks, then the traditional park ideal will die, and the American people will increasingly resent the obvious damage done to their landscape experience.

Modern revisionist park managers routinely ignore science that does not meet with their preconceived notions of the world, and routinely promote new management regimes without the slightest scientific understanding of the impact on humans. The most recent examples of revisionist mythology resulted in proposals for mandatory public transportation systems and removal of the people's visitor facilities. Science is not likely to provide an enlightened future at NPS without a major injection of common sense and proper respect for history and tradition.

Kenneth A. Barrick
Assoc. Professor of Geography
University of Alaska, Fairbanks

(Editor's Note: Richard Sellars preferred not to respond to these comments.)

Preserving Nature

Having lived, worked, and suffered through the sloughs of despond that characterized the effort to create and sustain a credible NPS science program, I once more raise my grizzled head and sniff the breeze created by Dick Sellars' *Preserving Nature in the National Parks* [17(2):1, 8]. Is that real live hope I smell in the wind? Or just a wish that will expire as so many previous signs of hope have done?

The forces for status quo and inertia have carried the day so far, keeping the still magnificent park system firmly tethered to the notion that park landscapes should be moulded to human perceptions. The emulsification agent that would allow science–especially ecology–to join the traditional mix of landscape architects, foresters, and engineers has yet to be found....

I understand that Director Stanton has undertaken once again to resuscitate our still unparalleled system and our once proud Service. If science is at last guaranteed a seat at management's head table, then perhaps the tarnished phrase "wise use" has a chance of regaining its integrity.

Thomas Hardy wrote, "If a path to the better there be, it lies in taking a full look at the worst." Science for years now has had the capability of showing us the worst and helping us avert it. So far we have elected instead to let the park system act it out. Here's one fervent Amen on behalf of the new resolve!

Jean Matthews
Former editor of Park Science
Vancouver, Washington

CD-ROM

We received the *Park Science* CD-ROM set, compiling volumes 1-18. This is an excellent use of technology, and we appreciate your efforts to get useful information to the parks.

Todd Brindle
Amistad National Recreation Area

• • •

Science scholarship program announced for 1999

The Canon National Parks Science Scholars Program was established in 1997 to develop the next generation of scientists working in the fields of conservation, environmental science, and park management. It is the first and only fellowship program of its kind to encourage doctoral students to conduct innovative research on scientific problems critical to the future of the national parks.

The program is underwritten by Canon U.S.A., Inc. Other collaborators include the National Park Service, the National Park Foundation (NPF), and the American Association for the Advancement of Science (AAAS). Each year, the program awards graduate student scholarships in four broad disciplines: the biological sciences, physical sciences, social sciences, and cultural sciences. The amount of each scholarship is $25,000 per year, for a maximum of three years and $75,000.

The program operates as follows:

1. Students submit dissertation proposals addressing specific research questions identified each year by NPS park managers
2. The proposals are evaluated by scientific panels convened by the AAAS
3. The AAAS panels select the winning graduate students who become Canon National Parks Science Scholars
4. The NPF transfers scholarship funds to each student's university
5. The students complete their graduate research, write a dissertation, prepare a popular article on the significance of the research, and give a public lecture about their work

In 1999, the Canon National Parks Science Scholars Program will award scholarships to eight doctoral students. Four honorable mentions will also be awarded and will include a one-time grant of $2,000. The 1999 competition will focus on four specific research questions described in the 1999 announcement and application.

For a 1999 announcement & application, contact Dr. Gary Machlis, Program Coordinator, Canon National Parks Science Scholars Program, Natural Resource Stewardship and Science, National Park Service, 1849 C Street NW (3127), Washington, DC 20240 or *gmachlis@uidaho.edu.* To download an electronic copy of the 1999 announcement and application, visit the NPS Social Science Web site at *www.nps.gov/socialscience/waso/acts.htm.* Applications are due June 15, 1999. PS

APPALACHIA

Champion trees of the Smokies

During a project to identify and map old-growth forests in Great Smoky Mountains National Park (GRSM–Tennessee and North Carolina), survey notes on big trees revealed that some compared favorably to those listed as state and national champions. Subsequent surveys located new record-setting trees for over 90% of the park's common tree species based on a 1978 list. In addition, with the use of an infrared laser rangefinder and a clinometer, accurate tree heights were collected for the first time in the Smokies; thus, nearly 100 potential national and state record trees have been located and measured so far. Maintaining and promoting the park champion tree list helps to instill a sense of appreciation for what the park preserves, as no comparable region exists anywhere in the United States, not even within the southern Appalachian bioregion.

The American Forests Organization maintains a national listing of the largest known examples of many U.S. trees in the *National Register of Big Trees*. A national champion is a specimen that has the most points for its species. The point scale is based on circumference, height, and crown spread. One point is given for every inch in circumference of the trunk at 4.5 ft (1.4 m) above average ground level, every foot in height, and one-quarter of the average crown spread in feet. A tree can be listed as a cochampion if it is within five total points of another tree of the same species.

In the 1998 edition of the *National Register*, the park contained 22 national champion trees (five are cochampions) representing 17 species (Table). This figure is highly significant in that over 15% of our common native trees are currently the largest known of their species in the country. The potential exists to increase this figure to over 20%. While the Great Smokies recorded more national champions in 1998 than any other unit of the national park system, the park was followed closely by Big Bend National Park (Texas) with 11 champs of 10 species, and Olympic National Park (Washington) with 10 champs of six species.

In spite of its relatively small size, but with nearly ideal growing conditions, high tree diversity, and protected ancient forests, the park likely has the highest concentration of record trees anywhere in the continental United States. The champion trees of the Smokies provide the best living approximation of the quality and size of trees that once existed in presettlement southern Appalachian landscapes. Several trees recently located now represent the maximum dimensions *ever recorded* for their species. It is extremely important to realize the value of forests that in 1999 still set new standards and shatter historical records.

1998 national champion trees of Great Smoky Mountains NP

* indicates cochampion

Species	Circ.	Ht.	Spread	Pts
Striped maple* '97	44"	77'	31'	129
Red maple '94	276"	141'	88'	439
Yellow buckeye '95	229"	136'	53'	378
Allegheny serviceberry '96	77"	101'	36'	188
Devils-walkingstick '96	23"	74'	16'	101
Bitternut hickory '96	153"	146'	74'	318
Red hickory '97	84"	140'	62'	240
Cinnamon clethra '95	10"	33'	12'	46
Cinnamon clethra* '97	9"	29'	10'	41
Fraser magnolia '93	113"	110'	59'	238
Fraser magnolia* '81	116"	107'	55'	237
Carolina silverbell '95	152"	103'	45'	266
Carolina silverbell* '95	151"	104'	40'	265
Carolina silverbell* '95	155"	96'	39'	261
Mountain laurel '97	48"	25'	18'	78
Sourwood '94	106"	96'	28'	209
Red spruce '86	169"	123'	39'	302
Red spruce* '97	144"	146'	34'	299
Black cherry '97	210"	134'	70'	362
Chestnut oak* '96	221"	144'	78'	384
Northern red oak '97	257"	134'	81'	411
Eastern hemlock '95	202"	165'	38'	377

NATIONAL CAPITAL

Hummingbirds succumb to vegetative "Velcro®"

Last September, birders at Rock Creek Park (Washington, D.C.) discovered four ruby-throated hummingbirds ensnared in the Velcro®-like seed heads (photo) of common burdock *(Arctium minus)*, a nonnative weed that had invaded a natural area near the park maintenance yard. Three of the hummingbirds were dead, but the group was able to free one that was still alive. Resource managers removed the 50-60 burdock plants, which can grow over 6 feet in height, and plan to control the species in the future.

The occurrence came as a surprise to park staff and even an expert on burdock, leading to an investigation into the nature of the phenomenon. Could a loggerhead shrike have been the cause? Although the shrike is well known for impaling its prey on sharp objects such as thorns, the hummingbirds were not impaled; the recurved barbs of the seed head would have made this impossible. More importantly, the shrike is rare in this part of the country and at this time of year. A more likely scenario is that the tiny birds had been feeding at a nearby sunflower, lit on the burdock for a rest, and got entangled, sealing their fate.

An electronic note posted on the NPS Natural Resource Bulletin Board and a scientific literature search generated some answers. Other accounts of wildlife being caught and killed in burdock in North America are on record. According to Martin McNicholl, an ornithologist in British Columbia, this plant species has been reported to occasionally kill small birds and brown bats (*Science News* 154(16):244); indeed, a resource manager at Wind Cave National Park (South Dakota) reported the death of a little brown bat in burdock at the park more than 10 years ago. And the problem also occurs in Eurasia, the native home of burdock. Most of the information, however, is anecdotal; a cursory literature search turned up very little scientific work that quantifies the impact of noxious weeds on birds and other wildlife.

Common burdock was first documented in this country in a flora published in 1672 and is now widespread in the United States

and parts of Canada. Commonly used as a medicinal herb, the plant is also well-known to farmers and ranchers who consider it a serious agricultural weed. Burs can lodge in the skin, eyes, ears, mouth, throat, or stomachs of grazing animals, causing irritation and pain. In wild mammals such as coyotes or foxes, the burs can lodge in the fur, causing it to become matted and irritated.

NPS PHOTO BY ROSA M. WILSON

One of four ruby-throated hummingbirds stuck to the Velcro®-like seed heads of

The hummingbird-burdock incident at Rock Creek Park is a poignant example of yet another way exotic plant species imperil the health of natural ecosystems. This point was amplified at a September conference on exotic plants held at the Patuxent National Wildlife Visitor Center in Maryland. Hosted by the National Park Service, the conference focused on the management of exotic plants in general. A mount of one of the hummingbirds trapped in the seed head was displayed, however, and served as a graphic reminder of the importance of preserving native vegetation habitat for wildlife.

Unfortunately, burdock is not the only nonnative plant species that has invaded Rock Creek Park. Exotic vines such as porcelain berry, Asian bittersweet, and Japanese honeysuckle are choking out native vegetation and literally dragging native trees down to the ground, destroying the upper canopy where warblers and other birds nest and thrive. Add this park's problems with exotic plant species to those of every other unit in the national park system and the scale of the problem nationwide begins to become apparent. The problem is so large that funds to combat exotics, staff positions dedicated to their control, and an organized nationwide approach for dealing with them have lagged far behind their pervasive, deleterious influence.

In early February, President Clinton signed an executive order formulating a federal strategy to deal with the problems of exotic species. The order proposes an increase of nearly $29 million for combating exotic pests and diseases and accelerating research on habitat restoration and biological integrated pest management tactics. An Invasive Species Council, chaired by Interior Secretary Babbitt, Agriculture Secretary Glickman, and Commerce Secretary Daley, will cooperate with a variety of groups to carry out the strategy.

SOUTHWEST

Interagency communications productive at Bandelier

Managing migratory wildlife where several agencies are involved is a challenge. Bandelier National Monument (New Mexico) is addressing just such a management challenge using two ongoing approaches to promote dialog between biologists and managers concerning migratory elk. The first approach is to sponsor a yearly symposium of biological research in the Jemez Mountains of northern New Mexico. The symposia have been very successful, attracting approximately 100 biologists and land managers each year. The second approach is to support and participate in the East Jemez Resource Council–an interagency group formed to promote understanding and coordination of natural and cultural resource management in the east Jemez Mountains.

In November 1998, the third symposium featured several papers on elk from both Los Alamos National Laboratory and Bandelier. Participants learned about the laboratory's elk tracking efforts that use global positioning system collars and efforts to create a predictive computer model for elk movements based on habitat, slope, aspect, and proximity to man-made structures. Presentations on simulated trampling and grazing, observations of elk behavior, and development of an elk visibility model from Bandelier's elk research program generated much interest and many questions. Also part of the symposium were papers on the 1950s rapid drought-induced ecotone shift in the ponderosa pine zone at Bandelier and a summary of vegetation recovery after the 16,500-acre "Dome" fire of 1996.

The East Jemez Resource Council was the invention of Bandelier's Chief of Resource Management Charisse Sydoriak. In 1998 the council was directed to make suggestions on elk hunting regulations to the New Mexico Department of Game and Fish. In drafting the recommendations, communications between biologists created two success stories for the park. First, a new subunit for elk hunting in areas adjacent to Bandelier will be created in the fall of 1999 to increase hunting pressure and reduce the winter elk population on the monument. Hunting in the new subunit will be limited to avoid long-period hunts that would likely drive animals onto the monument. A focus on cow-only rifle hunts will also maximize herd reduction until harvest goals are met, while maintaining quality archery bull hunts. Second, voluntary hunter check stations were cooperatively staffed by council personnel last fall to determine hunter numbers and success rate information–not otherwise available–in the planned subunit. From staffing check stations the council learned that hunter success was only 16% in the planned subunit area, approximately 50% below anticipated success. This information will be used to formulate future harvest targets in an adaptive interagency management approach aimed at accommodating both Bandelier's elk management goals and the goals of neighboring land managers.

• • •

Cowbird impacts assessed at Carlsbad Caverns

As in many parks, parasitism of songbird nests by cowbirds is a concern at Carlsbad Caverns National Park (New Mexico). For the past three years, park biologists have been monitoring songbird nests in the Rattlesnake Springs riparian habitat to determine the extent and effects of brood parasitism by the brown-headed cowbird. They found considerably higher parasitism of the state-endangered Bell's vireo than in other songbird species. Cowbirds parasitized 13 of 15 (87%) Bell's Vireo nests in 1997, causing abandonment in 6 of the completed nests. By July 1998, cowbirds had parasitized 19 of 25 (76%) Bell's vireo nests, causing abandonment in 11 nests.

Cowbird parasitism is a growing concern at Rattlesnake Springs. As of mid-July 1998, biologists had found 52 cowbird eggs in all nests, compared to 30 in 1997, and 13 in 1996. The high incidence of multiple cowbird

See "Highlights" on page 36

Popularity of parks affects policy making

National parks are favorite destinations of national and international tourists. The steadily increasing popularity of parks reflects the rising popularity of outdoor recreation, which places substantial pressure on national parks and has important implications for the long-term preservation of park resources. If human recreation dominates the management of a park, preservation is jeopardized and the case for biocentric ecosystem management is weakened. The viability of such parklands becomes threatened. In her article "National parks and the recreation resource" (Denver University Law Review 74(3):847-58), author Jan G. Laitos examines the growth of recreation as a use of leisure time, the increased visitation of public lands (including national parks) by people who wish to enjoy the outdoors, and the subsequent shaping of fundamental management policies for national parklands.

This article is part of a special emphasis issue of the Denver University Law Review that examines numerous legal issues relevant to the management of national parks. Entitled "National Park System Symposium," the issue runs about 300 pages and includes several articles specific to natural resource management issues: "Preserving nature in the national parks: Law, policy, and science in a dynamic environment" by Robert B. Keiter; "Ecosystem management and its place in the National Park Service" by John Freemuth; "The problem of statutory detail in national park establishment legislation and its relationship to pollution control law" by Robert L. Fischman; "Repairing the waters of the national parks: Notes on a long-term strategy" by Eric T. Freyfogle; and "ANILCA: A different legal framework for managing the extraordinary national park units of the last frontier" by Deborah Williams. Details on the issue are available on the Web *(www.de.edu/law/lawreview/home.html)*.

Midsize carnivores losing ground in the West

In the West, midsize carnivores like the fisher, marten, wolverine, and lynx have become as scarce as the wild places they inhabit. These animals inhabit old-growth forests, and like wolves and grizzlies, avoid roads, clear-cuts, and people. Before the turn of the century, midsize carnivores were common throughout the Rocky Mountains and the Cascades and all but the lynx ranged south into the Coast Range and the Sierra Nevada. The increasingly sparse abundance of the animals is attributable to trapping and mostly to loss of habitat from burgeoning development and logging of old-growth forest.

Information about the abundance and distribution of these species in the West has been extremely scarce because, unlike wolves and grizzlies, the midsize carnivores have not been the focus of researchers. For years, the lack of scientific information has impeded federal listings and concomitant protection of the species by the U.S. Fish and Wildlife Service. Cutbacks or pending cutbacks of the USDA Forest Service budget have precluded comprehensive studies of midsize carnivores by that agency. Powerful profiteers and governmental agencies with missions that oppose the conservation and protection of natural resources have repeatedly thwarted attempts to curtail loss of old-growth forest by various entities. In addition to loss of habitat, the persistence of midsize carnivores is threatened by trappers in Idaho and Montana. The entire study population of a researcher in Montana was caught and killed by trappers in the early 1990s. Logging roads throughout western forests not only fragment the habitat of midsize carnivores but also permit disturbances of sensitive habitats by four-wheelers and snowmobilers and access of remote areas by poachers. "Midsize carnivores" in the West desperately need assistance with their fight for survival, but instead "are losing ground" (Joel Bourne. Defenders 72(3):14-21).

Exotic species: a costly burden

"The war against [exotic plants] takes doggedness and a long-term perspective.... If we want our natural areas to have the species diversity and scenic beauty they deserve, we must give nature a hand" (Tenenbaum, D. 1996. Weeds from hell. Technology Review 99(6): 32-40). Highly aggressive, persistent, and noxious exotic plants are the primary threat to many natural and restored native ecological communities. The survival of millions of acres of such communities depends on the removal of the exotics. More than 4,000 floral and faunal exotic species are able to survive without human help in the United States. Of these, 79 species cost the nation an estimated $97 billion dollars between 1906 and 1991 in damage to agriculture, industry, and health. The damage from exotics to biological diversity has not been expressed in terms of dollars; however, according to E. O. Wilson, Harvard University biologist and authority on preserving biological diversity, invasion by exotics has probably been the largest cause of extinction through most of human history. Many, if not most, biologists are convinced that a reduction in diversity robs natural communities of resilience to recover from natural disasters such as fire or storms. A reduction in diversity also constitutes an elimination of genes and substances that benefit medicine, industry, and agriculture.

The takeover by exotic species is hardly natural. In the absence of their natural predators and competitors, they can rapidly outcompete native species. The author provides examples, a few of which are given here.

The Australian tree melaleuca displaces all native vegetation in wet and dry areas. In Florida, it dominates 500,000 acres and colonizes 50 acres per day. Hydrilla, a water weed, chokes 75,000 acres of rivers in Florida. Like many aquatic weeds, hydrilla jumps from one lake to another on boats and boat trailers. Kudzu, the vine that ate the South, can grow as many as 50 feet per year and smothers everything in its path, including buildings, trees, and utility poles. In the Northeast and Midwest, Eurasian water milfoil, a submerged plant, and purple loosestrife, a showy wetland flower, aggressively and comprehensively replace native wetland vegetation. The stench from decomposing purple loosestrife is oppressive. Cheatgrass in the West carpets 100 million acres. It is highly combustible

and returns quickly after fires. In other words, it fuels fires and benefits from them. Salt cedar in the Southwest has taken over streams and riverbanks. Its roots draw salt from below the soil, and its salty leaves raise the soil salinity and thereby retard the growth of native trees.

Sadly, many exotic species were purposely brought to the United States. Some plants were sold by nurseries and continue to be offered in spite of their known harm to native species. For example, 80% of Florida's exotic pest plants were sold by nurseries.

Getting rid of exotics defies simple solutions. Prohibiting the sale of foreign species would conflict with significant industrial interests in horticulture and agriculture. Banning them under the Federal Noxious Weed Act has as yet been underused. Early eradication may be best but first requires intensive public education followed by intensive public support. Another option is creating favorable conditions for native species. For example, in Everglades National Park (Florida), park staff stripped 8 inches of soil from the surface of 60 acres. In the remaining damper, lower soil, wetland species returned but not the exotic pesky Brazilian pepper tree. Biocontrol with introduced predators of exotics is controversial because of the risk that the introduced predator, also an exotic, may become a pest.

A leading role in biological controls by the federal government seems desirable, but money is in short supply. "When resources are allocated, exotics are a quiet issue and usually left to the end, even though it's in our mandate to preserve and protect natural areas," according to Carol DiSalvo, an entomologist with the NPS Environmental Quality Division who contributed to the article. Federal laws seem inadequate and not sufficiently enforced. Needed is public pressure.

El Malpais publishes natural history work

El Malpais National Monument announced in February 1998 the availability of a major new publication entitled "Natural History of El Malpais National Monument." Published by the New Mexico Bureau of Mines (Bulletin 156, 1997), the bulletin presents a comprehensive interpretation of the park's volcanic landforms and their associated biological components. Compiled by El Malpais Chief Ranger Ken Mabery, it devotes extensive coverage to lava tube caves, including their formation, mineralogy, cave ice, and fauna. Other features include a comparative analysis of seven basalt-dating techniques as applied to flows ranging from 725,000 to 3,000 years ago. The flora and fauna and the fire ecology and succession on lava flows is also cataloged. Maps, historic photos, species lists, charts, and a color photo atlas of the park's volcanic landforms are included in the 185-page volume. The bulletin is available from the publications room of the New Mexico Bureau of Mines and Mineral Resources, 505-835-5410, for $24.50.

Channel Islands I&M reports available

In the 1980s, Channel Islands National Park (California) developed a program to inventory and monitor natural resources (see Ecological Monitoring in Channel Islands National Park at *www.nature.nps.gov/im/chis/content.htm)*. This program was designed to be long term and ecosystem-based. Additionally, the program was intended to provide park managers with regular assessments of ecosystem health by determining limits of natural variation, diagnosing abnormal conditions, identifying potential agents of abnormal change, and prescribing remedial treatments.

The biologists responsible for monitoring at the park produce an annual report for each program component. These reports are a description of the monitoring activities and conditions for a given year and a summary of that year's data. Abstracts of these reports are available for review at the NPS I&M Web site *www.nature.nps.gov/im/chis/abslist.htm.* The following annual report abstracts on monitoring are available: 1982-96 kelp forest, 1982-87 tidepool, 1990-92 seabirds, 1989-93 marine debris, 1994-95 beach lagoon, 1993-95 terrestrial vertebrates, 1993-94 land bird monitoring, Santa Rosa Island water quality inventory (1995), and Status and Trend of Island Fox on San Miguel Island (1998).

Additionally, the Kelp Forest Monitoring Design Review (1996) abstract is accessible on the Web site. Monitoring design review is a formal process of evaluation by managers and scientific peers of the results of a monitoring program after several years of data collection. This review process, essentially a course correction, is critical to ensure that monitoring is providing the information and statistical power that is needed by park management. The park intends to conduct such a review for all of its monitoring protocols. To date, only the Kelp Forest Monitoring Program has undergone this review.

Photocopies of the reports and program protocols may be obtained for a fee from the NPS Denver Service Center, Technical Information Center; P.O. Box 25287; Denver, CO 80225-0287; 303-969-2130; e-mail: *tic-_work_orders/requests@nps.gov.*

Trail trampling and deterioration studied

A research biologist with the Aldo Leopold Wilderness Research Institute in Missoula, Montana, conducted experiments to evaluate the effectiveness of two recommended Leave-No-Trace practices–removing boots and using a geotextile groundcloth known as scrim (Cole, D. N. 1997. Intermountain Research Station. Research Paper INT-RP-497). In four different vegetation types, 6% more vegetation cover was lost when hikers wore lug-soled boots than when they wore lightweight running shoes. One year after trampling, however, the magnitude of cover loss did not differ between the two treatments. The different footwear had no effect on vegetation height. In another experiment, the short-term loss of vegetation from trampling was half in two different types of vegetation that were covered with geotextile groundcloths than in uncovered vegetation. Although lightweight shoes and geotextile groundcloth did no harm and provided short-term benefits, they provided no long-term benefits or meaningful reduction of adverse effects on resources.

An unrelated study in western Montana explored the relative deterioration of trails attributable to different types of recreational use (Influence of llamas, horses,

Continued on page 8

Continued from page 7

and hikers on soil erosion from established recreation trails in western Montana, USA. Environmental Management 22(2): 255-62). The research had the primary objective of assessing the relative effect of horses, llamas, and hikers on sediment yield after a simulated rainfall on established trails. A secondary objective was a better understanding of the mechanisms by which trail traffic increases erosion. The selected study site was a 1.0-1.5-m-wide trail section of Winkler gravely loams (soil consisting of clay, silt, and sand) with little entrenchment at an elevation of 1,250 m (4,100 ft). The habitat was Douglas fir and heath. Various trail traffic across seven plots was applied during June and July. Hikers wore non-lug-sole boots; horses were fitted with cleated shoes. Data were collected in dry conditions and after simulated rainfall. Under dry and wet conditions, more sediment for erosion was made available by horses than by llamas, hikers, or no traffic. More sediment became available for erosion from use by llamas than from no traffic, but yield of sediment for erosion did not differ between llamas and hikers. Traffic did not increase soil compaction on wet trails but decreased soil bulk density on dry trails. The decreased soil bulk density negatively correlated with increased sediment yield and seemed to increase trail roughness for horses but not for llamas or hikers. The data may assist managers with determining trail use by type of user.

Ungulate fence design improved

Members of the California Department of Fish and Game and the founding president of Desert Wildlife Unlimited are offering an improved fence design to protect water sources for native ungulates (Andrew, N. G., L. M. Lesicka, and V. C. Bleich. 1997. Wildlife Society Bulletin 25(4): 823-25). They set 1.5-m-long *t-posts* on 3-m centers and placed horizontal rails of either 25-mm steel pipe or 15-mm steel rebar at 50 and 100 cm above the ground. The rails were either welded or wired to the outside of the uprights. An additional t-post was attached to alternate uprights at a 30-degree angle on the inside of the enclosure to strengthen and stabilize the fence. The fence required about 30% less material and was less expensive than most earlier designs of such fences. The fence permits access by native ungulates but precludes access by feral equines (or livestock). The fence was placed around eight water sources in the field and was monitored 1989-95. Evidence of feral asses outside each of six exclosures was seen on all 127 inspections. Evidence of feral asses inside one enclosure was seen only once, namely when the fence had been dismantled by vandals.

Politics of wildfire analyzed

Severely dry conditions and gale-force winds promoted the spread of wildfire in the Greater Yellowstone Ecosystem in 1988. This ecosystem comprises Yellowstone and Grand Teton National Parks, seven adjacent national forests, and several other federal, state, and private lands in Idaho, Montana, and Wyoming. Approximately 995,000 acres or 45% of Yellowstone National Park burned. Another 590,000 acres in surrounding areas were affected by the fires. Ecologists and land managers largely agree that the fires were an ecologically important natural disturbance and that little could have been done to stop them. Policy makers on the other hand viewed the fires as failed policies, and many citizens lamented the destruction of the park, the loss of wildlife and beauty, and the adverse effects on the economy of surrounding communities. Many branded the federal government's fire policy a failure; however, scientific research and even casual observations revealed that wildlife in the burned areas abounds, trees are growing, and beauty prevails. The nearby communities did not suffer great economic hardships. In fact, nationwide publicity of the fires seems to have promoted the growth of tourism. The greatest damage may not have been from the fire, but from ridicule of the government by the public, abuse of public servants by members of the Congress, attacks on the integrity, intelligence, and professional abilities of civil servants and their associates by the media, and the public's loss of faith in the federal fire policy.

Pamela Lichtman (1998. The politics of wildfire: Lessons from Yellowstone. Journal of Forestry 96(5):4-9) contends that a realistic view of a fire policy must acknowledge that clear rules for every conceivable eventuality are not feasible. Before they can elicit support for natural fire and confidence in the federal fire policy, managers and ecologists must realize that the citizens' and politicians' view of wildfire as a crisis can undermine the stability of natural resource agencies. An honest appraisal of how much control humans have over wildfire must be clearly communicated to the public. The ecological objectives of a natural fire policy should be persuasively presented to resource constituencies and policy makers. Ideas and suggestions must be solicited from the public. Collective decision making cannot be ruled out. Quite importantly, people who are involved in conservation of natural resources cannot dissociate themselves from politics. They must understand how land management policies and ecosystem processes are interpreted and reinterpreted by citizens, elected leaders, and the media. Multiple realities and relative standards cannot be eradicated, and ecosystem management cannot progress until these realities become less disparate.

Fire and ecosystem management

A symposium at the 1997 annual meeting of the Ecological Society of America (Fire for restoration of communities and ecosystems. Bulletin of the Ecological Society of America 79(2): 157-60) addressed (1) fire as a necessary and viable option for ecosystem restoration by forest land managers; (2) operational use of fire in restoration in a complex and sometimes hostile sociopolitical environment; (3) definition of a natural fire regime for a particular ecosystem; and (4) duplication of natural fire regimes by management plans that include prescribed fire. The overwhelming message by speakers at the symposium was that fire must be an integral component of ecosystem management because its prevention in ecosystems where it was formerly common produced profound alterations in historic ecological conditions. The speakers reflected the 1996 policy by the Secretary of the Interior and the Secretary of Agriculture that "Wildland fire will be used to protect, maintain, and enhance resources and, as nearly as possible, be allowed to function in its natural ecological role." The sympo-

sium clearly established the need for and successful results of restoration with fire. The policy must be brought to fruition not only on federal land but in natural ecological communities in all ownership.

Ecosystem management activities in Southern Appalachians compiled

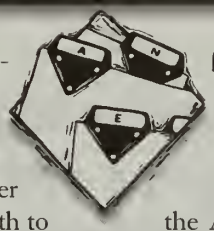
Lewis Publishers have recently released the book *Ecosystem Management for Sustainability: Principles and Practices Illustrated by a Regional Biosphere Cooperative.* This volume (ISBN 0-57444-053-5), edited by John D. Peine (Cooperative Park Studies Unit, University of Tennessee) includes a forward by Bruce Babbitt and contributions from 50 authors. Principles of ecosystem management from several sources are included in the introductory chapter. The book uses the Southern Appalachian Man and the Biosphere Program to illustrate the principles. Of the 23 chapters, 14 are dedicated to the following components of ecosystem management: resource assessments (Southern Appalachian Assessment); environmental monitoring (Great Smoky Mountains National Park, among several); management of a large carnivore (black bear); species repatriation (red wolf); management of isolated populations (brook trout); control of exotic species (European wild boar); control of pests and pathogens (dogwood anthracnose among several); air quality (Southern Appalachian Mountain Initiative); fire management, land use planning (gateway communities); managing biodiverity in historic habitats (grassy balds); and climate change, ecosystem stabilization and restoration (Clinch-Powell River Basin initiative), and managing a threatened ecosystem (high elevation spruce-fir forest). There is a chapter on the role of institutions in ecosystem management. Through the multi-authored contributions to this book, documentation of a comprehensive spectrum of ecosystem management and sustainable development is achieved.

The influence of land ethics on forest policy

Data from a nationwide survey of USDA Forest Service employees were used to compare the land ethics between foresters and other natural resource professionals and to examine the relation between one's land ethic and preferred forest policy options (Brown, G., and C. Harris. 1998. Journal of Forestry 96(1):4-12). The comparison revealed that foresters embrace a more utilitarian land ethic than biologists and other natural resource scientists in that service. Because the number of foresters, engineers, and range managers in the agency is declining while the number of natural resource scientists is growing, future management of national forests may be changing.

Needs assessed for marine waste disposal facilities

The Clean Vessel Act of 1992 (P.L. 102-587) provides for the distribution of grants to states for construction, operation, and maintenance of pump-out stations for portable toilets on boats in the United States. The article "Environmental management of human waste disposal for recreational boating activities" (Shafer, E. L., and J. Yoon. Environmental Management 22(1):99-107) is the description of a method that Pennsylvania used to estimate the number of pump-out facilities and dump stations it needed to service power boats of 16 feet in length to more than 40 feet during the May-November boating season on seven major water bodies. The estimation required the collection of information about the number and type of power boats on the water bodies; the number of boats with portable toilets or type III marine sanitation devices; the means by which boaters disposed of human waste; the number of marinas, boat docks, yacht clubs, and areas of congregation of boats in the state; the number, type, and condition of human waste pump-out facilities and dump stations; and the number of additional facilities the state needed to adequately service the current number of power boats. The information was collected by mailed questionnaires from a sample of 28% of 9,770 boaters and from 33% of all 212 marinas and boat docks in the coastal zone and inland waters of Pennsylvania. Statewide averages of the number of times a boat emptied a portable toilet or a holding tank, marina service time per sanitation device, number of hours of marina operation per weekend and weekdays, and number of weekends a marine operated during the boating season were used to estimate the required waste reception facilities for each of seven major water bodies. The study also revealed valuable information about various aspects of waste disposal. The authors discuss the limitations of the results and make suggestions for the improvement of the method.

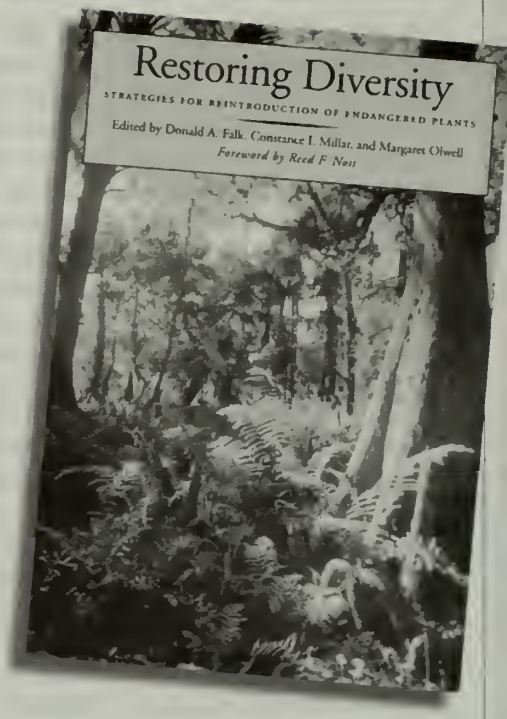


Leopold Institute publishes research abstracts on Web

As many readers know, the Aldo Leopold Wilderness Research Institute in Missoula, Montana, is the only research group in the nation dedicated to developing and communicating the knowledge needed to improve management of wilderness and other natural areas. Founded by the USDA Forest Service in 1967, the Institute operates under an interagency agreement among four wilderness management agencies of the federal government and the USGS Biological Resources Division. Together, scientists and managers from these agencies conduct, support, and coordinate research cooperatively on the biological and social attributes and benefits of wilderness, and threats to the same attributes and benefits. Additionally, the Institute provides managers, educators, policy makers, other scientists, and the public with the results of its studies. Some 340 professional research papers, technical reports, journal articles, and books have been published since 1969 on various wilderness management issues. A comprehensive bibliography of these publications is now listed on the Institute's Web site at *www.wilderness.net/leopold;* abstracts are available for papers published after 1984. The Leopold Institute also has a new e-mail address *(leopold_institute/rmrs_missoula@fs.fed.us)* and welcomes inquiries. PS

Restoring Diversity: Strategies for Reintroduction of Endangered Plants

Edited by D. A. Falk, C. I. Millar, and M. Olwell



A BOOK REVIEW BY JOHN T. TANACREDI, PH.D.

As *Restoring Diversity: Strategies for Reintroduction of Endangered Plants* points out, restoration ecology is "mostly about restoring hope." Edited by D. A. Folk, C. I. Millar, and M. Olwell, *Restoring Diversity* can help the reader to regain the rhythm of the "environmental ministry." This book gives hope to those of us in the business of trying to reverse decades of human-induced impacts and degradation to natural systems. Though not of "biblical proportions," *Restoring Diversity* has certainly "found me." This publication should be "Gideonized" for all park managers.

Restoring Diversity is divided into five major divisions: (1) Policy for Reintroduction; (2) Biology of Rare Plant Reintroduction; (3) Reintroduction in a Mitigation Context; (4) Case Studies; and (5) Guidelines for Developing a Rare Plant Reintroduction Plan. The introduction defines the language of restoration, including such terms as "enhancement," "reclamation," "revegetation," "reintroduction." Yet despite these definitions, the authors continue to emphasize that restoration is "characterized to a marvelous degree by uncertainty, risk, and unpredictability." They do not make any apologies for what little preservation of natural systems exists today. Although heavy on "strategic" planning, the authors also provide practical applications and case studies.

Part 1: Policy for Reintroduction

The authors of *Restoring Diversity* offer no panaceas, pointing out that "in a wounded world," we have little choice but to intercede to halt or block wholesale eco-victimization. Even with the considerable number of laws passed with the intention of protecting and preserving natural areas in perpetuity, the loss of biological diversity continues in a rampant and insensible manner. To make matters more difficult, even though there is a greater awareness and appreciation for restoration and a revitalization of "managed natural areas," the "biological understanding for relocation or reintroducing species, populations, and communities is poorly developed."

Chapter 1 by Larry Morse, "Plant Rarity and Endangerment in North America," sets the tone for the remainder of the book by stating that "most reintroduction and restoration projects should be considered experimental supplements to in situ conservation." Discussion of spatial and biological scales of reintroduction assumes that the goal of rare species is to survive rather than be made common. The book thus emphasizes the difficult management task of attention to the entire landscape, including immigration-extinction, zone flow and dispersal, pathogenic impacts, habitat influences, and biogeochemistry. If at all possible our goal should be "stability" through prevention of habitat fragmentation.

Discussions of reintroduction at a regional scale and the use of the "original" site status for rare species as the reference point for reintroduction is most applicable for the National Park Service, since the authors question "how recently must we document the original presence on a site?" The authors say that many conservationists "would probably be comfortable with 10 years rather than a scale of hundreds of years unless anthropogenic pollution or causes of extirpation heavily influence species existence at a site." Those of us in federal service realize that we may never see such a progressive restoration program, because we continue to document rare plant species in a time frame of the annual base funding for such programs. We need to look more critically at the reintroduction of native species based on a documented existence in the past, and the complex causative factors that were responsible for the loss of metapopulations. The authors suggest that we should not be "overly narrow [in our] definition of the site of original occurrence." In New York City, for example, a locally rare plant *(Cyperus schweinitzii)* was found on an abandoned, concrete airfield runway that had deteriorated after 50 years of no or little use. The two small plots were isolated and fenced in. If we hadn't inventoried the site prior to our reclamation effort (spreading wood chips and letting natural revegetation occur), we would have lost this rare plant population.

Of special interest to me were the discussions on finding single populations of rare plants, which reemphasized the desperate need for unbiased monitoring to assess conservation effort success. Inventories these days are all too often conducted for environmental impact statements by "environmental consultants, contractors, or developers," who have a vested interest in keeping species numbers and diversity levels low, and who are certainly not interested in long-term preservation.

The chapter on regulatory policy by C. B. McDonald should be pulled out by land managers and kept near their telephones. This chapter emphasizes the Endangered Species Act (ESA) and was interestingly skewed in its discussion on permitting, pointing out that "no permits are required

under U.S. Fish and Wildlife Service implementation of the ESA for threatened and endangered (T&E) plants!" It was good to see that the policy discussion covered the intent of the ESA to protect the "ecosystems" upon which all other species depend. The rehabilitation of impacted ecosystems is the goal, not just "save the T&E species."

The Hawaiian experience with T&E species is an eye-opener. Reading this section should rekindle, or keep lit, the fire of enthusiasm and dedication to preserve wild places before they become so degraded. One interesting note was the fact that transplantation and reforestation efforts designed to reverse the widespread impact of cattle grazing and agricultural development commenced in Hawaii in 1910 and continued through 1960; however, none of the originally transplanted native populations exist today! Today, of 103 species of native Hawaiian plants that have been transplanted into wild or semiwild areas, 35 are at risk of extinction. The discussion of "genetic pollution" or hybridization is interesting and should be the topic of a future conference proceedings.

Part 2: Biology of Rare Plant Reintroduction

Though no real "success" criteria are generic enough to be used for all rare plants and their reintroduction into natural systems, figure 6.3 covering what Bruce Povlick identified in his paper as the minimum viable population is important for land managers to review. Yet, as Povlick notes, a "minimum viable population" may be extremely difficult to maintain, especially in founding populations of rare plants. Povlick's paper presents a number of excellent case studies that set the stage for further exploration of the technical challenges of plant restoration ecology. Site introduction selection processes and population genetics with a horticultural perspective are covered by two well-referenced papers.

Richard Primacks' paper on the use of ecological knowledge to assist in reintroduction efforts emphasizes meeting all ecological requirements in order to provide a greater chance of success, measured by population dispersal beyond the reintroduction site and the "establishment of a dynamic metapopulation." Park natural resource management staff should use this paper as an introduction to the key elements that need to be identified before attempting to introduce rare plants. The intensity of such an effort will be daunting and should be acknowledged in advance by management so that appropriate resources can be made available. R. D. Sutter's paper reinforces this with his chapter on "Monitoring." He states succinctly that "if reintroduction is to be meaningful in the long term, its proponents and practitioners must acknowledge that design and planting are but the first steps in a commitment that extends for many years." Monitoring restoration and reintroduction efforts is the principle "feedback" mechanism to guide future efforts, to establish "success," and to provide input to bolster the scientific effort.

Part 3: Reintroduction in a Mitigation Context

As the editors note, "the most controversial application of reintroduction and restoration" is when it is required or recommended as mitigation of some regulatory or developmental actions. I am sure all NPS superintendents have experienced a wide range of proposals purportedly being "mitigatable" through the environmental assessment and analysis process. Few of these projects are ever monitored to see if the mitigation actually worked.

Ken Berg introduces us to the definitions of mitigation and A. H. Howald reveals the complexity of actions necessary in the "California Experience," revealing pitfalls and anticipated costs and presenting site case studies. I. B. Zeller's paper on created wetlands in California is directly applicable to east coast tidal marshes, and the lessons learned from fertilization requirements, altered predator population dynamics, canopy development, and overall marsh functioning were most informative. Chapters on the "Use of Corporate Lands" in preserving plant biodiversity, and new directions for rare plant mitigation policy present several interesting approaches to protecting rare plant species. A final chapter in this section, "FOCUS: Rare Plant Mitigation In Florida," is an excellent segue into Part 4: Case Studies.

Part 4 presents a number of practical examples of rare plant reintroduction projects with their "re-introduction history." Examples of different taxa are provided. Each case includes information on threats to the population, endangerment status, site requirements, and reintroduction conditions. Even funding levels are provided to help sort out applicability to your individual needs. The book concludes with Part 5, "Guidelines for Developing a Rare Plant Reintroduction Plan," which could be used to help justify the implementation of a rare plant reintroduction program in any national park unit.

Restoring Diversity...

1996 Island Press

Washington, D.C. & Covelo, CA

512 pages
Tables, figures, photos, index

Hardcover
ISBN 1-55963-296-8
$42.00

Paperback
ISBN 1-55963-297-6
$22.95

This is an excellent work that should help provide a foundation in the practice of restoration of natural systems. I recommend that all natural resources staff and superintendents in the National Park Service read it and then put into their respective libraries for future reference. PS

References

Stalter, R., M.D. Byer, and J.T. Tanacredi. 1995. Rare and endangered plants at Gateway National Recreation Area: A case for protection of urban natural areas. Landscape and Urban Planning 35:41-51.

John T. Tanacredi, Ph.D., is Chief, Division of Natural Resources, at Gateway National Recreation Area. His e-mail address is john_tanacredi@nps.gov.

Impacts to river biota studied in Zion Narrows

By Mikel J. Shakarjian and Jack A. Stanford

Of all the recreational opportunities provided by Zion National Park (Utah), hiking the Virgin River Narrows (fig. 1) is among the most popular activities. Annually, thousands of people wade into the waters of the North Fork Virgin River to enjoy its scenic steep-walled canyon, commonly known as The Narrows. The Narrows is not only a favored hotspot for river recreation, but also a biological oasis within the upper Colorado River system that contains critical habitat for a number of riverine species. While visitors enjoy the canyon experience, their wading activity disrupts the riverbed, altering the habitat of benthic (bottom-dwelling) organisms and potentially reducing populations.

Concern over the potential impacts of wading on river biota in the North Fork Virgin River led to a cooperative study by the National Park Service and researchers from the University of Montana, Flathead Lake Biological Station. In spring 1996, we began a study to characterize zoobenthic biomass at different locations in the river corridor. Recreational river use varied among sites and we expected to observe an impact gradient where low biomass was associated with intensive visitor use (trampling).

Visitors can enter the Narrows canyon from both an upstream and downstream location. To gain access from the upstream location, hikers are required to obtain a backcountry use permit. We relied upon the permit data to estimate hikers traveling downstream, and monitored wading activities on six separate days in August and September 1996 to estimate hikers traveling upstream from the downstream access point. Using this information, we were able to determine the average number of hikers per day passing each of our seven benthic sampling sites, providing an estimate of trampling impact at these locations. Three replicate samples were collected from each sampling site to determine zoobenthic biomass, using ash-free dry mass (g/m^2) and density (individuals/m^2).

Estimates of trampling impact within the river corridor revealed a gradient of decreasing impact upstream for all six days of the study. Trampling impact was the greatest at the most downstream site, located at the end of the Riverside Walk trail (mean =2,006), but decreased rapidly with less than 30% of the waders continuing a mile upstream to the next site at Orderville Canyon (mean = 609). Levels of trampling were very low at sites deep within the canyon. Less than 5% (mean =125) continued to the next upstream site at Big Springs and the least amount of wading activity occurred at the uppermost site (mean = 95).

With the trampling gradient established, we determined that sites with any trampling exhibited reduced benthic biomass when compared to their reference sites (no trampling), with the greatest decline occurring where trampling impact was most intense. The impact of hikers heading upstream from Riverside Walk resulted in a substantial decrease in biomass, but less than one-third of the waders actually hiked one mile upstream. Therefore, the heavy impact directly associated with the number of hikers is limited, with less than 70% of waders hiking just a short distance upstream from Riverside Walk.

A complicating factor in this kind of analysis is the longitudinal change of the river itself. Although trampling impact was lowest at the most upstream site, the river is very narrow there (a few meters) and confined in spots by the canyon, forcing hikers to walk in the riverbed for long stretches. The size of the stream and lack of a riparian zone results in the riverbed being thoroughly disturbed by wading activity and a significant reduction in zoobenthic biomass, even though the trampling impact was quite low by comparison.

In the Virgin River Narrows, we found the level of recreational river use and site characteristics to be clearly associated with zoobenthic biomass throughout the river corridor. Our study illustrates that the trampling impact of hikers creates a serious habitat disturbance where the severity of the impact is dependent upon the level of trampling and river characteristics.

Bill Hansen

Figure 1. The Zion Narrows is a spectacular river corridor that is very popular among hikers at various times of the year. The study examined the relationship between trampling of the aquatic environment and impacts to the organisms that live in the riverine habitat.

The North Fork Virgin River in Zion National Park is critical habitat for a number of desert fishes, which have experienced a steep decline in numbers throughout the Southwest and now exist only in isolated populations. Similarly, the stonefly, *Isogenoides zionensis*, is considered rare throughout its range; however, it thrives in the canyons of Zion National Park and can be found there in very high numbers. Many other important species also exist within this riverine habitat. The impact from intense recreational river use may threaten the viability of these populations due to habitat disturbance and the disruption of a healthy riverine food web based on benthic organisms. PS

Mikel Shakarjian is with the South Carolina Department of Natural Resources, River Conservation Program, 2221 Devine Street, Suite 222, Columbia, SC 29205; shakarjian@water.dnr.state.sc.us.
Jack Stanford is with the University of Montana, Flathead Lake Biological Station, 311 Biostation Lane, Polson, Montana 59860; stanford@selway.umt.edu.

A superintendent speaks out on the value of inventory and monitoring

Remarks of Superintendent Karen Wade, Great Smoky Mountains National Park

Editor's Note: Late last summer, Great Smoky Mountains National Park (Tennessee & North Carolina) hosted the annual training session of the NPS Inventory and Monitoring Program. The weeklong event featured the following lecture by Superintendent Karen Wade. Abridged here, her remarks to the 25 course participants resulted from a conversation with Keith Langdon, the park I&M Program Manager.

I'm pleased to have an opportunity to talk about the importance of inventory and monitoring from a superintendent's perspective. Having served in both large and small areas, historic and natural, in four regions of the system, I've begun to develop some perspective on resource management that may be of value.

For the most part, parks were established for their scenic and cultural characteristics and their economic value to local or regional communities as an attraction. The National Park Service has always managed them mostly from that standpoint. Therefore, Great Smoky Mountains National Park, for example, has become known more for its huge visitation (10 million visitors a year) rather than for being a refuge for one of the richest and most diverse collections of plants and animals in the temperate world.

Like the Smokies, most of the parks in the national park system are still relatively unknown biologically. We have probably drastically underestimated the biologic value of parks, since we have only just started a servicewide approach to inventorying.

Larger parks are recognized for their natural values largely because the public hears about issues related to charismatic megafauna, catastrophic fire, and so on. But the reality is that most park units are smaller historical parks. A significant percentage of these are military sites originally selected for their importance during the Revolutionary and Civil Wars. As strategic sites, they represent regional geologic prominence or are situated at the confluence of coastal or river systems. Nonmilitary units are also often located on sites with unusual habitats. The interesting result is that these units represent both regional and national biodiversity and contain many rare species and regional endemics. Many of these units have been protected for many decades, being perhaps only lightly grazed at most, and contain natural habitats that have long-since disappeared from the surrounding landscape.

As an example, when Keith Langdon from my staff visited Shiloh National Military Battlefield in Tennessee several years ago he called attention to the fact that the park contained 150 acres of southern bottomland hardwoods that had never been cut. This is an unusually large and representative sample of that habitat. In addition, Shiloh preserves rare lichens. I really enjoyed a recent exchange with Superintendent Woody Harrell as he bragged about having more species of fish than the Smokies. I thought that was good news...a superintendent who understands that it's the diversity of the resources that matters, whether natural or cultural. I also know that Stones River National Battlefield Park in Tennessee has plants not represented elsewhere.

The superintendents of the Appalachian Cluster have begun to realize that not only have we underestimated the value of the natural resources on these sites, but that the state and federal agencies that normally use public lands for inventory work have always kept a hands-off attitude towards these federal enclaves. Even they don't have a clue what wonders exist on these lands. I wonder if the public has even the remotest idea of the wealth of resources on parklands. Interestingly, we have tended to take credit for and count the large populations of creatures in large parks, but appear to have failed to take credit for the whole range of natural communities represented on smaller properties dispersed throughout the eastern United States.

Inventories are often seen as static lists of "things." I think we don't fully appreciate that almost *any* of our parks contain surprising holdings if all species on the site were known. Inventorying becomes exciting when we think of it as the opportunity to report the treasures of regional endemics, taxa new to science, unusually vigorous populations of uncommon species critical to long-term survival, exemplary natural communities, and so on. Some large, biologically complex parks may have many more "things," but most parks, regardless of their founding legislation, contain elements that make up an exciting array representative of the diversity of our nation, region, and locality.

If inventories tell managers the full story of (1) *what* resources they have, (2) *where* these resources are, and (3) *associate* the species with other species, sites, and phenological data, then managers will have a potent tool for making intelligent decisions, taking action, and defending parks against misguided and uninformed decisions and actions from within and outside the park. This type of information allows us to be good land stewards within a regional ecosystem context.

In my view the real threat to parks is ignorance. The possession of sound scientific data is often decisive in the political arena in which superintendents, regional directors, and agency directors must operate.

Long-term ecological monitoring is the logical extension of a thorough inventory whether applied to big natural areas or small cultural areas. A monitoring program must be knit together to track key ecological processes within the larger system of which we are a part (we can't track very many individual species). The components of the system should be related to one another so that we can better understand ecosystem function. Once we have data from a site or a watershed, we have an early warning system that we can defend in a public forum or in court if we have to.

I like to use the Smokies as an example of how critical this is. Some areas here receive 300% more air pollution than others. This is significant in choosing the sites where we monitor air pollution and in choosing the watersheds we study. The associations help us understand the system and explain our case, for in the final analysis we need to score for the advantage. We can do that by understanding *all* the relationships of our resources and helping our allies understand them, too. In most places, we cannot hope to ever have the ability to monitor everything, and we have learned that

See "Wade" in third column on page 39

Figure 1. Among the many needs for native plants at Lake Mead National Recreation Area is the restoration of abandoned roads. Routine automobile traffic and camping took their toll on this desert campsite in the creosotebush plant community. Closed by the park years ago, the site has since undergone restoration.

Reflections on a desert nursery operation

Need native plants for restoration projects? Establishing a park nursery is one solution, but should be considered carefully

By Alice C. Newton; photos by the editor

Lake Mead National Recreation Area (Nevada and Arizona) encompasses 1.5 million acres of which 1.2 million are land-based. The park is managed for conservation while providing recreational and other outdoor opportunities. Spanning three of the four great American deserts–Great Basin, Mojave, and Sonoran–this national recreation area is rich in natural resources, many of which are poorly known biologically. This incredible coverage of the Southwest allows for great diversity in plant communities, such as yellow pine and pinyon-juniper woodlands, creosote-bursage scrub, Joshua tree woodland, desert riparian woodland, alkali meadows and aquatic herb, and gypsum barren scrub. Providing native plants to meet the needs of various resource management projects in these plant communities has become quite a challenge.

At Lake Mead, we use native plants for landscaping and restoration work. Our plant selection guidelines state that only native plants (with certain exceptions) will be used for landscaping and restoration in park housing, campgrounds, and other visitor areas. Concessionaires and private property owners within the park are also encouraged to use native plants obtained from the National Park Service. Restoration projects to date have involved primarily off-road vehicular damage, road and utility corridors, abandoned roads (fig. 1), and riparian areas following eradication of the nonnative tamarisk. Future restoration projects will also include vast areas of overgrazed scrub and grassland.

Opportunity

In 1991, I was hired to remove native vegetation from and later restore approximately 12 miles of Lakeshore Road that were being widened, rebuilt, and in some places, moved (fig. 2, a & b). The position was classified as "temporary, not-to-exceed four years" because this was the anticipated duration of the road project. This project, funded by the Federal Highways Administration, was a catalyst for the park to begin addressing its

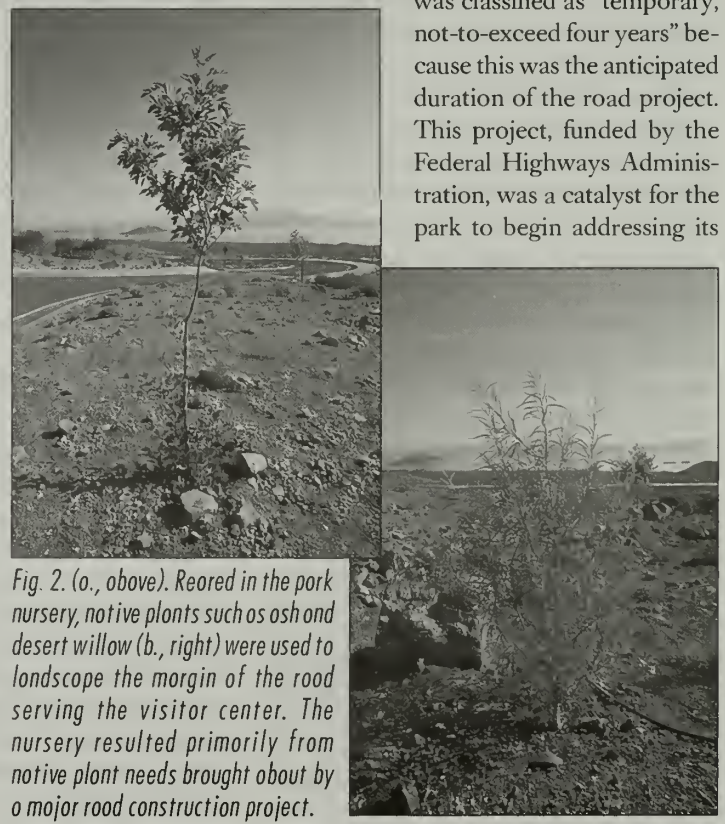


Fig. 2. (a., above). Reared in the park nursery, native plants such as ash and desert willow (b., right) were used to landscape the margin of the road serving the visitor center. The nursery resulted primarily from native plant needs brought about by a major road construction project.

Figure 3. Protected from strong desert sunlight by a shade cloth laid over a steel frame, the Lake Mead nursery currently provides space for approximately 3,000 plants. The plants get their start in the greenhouse (upper middle part of photo) before being moved to watering stations (foreground) for additional growing time. Pipes made of PVC serve as slide-through pots, allowing resource managers to transplant the seedlings to various restoration sites around the park with minimal disturbance to their long and delicate roots.

long-term needs for native plant material for other projects. My function was soon viewed as serving the specific needs of the road project and the general needs of the park, and my position was converted to permanent. With additional park funding, we expanded the newly established nursery beyond what was needed for the road project and began propagating and maintaining plant material for other park purposes.

Quite frankly, building and operating a native plant propagation facility is a little tougher than it sounds. My education is in ornamental horticulture with dual emphasis on park and nursery management, and landscape design and construction. I learned greenhouse and irrigation systems engineering along with plant propagation and nursery facilities management. My practical experience included nursery operations and native desert plant propagation at a state facility, and landscape construction for private contractors. Even though I had the right education and some experience, building the nursery was an incredibly time consuming and expensive task. A productive, permanent operation requires considerable commitment not only from the nursery manager, but also from the nursery manager's supervisors and park management.

Considerations

If you are contemplating building a nursery to serve park needs, here are a few things to consider. Where will it be located, and how much land will you need? If built within a park, must land be disturbed, or can land be rented for this purpose outside the park? Do you have a reliable cost estimate for the construction of the nursery? Does the park have the expertise to build it or will you have to hire contractors? Do you have access to electricity and large amounts of water suitable for irrigation, and how reliable are these supplies? Does your location have good sun exposure for at least 8-10 hours a day, with a suitable microclimate? Can the nursery be kept secure from theft, vandalism, and herbivory? Do you know how many, what size, and what species of plants will be needed and when? How much flexibility will you have or need? Do you have, or have access to, up-to-date technical knowledge of irrigation and greenhouse management methods? Where will you get supplies? Is knowledgeable assistance available during vacations or emergency situations? How fast can someone respond to a facility maintenance emergency? Is management willing to commit long term to budgets and personnel?

These are important questions that must be answered. For example, at Lake Mead we had no suitable place to build our facility outside the park, so we built it internally. Fortunately, we were able to use the site of an old sewage lagoon, previously disturbed land, which was secure. Unfortunately, we had to run power and water to the site at a cost of approximately $15,000. We considered using treated effluent for our water source, but found it too salty for use on container plants. (We do use it for flood irrigation, however.) We spent $6,000 to surround 2 acres with chain-link fence and quarter-inch wire mesh to exclude animals and provide security, and another $6,000 on irrigation materials. Our greenhouse (only 180 sq ft–fig. 3) was built with volunteer labor and about $200 in materials, but we spent about $3,000 on the office and secure storage building. The 16 ft x 32 ft barn was built by Boy Scouts as an Eagle Scout project, but we provided the foundation at a cost of $2,500. Whenever we used a contractor, if we could get one to come out to the park, we were charged a premium for driving time.

Size

You may not think you want a nursery as large as 2 acres, but consider your plant needs over the next few years. How many 1-, 5-, or 15-gallon plants are you going to need? Are you going to need space for salvaged plants, soil, and equipment storage? What happens to the plants when the project is delayed for a year (or three)? Consider access space, too, and keep in mind that a 15-gallon plant may take two years to grow to size. Or perhaps you will just grow plants in very small containers, to save space. You will need major greenhouse space for that, at a considerable cost over outdoor space. Also, plants in a greenhouse are extremely vulnerable to environmental disturbances. In the desert, a greenhouse without power will soar to over 130°F in a few minutes in the summer, and will drop

Building a nursery to meet the native plant needs of various resource management projects at the park required careful consideration of human and fiscal resources

See "Lake Mead" on page 16

"Lake Mead" continued from page 15

to well below freezing in a few hours in the winter. Higher humidity can allow devastating fungal or insect infestations, but tiny containers and seedbeds need to stay very moist. The longer a plant is in the house, the greater the cost.

You may have the space, the water, the power, the money, the construction capability, the time, and the ambition. But so far we have only discussed the easy stuff, the onetime headaches. Doing your homework, indeed, will prevent some real migraines down the road, but you are still bound to have some problems.

Staffing

Since Lake Mead has such a wide array of plant communities, we often grow plants with variable requirements for water, sunlight, and nutrients. We have containers of different shapes and sizes, different soil mixes, nutrient mixes, and hormone concentrations. There are several stations for irrigation, capable of using one of four different watering schedules, and each using a bewildering array of parts (fig. 4). Even though our nursery is not particularly big or complex, nobody just walks in and understands exactly how we operate. An experienced nursery worker will catch on pretty fast, but everyone else will need a lot of training.

Keep in mind, too, that absences must be covered. As the nursery manager, you are responsible for the care of your plants 24 hours a day, seven days a week. I strongly urge anyone thinking about building and operating a nursery to consider splitting the responsibilities between two people. This does not necessarily mean two full-time staff, but the nursery manager should always have trained staff to fall back on during vacations, other projects, illness, and other emergencies. Someone who knows how to repair a valve or major line break, program the clock, and is familiar with the watering needs of individual plants is invaluable to any nursery. This is most easily accomplished when the backup person is a part of the daily operations and knows the routine.

Figure 4. Raised in a harsh desert environment, plants at the nursery require constant care while the bewildering array of plastic watering lines demands continual vigilance. A power outage, leak, or break in a line could spell disaster for these fragile propugules in a relatively short period of time.

Weighing alternatives

By now you may be reevaluating your notion to start a production nursery. What are the alternatives? Perhaps you could share expenses with a nursery already established in your cluster in exchange for plant material. Among the desert parks of the Pacific-Great Basin Cluster two have production nurseries, one at Lake Mead and the other at Joshua Tree National Park. The Joshua Tree operation is geared toward arid plants such as creosotebush *(Larrea tridentata)* and bursage *(Ambrosia dumosa)*, while the Lake Mead operation can accommodate several thousand riparian plants such as Goodings willow *(Salix gooddingii)* and cottonwood *(Populus fremontii)*. The remaining desert parks in this cluster may take advantage of these facilities when needed. Perhaps you have an agricultural or horticultural college, a Natural Resource Conservation Service facility, or a private production nursery within a reasonable driving distance of your park that would grow materials for you under contract. Be aware, however, that contract growing has certain disadvantages that include inflexibility and lack of knowledge of native plant propagation and maintenance. Many native plants have no established methods for reproduction in a nursery, and trial and error propagation by a contract grower may prove to be very costly. Additionally, many contract nurseries are not oriented toward genetic diversity, preferring to clone plants like factories. But if you require material for one project only, a good contract grower may be just what you need.

Eight years ago, Lake Mead National Recreation Area had no means of addressing its growing need for native plant material. In contrast, during 1999, the park will devote a full-time position to rearing almost 10,000 plants of 30 species for use in five major park projects. Additionally, we will be able to provide material for many smaller landscaping and restoration projects. What began as a way to meet the needs of a road restoration project has lead to an ongoing nursery operation to meet the needs of the park for the long-term supply of genetically diverse, native plant materials. Filling this niche for the park is personally satisfying, as is getting out in the nursery early in the morning, sharing space with birds and the occasional rattlesnake, and caring for the living beings I helped to create. The journey has been a real challenge, but over all, well worth it. PS

Alice Newton is a Resource Management Specialist at Lake Mead National Recreation Area, 601 Nevada Highway, Boulder City, Nevada 89005. She can be reached at 702-293-8977; alice_c._newton@nps.gov.

Figure 1. In 1994, Mount Rainier National Park constructed a "coldframe" to serve several purposes. Its primary function is to provide growing space to "harden off" recent transplants (established in the greenhouse) before moving them outdoors to the lathe house. During winter the space is used for stratifying seeds, mixing media, and washing pots. This spring recently potted heathers (2-3 years old) will be moved here.

The propagation of three greenhouse programs in the Pacific Northwest

By Regina M. Rochefort, Matt Albright, and Pat Milliren

Restoration of human impacts has been an integral part of park management in the Pacific Northwest for over 50 years. Photographs from the archives of Mount Rainier National Park (Washington) illustrate revegetation of damaged areas in the subalpine life zone as early as 1930. In the 1970s, backcountry hiking reached record highs in Olympic and Mount Rainier National Parks, creating the need for many of our current restoration projects.

Small beginnings

In 1970, park volunteers Joe and Margaret Miller began a project in North Cascades National Park (Washington) that provided the catalyst for the complex restoration programs that now exist in North Cascades, Olympic, and Mount Rainier National Parks. The Millers showed that greenhouse propagation of high-elevation, native plants was possible and greenhouse transplants would survive in subalpine environments. In 1989, a regional revegetation committee was established. This committee provides a forum for discussion of field restoration and greenhouse methods. Although the committee meets infrequently, restoration specialists in the three parks talk frequently and try to meet at least once a year.

Currently, all three parks have restoration programs that use both greenhouse plants and on-site techniques such as seeding, layering, and transplanting. Greenhouses in each park were funded by different sources and have different staffing levels. Restoration personnel collaborate on development of greenhouse techniques, monitoring systems, and field guidelines for collection of plant materials. Each park has different specialties: North Cascades opened the door to greenhouse propagation of native species; Olympic made high-volume production of native heathers commonplace; Mount Rainier focused on plant collection guidelines and diversity in species production. Recently, we have collaborated on a Challenge Cost Share project with Dr. Yan Linart of the University of Colorado. The goal of the project is to develop plant collection guidelines that protect genetic diversity of native species. Field research was conducted on two species common to each park: *Aster alpigenus* and *Carex spectabilis*. Our intent is to develop guidelines that can be extended to other species with similar life history characteristics. Although the mainstay of each program has been high-elevation species, we are all venturing to lower-elevations species. Our reason for writing this article is to let others know the many different routes we have used to fund our programs and continue to manage them. We welcome questions, discussions, or suggestions from others contemplating or managing greenhouse programs.

Complex of North Cascades parks

In 1969, soon after the park was established, Superintendent Roger Contor recognized the problem of existing vegetation damage and the potential for increased damage at subalpine passes within the complex (North Cascades National Park and Ross Lake and Lake Chelan National Recreation Areas). Camping and climbing impacts were apparent at Cascade Pass, which was also an ancient trail used by native people traveling to the "east side" of the state. Other passes would become more vulnerable as State Route 20 was completed providing a route to the east side. In 1969, the superintendent hired Professor Dale Thornburgh, Humboldt State University, to survey bareground impacts at several passes and make restoration recommendations to the park (Thornburg 1970). Subsequently, longtime park advocates Joe and Margaret Miller volunteered to begin on-site rehabilitation experiments at Cascade Pass. After spending a couple of summers in the field, the Miller's started propagating native plants in their home greenhouse. By 1975, they convinced the park to build a small cold frame (48 sq ft).

See "Northwest" on page 18

"Northwest" continued from page 17

In 1976, Park Ranger Bill Lester, with the Miller's help and labor from the Young Adult Conservation Corps built the park's first small greenhouse (800 sq ft) in the town of Marblemount. Lester and numerous Native Plant Society and other volunteers donated many hours of greenhouse propagation time in addition to field planting time in an effort to restore the documented impacts at Cascade Pass and other backcountry sites. Around 1990, Lester was able to supplement the greenhouse budget by obtaining a contract to grow low-elevation native plants for landscaping the site of the park's new visitor center in Newhalem.

Figure 2 (above). Affording some protection from the elements, the Mount Rainier lathe house exposes seedlings to colder temperatures than they experienced in either the greenhouse or the cold frame. Plants thus accumulate carbohydrates (i.e., "harden off") and become better able to withstand adverse environmental conditions.
Figure 3 (right). A donation enabled Mount Rainier to build this 18,000 sq. ft. greenhouse in 1995. Native plants make their start in this temperature controlled facility, which also includes plumbing and benches.

In 1990, Lester and Resource Management Specialist Jon Jarvis obtained an NRPP (Natural Resources Preservation Program) grant to build a larger, more modern greenhouse for propagation. The new greenhouse is adjacent to the ranger station/wilderness information center so that visitors seeking information and backcountry permits can see the greenhouse and learn about the restoration program. The new greenhouse was dedicated to the Millers in 1993. It encompasses 1,728 sq ft and cost $62,000 to construct; construction of outdoor beds, work areas, and shaded space was completed in 1998 with financial support from Seattle City Light mitigation funds. The funds are set aside for erosion control projects around Ross Lake NRA.

Currently, the North Cascades revegetation program is supported by a ranger (Pat Milliren) in the wilderness district. Pat's position is a nine-month subject-to-furlough position; she supervises the greenhouse/wilderness revegetation program. A 12-week Student Conservation Association (SCA) volunteer position is dedicated to the program, and critical assistance is received from Washington Native Plant Society, the Mountaineers organization, and other volunteers. Most plants are grown for impacted sites in the subalpine zone (5,000-6,500 ft elevation). Annual greenhouse production rates are currently 1,000 plants per year. Species grown include woody heather shrubs *(Phyllodoce empetriformis, P. glanduliflora, Cassiope mertensiana)*, grasses, and sedges *(Carex sp., Phleum alpinum, Trisetum)*, and herbs *(Antennaria sp. and Potentilla)*. While wilderness restoration focuses on subalpine sites, the greenhouse will continue to produce plants for lower elevation sites for specific projects in developed zones.

Mount Rainier National Park

Mount Rainier's greenhouse program began in 1972 with the construction of a 240 sq. ft. greenhouse at park headquarters in Ashford (about 1,500 ft elevation). This greenhouse was used only sporadically until the park established a botanist position in 1984. When the first author of this article arrived at Mount Rainier, Superintendent William Briggle and Assistant Superintendent Robert Dunnagan stated that one of their goals was a park-wide restoration program that included an active greenhouse propagation program. With advice from the North Cascades staff, the greenhouse program was initiated in 1984 with production of 2,700 plants in 1985.

Over the past 12 years, greenhouse staffing, budget, and structures have slowly increased. Our first expansion was to obtain an SCA to staff the greenhouse for 12 weeks each summer. Gradually, shade houses and small coldframes were built with leftover PVC pipes, lumber, and pallets from other projects. We built lathe houses to protect and harden-off plants during the summer before they were transplanted in restoration sites. Plant production increased each year until 1988 when 10,000 plants were produced. In 1990, production increased to 16,000 plants when funding was available to support a year-round seasonal biological technician (Davis 1991; Rochefort and Gibbons 1992). In 1994, a 20 ft x 48 ft coldframe (fig. 1, page 17; cost $2,000) was constructed for propagation of heathers (*Phyllodoce glanduliflora, P. empetriformis,* and *Cassiope mertensiana*) and other shrubs that required two years in the greenhouse. The lathe house (fig. 2) was slowly expanded to cover 3,456 sq ft. In 1993, funding allowed for a permanent horticulturist position (GS-437-07) through the servicewide resource professionalism initiative. Ann Bell was the park's first horticulturist, and under her direction plant production increased from 20,000 plants in 1994 to 40,000 plants in 1996. Additionally, we received a private donation for $17,000 that the park was able to match to build an 18,000 sq. ft. greenhouse (fig. 3) in 1995 (total cost $38,000

for materials and construction including benches, electricity, and plumbing).

Currently, Mount Rainier grows about 20 species each year from a palette of about 50 plant species including shrubs such as heathers and huckleberry *(Vaccinium deliciosum)*, sedges (*Carex* spp.), grasses, and flowers (e.g., *Aster* spp., *Potentilla flabellifolia, Erigeron peregrinus*). Most of our restoration sites are in subalpine areas at elevations of 5,000-7,200 ft where we use species that are easily grown from seed or soft wood cuttings. Recently, we have started growing plants for restoration projects in the low-elevation developed zone; project funding covers propagation costs of $1-$3 per plant. The annual budget for the greenhouse fluctuates with funding levels between $6,000 and $15,000 (park base) in addition to the horticulturist's salary. The greenhouse staff includes one SCA, volunteers, and often a GS-05 seasonal biological technician. Most of our seeds for greenhouse propagation are collected by volunteers from the Olympia Native Plant Society. With the construction of a new greenhouse, we have increased annual production to 70,000 plants and developed a cadre of greenhouse volunteers under the direction of Horticulturist David Palumbo.

Olympic National Park

Backcountry revegetation for the restoration of eroded and trampled sites in wilderness is not new to Olympic National Park. Through the late 1970s and early 1980s revegetation was carried out at a number of popular wilderness camping areas throughout the park. In those days we used local transplants for spot planting in impacted areas to restore local plant communities. Although current projects rely more on greenhouse plants than local transplants, revegetation with plant material collected at the site has always been an important component of Olympic's restoration program.

During 1987, the park constructed a greenhouse for the production of road-edge plants for a federal highways project along the Sol Duc road. This began a new approach in restoration at the park concurrent with greenhouse propagation programs at North Cascades and Mount Rainier National Parks. Seedlings and rooted cuttings were propagated from plant material collected from precisely defined plant communities occurring along the Sol Duc road corridor. This program enhanced existing contracts with private growers and seed programs with the former Soil Conservation Service (now the Natural Resource Conservation Service). The greenhouse is 20 ft x 40 ft and was constructed by park carpenters during the winter. Total cost for the greenhouse is estimated at $22,000-$25,000; $13,000 for materials and the remainder for labor by park carpenters. Funding was provided by park base and project funding. The success of the Sol Duc restoration program demonstrated that the park greenhouse could provide the quantity of transplants needed for large-scale revegetation projects.

In 1988, with the completion of the Sol Duc Road project, Ruth Scott, Wilderness Resource Specialist, adopted the park greenhouse facility to reestablish a wilderness restoration program in montane and subalpine areas of the park. Beginning with easy-to-propagate species such as sedges, grasses, and forbs, greenhouse manager Matt Albright then expanded the program to include the more difficult to propagate ericaceous shrubs. After initial experimentation with two subalpine heathers, Phyllodoce empetriformis and Cassiope mertensiana, production methods from cuttings and seeds were developed for a number of highcountry ericads. Since 1991, these ericad species have comprised an increasingly large proportion of greenhouse plant production.

For several years, the greenhouse staff has maintained an annual production level of 20,000-30,000 transplants of a wide range of species including ericads, subalpine shrubs, trees, forbs, grasses, and sedges. With the initiation of the Sand Point Restoration Project along the park's wilderness coast, the greenhouse has started producing low-elevation coastal species. In the fall of 1996, 14,000 starts of lowland shrubs, sedges, and grasses were planted in the Pacific maritime spruce forest. An additional 35,000 transplants were propagated for spring and fall planting in 1997. The greenhouse is maintained by one permanent, subject-to-furlough horticulturist and one half-time employee assisted by a cadre of local and seasonal volunteers. The staff follows an annual cycle of fall cutting propagation, winter seed processing and sowing, spring and summer transplanting and fall out-planting. The single most expensive and labor intensive task in the revegetation is packing thousands of potted plants and providing for their transport to backcountry destinations via helicopter. In addition to base funds, the wilderness restoration program has been supported by grant funds such as the Canon USA-National Park Foundation "Expedition into the Parks" conservation program and the Washington State Nonhighway Off-road Vehicle Access Program, and volunteers from organizations such as the local Sierra Club Service and Wilderness Volunteers.

Summary

Greenhouse propagation of native plants has been an important and integral part of restoration programs at Mount Rainier, North Cascades, and Olympic National Parks for over a decade. Due to the number and magnitude of human impacts in our wilderness and natural areas and our short growing seasons greenhouse propagation is a necessity for effective revegetation of denuded sites. Although our programs have many similarities, funding sources, staffing, and production levels vary among programs and between years. We would like to offer our assistance and experience to anyone trying to start a greenhouse propagation program. PS

References Cited

Davis, C. A. 1991. Greenhouse manual: Mount Rainier National Park. Mount Rainier National Park. In-park report.

Rochefort, R. M., and S. T. Gibbons. 1992. Mending the meadow: High-altitude restoration in Mount Rainier National Park. Restoration and Management Notes 10(2):120-26.

Thornburg, D. 1970. Survey of recreational impact and management recommendations for the subalpine vegetation communities at Cascade Pass, North Cascade National Park. Unpublished report prepared for the National Park Service. Sedro Woolly, Washington.

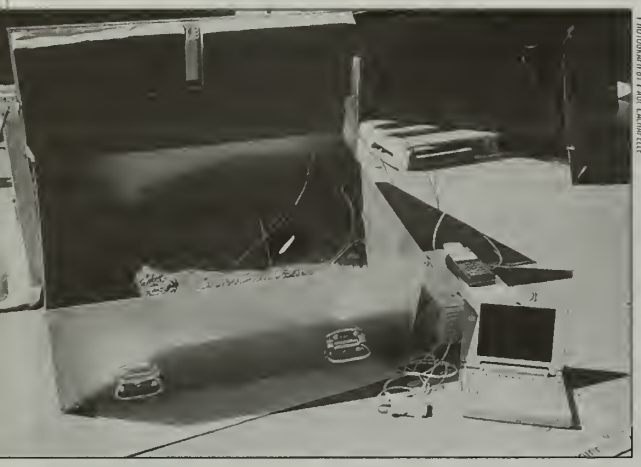
Regina M. Rochefort is currently Science Advisor at North Cascades National Park Service Complex and can be reached at 360-856-5700, ext. 254; regina_rochefort@nps.gov. *Her former position was Botanist at Mount Rainier National Park where she was responsible for managing the park restoration program.*

Matt Albright is the Greenhouse Manager at Olympic National Park. He can be reached at 360-452-4501, ext. 286; OLYM_reveg_crew@nps.gov.

Pat Milliren is a Park Ranger responsible for greenhouse management at North Cascades National Park complex. She can be reached at 360-873- 4590, ext. 36; pat_milliren@nps.gov.

"Hot Box" continued from cover

Now the pasteurized end-product is surface-applied out of the park in local flower gardens near the park headquarters in El Portal.



PHOTOGRAPH BY PAUL LACHAPELLE

gure 3. Two time-temperoture data loggers were used to record and mpare temperatures within the Hot Box. Temperoture probes were serted into vorious sections of the compost pile through o smoll hole the bock of the Hot Box. A loptop computer wos used to downlood ond splay the data from the data loggers.

Background

The development of backcountry composting toilet methods resulted from the need to reduce impacts including surface water pollution at overnight sites. Research of backcountry composting systems began in the mid-1970s and focused on sites with up to 2,000 overnight visitors per season (Fay and Walke 1977; Ely and Spencer 1978). Composting technologies became increasingly popular as research documented the ineffective breakdown of coliform bacteria using the "cat-hole" disposal technique (Temple et al. 1982) and as certain composting toilet technologies were shown to be a low-cost and effective solution to human waste treatment and disposal (Leonard and Fay 1979; Leonard and Plumley 1979). Thermophilic composting (also termed "batch" or "bin") and mesophilic composting (also termed "moldering" or "continuous") have been used with varying degrees of success in numerous national parks (Yosemite, Mt. Rainier, Olympic, Grand Canyon) and national forests (White Mountain, Green Mountain).

The aim of any composting technology is to optimize conditions for microbial growth. Combining the proper amount of carbon (also termed "bulking agent" and usually consisting of wood chips or shavings), moisture, ambient heat, and oxygen enhances the living conditions within the compost pile for natural oxygen-using microorganisms (aerobes). These aerobes use human waste as a food source, and consequently, the waste decomposes over time into a soil-like substance. Disease causing organisms (pathogens) within the human waste are reduced or eliminated due to competition, natural antibiotics, nutrient loss, and heat. The human waste and the carbon are in most cases manually mixed in an enclosure or sealed bin. The term end-product refers to the composted wood chips and human waste. The composting process functions optimally with a carbon to nitrogen ratio of 25-35:1 and a moisture content of 60% (Davis and Neubauer 1995). The aim of thermophilic composting, which requires frequent mixing and high wood-chip input (approximately 1 kg [2.2 lb] of carbon to 1 liter [~1 qt] of human waste), is to kill pathogens quickly and with hot temperatures. These temperatures result from microbial activity and can exceed 45°C (113°F). Once a sufficient amount of human waste has been collected, a compost "run" is started and can take up to several weeks to complete. Mesophilic composting in comparison is a long-term method that can take years to effectively reduce pathogens within the waste. This method differs from thermophilic composting because the frequency of mixing and the amount of carbon added are considerably lower with temperatures within the waste pile ranging from 10°- 45°C (50°-113°F).

Complete pasteurization of composting toilet end-product by either treatment method, however, can never be guaranteed and depends on the quality of field staff maintenance and site conditions. Heat treatment, such as the Hot Box can provide, is one method to ensure pathogen reduction and meet 40 CFR Part 503. Consequently, the Hot Box can help in a number of ways. First, if land management policy dictates that the end-product can be surface-applied at the backcountry toilet site, significant savings in transportation costs could result. Additionally, the biophysical and social impacts from using either pack animals or helicopter resources could be reduced. Second, while land management policy may dictate that the end-product be transported outside of a protected area boundary, heat-treated compost is less of a health and safety issue to field staff. End-product that is heat-treated in the backcountry would be a considerably lower health hazard to field staff regarding accidental spillage during transport or disposal. Since, for example, a fundamental tenet of the Wilderness Act states that the wilderness area be "protected and managed so as to preserve its natural conditions" (Wilderness Act of 1964, Sec 2c), surface-applied compost in these areas could be problematic. Unquestionably, increased nutrient levels resulting from on-site disposal could upset natural species assemblages by shifting the competitive advantage to invasive nonnative plant species; however, in areas with less stringent land policies, surface application of treated composting toilet end-product could be appropriate. For instance, there are several national forests where both mesophilic and thermophilic composting toilet end-product has been approved for on-site disposal. Nevertheless, state laws may be more restrictive than federal policies and therefore the land manager should review all applicable regulations. Third, if the end-product cannot be surface-applied at the site and the Hot Box cannot be used in the field because of staffing or ordinance issues, landfill disposal savings could result. Lastly, the treated end-product could be reintroduced into the composting toilets as bulking agent, which would reduce the amount of additional bulking agent needed.

Hot Box description and application

The Hot Box is a nearly airtight container that allows solar shortwave radiation or light energy to pass through the glazing (see fig. 2, page 1). The contents of the Hot Box absorb the light energy and convert it to long-wave radiation or heat energy, which becomes trapped inside the box. The 1996 USFS/NPS study demonstrated that temperatures of over 100°C (212°F) can be achieved and temperatures of 88°C (190°F) can be sustained for several hours.

The outside walls, floor, and removable tray are fabricated from an approximately 0.5-cm thick (0.2 in) aluminum sheet. A single transparent Lexan® Thermoclear polycarbonate sheet is used as the solar

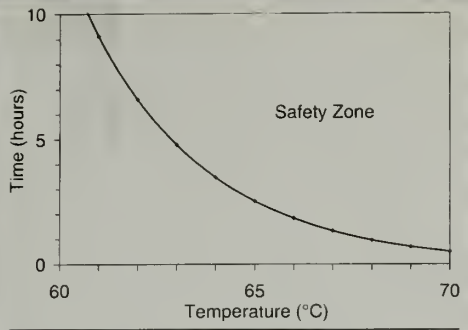


Figure 4. U.S. Environmental Protection Agency 40 Code of Federal Regulations (CFR) Part 503 time-temperature relationship for the heat-treatment of sewage sludge.

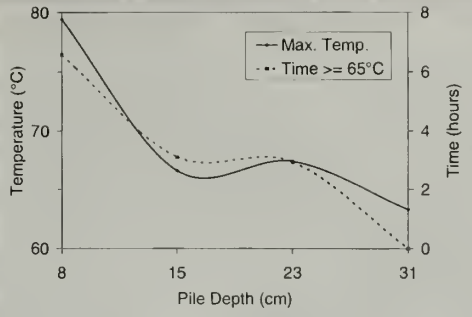


Figure 5. Comparisons are made between pile depths, the maximum temperature attained and the duration in hours at or above 65°C. Moisture content of the compost pile is equal (33.5%). Temperature readings are taken from the middle of the compost pile.

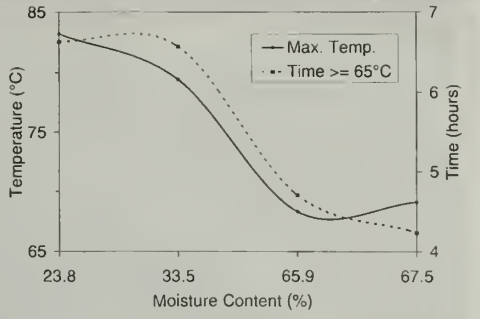


Figure 6. Comparisons are made between percentages of moisture content, the maximum temperature attained, and the duration in hours at or above 65°C. All pile depths are equal (8 cm). Temperature readings are taken from the middle of the compost pile.

glazing and is bolted at an angle specifically designed to maximize the angle of incidence during the summer solstice for the chosen latitude (at Yosemite, 38° N, a 15-degree angle was chosen). This angle could be adjusted for other locations. The inside walls and floor are insulated with 5-cm (2-in) polyisocyanurate closed-cell foam. A door is positioned at the back of the Hot Box in order to gain access to the tray. The original Hot Box measured 122 cm x 94 cm x 69 cm (48.1 in x 37 in x 27.2 in) at the highest end and 46 cm (18.1 in) at the lowest end. Four new Hot Boxes, measuring 122 cm x 122 cm x 61 cm (48.1 in x 48.1 in x 24 in) at the highest end and 20 cm (7.9 in) at the lowest end, have recently been built and appear to be more efficient because of their larger glazing and decreased internal air volumes.

Yosemite field staff operated the Hot Box during the 1997 and 1998 summer seasons at the park headquarters in El Portal, which is outside the park. Yosemite contains six backcountry composting toilets that collectively produce approximately 20 m^3 (700 ft^3) of end-product per year. Traditionally the end-product has been transported outside the park boundary.

End-product is transported in double plastic bags by pack animals to trailheads and then trucked to El Portal. Approximately 9 m^3 (300 ft^3) were pasteurized in 1998. Field staff emptied a portion of the bags into the Hot Box tray and allowed the compost to pasteurize for up to one week. One operator required one-half hour per day, two days per week, to perform this task. The 1996 USFS/NPS study concluded that pile depths of 12 cm (4.7 in) or less and two and one-half hours of direct sunlight with ambient air temperatures exceeding 28°C (83°F) were most effective at meeting the time-temperature requirement (fig. 5). Additionally, a moisture content of 60% or less allowed for maximum temperature attainment (fig. 6). Field staff would mix the end-product in the Hot Box tray several times during the heat-treatment process to ensure thorough pasteurization. After pasteurization, the finished compost was again bagged and brought to local flower gardens and spread thinly on the surface. Operators reported that the pasteurized compost resembled mulch and not human waste in both texture and odor, and was therefore more tolerable to work with.

Conclusion

The passive solar Hot Box has been used for two field seasons in Yosemite National Park, a location that is shown to be ideal to effectively pasteurize the compost from backcountry toilets. This application stems from the 1996 USFS/NPS study that demonstrated the use of the Hot Box as an effective method of pasteurizing the end-product from composting toilets. Field staff report that the developed Hot Box technology requires a minimum level of attention and maintenance by the operator and produced a compost that is dryer and appears less offensive to handle and transport.

While stringent regulations may negate the possibility that finished compost be surface-applied in wilderness and national park areas, the Hot Box holds tremendous potential to save either transportation costs and associated impacts in areas where the end-product can be surface-applied on-site, or disposal costs where the end-product must be transported and disposed off-site. This passive technology can serve as a sound and sustainable backcountry management technique, alleviating impacts, costs, and extensive use of human and animal resources, while providing an added safety margin to field personnel. PS

Literature Cited

Cook, B. 1981. Field evaluation of composting toilets. Pages 83-98 *in* N. I. McClelland and J. L. Evans, editors. Individual on-site wastewater systems: proceedings of the seventh national conference. National Sanitation Foundation, Ann Arbor, Michigan.

Davis, B., and P. Neubauer. 1995. Manual for bin composting and waste management in remote recreation areas. (4th ed.) Green Mountain Club, Waterbury Center, Vermont.

Ely, J., and E. Spencer. 1978. The composting alternative: waste disposal in remote locations. Appalachian Mountain Club, Gorham, New Hampshire.

Fay, S., and R. Walke. 1977. The composting option for human waste disposal in the backcountry. (Forest Service Research Note NE-246). USDA Forest Service Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

Jensen, M. E. 1985. National Park Service remote area toilet facilities: experiences and observations 1983 and 1984. (NPS Report No. 85-01-NPS/ESSD). Environmental Sanitation Program, National Park Service, Washington, D.C.

Lachapelle, P. R., B. Land, and J. C. Clark. 1997. The problem of human waste disposal in national parks: a solar energy experiment in Yosemite National Park, California, U.S.A. Mountain Research and Development 17(2):177-80.

Land, B. 1995a. Composting toilet systems: planning, design, and maintenance. (USFS Technical Report No. SDTDC 9523-1803). USDA Forest Service, Technology and Development Program, San Dimas, California.

See "Hot Box" in right column on page 24

PHOTO BY KATHIE MEYER

Figure 1. Desert tortoises, represented by this mole photographed in Joshuo Tree Notionol Pork, hove the greotest lotitudinol distribution of ony of the four North Americon tortoises ronging from southwestern Utoh to northern Sinoloo Stote in Mexico, o ronge of 1,100 km (683 mi). Across this vost ronge, the desert tortoise occupies o stoggering diversity of plont communities from tropicol deciduous thorn scrub in Mexico, ocross the Mojove ond Sonoron Deserts, to the edge of the Greot Bosin Desert ond the Colorodo Ploteou.

Studies of reproductive output of the desert tortoise at Joshua Tree National Park, the Mojave National Preserve, and comparative sites

By Jeff Lovich[1], Phil Medica[2], Hal Avery[1], Katherin Meyer[1], Gillian Bowser[3], and Alan Brown[2]

The stability of any population is a function of how many young are produced and how many survive to reproduce. Populations with low reproductive output and high mortality will decline until such time as deaths and births are at least balanced. Monitoring populations of sensitive species is particularly important to ensure that conditions do not favor decline or extinction.

Turtles, including tortoises, are characterized by life history traits that make them slow to adapt to rapid changes in mortality and habitat alteration. Long life spans (in excess of 50 years), late maturity, and widely variable nest success are traits that allowed turtles to outlive the dinosaurs, but they are poorly adapted for life in the rapidly changing modern world. Increased mortality of young and adults can seriously tip the delicate balance required for turtles to survive.

The desert tortoise

The desert tortoise (fig. 1) is a federally threatened species to the north and west of the Colorado River with full protection under the Endangered Species Act (Ernst et al. 1994). The listing of the tortoise in 1990 was based on the perception of rapid population declines due largely to human-induced changes in the Mojave Desert ecosystem (Fish and Wildlife Service 1994; Lovich and Bainbridge, in press). The Recovery Plan for the desert tortoise, prepared by the U.S. Fish and Wildlife Service, identifies research on the reproductive output of the species to be a high priority for land management agencies tasked with the responsibility of recovery, and we hope, future delisting. To that end, in 1997 we initiated research on the reproductive output of the desert tortoise at several study sites in the Mojave Desert. Research support has been generously provided by the U.S. Geological Survey, Joshua Tree National Park, the California Desert District of the Bureau of Land Management, the Palm Springs-South Coast Resource Area of the Bureau of Land Management, Banning Veterinary Hospital in Banning, California, University Orthopedics, in Las Vegas, Nevada, and J. F. Kennedy Memorial Hospital in Indio, California.

Previous research on reproductive output of desert tortoises conducted by Fred Turner, Phil Medica, and others in the early 1980s demonstrated a strong correlation between clutch frequency, or how many clutches a female produces in one reproductive season, and biomass of annual plants that tortoises utilize for food. Production of annual plant biomass is in turn related to the timing and quantity of rainfall. One of our goals is to obtain more detailed data on the relationships between rainfall, annual plant biomass, and various measures of tortoise reproductive output. The information generated will provide resource managers with models relating reproductive output of tortoises to easily measured environmental variables. Such data are especially important in areas where tortoises and livestock may compete for resources such as food plants.

Study sites

The three study sites established in the spring of 1997 included Joshua Tree National Park, the Mojave National Preserve, and another in an area administered by the Bureau of Land Management (BLM) near Palm Springs, California. Two additional sites were added in the spring of 1998: one in Piute Valley, Nevada, and one in St. George, Utah, both on lands administered by the Bureau of Land Management. Studies in Utah are being conducted in cooperation with U.S. Geological Survey Research Biologists Todd Esque and Dustin Haines. The sites in the Mojave National Preserve and near Palm Springs are located in active cattle grazing allotments.

Methods

Thirty-six female tortoises were equipped with radio transmitters in 1997 (fig. 2), located at weekly or biweekly intervals April-July, and x-rayed (fig. 3) to determine the presence of shelled eggs. The x-ray procedure exposes tortoise embryos to radiation

[1] U.S. Geological Survey, Canyon Crest Field Station, Department of Biology, University of California, Riverside, CA 92521-0427.
[2] U.S. Geological Survey, Las Vegas Field Station, 4765 West Vegas Drive, Las Vegas, NV 89108.
[3] Joshua Tree National Park, 74485 National Park Drive, Twentynine Palms, CA 92277.

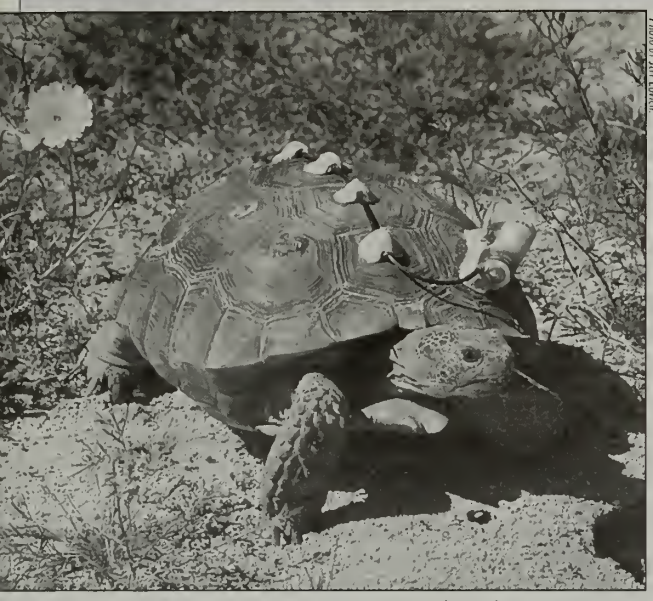


Photo by Jeff Lovich

Figure 2. Research bialagists use many toals to callect data. Desert tartaises, like this femole photagraphed in Jashua Tree Natianal Park, are frequently equipped with radia transmitters far projects that require trocking ond relocotion of individual animals. Valuable data an movements, home range and ather behaviars are obtained fram studies using this technalagy.

doses much lower than internationally accepted levels established for developing human embryos (Hinton et al. 1997). Studies in the Mojave National Preserve were complemented with the use of ultrasound technology to determine the presence and size of follicles (eggs) prior to their detectability using x-radiography.

Results

At the Palm Springs site, 9 out of 10 females produced a total of 72 eggs in the 1997 reproductive season (one produced no eggs). Of these nine females, six produced second clutches and at least one produced a third clutch. Mean size of first and second clutches was 4.33 and 5.00 eggs, respectively. The earliest date of egg laying occurred April 18-23, about one month earlier than previously reported in the literature. In contrast, at sites nearby in Joshua Tree National Park, only one of eight females produced a clutch (five eggs), and she occupied the wettest microhabitat sampled that year. Most of the other monitored tortoises in the park occupied areas that were in the second year of drought with little or no production of annual food plants. Modest germination at the Mojave National Preserve allowed 12 of 18 monitored tortoises to produce single clutches (there were no subsequent clutches) in 1997. Differences among sites appear to be related to patterns of rainfall and annual biomass production, as expected.

Of particular interest is the fact that the average annual number of eggs produced per female at the Palm Springs site was more than double (8) that of tortoises at Mojave National Preserve (3.58). Such wide variation in annual reproductive output should be accounted for in any future population viability analyses for the species. Our results for 1997 have another aspect worth noting in that they underscore the fact that even well-protected natural areas like parks and preserves cannot protect sensitive species from the vagaries of climate variation. In this case, tortoises at a relatively wet and productive industrial site produced far more eggs than tortoises in fully protected, but drought-stricken, areas.

The results for 1998, an El Niño year, were remarkably different. At Palm Springs, 12 of 13 tortoises laid eggs and all 12 that produced eggs laid second clutches; about one-third produced triple clutches. Of interest is the fact that mean first and second clutch sizes did not differ from a statistical standpoint between 1997 and 1998 at Palm Springs. At Joshua Tree National Park, seven out of seven females laid eggs, and five produced second clutches. These differences with 1997 data seem to reflect the wet and highly productive conditions fostered by El Niño's rains. Rain that fell in late summer and early fall gave tortoises an opportunity to drink and feed on "summer" annuals prior to hibernation. Upon emergence from hibernation they were presented with a veritable cornucopia of winter annual food plants that germinated as a result of continued El Niño rains (fig. 4, page 24). Thus, to date our studies suggest that in years when tortoises have an abundance of food plants, more tortoises may reproduce and produce more clutches, but that they produce a relatively constant clutch size, regardless of conditions.

Photo by Jeff Lovich

Figure 3. This x-radiagraph af a desert tartaise callected near Palm Springs (Califarnia) an 20 May 1997 cleorly shaws the autlines af eight shelled eggs. Femoles retain shelled eggs for 3-6 weeks prior to depasiting them in nests. Nests are aften canstructed in the mauth af a tartaise

Future plans

The study will continue through the 1999 reproductive season at all five sites and through the 2000 season at Joshua Tree National Park and the site near Palm Springs. The data generated will provide natural resource managers with locally and regionally specific information on reproductive output of this threatened species and its relationship to environmental determinants such as rainfall and annual plant biomass production. Ultimately, these data can be used to build more accurate demographic models to better understand the recovery potential of desert tortoises. PS

Literature cited

Ernst, C. H., J. E. Lavich, ond R. W. Borbour. 1994. Turtles af the United States and Conoda. Smithsonian Institution Press, Washington, D.C. 578 pp.

Fish ond Wildlife Service. 1994. Desert tortoise (Majave populotion) recovery plan. U.S. Fish ond Wildlife Service, Portland, Oregon. 73 pp. + appendixes.

Hinton, T. G., P. Fledderman, J. Lavich, J. Congdon, and J. W. Gibbons. 1997. Radiographic determinatian af fecundity: is the technique safe for developing turtle embryas? Chelonian Conservatian and Bialagy 2:409-14.

Lovich, J. E. and D. Boinbridge. In press. Anthropagenic degradotion of the southern California desert ecasystem and praspects for naturol recovery and restaration: A review. Environmental Management.

See "Tortoise" on page 24

"Tortoise" continued from page 23

Jeff Lovich is a Research Manager with the USGS Biological Resources Division, Western Ecological Research Center, and Station Leader of the Canyon Crest Field Station located at the University of California, Riverside. He has been studying turtles for 20 years and desert tortoises since 1991. He received his Ph.D. in ecology from the University of Georgia in 1990. Additional information on the desert tortoise can be found by visiting his Web site at www.werc.usgs.gov/cc/lovich.htm. *He can reached at* jeffrey_lovich@usgs.gov.

Kathie Meyer is a Wildlife Biologist at the Canyon Crest Field Station of USGS. She received a B.S. Degree in wildlife biology, from Humboldt State University in Arcata, California in 1995. She has worked with a variety of desert species including bighorn sheep, western pond turtles, and desert tortoises.

Gillian Bowser is an Ecologist with the National Park Service at Joshua Tree National Park. She received her Ph.D. from the University of Missouri at St. Louis in 1998. She has worked with the National Park Service since 1980 on insects, small mammals, and large herbivores. She has worked at Joshua Tree for two years and is currently leading Earthwatch volunteers in an effort to monitor desert tortoise populations in the park. Her e-mail address is gillian_bowser@nps.gov.

Alan Brown was a Wildlife Technician with the USGS Biological Resources Division at the Las Vegas Field Station, Las Vegas, Nevada. He assisted with desert tortoise density estimation studies conducted throughout the Mojave Desert (including the Mojave Preserve) between 1994 and 1997 as part of the Desert Tortoise Research Project, and participated in the desert tortoise reproduction study in the Mojave Preserve in 1997. He is completing his B.S. Degree in wildlife biology at the University of Montana, Missoula, Montana.

Phil Medica is a Research Wildlife Biologist with the USGS Biological Resources Division, and Station Leader of the Las Vegas Field Station, Las Vegas, Nevada. He has studied reptilian ecology for the past 30 years throughout the Southwest, the growth of desert tortoises at Rock Valley on the Nevada Test Site since 1967, and tortoise populations in southern Nevada on BLM lands for the past 10 years. He received a B.S. Degree in Wildlife Management in 1964, and an M.S. Degree in Biology (herpetology) in 1966 from New Mexico State University.

Hal Avery is a Research Wildlife Biologist at the Canyon Crest Field Station of USGS and has studied the reproductive biology of turtles since 1985. He has conducted research related to desert tortoise ecology and conservation since 1990 and is currently conducting research on ecosystem ecology in the Mojave Desert. He received his Ph.D. from the University of California, Los Angeles in 1998.

Photo by Kathie Meyer

Figure 4. In the spatially and temporally variable environment of the desert, resources such as rain and the annual plants that germinate in response to precipitation fluctuate widely. This photograph, taken in Joshua Tree National Park, shows how abundant annual plants can be in some years. In other years or places germination may be sparse or absent. Animals like the desert tortoise need strategies to cope with these large variations in productivity.

"Hot Box" continued from page 21

Land, B. 1995b. Remote waste management. (USFS Technical Repart Na. SDTDC 9523-1202). USDA Farest Service, Technalagy and Develapment Pragram, San Dimas, Califarnia.

Leanard, R. E., and S. Fay. 1979. Campasting privy wastes at recreatian sites. Compost Science/ Land Utilizatian 20(1):36-39.

Leonard, R. E., and H. Plumley. 1979. Human waste dispasal in eastern backcauntry. Jaurnal of Farestry 77(5):349-52.

Leonard, R. E., E. L. Spencer, and H. J. Plumley. 1981. Backcountry facilities: design and maintenonce. Appalachian Mauntain Club, Baston, Massachusetts.

McDanald, J., R. Stanley, and D. McCauley. 1987. Maunt Whitney salar toilet. USDA Farest Service Engineering Field Nates 19:13-19.

Maunt Rainier National Park. 1993. Backcauntry toilet technology workshop. USDI National Park Service, Mount Rainier Notionol Park, Ashford, Washingtan.

Temple, K., A. Camper, and R. Lucas. 1982. Patential health hazards fram human wastes in wilderness. Journal af Sail and Water Canservatian 37(6):357-59.

Voorhees, P., and E. Waadfard. 1998. NPS and the $300,000 privy: a parable far management. The Gearge Wright Farum 15(1):63-67.

Weisberg, S. 1988. Composting optians far wilderness monogement of human waste. Skagit District, Narth Cascades Natianal Park. USDI National Park Service, Sedra Waaley, Washingtan.

Wilderness Act of 1964. Pub. L. Na. 88-577. 16 U.S.C. § 1131-36.

Yosemite Notionol Park. 1994. Backcauntry human waste management: a guidance manual far public composting toilet facilities. USDI Natianal Park Service, Yasemite Natianal Park, El Partal, Califarnia.

Paul Lachapelle is a Research Assistant at the University of Montana. He can be reached at School of Forestry, SC 460, University of Montana, Missoula, MT 59812; 406-243-6657; Fax: 406-243-6656; paullach@selway.umt.edu.

John C. Clark is Facility Management Specialist at Yosemite National Park. He can be reached at El Portal, California 95318; 209-379-1039; Fax: 209-379-1037; john_c._clark@nps.gov.

Dwarf Shrew found in Rocky Mountain National Park

By Erin Muths

The dwarf shrew *(Sorex nanus)* is one of the smallest mammals in the world and is the smallest mammal in the southern Rocky Mountains (Armstrong 1987; Fitzgerald et. al 1994). Rocky Mountain National Park (Colorado) currently has no information of the dwarf shrew occurring in the park although Estes Park is the type locality (Armstrong 1987) for this species. The holotype was collected by E. A. Preble in 1895 at "Estes Park" and could easily have been taken at a location now within the park boundaries. Additionally, shrews have recently been suggested as potential bioindicators of environmental change and degradation by researchers at the University of Toronto (Ray 1998) and may provide important information for resource managers in this regard.

I found a dead dwarf shrew at Lake Husted (UTM zone 13; 448385E, 4484207W; 3,388 m; 11,116 ft) in the northeast corner of Rocky Mountain National Park on 17 July 1997. This specimen represents a new locality for *Sorex nanus* and is the first reported within Rocky Mountain National Park[1] (Jeff Connor, Rocky Mountain National Park, telephone conversation with author, 21 January 1999). Previously, the altitudinal record for *Sorex nanus* was 3,350 m (Hoffman and Pattie 1968; Hoffman, personal communication). This specimen was found 38 m (125 ft) higher, at the edge of Lake Husted in a mossy area surrounded by rocky glacial debris and low-lying juniper shrubs. The specimen was intact except for a small hole in its skull. I measured its total length, tail length, and hind foot length and examined the skull in the laboratory.

The shrew had brown fur dorsally with a lighter underbelly and measured < 90 mm (3.5 in) total length. Its tail was 40 mm (1.6 in), and its hind foot was 12 mm (0.5 in). The carcass weighed approximately 2.5 g (< 0.1 oz) but was considerably decayed when weighed. From these measurements, I determined the specimen to be *Sorex nanus*. The specimen was also examined by D. Armstrong (University of Colorado) and compared to a confirmed *Sorex monticolus* specimen; this shrew was smaller in all dimensions. Based on measurements and direct comparison my identification as *Sorex nanus* was confirmed.

Dwarf shrews are primarily montane in distribution and have been collected from rock slides and spruce-fir bogs (Brown 1967), alpine tundra (Hoffman and Taber 1960; Hoffmann and Pattie 1967), and marsh and forest clear-cut (Spencer and Pettus 1966). Hoffmann and Owen (1980) report an altitudinal range of "at least" 740-3,350 m (2,428-10,991 ft). Although the carcass appeared intact and essentially undisturbed, it is possible that the shrew was carried to the site by a bird and dropped, but this could not be confirmed.

Rocky Mountain National Park has listed the dwarf shrew in its Resource Management Plan (USDI National Park Service 1998), but the project is currently unfunded. When funding is obtained, potential projects might include a simple determination of the abundance and distribution of the dwarf shrew in the park to provide baseline data for monitoring population trends; studies of the habitat requirements of the shrew; studies of predator-prey interactions, and the potential for visitor impacts on the shrew.

As more people travel into the backcountry risks associated with human disturbance clearly increase. Even low volume human activity at higher elevations can have profound effects on the delicate alpine tundra plant communities and may have related effects on small mammals, such as the shrew, which may use these ecosystems exclusively. Shrews exist within very small areas that must sustain them throughout their lives. Even small disturbances of fragile ecosystems have the potential to disrupt individuals and perhaps to disrupt entire populations of shrews.

[1]A dwarf shrew was documented in 1967 for Larimer County, Colorado, just north of the park (Jeff Connor, Rocky Mountain National Park, telephone conversation with author, 21 January 1999).

Acknowledgments

Thanks to Dave Armstrong, University of Colorado, for help with identification; Therese Johnson, Craig Axtell, and Jeff Connor at Rocky Mountain National Park and Steve Corn, USGS Biological Resources Division, for encouragement and support. PS

Literature cited

Armstrong, D. A. 1987. Rocky Mountain mammals, a handbook of mammals of Rocky Mountain National Park and vicinity, Colarada. Revised edition. Colarada Associated University Press, Boulder. 223 pp.

Brown, L. N. 1967. Ecological distribution of six species of shrews and comparison of sampling methods in the central Rocky Mountains. Journal of Mammalogy 48(4):617-23.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado.

Haffmann, R. S. and D. L. Pattie. 1968. A guide to Montana mammals: Identification, habitat, distribution and abundance. University of Montana Print Service, Missoula, Montana. 133 pp.

Haffmann, R. S. and J. G. Owen. 1980. *Sorex tenellus* and *Sorex nonus*. Mammalian Species 131:1-4.

Ray, J. 1998. Shrews may predict environmental degradation. University of Toronto press release, 28 January 1998. Published on-line at *www.eurekalert.org/releases/utc-shmpeodo.html.*

Spencer, A. W. and D. Pettus. 1966. Habitat preferences of five sympatric species of long-tailed shrews. Ecology 47:677-83.

USDI National Park Service. 1998. Resource Management Plan. Rocky Mountain National Park, Estes Park, Colorado. 696 pp.

Erin Muths is a Zoologist with the USGS Biological Resources Division, Midcontinent Ecological Science Center. She made the discovery of the dwarf shrew while working on a project on boreal toads funded partially by Rocky Mountain National Park. She can be reached at 4512 McMurry Ave.; Fort Collins, CO 80524; 970-226-9474; Fax 970-226-9230; erin_muths@usgs.gov.

Fig. 1. Old logging roads, such as this one in Whiskeytown National Recreation Area (California), are the primary source of sediment that washes into rivers and streams, degrading habitat for salmon and steelhead trout. To address the problem, the park and Shasta College teamed up to deploy innovative treatments for the restoration of watersheds and habitat recovery. This road was "outsloped[1]" to reduce erosion and sedimentation.

Cooperative watershed restoration in Whiskeytown National Recreation Area

Innovative partnership provides a model for restoration of a scarred landscape

By John McCullah and Gretchen Ring

Salmonid fisheries continue to decline in the Pacific Northwest. As a result, more populations of salmon and steelhead trout continue to be listed as endangered or threatened. A primary cause of this decline is loss of habitat due to impacts from upland erosion and sedimentation.

In many steep, forested watersheds old logging roads (fig. 1) are the primary source of the sediment that degrades rivers and streams. Roads cause erosion and greatly increase the potential for slope failure during large and episodic storm events. Roads alter the natural drainage patterns, and steeply cut slopes intercept subsurface flows, converting them to surface runoff. Drainage ditches and berms concentrate flows in channels, efficiently delivering sediment to streams. Most importantly, roads are frequently constructed by placing fill material in drainage channels. That fill becomes part of the drainage system and, given enough time, has a high probability of ending up in rivers and streams. Clearly, watershed restoration strategies are needed to deal specifically with road-related erosion and sedimentation.

The Whiskeytown situation

Located 8 miles west of Redding, California, Whiskeytown National Recreation Area primarily occupies the Clear Creek watershed, an important tributary to the Sacramento River. With a history of past logging, this unit of the national park system has experienced many erosion and sedimentation problems. For example, roads were constructed by placing fill in runoff channels, which alters the natural drainage patterns and basin hydrology, and increases the potential for stream diversions and washouts. Poor road drainage and saturated fill can result in severe landslides. Two large debris flows in the park were initiated at the intersection of stream channels and roads during heavy rains in January 1997.

Solutions to these problems require specially trained watershed restorers such as geomorphologists and heavy equipment operators to identify and treat the numerous watersheds impacted by roads. The National Park Service is addressing these issues at Whiskeytown by cooperatively engaging in ecosystem restoration activities and encouraging education and technology transfer related to these experiences.

Cooperative agreement

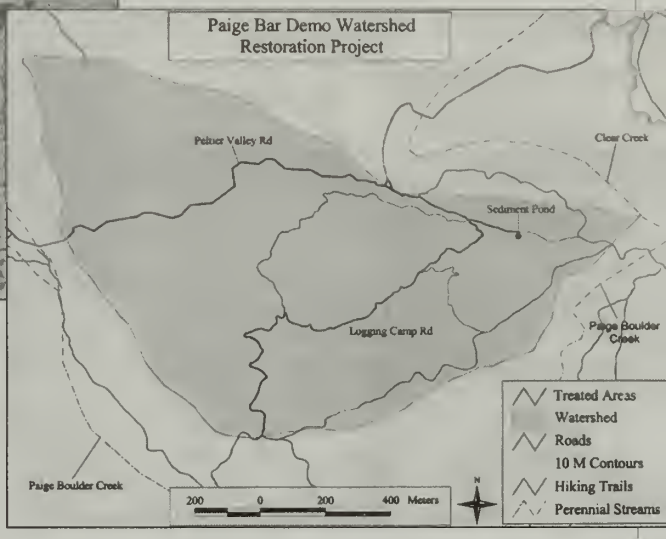
In 1996, Whiskeytown and Shasta College entered into a cooperative agreement that enables them to share resources, including funds, for the completion of mutually beneficial projects, primarily watershed restoration. The cooperative restoration program blends education with technology and encourages adaptive management and the use of innovative techniques to treat habitat degradation in the park caused by old roads. Furthermore, it trains students in restoration ecology, provides a potential employment venue for former timber workers, and improves habitat for salmon populations.

The park serves as a living laboratory in which students conduct actual watershed inventories, develop restoration techniques, engage in monitoring activities, and implement restoration plans. Shasta College provides expertise in various disciplines such as geographic information systems (GIS), watershed restoration, heavy equipment operation, and horticulture; a student workforce performs the work. As part of the agreement, Shasta College developed a watershed restoration class to prepare students for jobs in ecosystem management with practical experience coming from a pilot restoration project at the park. The class emphasizes the geomorphic or landform restoration approach to ecosystem restoration. The pilot sub-watershed restoration project was funded by the Bureau

[1]In hilly terrain, roads typically slope inward toward the hill where a ditch and culvert system drains runoff. As culverts and ditches become plugged, runoff concentrates, drains across the road, and creates gullies. Outsloping reverses drainage to the downhill side of the road. Fill is excavated and placed into the uphill cut, resulting in a 2-5-degree slope to the downhill side. Water runs off without forming gullies and subsequent erosion and sedimentation.

Fig. 2 (left). Heavy equipment is used to treat the drainage problems pased by the ald lagging raads. Here, a culvert is installed to restare natural drainage patterns and reduce erasian af the fill.

Fig. 3 (belaw). The 300-acre Paige-Bar sub-watershed was the site af the demanstratian restaratian project at Whiskeytawn. The project represents a significant start ta the many thausands af acres af Clear Creek watershed in need af restaratian at the natianal recreatian area.



of Reclamation ($40,000) through the Central Valley Improvement Act, and by the National Park Service through a Challenge Cost-Share Grant ($30,000).

Goals and treatment philosophy

The restoration goals for Whiskeytown National Recreation Area include restoring naturally functioning ecosystems by treating and removing scars on the landscape such as roads. Other management tools, such as prescribed fire and exotic plant removal, can then be employed to enhance biodiversity.

Previous restoration work and studies in Redwood National Park (Spreiter 1994) and Grass Valley Creek Watershed (McCullah 1994) indicate that the primary source of erosion and cause of sedimentation of streams is the extensive road network left over from past logging. These projects clearly demonstrate that physical treatments to restore the hydrologic systems, recover soil from stream channels, and remove road scars set the stage for recovery of the biological systems, and these methods are probably the most cost-effective way to prevent erosion and sedimentation, and reduce the maintenance burden.

These physical treatments frequently include the use of heavy equipment such as hydraulic excavators (fig. 2) and bulldozers to repair and restore the drainage patterns that existed before roads were built. A new axiom is emerging among watershed restorers: for cost-effective road restoration, employ the same type and size of equipment that caused the problem. The key to cost-effective sediment reduction, however, is prevention, not treatment of what already happened. Erosion inventories, therefore, must evaluate all existing and potential problems along roads and document the amount of erosion that may potentially occur, particularly at road and stream crossings.

The demonstration project

The 120-ha (300-acre) Paige-Bar sub-watershed (fig. 3) was chosen as the demonstration pilot project. It is located in the lower Clear Creek watershed near the Whiskeytown National Environmental Education Development Camp. Proximity to the camp is significant in that 3,000 fifth and sixth graders visit it every year and see the restoration work that has been accomplished as part of their restoration education. The site was extensively logged in the 1960s and most recently in 1973, just before NPS acquisition of the lands. Approximately 2 km (1.2 mi) of main-use road (Peltier Valley Road) and several kilometers of old haul roads, including the badly eroded Logging Camp Road, exist on the site. These old roads are currently used for recreation, primarily hiking, mountain biking, and horseback riding. Additionally, numerous old landings built in the stream channels are eroding and producing sediment.

Inventory

Before beginning field inventories, students from the Shasta College Watershed Restoration class drew the entire micro-drainage network of the Paige-Bar sub-watershed onto a 7.5-minute topographical map. They also delineated roads and streams on clear mylar, laying it over aerial photos and orthophotos. Both recent and older stereo aerial photos were studied in order to identify eroding sediment sources; erosion is often hidden by dense vegetation but may be clearly visible in photos taken immediately after a disturbance. Historic aerial photo analysis is an efficient way to become thoroughly familiar with the drainage network, history of road construction, timber harvest, and other disturbances.

For cost-effective road restoration, employ the same type and size of equipment that caused the problem

See "Whiskeytown" on page 28

"Whiskeytown" continued from page 27

The inventory work was completed in the summer and fall of 1996. During this phase groups of students worked as an interdisciplinary team, inventorying the landforms and exploring answers to the question, "why is the landscape like this?" The geomorphic perspective is especially important; therefore, the students were given some training in geology and fluvial processes. As part of their training, they toured the nearby Grass Valley Creek watershed to evaluate the efficacy of the treatments used there.

The students developed inventory forms based on advice from Redwood National Park geologists. Their strategy divided the inventory into two distinct areas: the *site* where the road crosses a drainage and the *road segment* between two sites. Consequently, the road erosion inventory form featured a section for sites (swale or stream crossings) and a section for road segments. As the teams inventoried the road, they filled out the appropriate section of the form. Photographs were taken of each site or segment. Road condition, accessibility, width, and length were also noted and recorded on the data sheet.

Data were collected for the sites, including the type of site, i.e., stream crossing, headwater swale crossing, spring, crossroad drain, or other. The amount of fill in the site was estimated as an order of magnitude ranging from "small" (1-5 m^3; 1.3-6.5 yd^3) to "extra-large" (greater than 50 m^3; 65 yd^3). Potential for future erosion was evaluated and treatments recommended. Possible treatments for sites included a shallow dip (10% of the fill removed), culvert replacement (see fig. 2, previous page), a large dip (50% of the fill removed), or complete crossing removal (100% of the fill removed). Justifications for the treatment recommendations were also recorded. Students also collected data for the road segments. The amount of fill in the road was estimated, and the potential for future erosion was assessed as high, moderate, or low. Based on this information a potential treatment was recommended for segments. Possible treatments included outslope, outslope with rolling dip, or recontour (partial or complete road removal).

The information collected was entered into a database and linked to a GIS. The Shasta College engineering and GIS students got involved at this point and developed GIS maps; thus, the attributes for each site and segment could be queried using ArcInfo software. A total of 27 sites and 29 segments were identified on Peltier Valley Road; 31 sites and 19 segments were identified on Logging Camp Road. Segments and sites and the degree of erosion potential for each road are listed in Tables 1 & 2.

Table 1. Summary of Segments and Sites on Peltier Valley Road

Type	Number	Erosion Potential
Road segments	5 segments	High
Road segments	16 segments	Moderate
Road segments	8 segments	Low
Stream crossings	15 crossings	High
Stream crossings	1 crossing	Low
Swale crossings	5 crossings	High
Headwater	1 headwater	Low
Skid trails	2 trails	High
Springs	2 springs	Moderate
Other	1 culvert pull	Moderate
Springs	1 spring	Moderate
Other	1 slump	High

Table 2. Summary of Segments and Sites on Logging Camp Road

Type	Number	Erosion Potential
Road segments	11 segments	High
Road segments	7 segments	Moderate
Road segments	1 segment	Low
Stream crossings	12 crossings	High
Stream crossings	2 crossings	Moderate
Swale crossings	2 crossings	High
Swale crossings	2 crossings	Moderate
Skid trails	9 trails	High

Project design & implementation

Peltier Valley Road

The watershed restoration students completed designs and prepared implementation plans for work on Peltier Valley Road based on the existing and potential problems identified in the inventory. The work was performed by the Watershed Restoration class and the Heavy Equipment Operations class. Shasta College also contracted the services of a heavy equipment operator with restoration experience in Redwood National Park and Grass Valley Creek watershed. The heavy equipment consultant provided on-site supervision and demonstrated equipment use. Altogether, Shasta College performed the following work on Peltier Valley Road:

1. Reconstructed approximately 2,000 m (1.2 mi) of the Peltier Valley Road using outsloped road design
2. Excavated rolling dips at each of the 23 swale and stream crossings
3. Replaced or installed seven appropriately sized and redesigned culvert crossings to reduce erosion
4. Treated all disturbed soil by seeding with native grasses and mulching

Sediment pond

Using remnants of an old logging road as an embankment, the students designed and constructed a sediment pond in the lower reaches of the watershed. The pond is used to monitor and measure sediment production before and after treatment. The drainages of both the Peltier Valley Road and Logging Camp Road converge at the location chosen for the sediment pond. The pond has an expected life of three years after which it and the old road will be removed and the stream returned to its natural course.

The pond weir was constructed with layers of continuous berm (fig. 4) stacked in a triangular shape. MBW, Inc., donated the use of their Continuous Berm Machine and demonstrated its use. This machine can encapsulate soil, sand, or rock in filter fabric to make a berm that is 0.4 m high by 0.3 m wide (~1.3 ft x 1.0 ft). In this situation the berm was filled with existing channel material; no nonnative sediment was introduced to the stream. The berms conform tightly to the stream bottom because they are very heavy with a density of 1,600 kg / m^3 (2,691 lb/yd^3). The berms can be

Fig. 4. A sediment pond was constructed within the lower reaches of the watershed to monitor erosion before and after restoration work. After three years, it will be removed and the stream restored to its natural course.

stacked much steeper than the angle of repose without slumping, and they can be used as spillway weirs without stream erosion because of the support provided by the fabric (Ellis 1997). The continuous berms were reinforced by driving willow stakes through the fabric.

The sediment pond has performed well. The weir has been through a number of rainstorms and it has been subjected to a variety of flows. The vegetation around the pond is well established. The willows planted within the berms have achieved heights of over 2 m (6.6 ft) and are rooting both inside and below the berms.

Logging Camp Road

As already mentioned, Whiskeytown and Shasta College received a $30,000 Challenge Cost-Share Grant from the National Park Service in 1997. This grant funded removal of the Logging Camp Road. Although the road was decommissioned, a single-track, multiuse trail was left in its place. Stream crossings have been completely excavated and recontoured (except for the trail) by pulling back all fill.

The Shasta College Watershed Restoration class supervised the work. The Heavy Equipment Operation class and the experienced heavy equipment consultant performed the work, which was completed in October 1998. Costs associated with complete road removal were closely monitored, and the sediment pond facilitated erosion monitoring during the construction activities.

Conclusion

This pilot project provided an invaluable opportunity for the National Park Service to work with Shasta College in further developing watershed restoration strategies for Whiskeytown National Recreation Area. Park staff participated in the Watershed Restoration class and worked alongside students in inventorying the roads and developing treatment plans. Grant funding from the National Park Service and the Bureau of Reclamation (total of $70,000) allowed the students to perform actual roadwork that will benefit the Sacramento River fisheries. Our experience gained in this cooperative, pilot restoration project holds great potential as a model for erosion and sediment source inventories, watershed restoration designs, and road treatments for use by the multiple federal, state, and local agencies now involved in restoration activities in the Clear Creek and Sacramento River watersheds. PS

References

Ellis, R. 1997. Report on the design and construction of a sediment pond using continuous berms as a downstream weir. Unpublished report. Geotechnical Engineering Department, University of California, Berkeley.

McCulloh, J., and M. T. Conrad. 1994. Gross Valley Creek watershed, Trinity County California, restoration work in a severely eroding decomposed granite watershed. Pages 427-40 *in* Proceedings of the International Erosion Control Association Conference XXV. Reno, Nevada.

Spreiter, T., J. Franke, and D. Steensen. 1994. Perspectives on watershed rehabilitation in Redwood National Park. Professional Paper. National Park Service, Redwood National Park. Arcata, California.

Spreiter, T., and N. Youngblood. 1996. Trip report: Review watershed inventory process and tools in Clear Creek watershed. Whiskeytown National Recreation Area. National Park Service, Redwood National Park. Arcata, California.

Spreiter, T. 1992. Watershed restoration manual. National Park Service, Redwood National Park, Arcata, California.

Steensen, D. L. 1997. Trip report: Reconnaissance of landslides and channel changes associated with the 1997 New Year's storm event. National Park Service, Geologic Resources Division, Lakewood, Colorado.

Western Shasta Resource Conservation District. 1996. Lower Clear Creek watershed analysis. Bureau of Land Management, Redding Resource Area. Redding, California.

John McCullah is a Certified Professional in Erosion and Sediment Control and served as the director of the pilot restoration project. He received a B.S. Degree from Humboldt State University in watershed management with an emphasis in watershed geology and is currently President of Salix Applied Earthcare, a natural resource consulting firm in Redding. John is a part-time instructor at Shasta College. He can be reached at Salix Applied Earthcare; 3141 Bechelli Lane; Redding, CA 96002; 530-224-0878; Fax 530-224-0879; edraw@sunset.net.

Gretchen Ring holds a B.A. Degree in physical geography and biology minor from California State University, Chico. She has been with the National Park Service since 1992. She is the Botanist at Whiskeytown National Recreation Area and the coordinator of the Watershed Restoration Program. She can be reached at Whiskeytown National Recreation Area; P.O. Box 188; Whiskeytown, CA 96095; 530-241-6584 ext.247; Fax 530-246-5154; gretchen_ring@nps.gov.

RICHARD D. ALLEN

Figure 1. Named for its large, inflatable snout, the elephant seal (male shown here) is making a pronounced comeback at Point Reyes National Seashore. Colonization of the seashore began in the early 1970s with a breeding colony first noted in 1981. The park is monitoring the growth of the population, estimated at 1,500 in 1998.

Mirounga massing at Point Reyes

BY SARAH G. ALLEN

While exploring tide pools at a remote area at Point Reyes Headland, park rangers discovered a female elephant seal and pup in 1981. From that first birth, a colony grew and swelled in number over 15 years with nearly 400 pups born in 1998. They are a challenging addition for Point Reyes National Seashore (California), though, as the park is visited by more than two million humans annually. The park is currently developing a strategy for protecting and managing elephant seals by gathering sufficient information on seal habitat needs and potential conflicts.

Elephant seals of the genus *Mirounga* are the largest in size of all pinnipeds of the world. The term *Mirounga* is derived from an Australian aboriginal name for the elephant seals and represents two species in the genus; the northern species *(Mirounga angustirostris)* is of the northern latitudes. The name "elephant seal" derives from the large inflatable snout of the male (fig. 1). They rely on a thick layer of subcutaneous fat for insulation and use this fat for energy when fasting onshore for long periods. Females lack the large nose and are much smaller in size. Elephant seals weigh up to 2,300 kg (3,000-5,000 lb) and tend to be around 380-410 cm (12-14 ft) in length, whereas females weigh 600-800 kg (1,320-1,760 lb) and are 280-300 cm (9-10 ft) long. The life span of elephant seals is poorly studied but the oldest female whose age is known at Point Reyes Headlands was 21 years.

Charles Scammon, a British seal hunter who explored and exploited the Pacific coast in the 1800s, recorded that northern elephant seals were distributed from Cabo San Lazaro, Baja, Mexico, to Point Reyes, California. By the turn of the century, elephant seals nearly were extinct because sealers hunted them for the high quality oil that could be produced from their blubber; one bull elephant seal could yield nearly 25 gallons of oil.

With protection provided first by the Mexican government on Isla Guadalupe and later by the United States on the Channel Islands, California, the population recovered at an astounding rate, growing an estimated 6-8% per year. As the colony grew, seals began colonizing new sites, expanding northward. Pups were first seen on San Miguel Island, California, in 1957. From a low count of only a few hundred animals in the 1890s, the worldwide population has grown in 100 years to around 150,000.

Colonization of Point Reyes

Point Reyes is just one of around 11 breeding sites for this species along the eastern Pacific rim and until the mid 1990s was the most northern. Colonization of Point Reyes began in the early 1970s when individual animals were sighted with increasing frequency. Then in 1981, a breeding colony formed at Point Reyes Headland when a pup was seen with a female and attended by an adult male. The colony was situated in an inaccessible pocket beach at the base of a steep cliff. Since then, the colony has grown exponentially. In 1998, the estimated number was around 1,500.

The park has monitored the growth of the colony with weekly surveys, flipper-tagging individuals, and monitoring human interactions with remote camera. During winter 1994-95 and the El Niño of 1998, severe storms and high tides (aggravated by the elevated sea level of the El Niño) pummeled the pocket beach where the main colony congregates. Many pregnant females were unable to find space for birthing in the midst of these storms and a few selected alternative beaches at Point Reyes with its relatively tranquil waters and ample space. These new subcolonies were revisited annually since then, indicating that the colony is spreading.

Annual cycle

Elephant seals congregate onshore at these terrestrial colony sites three times per year, but the total numbers and proportion of various age and sex categories varies per season: the breeding season (December-March), the molt (March-July), and the juvenile haul out (September-November). During the rest of the year (nearly 80%), the seals are entirely pelagic, living only in the ocean

Elephant seals have a hierarchical breeding system with large dominant males aggressively defending their position near

Figure 2. With numbers on the rise at Point Reyes, elephant seals are overflowing onto publicly accessible beaches. Resource managers now have several considerations to balance along with species recovery: public safety, wildlife harassment, transmission of diseases between seals and dogs and cattle, and disruption of colonization at new beaches.

groups of females. Females begin pupping within a few days of their arrival with the first pup born around mid-November. Small discrete colonies such as the Point Reyes Headland colony may have only a few dominant bulls, whereas large, continuous colonies such as the San Miguel Island colony may have an array of bulls and subordinate males at intervals along a beach.

Females usually give birth to a single pup, weighing around 32 kg (70 lb) and displaying a black coat of fur. Pups cannot swim at birth, and consequently, are vulnerable to storms and disturbance. Mortality rates of pups have been low most years at Point Reyes Headland, but with increased density coupled with severe storms as occurred in 1992, 1995, and 1998, the survival of pups decreased. In 1995, survival was only around 45% and only around 25% in 1998.

Marine habitats

Elephant seals spend 60-80% of their time at sea, but little is known about their distribution or behavior at sea. In recent years, though, new technology in the form of satellite tags and time-depth recorders has enabled researchers to discover that elephant seals can dive up to one mile deep and stay under water for almost two hours. Elephant seals disperse rapidly and widely from the colonies; one elephant seal tagged at San Miguel Island, for example, was located in the Bering Sea within two weeks. They range west as far as 173°W longitude, beyond the Hawaiian Islands, and north to the Bering Sea and eastern Aleutians. In the Gulf of the Farallones, we have correlated elephant seal distribution with deep waters off the continental shelf. The most current information on the diet of elephant seals indicates that they forage in the midwater zones, likely eating cephalopods and Pacific hake, although seals are also known to prey on skates, rays, sharks, shrimp, and crab.

Elephant seals are in turn preyed upon by primarily the great white shark *(Carharodon carcharias)*. Point Reyes Bird Observatory biologists on the Farallon Islands estimate that around 10% of the elephant seal population is preyed upon annually by great white sharks. Many incidences of shark attacks on seals and sea lions have been observed at Point Reyes Headland by park personnel over the past decade.

Management issues

The arrival of elephant seals at Point Reyes is an extraordinary example of the benefits of simple protective measures like the Marine Mammal Protection Act; however, now many land management agencies such as the National Park Service are faced with several new issues. The main colony was inaccessible, but with crowding, the colony began to overflow onto three nearby beaches, two of which are accessible to park visitors (fig. 2).

Issues that surfaced since 1995 include public safety from seals, harassment of seals by park visitors, potential disease transmission between seals and dogs and cattle, and disruption or deterrence of colonization at new beaches. Park docents logged 880 hours over 35 days of educating visitors during weekends and holidays, and on nearly 30% of these days, people were observed harassing seals. Most pinnipeds on land react to the approach of humans (especially with dogs) and will stampede into the water when approached too closely. Behavioral changes, such as retreating into the water or cessation of nursing activity, are defined as disturbance under the Marine Mammal Protection Act. At newly established colonies, human presence can deter pregnant females from pupping on beaches. Of additional concern is the transmission of serious diseases (e.g., canine distemper) from dogs to seals, and the National Marine Fisheries Service recommends that dogs be prohibited on beaches where pinnipeds occur.

Safety issues are of concern from both direct and indirect encounters with seals. Elephant seals are known to chase and bite people when seals are approached too closely. This is of special concern during the breeding season when male seals are fighting and females are defending their young. Because elephant seals are a favored prey item of great white sharks, there is concern that the visiting public may be at greater risk while boating or swimming in Point Reyes waters around seal haul out sites; the region has one of the highest incidence rates of white shark attacks on people in the world.

The park produced an elephant seal management plan to address the myriad of issues associated with the seal colony expansion. Some additional long-term potential conflicts include impact of elephant seals to other resources in the park such as the western snowy plover *(Charadrius alexandrinus nivosus)*, which was listed as a threatened species by the U.S. Fish and Wildlife Service in 1993 and several rare native plants in the coastal dune community.

Elephant seals are a heroic species that exemplifies the remarkable recovery of a species given simple protective measures; they are also impressive and fascinating to the visiting public. The task of the park is to strike a balance between enabling the elephant seal colony to continue to recover and responding to the visitor interest. Beginning in 1996, the park initiated a docent program to educate visitors and protect seals; a total 33-45 volunteers interacted with visitors and collected data. This coming year, the program will be expanded, as will research on the colony as we attempt to discern why seals choose some beaches over others for breeding. PS

Sarah Allen is an Ecologist with Point Reyes National Seashore and Program Lead for the Inventory and Monitoring Program for the Pacific-Great Basin Support Office. She also serves as Science Advisor for the national seashore and Great Basin Support Office. She received her B.S., M.S., and Ph.D. from the University of California, Berkeley, in wildland resource science. Sarah can be reached at 415-663-8522, ext. 224; sarah_allen@nps.gov.

"Real-time" air quality monitoring data displayed at Great Smoky Mountains

By Dee Morse, John Ray, and Jim Renfro

In Great Smoky Mountains National Park (Tennessee and North Carolina), air pollution seriously damages park resources. Visibility is impaired by a uniform haze that affects scenic vistas. Landscape features and colors fade, diminishing the experience of visitors to the park. Air pollution in the form of ground-level ozone threatens human health and vegetation. A variety of plant species (black cherry, yellow poplar, sassafras, tall milkweed, and cutleaf coneflower) show symptoms of ozone injury to foliage. Other airborne pollutants, including sulfur and nitrogen compounds, result in acidification of some high-elevation streams, soils, and plants.

Data collection for the assessment of air pollution impacts on resources in national parks has been successful in addressing this resource management concern. Public awareness, however, should not be underestimated as a partner to science as an effective means of protecting park air resources. An informed public can be a strong ally in these efforts. Now, using modern communication methods, computer exhibits can show visitors real-time visibility, air pollution concentrations, and weather conditions.

Real-time data exhibited

Currently, Great Smoky Mountains National Park is using real-time visibility data in an interpretive exhibit on air quality at the Sugarlands Visitor Center. Park Superintendent Karen Wade is excited about the exhibit. "It is important for the public to understand how air pollution affects park resources, since the public plays a key role in bringing about those actions necessary to prevent air pollution impacts," Wade said. "The park should use the best information and tools available to increase public awareness."

The exhibit at Sugarlands Visitor Center consists of two 3 ft x 9 ft panels located in the visitor center. The panels display information about the cause and effect of air pollution at the park (fig. 1). Monitors in each panel are linked to air monitoring equipment at the park's Look Rock air quality station and observation tower and show current visibility, ozone concentrations, and meteorological conditions. An air quality brochure is also available at the visitor center for individuals who would like more in-depth information about air pollution impacts at the park.

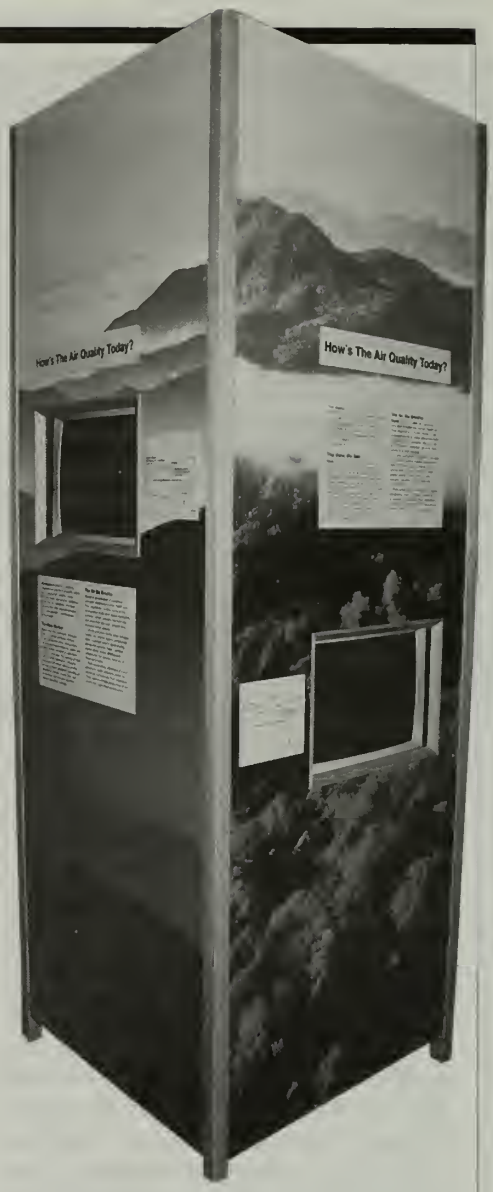


Figure 1. The interpretive exhibit inside the Sugarlands Visitor Center describes the air quality condition at the park, displays photos comparing good (100 miles +), bad (~20 miles), and current visibility images at Look Rock, and features ozone and meteorological data that are updated every 15 minutes.

At Look Rock, a digital zoom camera captures visibility images (fig. 2), a nephelometer gathers optical visibility data, an ozone analyzer measures ozone concentrations, and meteorological monitoring equipment collects weather-related information (fig. 3). The digital camera, mounted atop Look Rock observation tower, is aimed toward the crest of the Great Smoky Mountains to capture images characteristic of the park and familiar to visitors. The camera is equipped with a personal computer modem. The camera and support computer, housed in a secure, environmentally controlled enclosure, have the following capabilities:

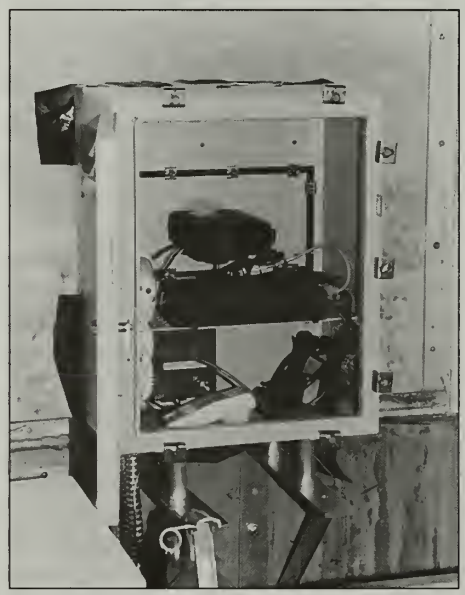


Figure 2. Capturing a new visibility image every 15 minutes, the digital camera is mounted inside the observation tower at Look Rock. The digital image is transmitted by telephone line and short-haul modem to the Look Rock air quality shelter (right).

Figure 3 (below). Instruments at Look Rock record weather data, measure ozone, and analyze visibility distance (visual range). A data logger collects the information and forwards it to Sugarlands Visitor Center.

1. Acquisition of a digital image at selected time intervals
2. Automatic light-level and color-balance adjustment
3. Image capture across a wide dynamic range
4. User-selectable camera field of view
5. Off-site reconfiguration and reset capabilities
6 Reliable operation over a wide ambient temperature range

The digital image is transmitted by telephone line and short-haul modem to the Look Rock air quality shelter. There, a data logger and computer record measurements from the nephelometer, ozone analyzer, and meteorological sensors. Data are sent every 15 minutes through a telephone line to a computer at Sugarlands Visitor Center and to a local Internet service provider in Knoxville, Tennessee. The visitor center computer performs the following functions:

1. Acquires image and data files
2. Validates the data and image files
3. Formats the image and data files for display on exhibit monitors
4. Cycles visitor display screens
5. Provides for on- and off-site modifications of the display programs
6. Provides for on- and off-site system troubleshooting

The computer operates a Windows-based program that is easy to use. Park staff can troubleshoot individual computer system components and change the displayed information. The staff have dial-up computer access to the digital camera and to the data logger to make changes in operational modes, reboot the camera computer, or conduct troubleshooting activities.

On each of the 21-inch monitors in the exhibit, three different display screens are cycled for the public to view. One screen provides a current video image from Look Rock and information on current visibility conditions (fig. 4), shown as visual range in miles. Static images of a good visibility day and a typical day (i.e., the current seasonal average) are also presented on the screen, inviting comparisons with current visibility conditions. A second screen provides information about current ozone concentrations at Look Rock. The current hourly concentration is displayed on the screen along with the previous day's maximum and minimum hourly ozone concentrations. In the lower half of the screen, a static scale shows public health-related effects from ozone. A third screen provides meteorological information from Look Rock. This includes current wind direction and speed, ambient temperature, relative humidity, and precipitation.

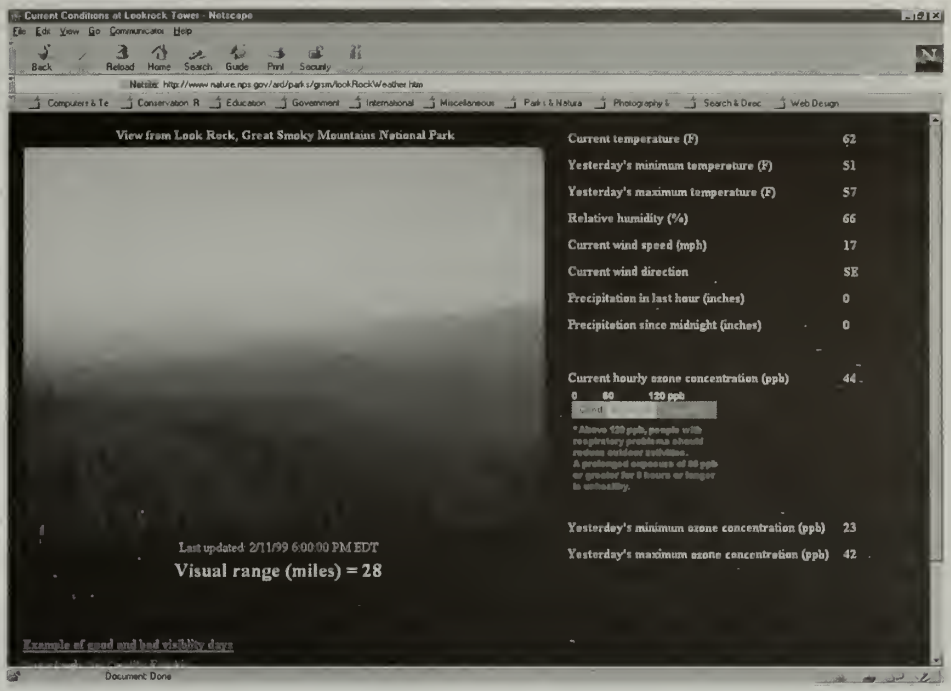


Figure 4. A "reol-time" photogroph of the view from the Look Rock observotion tower is published on the World Wide Web every 15 minutes. The coption documents the time when the imoge wos mode and the visuol ronge depicted in the scene. Meteorologicol dota including temperature, relative humidity, precipitatian, ond wind speed and directian are updated every 15 minutes. Ozone cancentrations are updated hourly.

First on the Web

The real-time interpretive air quality exhibit at Sugarlands is also the first exhibit of its kind to present current monitoring data in a national park on the World Wide Web. The information from Look Rock is sent via the Internet to the Air Resources Division in Denver, Colorado. There it is published on the World Wide Web at *www.nature.nps.gov/ard/parks/grsm/lookRockWeather.htm.*

The technology used for this exhibit can also be used to present monitoring data from a variety of other natural resource management activities in a park. This interpretive approach serves as a very effective resource management tool. The presentation of real-time monitoring data not only enables park managers to provide the public with current data, but it also provides an opportunity to easily modify and update the presentation of data results.

Funding for the exhibit and its link to the monitoring equipment was provided through a partnership with the NPS Air Resources Division, U.S. Environmental Protection Agency, Great Smoky Mountains Natural History Association, and Great Smoky Mountains National Park.

The total cost for this project at Great Smoky Mountains National Park was approximately $50,000. The cost, however, was unique to the monitoring setup at the park and may be approximately the same or lower at other units of the national park system, depending on configuration and location of the monitoring equipment. The Air Resources Division has limited funds available each fiscal year to assist with the development of real-time exhibits in units that are monitoring air quality parameters. PS

Dee Morse is an Environmental Protection Specialist with the Air Resources Division of the NPS Natural Resource Program Center in Lakewood, Colorado. He can be reached at 303-969-2817; dee_morse@nps.gov.

John Ray is an Atmospheric Chemist, also with the Air Resources Division. He can be reached at 303-969-2820; john_ray@nps.gov.

Jim Renfro is an Air Resources Specialist at Great Smoky Mountains National Park, Gatlinburg, Tennessee. He can be reached at 423-436-1708; jim_renfro@nps.gov.

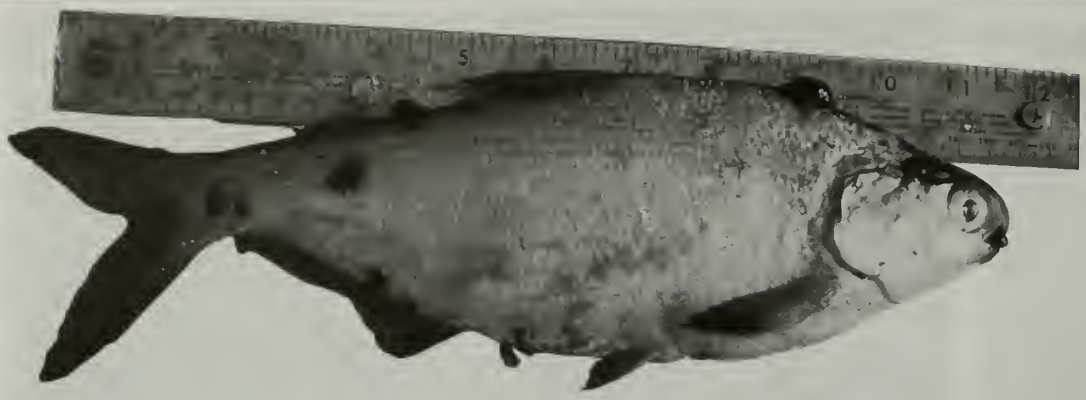


Figure 1. An adult gizzard shad exhibiting multiple raised black tumors.

Persistent expression of tumors in Lake of the Arbuckles gizzard shad

A summary of eight years of study

By Gary K. Ostrander, Ron Parker, and William E. Hawkins

During the spring of 1991, while conducting studies on the health of fishes in various lakes and rivers in Oklahoma (e.g., Kuehn et al. 1995), we were asked to investigate reports of large black tumors appearing on the skin of gizzard shad *(Dorosoma cepedianum*–fig. 1). The shad were collected from a lake within Chickasaw National Recreation Area in south-central Oklahoma. The Lake of the Arbuckles is a 2,350-acre reservoir fed by Guy Sandy Creek, Buckhorn Creek, Rock Creek, and its tributary, Travertine Creek (fig. 2). The lake has a mean depth of 9 m (~30 ft) and 58 km (36 mi) of shoreline. In 1996, the park recorded more than 70,000+ boater visits and approximately 20,000 boats on the lake with most visitors participating in sport fishing activities. The primary sport fish within the recreation area include largemouth, smallmouth, and spotted bass; crappie; channel catfish; and sunfish. The incidence of tumors on gizzard shad is of concern because the species is a forage fish in Lake of the Arbuckles, the park's largest aquatic resource, and it is unexplained.

Construction and filling of the Lake of the Arbuckles was completed in 1967 and nothing in its history suggests any significant contamination could be responsible for tumors appearing in the fish. Nonetheless, we began a comprehensive study in August of 1991 with the ongoing objective of determining the nature and extent of the lesions appearing in the gizzard shad residing in the lake.

Malignant tumors documented

The initial survey of Lake of the Arbuckles revealed that 14 of 105 gizzard shad collected exhibited one or more raised black lesions. Grossly, the lesions were primarily distributed over the head, trunk, and fins as superficial raised masses that were almost always darkly pigmented (see fig. 1) and ranged in size from 0.1 to >2.0 cm (0.04-0.79 in) in diameter. The lesions were ultimately diagnosed as subcutaneous spindle cell tumors that most likely arose from the cells that surround nerves or from pigment cells (Ostrander et al. 1995).

Subsequent surveys of the lake (1991-96) and the collection of over 1,200 adult and at least 2,000 juvenile shad have revealed that at any one time approximately 20% of the adult shad (>1 year) exhibit one or more tumors. To date, tumors have not been seen in any of the juvenile shad that we have examined. The significance of these observations lies in the fact that fish exhibiting tumors in 1996 were not present when the lesions were first discovered in 1991; thus, whatever is responsible for the formation of the tumors is still exerting its effect today.

What is causing the tumors?

Once the diagnosis of malignant cancerous tumors in the gizzard shad was made, the focus of our efforts shifted to attempting to determine the cause. Cancer in fishes has been previously reported at various locations in North America (e.g., Puget Sound, Boston Harbor, The Great Lakes), but never in a national park (reviewed in Harshbarger and Clark 1990). Typically, tumor-bearing fish populations are found in areas high in human-caused pollution with aromatic hydrocarbons (e.g., fossil fuels) or heavy metals most often being implicated; thus, our initial studies focused on the analysis of the water and sediments of the Lake of the Arbuckles. Water and sediment samples were collected from a variety of locations and subjected to gas chromatography-mass spectrometry. The resulting spectra were matched to an online library of 44,000 environmental contaminants. No significant matches were found. Likewise, analysis of water, sediment, and shad tissue samples did not reveal significant levels of chromium, nickel, lead, cadmium, or copper–all previously implicated in tumor formation in other vertebrates, including humans. Finally, we used inductively coupled plasma mass spectrometry to determine if significant levels of 64 trace elements (e.g., arsenic, selenium, mercury, etc.) correlated with the high levels of tumors seen in the gizzard shad. Again, no significant increase in any of these elements was observed (Ostrander et al. 1995, Jacobs and Ostrander 1995).

The region around the Lake of the Arbuckles is the site of natural deposits of uranium and as such we explored the hypothesis that elevated levels of radioactive uranium or its by-product radon gas could be contributing to the high tumor incidence seen in the Lake of the Arbuckles. Water samples were collected from Lake of the Arbuckles and Lake Carl Blackwell and analyzed for gross alpha/beta and radon-222 radiation. Lake Carl Blackwell is also located in central Oklahoma and contains a large population of tumor-free shad. As with the other chemical analyses, no increase in the background levels of uranium, total radioactivity, or radon were observed. Moreover, no differences were noted between the two lakes (Geter et al. 1998).

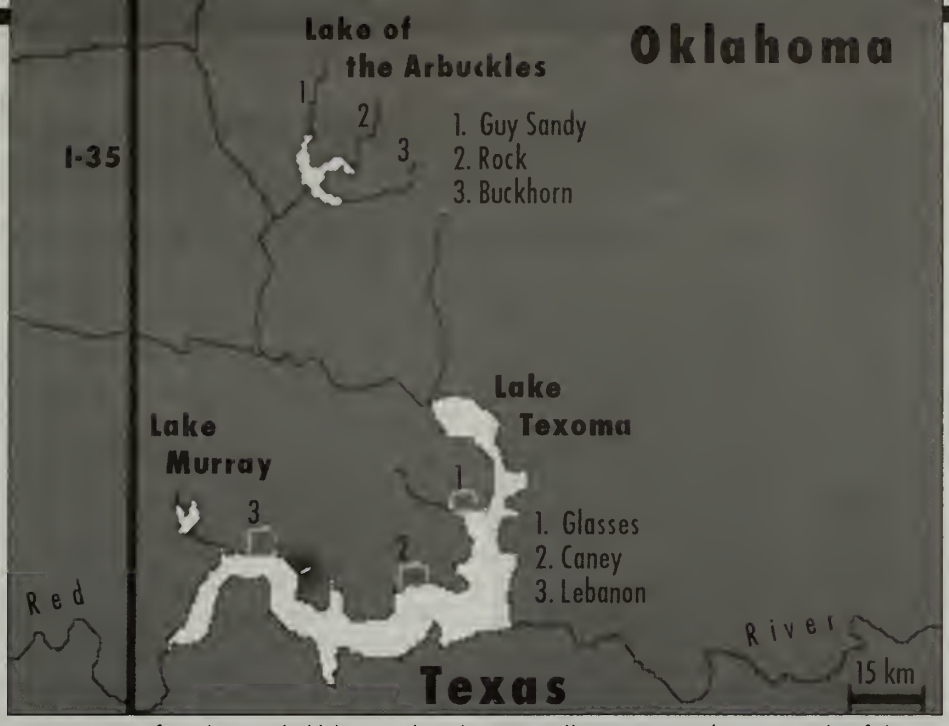


Figure 2. Map of south-central Oklahoma and northern Texas illustrating sampling sites. Lake of the Arbuckles is within Chickasaw National Recreation Area.

According to earlier research, viruses can cause tumors in fish and other organisms. Among fishes, at least two examples of tumors similar to what we are observing in the Lake of the Arbuckles have been linked to retroviruses (discussed in Ostrander et al. 1995). Our laboratory developed a test for the assessment of a retroviral cause of these tumors. Examination of the tumors for reverse transcriptase, an enzyme indicative of the presence of a retrovirus, was negative. Likewise, analysis of the tumors by electron microscopy failed to reveal the presence of any retroviral or other viral particles. Along these same lines, the occurrence of tumors was not seasonal as often is the case with virally induced cancers in feral fish population (Ostrander et al. 1995).

We have also investigated the possibility that tumors in the gizzard shad may arise from only a certain segment of the population. That is, it is reasonable to hypothesize that if restricted interbreeding was occurring within a segment of the population the tumor phenotype could be carried through successive generations. The mechanism for such an occurrence has been previously identified in fish and humans. The best studied example is the occurrence of melanomas in laboratory populations of *Xiphophorus* (swordtails and platys–fish that bear live offspring) that are caused by the altered expression of a tumor suppressor gene (reviewed in Ostrander and Blair 1997). Altered expression of tumor suppressor genes and oncogenes have been implicated in a variety of human cancers including those of the breast, ovary, kidney, and eye. We have recently completed pilot studies in which we examined tumor-bearing and nontumor-bearing individuals for obvious genetic markers. Specifically, we performed random amplified polymorphic DNA (RAPD) and double-stringency polymerase chain reaction (DS PCR–laboratory techniques that facilitate detection of DNA-based diseases) analysis (described in Geter et al. 1998). Tumor-bearing gizzard shad were indistinguishable from nontumor-bearing gizzard shad by genetic marker analysis performed in our studies.

Cancer in fishes has been previously reported at various locations in North America, but never in a national park

Field studies, in which fish were sampled from various locations at different times of the year supported the hypothesis that tumor-bearing and nontumor-bearing shad collected from Lake of the Arbuckles represent a single genetically homogeneous population (Jacobs and Ostrander 1995).

Tumors in other fish?

The primary focus of our studies for the last six years has been the gizzard shad and, as such, our sampling methods are optimized to target this species. Nonetheless, we often capture nontarget species in our nets. These fish are routinely examined grossly for tumors and on occasion complete necropsy is performed. The most common non-shad species caught is the catfish, and to date no tumors have been seen. Over the years we have also caught about 30 bass, including white, smallmouth, and largemouth. Two individuals have presented tumors and one of these has been examined in some detail (Hawkins et al. 1996). A white bass exhibited a tumor that was a solitary soft round mass that bulged from the anal fin. The lesion was suggestive of a poorly differentiated hemangiopericytoma (a tumor that likely arose from cells surrounding a blood vessel), though it might have derived from a nerve sheath, pigment cells, fibroblasts, or smooth muscle. Hemangiopericytoma is a relatively rare lesion in wild fish. Its discovery in a white bass from the same location in which resident gizzard shad exhibit a high frequency of similar lesions arising from cells around nerves instead of blood vessels is of concern. Further surveys and studies of non-shad species are needed.

Unlike hemangiopericytoma, pigmented subcutaneous spindle cell neoplasm is a tumor that arises from cells surrounding nerves. Tumors of this type were first observed in gizzard shad in 1991 and thought to be limited to Lake of the Arbuckles; however, a similar incidence (~20%) of this disease has now been documented in three additional lakes. Two of these lakes, Texoma and Murray, are located about 55 km (34 mi) south of Lake of the Arbuckles and share the same drainage. Sampling was conducted at multiple sites at lake Texoma (Glasses, Caney, and Lebanon) and one site at Lake Murray (see fig. 2). Both Lake of the Arbuckles and Lake Murray were stocked by the Oklahoma Department of Water Quality with gizzard shad from Lake Texoma in 1980 (J.Pigg, personal communication). This suggests that antecedents of tumor-bearing shad from Lake of the Arbuckles and Lake Murray were introduced from the same source at the same time; that is, they may have a common ancestor that carried this deleterious trait. A third lake, Fort Supply, is found in the

See "Shad" on page 36

"Shad" continued from page 35

western panhandle region and is outside this drainage. In all cases the incidence of tumors remains roughly 20%.

For the study, researchers collected juvenile and adult shad from Lake of the Arbuckles with a beach seine.

Future direction

To date we have not been able to determine the cause or source of the tumors appearing in gizzard shad in four Oklahoma lakes. Moreover, neither the geographical extent of the outbreak nor when it began are known. Finally, the exact cell(s) of origin for the tumors remains to be determined. Our current studies are focused on answering these questions. PS

Literature Cited

Geter, D. R., W. E. Hawkins, J. C. Meons, and G. K. Ostrander. 1998. Pigmented subcutaneous spindle cell tumors in gizzard shad *(Dorosoma cepedionum)*: Occurrence in two additional lakes and further investigations into the etiology of the lesions. Environmental Toxicology and Chemistry 17(11):2282-87.

Jacobs, A. D. and G. K. Ostrander. 1995. Etiological studies of subcutaneous neoplasms in feral gizzard shad, *Dorosoma cepedionum*. Environmental Toxicology and Chemistry 14:1781-87.

Kuehn, R. L., K. D. Berlin, W. E. Hawkins, and G. K. Ostrander. 1995. Anthropogenic contominants and fish health near three oil refineries. Journal of Toxicology and Environmental Health 46:101-16.

Harshbarger, J. C. and J. B. Clark. 1990. Epizootiology of neoplasms in bony fish of North America. Science of the Total Environment 94:1-32.

Hawkins, W. E., D. G. Gregory, A. D. Jacobs, and G. K. Ostrander. 1996. Unusual dermal hemangiopericytoma in a white bass, *Morone chrysops*. Journal of Aquatic Animal Health. 8:150-54.

Ostrander, G. K., W. E. Howkins, R. L. Kuehn, S. D. Jacobs, K. D. Berlin, and J. Pigg. 1995. Epizootic of peripheral nerve sheath tumors in feral gizzard shad *(Dorosoma cepedionum)*. Carcinagenesis 16:1529-35.

Ostrander, G. K., and J. B. Blair. 1997. The role of growth factors during teleost carcinogenesis. Pages 73-78 *in* L. Rassi, R. Richardson, and J. Harshbarger, editors. Spontaneous animal tumors: A survey.

Gary K. Ostrander, Ph.D., is with the Department of Biology and Division of Comparative Medicine at Johns Hopkins University in Baltimore, MD 21218; 410-516-8215; gofish@jhu.edu. *From 1990 to 1996, while on the faculty at Oklahoma State University, Dr. Ostrander directed one aspect of his research program toward understanding the causes of cancer in wild fish populations. Ron Parker is Resource Management Specialist at Chickasaw National Recreation Area, Oklahoma; 405-622-3161 x403;* ron_parker@nps.gov. *William E. Hawkins, Ph.D., is an associate director of the Institute of Marine Sciences at the University of Southern Mississippi, Ocean Springs, MS 39566-7000; 228-872-4215;* whawkins@seahorse.ims.usm.edu. *During 25 years with the institute's Gulf Coast Laboratory, Dr. Hawkins has managed an electron microscopy and histology laboratory dealing mainly with pathological studies of aquatic organisms.*

"Highlights" continued from page 5

eggs being laid in vireo nests (2.0 eggs per nest in 1998) is an indication that cowbird egg production can outpace the breeding capacity of preferred hosts. The high rate of parasitism on Bell's vireo is alarming and could lead to an unstable population that is susceptible to extirpation. These numbers indicate that the continued presence of Bell's vireo at Rattlesnake Springs is at risk, requiring long-term monitoring and management action.

To reduce the impacts of cowbirds, the park has removed horses from Rattlesnake Springs, buried powerlines that were commonly used as perches by cowbirds, and removed or addled cowbird eggs from Bell's vireo nests. Future management actions may include increasing the riparian habitat and trapping cowbirds.

Rocky Mountains

Whirling disease found in Yellowstone

During the 1998 field season, staff from Yellowstone's Aquatic Resources Center confirmed the presence of whirling disease in the park. In recent years, the disease, caused by a parasite that attacks the cartilage of young fish, has been found in streams around the park, but previous sampling efforts had not indicated its presence within Yellowstone. In three separate tests, native Yellowstone cutthroat trout taken from Yellowstone Lake near the mouth of Clear Creek, a major spawning tributary, tested positive for whirling disease. Fish affected by the disease are unable to feed normally, which often results in their being more subject to predation, starvation, and premature death. Biologists will test additional fish from in and around the lake during the summer of 1999 to learn more about the extent of the disease.

• • •

NAS begins review of natural regulation in Yellowstone

In 1998, Congress requested that the National Academy of Sciences (NAS) initiate a comprehensive and objective review of ungulate management in Yellowstone. The group's first visit to Yellowstone occurred in mid-January, during which they heard from a variety of speakers. Twelve scientists have been appointed to the task, which is expected to take approximately two years and has been allocated funds of $500,000. PS

Ecosystem-based assessment of biodiversity associated with eastern hemlock forests

By Carolyn G. Mahan

The eastern hemlock *(Tsuga canadensis)* is a shade-tolerant, late-successional conifer that provides a unique cover type in the eastern forest (Rogers 1978). Eastern hemlock stands are highly valued at Delaware Water Gap National Recreation Area (New Jersey and Pennsylvania–fig. 1) and Shenandoah National Park (Virginia) because of their aesthetic, recreational, and ecological qualities. Personnel and cooperators from Delaware Water Gap and Shenandoah have conducted ecological studies in hemlock stands and identified numerous species of plants and wildlife, some of which are sensitive species, within this unique forest habitat (Sciascia and Pehek 1995, Battles et al. 1996). For example, blackburnian warblers *(Dendroica fusca)* and water shrews *(Sorex palustris)* are closely associated with hemlock stands (Benzinger 1994, Sciascia and Pehek 1995). At Shenandoah National Park, some populations of the federally endangered Shenandoah salamander *(Plethodon shenandoah)* occur in dense hemlock stands (Mitchell 1991, Watson et al. 1994). Moreover, plant species such as painted trillium *(Trillium undulatum)* grow primarily under the canopy of hemlock stands (Radford et al. 1968).

The aesthetic, recreational, and ecological values of hemlock stands at Delaware Water Gap and Shenandoah are threatened by the hemlock woolly adelgid (*Adelges tsuga* Annands; HWA), an exotic insect pest that attacks and can kill eastern hemlock trees (McClure 1991–fig. 2, page 38). The hemlock woolly adelgid was first detected in Shenandoah in the winter of 1988 and now infests all eastern hemlock stands at that park causing significant mortality of hemlock trees (Watson et al. 1994). Resource managers at Delaware Water Gap learned in 1989 that hemlock stands were infested with the insect (Evans 1995).

The biodiversity associated with hemlock stands could be at risk if the current trend of HWA infestation and resulting mortality continues. The National Park Service endeavors to protect and maintain the natural heritage of its lands, particularly under the threat of an invasive exotic species such as the adelgid. Baseline information on the biotic components of hemlock ecosystems is fundamental to the protection and restoration of biodiversity and to the maintenance of ecosystem dynamics in hemlock stands at both Delaware Water Gap and Shenandoah.

The Pennsylvania State University (Penn State) and the Biological Resources Division (BRD) of the U.S. Geological Survey in cooperation with the National Park Service have conducted research to assess the biodiversity associated with hemlock and complementary paired hardwood ecosystems at the two parks (Ross et al. 1996, Yahner et al. 1996). The goals of this project were to: (1) assemble and synthesize existing information on terrestrial floral and faunal diversity at both parks; (2) develop and establish study site design for forest stands at both parks; (3) develop and standardize specified field protocols and procedures for a biodiversity inventory in hemlock and complementary hardwood ecosystems at both parks; (4) conduct aquatic biodiversity sampling in hemlock and complementary paired hardwood ecosystems at Delaware Water Gap; and (5) conduct terrestrial biodiversity sampling in a hemlock and a complementary hardwood stand at Shenandoah National Park. Aquatic research, similar to that being conducted at Delaware Water Gap, is not being conducted at Shenandoah primarily because hemlock stands at Shenandoah tend to be small and exist as very narrow strips along stream corridors. The effects of hemlock on aquatic biodiversity, therefore, may be difficult to ascertain because the non-hemlock components of the forest contribute a much larger proportion of the leaf litter inputs entering the stream.

Figure 1. Eastern hemlock (Tsuga canadensis) *ravine at Hornbeck Hollow, Delaware Water Gap National Recreation Area, Pennsylvania.*

Biodiversity database

To meet the first objective, we compiled information from existing reports, publications, museums, and databases (including NP Flora/Fauna) on terrestrial floral and faunal biodiversity found in and around the two parks (Mahan 1997a, 1997b). Biodiversity information was integrated with existing data in a newly created computerized database using Microsoft Access (termed the Biodiversity Database). Biodiversity information was collected for amphibians, reptiles, birds, mammals, vascular and nonvascular plants, and invertebrates. The database significantly enhances the information available on terrestrial biodiversity in and around the two parks. Furthermore, NP Flora/Fauna contains little to no information on invertebrates present in either park. The Biodiversity Database, however, contains over 8,000 and 1,500 species of invertebrates that potentially could be located at Delaware Water

See "Hemlock" on page 38

"Hemlock" continued from page 37

Gap and Shenandoah, respectively. The Biodiversity Database was installed at both parks in 1997.

Selection of forest stands

To meet the second objective, BRD researchers developed a landscape analysis methodology to select forest stands for conducting biodiversity inventories (Smith et al. 1996). Stand boundaries at both parks were defined using forest cover-type maps provided by resource managers at each park (Myers and Irish 1981, Teeter 1988). Geographic Information System (GIS) methods were used to tabulate landscape attributes of hemlock stands. Hemlock stands were clustered into three topographic types based on their landscape attributes generated from a 1:24,000 digital elevation model (USGS topography) (Smith et al. 1996). Landscape attributes used for classifying and clustering hemlock stands included: elevation, percent slope, aspect, and terrain shape (Smith et al. 1996). Hemlock stands in each topographic type were then paired with hardwood forest stands using multivariate distance based on similar landscape attributes. Potential study stands were visited at Delaware Water Gap and Shenandoah to check the appropriateness of using the proposed methodology to stratify stands based on topographic type. Fourteen and seven pairs of hemlock and hardwood forest stands were selected as potential study sites at Delaware Water Gap and Shenandoah, respectively (Mahan 1997c, 1997d).

Biodiversity inventories: protocol manual

For the third objective, a manual that details standardized field protocols for inventorying terrestrial and aquatic flora and fauna was prepared (Mahan et al. 1998). Protocols for terrestrial floral and faunal inventories were standardized and developed by researchers at Penn State. Protocols for aquatic sampling were standardized and developed by researchers from the USGS Biological Resources Division (Ross et al. 1996). The protocol manual was reviewed by resource managers at Delaware Water Gap and Shenandoah and researchers associated with the Smithsonian Institution's Monitoring and Assessment of Biodiversity Program (see Dallmeier 1992).

Aquatic biodiversity inventories at Delaware Water Gap

To obtain the necessary information on the aquatic components of biodiversity (objective 4), macroinvertebrate and fish assemblages were sampled in stream reaches within 14 hemlock and paired hardwood stands at Delaware Water Gap during 1997. Aquatic macroinvertebrates and fish were sampled were sampled during April and July, respectively. Sampling events were timed to maximize resident species diversity (Ross et al. 1996). Length of stream reaches sampled were proportional to stream width and reflected existing landscape variation (Ross et al 1996). Macroinvertebrate and fish samples were collected from a variety of microhabitats within stream reaches in each stand. Streams draining hemlock forests at Delaware Water Gap contained approximately 37% more taxa of aquatic invertebrates than streams draining hardwood stands (Snyder et al. 1999). In addition, streams draining hemlock forests supported more predatory invertebrates than stream draining hardwood stands. Finally, brook trout *(Salvelinus fontinalis)* were more likely to occur in streams draining hemlock forests (Snyder et al. 1999).

Terrestrial biodiversity inventories at Shenandoah

To obtain the necessary information on terrestrial flora and fauna (objective 5), a biodiversity profile inventory (plot-based sampling) using numerous sampling protocols was conducted in conjunction with more extensive sampling across a larger area (stand-based sampling). The terrestrial biodiversity profile inventory was conducted during 1997 at one hemlock stand (Limberlost) and a complementary paired hardwood stand (Matthew's Arm) in Shenandoah National Park. The biodiversity profile inventory included intensive sampling for terrestrial plants, vertebrates, and invertebrates from the forest soil to the forest canopy within a 20 m x 20 m plot. Although preliminary results suggest that hardwood forests are more biologically diverse than hemlock forests at Shenandoah, hemlock forests do seem to have unique species composition and structure. For example, many families of terrestrial invertebrates were only found in the hemlock stand (Sullivan et al. 1998). Several families of flies that depend on decaying organic matter and fungi were more abundant in the hemlock forest. Furthermore, orb-weaving spiders, a group of spiders that requires open habitat structure, were more abundant in the hemlock forest. Individuals of the bark lice family Peripsocidae, and the millipede family Parajulidae, also were more abundant in the hemlock than the hardwood forest at Shenandoah. Red-backed salamanders *(Plethodon cinereus)*, which feed on large detritivorous invertrebrates, such as millepedes, were significantly more abundant in the hemlock forest. Finally, southern red-backed voles *(Clethrionomys gapperi)*, a fungivorous small mammal species, appear to be more abundant in the hemlock forest at Shenandoah.

Figure 2 (above). Eastern hemlocks at Thornton Gap, Shenandooh Notional Park, have died as a result of hemlock woolly adelgid infestation. Note the gap created in the forest canopy by the dead hemlock.

Hemlock stands at Shenandoah National Park and Delaware Water Gap National Recreation Area support unique assemblages of terrestrial and aquatic species that contribute significantly to the biodiversity of the mid-Atlantic's predominantly hardwood landscape. Loss of hemlock ecosystems due to infestation by the hemlock woolly adelgid may result in significant losses of biodiversity especially in unique invertebrate assemblages. These baseline data on the biotic components of hemlock ecosystems is fundamental to the protec-

tion, maintenance, and restoration of hemlock ecosystems threatened by the hemlock woolly adelgid. PS

Literature Cited

Battles, J. J., N. Cleovitt, and T. J. Fahey. 1996. Quantitative inventary af understory vegetation of twa eastern hemlock *(Tsuga canadensis)* stands in Deloware Water Gap Notianal Recreation Area. Draft finol repart. USDI, Natianal Park Service, Mid-Atlantic Regian.

Benzinger, J. 1994. Hemlock decline and breeding birds-I: Hemlack ecology. Recards af New Jersey Birds 20:2-12.

Dollmeier, F. 1992. Long-term manitaring of biological diversity in tropical farest areas. SI/MAB Bialagical Diversity Pragram, Smithsanion Institute and United Nations Educational, Scientific, and Cultural Organizatian (UNESCO), Washington, D.C.

Evans, R. A. 1995. Hemlack ravines at Delaware Water Gap Nationol Recreatian Area: highly valued, distinctive, and threatened ecosystems. Repart. USDI, Notionol Park Service.

Kim, K. C. 1993. Biodiversity, conservation, and inventory: why insects matter. Biodiversity and Canservatian 2:191-214.

Mohan, C. G. 1997a. Computerized biadiversity taxanamic datobose: biological diversity documented, or patentially present, at Deloware Water Gap Nationol Recreation Areo. Progress repart that accampanied Biodiversity Database. The Pennsylvania Stote University, University Pork, Pennsylvonio.

Mahan, C. G. 1997b. Computerized biodiversity taxanamic database: Bialagical diversity dacumented, or patentiolly present, at Shenandooh Notionol Pork. Progress repart that accampanied Biodiversity Datobose. The Pennsylvonio Stote University, University Pork, Pennsylvania.

Mahan, C. G. 1997c. Stand-based study site selection for sampling biolagical diversity in hemlock and nonhemlack farests at Delaware Water Gap Natianal Recreatian Area. Progress report on site selection. The Pennsylvania State University, University Park, Pennsylvania.

Mahan, C. G. 1997d. Stand-based study site selectian far sampling biological diversity in hemlack and nonhemlock farests at Shenandoah Nationol Park. Pragress repart on site selection. The Pennsylvania State University, University Pork, Pennsylvania.

Mahan, C. G., K. A. Sullivan, K. C. Kim, R. H. Yahner, M. D. Abrams, C. Snyder, J. A. Yaung, D. Smith, D. Lemarie, R. Rass, and R. Bennett. 1998. Biodiversity profile assessment af eastern hemlack forests: sampling protocols and pracedures. ERRI Report No. 9806. USDI, Natianal Park Service, Mid-Atlantic Regian.

McClure, M. S. 1991. Density-dependent feedback and papulatian cycles in *Adelges tsugae* (Homaptera: Adelgidae) an *Tsuga canadensis*. Enviranmentol Entomalagy 20:258-64.

Mitchell, J. C. 1991. Reptiles and amphibians. *In* Virginia's Endangered Species. McDanald and Woodward Publishing Ca. Blacksburg, Virginia.

Radford, A. E., H. E. Ashles, and C. R. Bell. 1968. Manual of vascular flara af the Carolinas. The University af Narth Caralino Press. Chapel Hill, North Caralina.

Rogers, R. S. 1978. Forest daminated by hemlock *(Tsuga canadensis)*: distributian as related to site and postsettlement history. Canadian Jaurnal af Batony 56:843-54.

Rass, R., C. Snyder, D. Smith, and J. Yaung. 1996. Aquatic biadiversity in eastern hemlack forests; study plan. U.S. Geological Survey, Bialagical Resources Divisian, Leetawn Science Center. Leetown, West Virginia.

Scioscia, J. C. and E. Pehek. 1995. Small mammal and amphibian papulations and their microhabitat preferences within selected hemlack ecasystems in the Delaware Water Gap Natianal Recreatian Area. Draft finol report. USDI, Notional Park Service, Mid-Atlantic Region.

Smith, D. A., C. Snyder, and J. A. Young. 1996. Sampling design methodology—hemlock biodiversity research pragram; pragress repart. U.S. Geological Survey, Biological Resaurces Divisian, Leetown Science Center, Leetown, West Virginia.

Snyder, C., J. A. Young, D. Smith, D. Lemarie, R. Ross, and R. Bennett. 1999. Influence of eastern hemlock on aquotic biadiversity in Delaware Water Gap Natianal Recreatian Area. Aquotic Ecology Laboratory, Biological Resaurces Divisian, United States Geologicol Survey, Kearneysville, West Virginia.

Sullivan, K., C. G. Mahan, K. C. Kim, R. H. Yahner, and M. D. Abrams. 1998. Assessment of biodiversity assaciated with eastern hemlacks at Shenandooh Notionol Pork. Center for Biodiversity Research, Enviranmentol Resources Reseorch Institute, The Pennsylvania State University, University Park, Pennsylvonia.

Watson, J. K., G. M. Hunt, and J. R. Rhea. 1994. Farest health evaluatian af the hemlock woolly adelgid, *Adelges tsugae* Annand, infestatians in Shenandoah National Park, Virginia. Pragress Repart. USDI, National Park Service.

Yahner, R. H., K. C. Kim, and M. D. Abrams. 1996. Ecosystem-based assessment of biodiversity assaciated with eastern hemlock forests. A research praposal submitted by The Pennsylvania State University to USDI National Park Service.

Carolyn Mahan is currently an Assistant Professor of Biology, Department of Biology, Penn State, Altoona, PA 16601; 814-949-5530; cgm2@psu.edu. *She served as coordinator of the hemlock project in a post doctoral position at Penn State.*

"Wade" continued from page 13

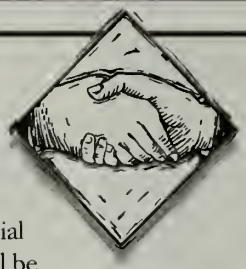
indicator species are not the most reliable indicator of what is going on in the ecosystem.

I just spent four days on Hazel Creek in the park with the fisheries crew, representatives of the North Carolina fisheries program, and the North Carolina local chapter of Trout Unlimited. We collected and transported 175 native brook trout to a stream that had died in the 1920s because of silt loading from logging before the park was established. This was the third year I participated. In past years, we have censused streams, collected data, and looked for restoration sites for brook trout. I cannot describe how moved I was to walk along an old railroad bed with park neighbors and allies carrying back into the wilderness descendants of those living creatures that were destroyed so many years ago. To have come to a point where we could overcome ignorance and take yet another step towards full restoration of this significant park, brought this superintendent to tears. I was not alone in that feeling. The Trout Unlimited representatives who had paid for the project shared it, as did the North Carolina agency people who now count park resources as part of theirs.

I have less trouble imagining the National Park Service having the ability to inventory *what* exists in parks than imagining us keeping the momentum going to continue monitoring for all time. In the field last week, I felt perhaps it's being able to communicate those special moments that will enable us to keep people's interest alive in spending the money for monitoring. Let's be sure to share with the public what monitoring really means for our resources.

Finally, let me finish by telling you that the Smokies is now in the initial stages of attempting a feat that has not been accomplished in the world: a complete inventory of all our species including bacteria. One of the main reasons for doing such a project is to heighten public awareness of just how important such a project is in order to provide stewardship for these resources in perpetuity. When you read about the Discover Life in America/All Taxa Biodiversity Inventory in the Smokies, please remember that we are not only trying to share with the world the significance of this park, but also the significance of the treasure house of resources preserved in national parks. Getting people excited about what we find in the Smokies may help all land managers with the challenge of articulating why we need to know and what it means once we do know. PS

Meetings of Interest



March 22-26

The 10th George Wright Society Conference on Research and Resource Management in Parks and on Public Lands is quickly approaching. This biennial gathering of researchers and resource managers will be held in Asheville, North Carolina, near Blue Ridge Parkway and Great Smoky Mountains National Park. Entitled *On the Frontiers of Conservation: Discovery, Reappraisal, and Innovation,* the conference is organized around concurrent sessions with tracks on management, analysis and synthesis, and Appalachian issues. Details of the conference, its program, and session abstracts are now posted online at *www.portup.com/~gws/gws99.html,* or contact the Society at *gws@mail.portup.com* or 906-487-9722.

May 23-27

To convene in Missoula, Montana, the conference *Wilderness Science in a Time of Change* is fast upon us. Since the first National Wilderness Research Conference in 1985, interest in wilderness has increased, international and societal definitions of wilderness have evolved, and wilderness science has improved. The science gathering will feature research results and knowledge synthesis and its management implications. Three symposia are planned: (1) *Science for understanding wilderness in the context of larger systems;* (2) *Wilderness for science: A place for inquiry;* and (3) *Science for wilderness: Improving management.* Plenary sessions will explore the interface of science and wilderness. Details of the conference including the agenda are posted on the Web at *www.umt.edu/wildscience/default2.htm.* For program information contact David Cole, *Cole_David/rmrs_missoula@fs.fed.us;* registration information is available from Clare Kelly, *ckelly@selway.umt.edu* or call 888-254-2544.

September 23-25

The Society for Ecological Restoration is planning the international conference *Reweaving the World: Restoration, Community, Culture,* to be held at the Presidio in San Francisco, California. Three symposia are planned: *Restoration of Public Lands; Watershed Politics and Management; and Community, Connection, and Stewardship.* The conference will explore ecological restoration from numerous perspectives and scales: large, small, and personal. Workshops, field trips, and presentations will explore current practice and science as it relates to the growing field of ecological restoration. The Society is accepting abstracts and posters until March 15 on the following topics: ethics, research, mining reclamation, wildlife, wetlands, forests, marine, grasslands, fire ecology and management, monitoring, resource education, among others. Conference information can be found at *www.sercal.org/ser99.htm,* or contact the program chair at *amshoff@earthlink.net;* 805-634-9228.

October 11-13

The Fifth Biennial Scientific Conference on the Greater Yellowstone Ecosystem is now in the works and accepting proposals for papers and panel sessions. Entitled *Exotic Organisms in Greater Yellowstone: Native Biodiversity Under Siege,* the conference will explore the conservation of wild biological resources, which is increasingly a matter of protecting native plant and animal assemblages from the threat of nonnative invasions. Topics for discussion include defining "nonnative," the use of biocontrols, ethical considerations for nonnatives, related socioeconomic issues, research and management of numerous nonnative species, and the effects of nonnatives on resources and the human experience in greater Yellowstone. One-page, double-spaced abstracts should be transmitted electronically to *joy_perius@nps.gov* by March 1. The conference will be held at the Mammoth Hot Springs Hotel; registration information is available by calling 307-344-2209.

BULK RATE
POSTAGE & FEES PAID
U.S. Department of the Interior
Permit No. G-83

PARK SCIENCE
Integrating Research and Resource Management
National Park Service
Natural Resource Information Division
WASO-INFO
P.O. Box 25287
Denver, CO 80225-0287

*GPO 773-055

PARK SCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT
Volume 19 • Number 2 • December 1999

U.S. Department of the Interior • National Park Service

Taming the wild pecan at Lyndon B. Johnson National Historical Park

By Marvin Harris

Preface

When President Johnson donated the LBJ Ranch to the people of the United States, one of the few requests he made was that the ranch "...remain a working ranch and not become a sterile relic of the past." To that end, Lyndon B. Johnson National Historical Park, Texas, is attempting to preserve a cultural landscape that includes the ranching and farming activities that LBJ engaged in when he lived here. The pecan orchard, along with other crops and the cattle herd, is managed for sustainable production. The goals are to produce a crop using the best management practices available and to adhere to NPS policies and regulations. Among the policies that we adhere to are those concerning integrated pest management (IPM). The Pecan IPM Plan will meet this responsibility, by reducing the use of pesticides to an absolute minimum, while still fulfilling the cultural and natural resource mandates of the park.

Introduction

National parks provide insights into many facets of the United States of America from the wild beauty of preserved wilderness to carefully managed agroecosystems that reflect our reliance on nature for sustenance and livelihood. The Lyndon B. Johnson National Historical Park contains much of this spectrum within its boundaries, and one plant species in particular provides a link from the frontier of the past to today's society. This plant is the pecan, *Carya illinoensis* (Wang) K. Koch, which is recognized by the Texas Legislature as the state tree of Texas. Cabeza de Vaca's 16th century journal provided the first written record of the pecan. While a captive of American Indians for six years, he noted returning every other year to camp on the river (probably the Guadalupe) to dine for several months almost entirely on pecans. Early traders bartered with wild nuts. Settlers thinned out other trees while leaving the still abundant 100+ foot-high wild pecans to provide nuts and some shade for the cattle that could now graze on the grass that the partially cleared land would support. The wild pecans were the sole source of these delectable nuts until vegetative propagation began late in the 19th century. The pecan is native along the rivers in Texas, and the native range extends eastward to the Mississippi River Valley. George Washington carried pecans as a snack and Thomas Jefferson had trees imported and planted at Monticello, anticipating the massive plantings in Georgia many decades later.

Until the early 1970s, more than 50% of Texas pecan production came from naturally occurring trees. Today, about 35% of the average annual crop of about 65 million pounds in Texas comes from the wild trees. A microcosm of pecan domestication–from wild trees growing in closed canopies adjacent to rivers and streams, to thinned river bottoms suitable for cattle and pecan operations, to a vegetatively propagated pecan orchard (figure 1)–is represented at the LBJ National Historical Park. At the park, an integrated pest management plan has been developed to allow the orchard to be agriculturally productive. The approach to IPM combines an understanding of how natural processes would proceed if left alone, with careful monitoring

Figure 1. Located in the Lyndon B. Johnson birthplace yard, this pecan orchard is managed for sustainable production using integrated pest management techniques. Other pecans on the national historical park are wild and are managed differently.

See "Pecan" on page 20

PARK SCIENCE ISSN-0735-9462
Integroting Reseorch ond Resource Monogement

Volume 19 – No. 2 • December 1999
www.nature.nps.gov/parksci

Publisheo by
U.S. Deportment of the Interior
Notionol Pork Service

Director
Robert Stanton

Associate Director, Natural Resource Stewardship & Science
Michoel Soukup

Eoitor
Jeff Selleck
(jeff_selleck@nps.gov)

Editoriol Office
Notionol Pork Service
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287
Phone 303-969-2147
FAX 303-969-2822

Park Science is o reseorch ond resource monogement bulletin of the Notionol Pork Service thot reports recent ond ongoing noturol ond sociol science reseorch, its implicotions for pork plonning ond monogement, ond its opplicotion in resource monogement. It is published bionnoully, in the summer ond foll, by the Noturol Resource Informotion Division of the Noturol Resource Progrom Center. Additionol issues, including themotic issues thot explore o topic in depth, ore published on occosion. Content receives editoriol review for clority, completeness, usefulness, bosic scientific soundness, ond policy considerotions; moteriols do not undergo ononymous peer review. Deodline for submissions is Moy 15 for the summer issue ond August 15 for foll. Letters thot oddress the scientific content of on orticle ore welcome; they moy be edited for length, clority, ond tone. Mention of trode nomes or commerciol products does not constitute endorsement or recommendotion for use by the Notionol Pork Service.

Park Science is olso publshed on-line (ISSN-1090-9966). All bock issues of the publicotion, orticle submission guidelines, ond other useful informotion reloted to the publicotion con be viewed ond downlooded from the website www.noture.nps.gov/porksci.

Park Science occepts subscription donotions from non-NPS reoders. If you would like to help defroy production costs, pleose consider donoting $10 per subscription per yeor. Checks should be mode poyoble to the Notionol Pork Service ond sent to the editor.

Contributors—Elizobeth Rockwell (Informotion Crossfile)

Contents

Departments

Features

In the next issue...

Originally planned for this issue, our emphasis on the social sciences in parks will appear next time in *Park Science*. Guest editor Jared Ficker of the NPS Social Science Program has pulled together a broad array of articles that explore the application of economics, political science, sociology, and other social science disciplines in park management. Publication will be in the early winter with a routine edition of *Park Science* following in summer.

Interpretation joins the mix

I am excited to welcome Judy Visty, Fall River District Interpreter at Rocky Mountain National Park, to the Park Science Editorial Board. Judy occupies a new board position that reflects our deliberate effort to be more inclusive of interpretation in the articles contained in this publication. The change will be subtle, but with Judy's help, I will look for opportunities to incorporate the implications of research on interpretive operations in parks and to relate the role of interpretation in sharing the results of research and its application in resource management. Similarly, I welcome Jared Ficker of the NPS Social Science Program as a new board member, serving the interests of the social sciences. His expertise will help integrate this important and growing field into the mix of articles that routinely appears in these pages. Judy's and Jared's appointments are the result of a call for nominees over a year ago and are sure to serve the publication well. Thanks to all who expressed an interest in serving *Park Science* in these positions.

–Jeff Selleck, Editor

Corrections

Omission

Last issue, the article on elephant seals at Point Reyes (volume 19(1):30-31) failed to acknowledge the financial support for the project from Canon U.S.A., Inc. Since 1995, Canon has provided over $3,500,000 in cash and equipment to 49 parks through Expedition Into the Parks, a grants program administered by the National Park Foundation. We apologize for the omission.

URL in error

Also last issue, the Information Crossfile piece entitled "Popularity of parks affects policy making" cited a faulty URL for the full-length text on the World Wide Web. The URL should have read www.du.edu/law/lawreview/home.html.

Tortoise what?

Lead author Jeff Lovich ("Studies of reproductive output of the desert tortoise...," *Park Science* 19(1):22-24) pointed out a humorous error in the caption for figure 3 that ran with the article. A publication layout problem obscured the final word of the last sentence such that it read, "Nests are often constructed in the mouth of a tortoise." The missing word was "burrow."

Any inconvenience this may have caused for the tortoise (or the authors) is regretted. –*Editor*

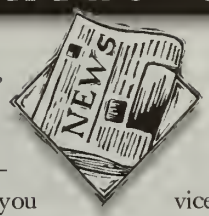
Guest editors, ideas wanted

Park Science occasionally publishes thematic issues that explore topics of special interest to resource managers. The bulk of such issues is devoted to the in-depth treatment of the topic. The departments of the publication (Highlights, Information Crossfile, and the others) are unaffected and continue to report their resource management news in the usual way. Examples of past themes are "Global Change" (volume 10(4)) and "Pollution in Parks" (volume 6(4)). Our next issue (volume 20(1)), in the works for more than a year, will be titled "Social Science–Useable Knowledge for NPS Managers."

Thematic issues are commonly put together by a guest editor (or editorial team) who sees a need and has the interest, ability, and specialized subject-area knowledge to solicit, gather, review, edit, and prepare the bulk of the materials for the issue. The editor serves as a technical consultant to the guest editor during development of the concept and materials for the thematic issue, and is responsible for the layout and design of the issue, its printing, and circulation. The Park Science Editorial Board reviews the materials for these issues and may also aid in their development.

Planning for a thematic issue begins with a proposal submitted usually one to two years before release of the publication. A proposal states the theme, its timeliness and relevance to the publication audience, and the article treatments envisioned to systematically cover the topic. It also describes a process and approximate time line for announcing the issue, inviting contributions, and reviewing and preparing the materials for publication. Finally, it spells out the qualifications of the guest editor. The Park Science Editorial Board considers proposals based on the currency of the topic, applicability of the material, budget, and publishing schedule. If selected, the editor and guest editor outline their respective roles and responsibilities and begin work on the project.

Topics suggested recently for thematic issues have included hazardous materials, damage assessment procedures, GIS, ecosystem management, and the contributions of various NPS operations to the Environmental Quality Initiative. If you would like to serve as guest editor to bring one of these ideas to fruition, or if you have a proposal for a thematic issue and a guest editor who could pull the materials together, please contact *Park Science* editor Jeff Selleck (jeff_selleck@nps.gov). Proposals for thematic issues and nominations of guest editors are accepted at any time.



Science scholarship program announced for 2000

The Canon National Parks Science Scholars Program will award scholarships to eight doctoral students in 2000. Each student selected will receive $25,000 per year for up to three years to conduct dissertation research in the national parks. In addition, four honorable mentions will be awarded a one-time scholarship of $2,000.

The competition will focus on four research topics within the biological, physical, social, and cultural sciences. Selected by the National Park Service, the research topics are of critical importance to the management of the national park system. Students applying for 2000 scholarships must submit dissertation proposals that address these topics.

For an application and guidelines, contact Dr. Gary Machlis, Program Coordinator, Canon National Parks Science Scholars Program, Natural Resource Stewardship and Science, National Park Service, 1849 C Street NW (MIB 3127), Washington, D.C. 20240; gmachlis@ uidaho.edu or visit www.nps.gov/socialscience/waso/acts.htm. Applications are due 1 June 2000. Winners will be announced shortly after 7 August 2000.

Highest natural resource honors bestowed

The National Park Service recently presented five individuals with its 1998 Director's Awards for Natural Resource Stewardship. The honors recognize outstanding achievements in the protection of ecosystem health in parks. The awards were given during September at the Society of Ecological Restoration's annual meeting, held at the Presidio in San Francisco. This year's winners have fought to prevent exotic plants from destroying native vegetation, developed programs to inventory and monitor park plants and animals, and applied science to help managers make sound decisions.

Kathy M. Davis, Chief of Resource Management with the Southern Arizona Office (Phoenix) is the recipient of the Director's Award for Natural Resource Management. She is recognized for her leadership in the development and implementation of the NPS Resources Careers Initiative. Under Kathy's leadership, the Resources Careers task force conceived, developed, and completed professional, career-ladder position descriptions and classification evaluation statements in natural and cultural resource series and in interdisciplinary series. Her efforts affect every resource manager in the National Park Service by creating a framework for professionalization and success. Additionally, Kathy serves as an effective resource manager for 10 small parks in southern Arizona.

William Halvorson is the Cooperative Park Studies Unit Leader at the University of Arizona–USGS Biological Resources Division. Halvorson is a champion of research applicabil-

Continued on page 4

Continued from page 3

ity in park management. His continual, professional support of park staffs and commitment to quality research and resource management in national park areas in southern Arizona has enabled these units to overcome significant challenges. One of his trademarks is communication of research results through such means as a forum he helped found for the discussion and evaluation of natural and cultural resource programs. Additionally, he published Bajada (a research newsletter) for several years and coauthored an important chapter entitled "A lesson learned from a century of applying research to management of national parks" for the 1996 book, *Science in Ecosystem Management in the National Parks.*

Karen Wade is the winner of the Director's Award for Superintendent of the Year for Natural Resource Stewardship. As Superintendent of Great Smoky Mountains National Park, North Carolina and Tennessee, Karen encouraged her staff to initiate the All Taxa Biodiversity Inventory, an ambitious effort to identify all species living within the park. Under her direction, the park developed a strategy to complete the inventory without significant federal funding. Additionally, Karen is widely regarded as a creative thinker and believes strongly that partnerships among a broad cross-section of constituents are key to solving problems related to park issues. She has recently become Intermountain Regional Director of the National Park Service.

Richard R. Potts II is the Natural Resource Program Manager at Kalaupapa National Historical Park, Hawaii, and recipient of the Trish Patterson-Student Conservation Association Award for Natural Resource Management in a Small Park. In just over three years, Rick has transformed natural resource management at the park from virtual nonexistence into an energetic program that addresses a wide range of issues from an ecosystem perspective. He has identified threats within designated, high priority "special ecological areas" within the park, and obtained funding to equip a vegetation management specialist. Under Rick's leadership, several thousand acres of native Hawaiian ecosystems are being protected from alien ungulates by fencing, administrative hunting by local hunters, and aerial shooting. Also, he has also instituted monitoring programs for key native Hawaiian species, developed population estimates of axis deer and pigs, and helped protect marine and freshwater resources in Kalaupapa. As a result of the award, the Student Conservation Association will underwrite a seasonal SCA Resource Assistant position for the park.

Joseph Dunstan is the Sustainability Coordinator for the Pacific West Region and recipient of the Director's Award for Excellence in Natural Resource Stewardship through Maintenance. Joe is a leader in promoting sustainable practices and opportunity planning in parks. He has been able to increase the role of sustainability in the parks by conducting team evaluations of such park operations as maintenance, concessions and visitor services, handling of waste, and energy uses. The team identifies resources flowing into a park, describes how the activities of staff and visitors alter those resources, and explores ways parks can incorporate additional sustainable practices into daily routines.

Park Science congratulates these winners and encourages readers to be thinking of nominees for the 1999 awards. Nominations will be solicited in the near future on the NPS Natural Resources Bulletin Board on cc:Mail.

Former chief scientists on the move

Over the past two years, three former regional chief scientists with the National Park Service have moved on to other career positions in the federal government and one has retired.

Dr. William Anderson retired from the National Park Service in March 1998. Bill began his NPS career in 1973 as a plant pathologist with the NPS Ecological Services Laboratory in Bay St. Louis, Mississippi. In 1976, he began a five-year stint with the North Atlantic Region as a plant scientist. In 1981, he became the Chief Scientist of the National Capital Region and retired in the position of regional Natural Resource Officer. While with the region, Bill helped establish the Center for Urban Ecology, providing quality laboratory and office space for his staff. He also helped bring about interregional support within the National Park Service for the Chesapeake Bay Initiative.

Dr. Suzette Kimball left the National Park Service in October 1998 to became the Eastern Regional Biologist with the USGS Biological Resources Division (BRD) in Kearneysville, West Virginia. Suzette joined the Park Service in 1991 as the research coordinator for the barrier island component of the Global Climate Change Program. She also served as Southeast Regional Chief Scientist before assuming the position of Associate Regional Director. During her NPS career, she was a member of the NPS Science Advisory Council, Natural Resources Advisory Council, and the ad-hoc geologic resources advisory group. In her new post, Suzette oversees BRD programs, facilities, and services, including seven scientific research centers, for an area that stretches from Canada to the Caribbean and west to the Mississippi River.

During fall 1999, Dr. Dan Huff accepted a detail with Region 6 of the U.S. Fish and Wildlife Service (FWS) to serve as team leader for the development of the Jackson (Wyoming) bison and elk management plan and environmental impact statement. Dan's position is funded jointly by the NPS and FWS under a cooperative agreement. As former Rocky Mountain Regional Chief Scientist and Intermountain Assistant Regional Director for Natural Resources and Science, Dan was a leader in addressing controversial and complex wildlife management issues, serving for several years as the chair of the Greater Yellowstone Interagency Brucellosis Committee. His new position is sure to be similarly important and challenging.

As the article on page 14 explains, Dr. Ron Hiebert has been selected as the first Research Coordinator of the Colorado Plateau CESU in Flagstaff. He remains with the National Park Service in this role. Ron served as the Regional Chief Scientist in the Midwest Region beginning in 1988, becoming its Assistant Regional Director for Natural Resources in 1995. Throughout his career, Ron has been interested in the preservation and restoration of ecosystems and the management of exotic plant species. Additionally, he has been involved with numerous NPS initiatives and work groups and has served as chair of the Park Science Editorial Board since 1994.

All four former regional chief scientists distinguished themselves in their positions of leadership and will be missed. *Park Science* thanks them for their contributions to the resource preservation mission of the National Park Service and for their support of this publication. We wish them success in their new endeavors. PS

Figure 1 (above). First sight of Novosso Island reveals the beacon (arrow), location of the "dry" team's camp.

Figure 2 (map). Shaped like an oyster, Navassa is located approximately 100 miles south of Cuba and 35 miles west of Haiti.

Natural history on a little-known island: Cracking Navassa's oyster

ARTICLE AND PHOTOGRAPHS BY JIL M. SWEARINGEN

As an entomologist for the National Park Service, I recently participated in an expedition to survey the natural resources of Navassa Island (figure 1), a small U.S. territory in the Caribbean Sea (figure 2). Located about 35 miles west of Haiti and 100 miles south of Guantanamo, Cuba, Navassa had been under the administration of the U.S. Coast Guard, which operated a beacon there since the early 1900s (arrow, figure 1). In 1996, the Department of the Interior began to administer this 1.9-square-mile spot of land, and in 1998 requested a natural resources inventory in order to determine the island's future status. This was an exciting opportunity to participate in a historic, scientific expedition to document the natural history of a remote, Caribbean island, and a chance to make discoveries that would prove significant in the disposition of the island.

National parks, wildlife refuges, and other protected public lands are set aside, by and large, to preserve unique, uncommon, beautiful, and otherwise exceptional examples of natural landscapes, scenery, historic and cultural resources, geologic and hydrologic features, and biological resources, including large animals or "showy megafauna." While protection of a selected keystone species is sometimes the main purpose for land preservation, the decision is rarely based on good knowledge of the plants, insects, and other less conspicuous occupants of a site. These elements of biodiversity far outnumber vertebrate species and provide essential food and habitat for their mammoth cousins. Large, natural areas such as national parks, nature preserves, and wildlife refuges, are likely to contain significant biological diversity, requiring many years of scientific inquiry to reveal. Navassa Island was certainly an exception to this rule; it was proposed for designation as a U.S.-managed national wildlife refuge in June 1999, based primarily upon the results of our brief, but intensive natural resources survey.

Survey teams assembled

The Center for Marine Conservation in Washington, D.C., organized the expedition, which consisted of terrestrial (figure 3) and marine resources teams (table 1, page 6). The goal was to conduct as complete as possible inventories of the plants, invertebrates, herpetiles, birds, mammals, fish, corals, and other organisms during a 12-day visit. A geologist was included to sample rocks, soils, and other materials, for the purpose of determining the age and composition of the island and to attempt to unravel the island's geologic history. My role as part of the terrestrial team was to assist with the entomological surveys and to help photo-document the journey and survey activities.

Historical exploration of Navassa

Although our surveys of Navassa Island would be the most comprehensive, they were not the first. The island was discovered in 1504, when Christopher Columbus dispatched members of his crew from Jamaica to Hispaniola to get some badly needed supplies. They encountered Navassa en route and inspected it briefly, becoming the first known to set foot on it. Because the crew reported an apparent lack of water, Columbus had no interest in revisiting the island. Knowledge of the island's natural resources, particularly the flora, began accumulating in the late 1700s. Around 1785, Swedish botanist Olaf Swartz, sailing for Jamaica, passed by Navassa and recorded two cliff-dwelling plant species, which he presumably could see from his ship. The island became U.S. property in 1857 when Peter Duncan, a U.S. citizen, claimed Navassa under the provisions of the newly passed (1856) Guano Act, which allowed any person to lay claim to uninhabited islands that contained large amounts of guano fertilizer. Mr. Duncan set up a mining operation and mined the phosphate guano from 1865-98, with the help of recently freed slaves from Baltimore, Maryland. In October 1928, E. L. Ekman, a second Swedish botanist, spent two weeks on Navassa and reported 102 plant species, 44 of which he believed to be native. He published the results of his survey in the journal "Arkiv for Botanik" in 1929. Fifteen

Figure 3. The terrestriol survey crew consisted of (clockwise from top row, right, ending in center) Robert Powell, Bill Buck, Tom Zononi, Jil Sweoringen, Worren Steiner, Robert Holley, Jomes Olond, ond Michoel Smith.

"Navassa" continued on page 6

"Navassa" continued from page 5

months later, H. A. Rehder, from the Arnold Arboretum of Harvard University, collected about two dozen plants. He was followed by Dr. George Proctor, a botanist with the Institute of Jamaica, who visited the island for four days in 1956 and documented 38 species of plants.

Before our expedition in 1998, only one invertebrate (a spider) was known for the island and no published records of any insects existed, although two beetle specimens (different species) were located in the Museum of Comparative Zoology, Harvard University. Beyond these, any invertebrates we collected would be new records for the island.

Figure 4. A Coast Guard helicopter, on board the cutter, ferried the survey participants to the island.

Getting there

Against this historical backdrop the terrestrial, or "dry team," met for the first time in Ft. Lauderdale, Florida, on July 21 1998, and began final preparations for the intensive 12-day survey of the natural resources of Navassa Island. We departed early the next morning by charter plane (Fandango Air) for Guantanamo Bay, Cuba, where we spent the night on base and had one morning to purchase all of our food and other perishables for the expedition. In Guantanamo Bay, we were loaded onto a 270-foot Coast Guard cutter (figure 4) for a 12-hour, overnight journey to the island. We were extremely well looked after while under the care of the Coast Guard, whose outstanding logistical support made the terrestrial survey possible. Getting onto the beachless, cliff-rimmed island is treacherous and requires a helicopter for most purposes. A rusted, part-rope, part-steel ladder hangs from a cement slab at Lulu Bay and is used by Haitian fisherman who frequent the island. However, from the cutter anchored offshore, we were ferried to the island by helicopter, along with our supplies and six, 50-gallon barrels of water, requiring nine sorties.

Once on the island, we were impressed and surprised by the vast expanse of forest (figure 5) and highly eroded and pitted limestone rock base. Several grassy savanna-like clearings in the vicinity of the lighthouse were welcome openings. We set up camp at the base of the dismantled lighthouse and in an adjacent roofless building, the base of which, we discovered, held two large cisterns of water. We deemed this water clean enough to use for washing, which greatly reduced the demands placed on our limited drinking water supply. During the following week and a half, we explored the island using limited remnant paths from the mining operations, and otherwise made our way slowly through the dense vegetation with the help of global positioning system units, to prevent our getting lost and also to obtain digital location points.

Table 1.
Navassa expedition participants

Terrestrial Resources Team		
Expedition Coordinator	Michael Smith	Center for Marine Conservation
Botanists	Bill Buck & Tom Zanoni	New York Botanical Garden
Entomologist	Warren Steiner	Smithsonian Institution (Dept. Entomology)
Entomologist	Jil Swearingen	U.S. National Park Service
Geologist	Robert Halley	U.S. Geological Survey
Herpetologist	Bob Powell	Avila College (Kansas City, MO)
Ornithologist	James Oland	U.S. Fish and Wildlife Service
Marine Resources Team*		
Marine Mammalogist	Nina Young	Center for Marine Conservation
Phycologist	Barrett Brooks	Smithsonian Institution (Dept. Botany)
Submersible Technician	Ian Griffith	Deep Ocean Exploration & Research (CA)
Phycologist	Diane Littler	Smithsonian Institution (Dept. Botany)
Phycologist	Mark Littler	Smithsonian Institution (Dept. Botany)
Ichthyologist	Llena San	CEBSE & National Mus. of Natural History (Santo Domingo, Dominican Rep.)

*The marine surveys were conducted from the ship Maga del Mar, operated by Captain Rafael Castellanos and four crew, and owned by the Dominican Ministry of Fisheries.

The surveys

The surveys revealed that Navassa's terrestrial and marine environments have significant biological and cultural values in need of protection. The surface terrain and geology reveal an ancient and isolated island, estimated to be between 2 and 5 million years old, and the island's biota includes a rich diversity of plants and animals, including some that occur nowhere else. The human history of the island is equally interesting and deserves separate attention.

Plants

About 120 plants are known to occur on the largely forested island, dominated by four species of tropical-subtropical trees: *Sideroxylon foetidissima, Ficus populnea var. brevifolia, Coccoloba diversifolia*, and the highly toxic poisonwood, *Metopium brownei*, that plagued the group with blistering poison ivy-like skin rashes. Two endemic palms occur on the island, one found commonly, and the other barely hanging on as a single live specimen. A number of exotic plants occur on Navassa, including the popular ornamental Madagascar periwinkle *(Catharanthus roseus)*, almost certainly introduced by people visiting or residing on the island during the past hundred or more years.

Invertebrates

In attempting to collect as many different species of insects and other invertebrates as possible during our visit, we employed a wide array of collecting techniques and placed traps in a variety of habitat types and zones. Trap methods included pitfall cup traps (figure 6) and Malaise traps (vertical flight intercept nets) fitted with yellow pans of soapy water set on the ground to catch insects that fall

Figure 5. The mostly forested landscape of Navassa Island conceals its rugged terrain of pitted limestone, which required care to safely negotiate during the expedition.

Figure 6. The entomologists used pitfall traps, shown here, and other survey techniques to collect insects and other invertebrates.

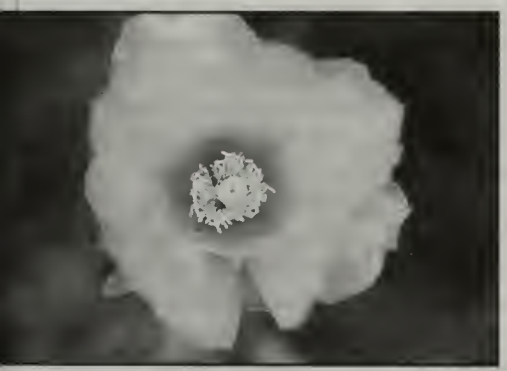


Figure 7. Preliminary results from the terrestrial survey indicate over 500 new insect species records for the island, including an unidentified bee species that was found pollinating a prickly pear cactus (Opuntia nashii).

when they hit the nearly invisible screening. Night-flying insects were attracted using black (ultraviolet) lights against white sheets that were hung at different locations. Various manual methods were used to sample leaf litter, soil, rotten wood, fungi, foliage, air, and water.

A preliminary examination of our collections reveals 650 species of invertebrates, including over 500 new insect species records for Navassa (figure 7), 30% of which may be endemic. Over 100 non-insect arthropods, mostly spiders, make up the rest. Many specialists will be needed to work on this diverse material to get it to final species-level identifications.

Vertebrates

Vertebrate surveys confirmed the existence and abundance of four endemic herpetiles, two lizard species *(Celestus badius* and *Anolis longiceps)* and two gecko species *(Aristelliger cochranae* and *Sphaerodactylus becki)*, all previously reported for the island. Four other known species, including a large endemic iguana that may have been eaten to extinction, and a boa, could not be relocated. Several dozen species of tropical birds inhabit the island, and are dominated by the highly vocal white-crowned pigeon, red-footed booby, and brown booby. A number of cliff-nesting birds including the bridled tern, added to the diversity. No endemic mammals are known to occur on Navassa, and the group is now represented exclusively by introduced species such as the black rat, goat, dog, and possibly cat.

Reflections

This expedition was valuable to me as a scientist and NPS employee, and on a personal level. It was the first "rapid bioassessment" project I had participated in and, while exciting for me, came with some sources of anxiety. First, I was the only female on the terrestrial team and would be living very closely with seven men I had not previously known (except for my husband, the other entomologist on the team) on an isolated, exposed speck of land in the middle of the Caribbean Sea. Secondly, the terrain was extremely difficult to negotiate and the climate was uncomfortably hot and humid. Each of us was keenly aware that a single, serious injury could jeopardize the entire effort and require emergency rescue by helicopter, which was not readily available until the completion of our survey. And, I was selected to join the expedition with only five days' advance notice. Due to the complicated logistics, careful preparation and planning were required before and throughout the course of the trip. Fortunately, the eight of us got along swimmingly. We worked very hard, shared camp duties equitably, learned a lot from each other, and had a lot of fun despite the heat, sweat, and unrelenting poisonwood rashes.

The experience also got me thinking about the general lack of information about invertebrates in most of our national parks and other preserves and the great need for surveys to illuminate this information. Rapid bioassessment-type surveys, such as the one conducted on Navassa, attempt to collect comprehensive information on the biodiversity of an area in a short period of time. Surveys conducted under the NPS Inventory and Monitoring (I&M) Program attempt to identify 90% of the vertebrates and vascular plants in a given park over a longer period of time. Invertebrates, non-vascular plants, fungi, and other critical elements of diversity are not currently included in these surveys. In addition to species lists, the I&M inventories also compile information about the distribution of species in a park (at least for threatened and endangered species or other species of concern), their relative abundance, and their association with habitats. Both approaches to species inventorying, while limited, provide information that helps us better understand the ecological value of our natural resources and can direct us in our land protection efforts. Ideally, biological surveys should be as inclusive as possible and be continued over an extended period of time to document short-lived or highly seasonal species. PS

References

Powell, R. Herpetology of Novosso Island, West Indies. Coribbeon Journal of Science **35(1-2):**1-13.

Proctor, G. R. 1959. Observations on Novosso Island. Geonotes, Quorterly Journal of the Jomoico Group Geologic Association Volume II, Port **2:**49-51.

Steiner, W., and J. Sweoringen. 1999. Entomology on Novosso Island. Project Update for Smithsonion Institution Department of Entomology. (Jonuory). 2 pp.

Jil Swearingen serves as Integrated Pest Management Coordinator for the NPS National Capital Region, Natural Resource and Science Services, Center for Urban Ecology, Washington, D.C.; jil_swearingen@nps.gov.

Editor's Note: Visitation to Navassa Island requires permission from the U.S. Department of the Interior, Fish and Wildlife Service.

PACIFIC-GREAT BASIN

Prescribed fire effects investigated

Redwood National and State Parks (California) have formed a partnership with the research branch of the USDA Forest Service in order to study the effects of prescribed fire on ecosystem function of coastal prairies. The study site is the Bald Hills, an area within Redwood National Park that includes about 1105 ha (2,729 acres) of coastal prairies and 620 ha (1,531 acres) of oak woodlands. This area has a history of occupation and burning by American Indians over the past 4,000 years, followed by a reduction in fire frequency in association with European settlement during the last 150 years. The park currently conducts the majority of its prescribed burns within the Bald Hills in an attempt to restore natural processes in this fire-dependent ecosystem. However, the effects of prescribed burning on this area are not fully understood.

The study approach is twofold. First, the research will experimentally evaluate the effects of prescribed fire on populations of small mammals and reptiles. Objectives are to determine the effects of prescribed fire on population characteristics (e.g., density, survival, and fecundity) of small mammals and reptiles, and to determine how long potential effects last. The second research component will evaluate associations between raptor abundance and burn history (frequency of burns and number of years since last burn) throughout the Bald Hills. The researchers hope to determine whether potential effects on prey populations observed in the first component are influencing habitat use patterns of a major group of predators in the Bald Hills. Focus of the research is on the prairie habitat, the dominant habitat type in the Bald Hills.

Aerial view of Maneze Prairie seven weeks after the three study grids were burned. Each of the three treatment (burned) grids is located near the center of the burned area, and each of the three control (unburned) grids is located to the left of a burned area.

The study is being conducted on Maneze Prairie, an area within the Bald Hills that had not burned in at least the 20 years before this study. In preparation for prescribed burning, personnel from the parks set up rectangular grids (0.4 ha or about 1 acre in size) 80 meters apart. During September 1998, staff burned every other grid in Maneze Prairie, including a buffer strip >40 m wide, resulting in three treatment (burned) and three control (unburned) grids (see photo).

The burn provided an opportunity to obtain short-term movement and mortality information for California voles *(Microtus californicus)*. The researchers radio-collared and tracked 18 adult voles in the three burned grids (6 voles per grid, 3 males and 3 females) before and up to a month after the prescribed fire. They will continue to sample small mammal and reptile populations and vegetation structure and composition four times per year for the next 2–4 years. Analysis of variance procedures will be used to compare changes in population characteristics from pre-treatment to post-treatment sample periods between burned and unburned grids.

The study of association between raptor abundance and burn history was initiated during the winter of 1998–99 and will continue throughout the upcoming years. To calculate an index of raptor abundance, the researchers are conducting standardized roadside counts along the Bald Hills Road. Observations of raptors are marked on a map, and behavioral information (e.g., hovering, flying, perched) is recorded. Frequency analyses will be used to evaluate relationships between raptor abundance and measures of burn history (e.g., burn frequency and number of years since last burn).

Results from the ongoing research will be reported in a future issue of *Park Science* and in journal articles.

CHESAPEAKE

Forest studied at George Washington Birthplace

Marc D. Abrams, Professor of Forest Ecology and Tree Physiology in the School of Forest Resources at Penn State University, recently completed a study of the composition, structure, and dendroecology of a mature loblolly pine-mixed hardwood forest at the George Washington Birthplace National Monument, eastern Virginia. Loblolly pine, sweetgum, holly, blackgum, and several oak species dominate the forest. Blackgum trees dominated recruitment from 1840-1900, based on current age structure. All other tree species are less than 100 years old. A compilation of major and moderate radial growth releases revealed multiple disturbance events in most decades from 1870-1990. A dramatic increase in the radial growth of blackgum occurred in the late 1880s, probably in response to selective logging of pine and hardwood timber species. This disturbance stimulated the recruitment of blackgum followed by loblolly pine and other hardwood species. A decline in blackgum recruitment occurred during the 20th century. The existing loblolly pine range in age from 64-105 years, and this species stopped recruiting in 1935. Seedlings and saplings of all species are scarce, with the exception of holly, a highly shade-tolerant, understory tree species. Loblolly pine trees in the overstory may exhibit future declines because of their relatively short longevity, insect attack, and windthrow. Given current conditions, the future stand composition most certainly will contain less loblolly pine and more hardwoods, including sweetgum, blackgum, and holly.

NEW ENGLAND

Johnson to Rhode Island

The Northeast Region recently hired Elizabeth Johnson, former Chief of Research and Resource Planning at Delaware Water Gap National Recreation Area, as the Regional Inventory and Monitoring Coordinator. Beth will be stationed at the University of Rhode Island on the Kingston campus.

Millennium checkup

The millennium can be a useful milestone to measure progress with the resource stewardship of our national parks. The Northeast Region in conjunction with the George Wright Society and the Conservation Study Institute will host a conference at Valley Forge, Pennsylvania, 19-21 January 2000, which will provide an opportunity to reflect on the region's work, share successful approaches, and prepare for meeting the challenges of stewardship in 2000 and beyond. For more information please refer to the conference website at http://www.portup.com/~gws/ner2000.html. PS

Ecological stewardship works published

The much anticipated, three-volume work *Ecological Stewardship: A Common Reference for Ecosystem Management* (ISBN 0-08-043206-9) is now in print. Published by Elsevier Science (www.elsevier.com) in association with the USDA Forest Service and the World Resources Institute, the three-volume set is the result of work begun in 1995 at the interagency Ecological Stewardship Workshop in Tucson (*Park Science* **16**(2):13-15). At the workshop, participants detailed plans for documenting the knowledge base and management challenges for implementing ecological stewardship approaches to natural resource management. As a result, 60 papers were drafted and address both the scientific and management aspects of six themes: shifting public values; expectations and law; social and cultural dimensions; humans as agents of ecological change; biological and ecological dimensions; and economic dimensions and information collection and evaluation. Volume I presents key findings and volumes II and III are the full papers. At 1,500 pages, the hardback set costs $250 and includes a CD-ROM.

Also recently published is the USGS report *Status and Trends of the Nation's Biological Resources*. This two-volume set details the issues affecting biological resources and the status and trends of these resources in specific regions of the United States. The full-color report (stock number 024-001-03603-7) contains 1,000 pages of information ranging from descriptions of the natural processes affecting our nation's ecosystems, reasons for the current condition of our natural resources, and discussion of the forces that have the most significant impact on these resources, among other topics. The report is available from the Superintendent of Documents, U.S. Government Printing Office (www.gpo.gov/su_docs/sale.html), for $98.

Deer census methodologies reviewed

The large increase in white-tailed deer numbers in recent decades throughout much of the eastern United States has resulted in an urgent need to determine the size of many deer populations. To assist resource managers and biologists in selecting a census technique suitable for local conditions and a variety of project goals and objectives, authors Allan O'Connell, Jr.[1], Linda Elyse[2], and John Zimmer[3] have published the "Annotated bibliography of methodologies to census, estimate, and monitor the size of white-tailed deer *(Odocoileus virginianus)* populations." The methodologies described in the bibliography include references in the field of sampling techniques, enumerating and estimating biological population size, monitoring trends, and an extensive list of scientific literature in these fields specific to white-tailed deer. A historical account of techniques used to count and estimate the size of deer populations during the 20th century also has been provided. Citations appear in ProCite format (version 4.03) with abstracts and keywords; indexes for keywords and authors have been included to facilitate retrieval of information.

The report was funded through the NPS white-tailed deer research initiative and is published by the NPS Boston Support Office (Technical Report NPS/BSO-RNR/NRTR/00-2, July 1999, NPS D-200). It is available on the World Wide Web in both HTML and PDF formats. To see the report, visit www.pwr.usgs.gov/library/bibs.htm and click on the title of the bibliography.

[1]Cooperative Park Studies Unit, Patuxent Wildlife Research Center, USGS-BRD, University of Maine, Orono.
[2]Department of Wildlife Ecology, University of Maine, Orono.
[3]Acadia National Park, Bar Harbor, Maine.

Northeast reports available

The Natural Resource Management and Research Office of the NPS Boston Support Office has recently published the following reports:

Schauffler, M., and G. L. Jobabsen, Jr. 2000. Paleoecology of coastal and interior *Picea* (spruce) stands in Maine. Research summary and management recommendation. NPS/BSO/RNR/NRTR/00-1. NPS D-204.

Glanz, W. E., and B. Connery. 2000. Biological inventories of Schoodic and Carea Peninsulas, coastal Maine, 1996. NPS/BSO/RNR/NRTR/00-4. NPS D-199.

Sneddan, L. 1999. Classification of coastal plain pondshore communities of the Cape Cod National Seoshore. (Number not assigned as of press time).

Chilelli, M., J. R. Gilbert, B. Griffith, and A. F. O'Connell, Jr. 1998. Analysis of factors affecting population viability and reintraduction attempts of native mammals in Acadia National Park. Technical Report NPS/NESO/RNR/NRTR/98-06. NPS D-191.

Higgins, J., A. F. O'Connell, Jr., and F. A. Servella. 1998. Survey of flying squirrels and their association with vegetation communities on Mt. Desert Island (Acadia National Park), Maine. Technical Report NPS/NESO/RNR/NRTR/98-08. NPS D-194.

Matz, A., J. R. Gilbert, and A. F. O'Connell, Jr. 1998. Acadia's bald eagles: research summary and management recommendations. Natural Resources Report NPS/NESO/RNR/NRTR/98-07. NPS D-192.

The last report listed was funded through the Natural Resources Preservation Program. Eight pages in length, it is a compilation of ecotoxicology and the effects of human disturbance on nesting eagles.

Copies of the reports are available from the Boston Support Office (carol_daye@nps.gov).

Yellowstone bears in print

Staff of Yellowstone National Park and their research colleagues have recently published several professional articles addressing various bear ecology and management issues in the world's first national park:

Cansala Murphy, S., and B. Kaeding. 1998. Fishing Bridge: 25 years of controversy regarding grizzly bear management in Yellowstone National Park. Ursus **10**:385–393.

Gunther, K. A., and H. E. Hoekstra. 1998. Bear-inflicted human injuries in Yellowstone National Park, 1970–1994. Ursus **10**:377–384.

Murphy, K. M., G. S. Felzien, M. G. Harnacker, and T. K. Ruth. 1998. Encounter competition between bears and cougars: some ecological implications. Ursus **10**:55–60.

PRIMENet report out

The First Annual Report (1999) of the Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet) was published in June. The report describes progress at the 14 designated PRIMENet parks

Continued on page 10

Continued from page 9

on establishing research and monitoring of air pollution and UV effects on park resources. Copies of the report, now being reprinted, are available from NPS PRIMENet coordinator Kathy Tonnessen (kathy_tonnessen@nps.gov).

Visibility in the parks

The NPS Air Resource Division and the Cooperative Institute for Research in the Atmosphere (CIRA of Colorado State University) have published "Introduction to Visibility" (ISSN 0737-5352-40). Written by William C. Malm of the National Park Service, the primer examines the nature of visibility problems in the national parks, beginning with a look at the physics of light, its interaction with particles in the atmosphere, and the nature of vision through the atmosphere. The resource is easy to understand, printed in full color, and available from the author (malm@terra.cira.colostate.edu).

Prescribed fire volume released

The Tall Timbers Research Station of Tallahassee, Florida, has published volume 20 in its Tall Timbers Fire Ecology Conference Proceedings series. Entitled, "Fire in Ecosystem Management: Shifting the Paradigm from Suppression to Prescription," the collection of nearly 80 papers recounts the successful conference of the same name (*Park Science* 16(4):11, 30), which was held in Boise, Idaho, in May 1996. The proceedings (ISSN 0082-1527) cost $40 and are available from the Tall Timbers website (www.talltimbers.org). The full citation of the proceedings is:

Pruden, T. L., and L. A. Brennan. 1998. Fire in ecosystem management: shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahassee, Florida. 462 pp.

Thesaurus of keywords

Marilyn Ostergren is the NPS coordinator for the Inventory and Monitoring Program's Natural Resource Bibliography Inventory (NRBIB). She has developed a thesaurus of natural resource keywords in conjunction with NRBIB database development at parks. The thesaurus may be useful to anyone who wants to use standardized terminology. Richard Aroksaar is an Automation Specialist with the Columbia-Cascades Support Office and has assisted Marilyn, who is also based at the Seattle office, with converting the original text and Windows help file versions to a set of HTML web pages for use on the Internet. The NRBIB thesaurus is available on the NPS NatureNet website at www.nature.nps.gov/nrbib/a.htm.

Calling all ecological restorationists

The Society for Ecological Restoration is compiling a comprehensive database of ecological restoration expertise. Known as the Ecological Restoration Directory, the integrated database will be available both online and in printed form and will include listings of individuals, organizations, agencies, and businesses in addition to available training programs, workshops, and educational services. All entries will be cross-referenced, making the database easy to use, with the information being updated periodically. The directory is funded by the Plant Conservation Alliance (formerly the Native Plant Conservation Initiative), which is also developing a directory of native plant materials.

Those interested in filling out the restoration expertise questionnaire can do so on-line at www.nps.gov/plants/restore/directory. Alternatively, surveys and additional information are available from Jane Cripps; e-mail: jbcripps@eeb32.biosci.arizona.edu; or 520-626-7201. Questionnaires will be accepted through January 2000.

"Ecoregions" by Bailey

Robert G. Bailey, the USDA Forest Service senior geographer and developer of a well-known ecoregion classification system, has published *Ecoregions*, a work that builds upon his earlier book, *Ecosystem Geography*, to characterize the major ecoregions of the Earth. Numerous photographs of representative ecoregions and outstanding color figures are complemented by two color maps showing the major ecoregions of the continents and of the oceans. This book is a significant contribution to the study and classification of ecosystems. Published by Springer-Verlag New York (www.springer-ny.com/ecology/ecoregions), it is available in both softcover (ISBN 0-387-98311-2; $39.95) and hardcover (ISBN 0-387-98305-8; $79.95), and is 192 pages long.

Genetics & plant restoration

Vegetation restoration and reintroduction of species require careful consideration of genetics (Havens, K. 1998. The genetics of plant restoration: an overview and a surprise. Restoration and Management Notes 16:68-72). Generalizations based on work with a limited number of species are extremely difficult to make. Yet, generating complete information for every species to be restored is unrealistic. Moreover, time and financial constraints and the sheer magnitude of restoration of plant diversity invariably force practitioners to act on educated guesses. Information from an albeit limited number of studies presented in a symposium about plant population genetics at the Chicago Botanic Garden in October 1997 and several recently published guidelines and case studies on restoration of rare plants provide starting points for restorations and reintroductions.

Reductions in population size or plant density or fragmentation of populations can lead to reductions in genetic variation and accompanying loss of fitness in most plant groups. Loss of genetic variation may be greater in species that once occurred in large, highly outcrossing populations. To prevent such genetic hazards in reintroduced plants, large, genetically diverse populations should be created. Equal number of seeds or plants from each maternal line in newly created populations can decrease inbreeding and increase genetic variation. Propagules must be collected with this goal in mind. Seeds must be collected from a randomly stratified sample of plants, so that they include seeds from individuals of different types (e.g., sizes) and from different types in different locations. Seeds from each maternal plant should be kept separate to not only equalize founder representation in reintroductions, but also, if desirable,

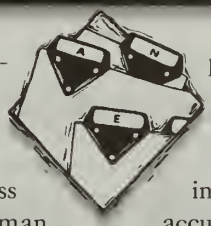
to purge the genetic load in some lines. Propagules should be from the same ecoregion and, if known, from the same evolutionary line. Propagules with a high site fidelity may be less important in highly outcrossing species. Hybridization between populations may have been common in the evolution of many species and may have rendered hardier individuals. Whether one wishes to introduce, reintroduce, or augment populations is important in the mixing of propagules. For example, introductions should be made in the historic range, and propagules from a site, if available, are preferable for reintroductions. However, species conservation should prevail over population integrity if the choice is between preservation and integrity of a species.

Social sciences & ecosystem management of national forests

The USDA Forest Service applies ecosystem management to national forests. A research social scientist of the bureau (Allen, S. 1997. A social scientist's view of ecosystem management. Journal of Forestry 95(9):48) explains that ecosystem management of the forests exceeds restoration and maintenance of ecosystem functions and provision of goods and services. It expands social services. Ecosystem management of the forests requires increasing the understanding of social and economic systems and their links with biophysical systems, widening the scales of inventories, exploring alternative models of collaboration and decision making, and turning spaces into places. Inventories are made not only of fauna and flora, but also of past and present uses of natural resources, of economic and noneconomic values of such uses, and of people's knowledge and attitudes about national forests. One such inventory was of the social, economic, biological, and physical conditions of the 144-million-acre Columbia Basin to provide managers with information. In ecosystem management of national forests, involvement with public land stakeholders exceeds that required by the National Environmental Policy Act and provides a steady stream of communication with the public for better management of resources by many entities. In its infancy is a plan of having the public identify places and common visions for public land management.

Humans and ecosystem management

Oliver Houck, Professor of Law, directs the Tulane Environment Law Program and works in natural resources, coastal, wildlife, and water pollution control law. He has served as U.S. Attorney in Washington, D.C., and as General Counsel to the National Wildlife Federation. His essay "Are humans part of ecosystems" (Environmental Law 28:1-14) was derived from his "Distinguished Visitor" lecture at the Northwestern School of Law of Lewis and Clark College. It is a humorous presentation of his perspective of ecosystem management. Obviously, the author contends, humans are part of ecosystems but not their measure. Current government planning is dangerous if it intends to put humans back into the definition of ecosystems and predicates management goals not on a natural system but on human needs and desire. The measuring of ecosystems and management goals must be done by species other than humans. The bottom line is to assess the needs of nonhuman species.



To make his point, the author relates how his beloved dog got into the Puppy Chow, which was in a paper bag behind a door that was inadvertently left open. This dog could chew through tougher material than paper and just about ate herself to death. After the dog and her owners spent an anxious night at the veterinarian, the management of the dog food became more rigorous and was certainly not based on dog desire.

The analogy is that perfectly nice and lovable human beings are over their eyeballs into Puppy Chow all the time: subdivisions in floodplains, shoreline condominiums, and sundry desirable activities that lay thick blankets of smog over beautiful vistas. Needed are flexible systems that keep humans out of the chow. The best measures of ecosystems are representative species that indicate natural conditions. The role of humans is the management of ecosystems and themselves toward this goal.

Dam removal

The 1992 National Inventory of Dams lists more than 75,000 large dams and about 2 million smaller dams in the United States. Dams generate power, provide flood control and water supply, facilitate community development, and create opportunities for recreation. Dams also profoundly change ecological communities and degrade river systems. They turn riverine communities into lacustrine communities. Over time, impoundments create severe water-quality problems due to nutrient enrichment and increased productivity, accumulation of contaminants, and sedimentation with concomitant shallowing. Highly eutrophic conditions can lead to algal blooms and excessive growth of aquatic vegetation. These problems substantially raise the cost of maintenance or rehabilitation. Furthermore, tens of thousands of small dams are old and deteriorating; their repair and removal are expensive. To date, dams have typically been removed for reasons of public safety and prohibitive costs of repair. However, an awareness of the harmful effects of dams on the environment and high cost of repair is increasing, and the restoration of river ecosystems has gained attention.

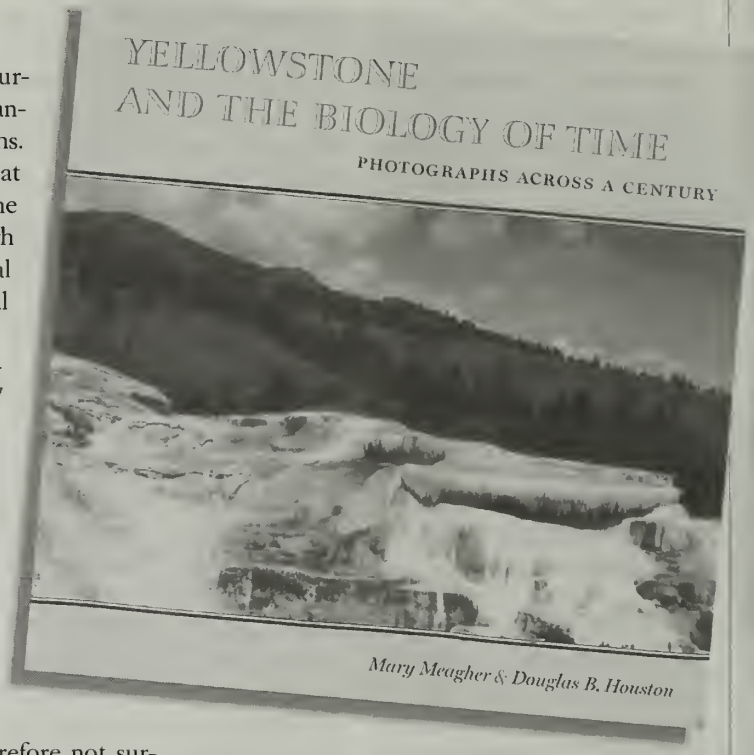
An article published in the journal Environmental Management (Socioeconomic and institutional dimensions of dam removals: The Wisconsin experience. Environmental Management 22(3):359-370) reports that more than 30 of 3,600 dams in Wisconsin were removed in the past few decades. It also documents the related legal, financial, and socioeconomic issues associated with the removals.

Community support for dam removal and loss of impoundments is limited. Yet, the estimated cost of repair has been three times higher than the cost of removal. Watershed-scale ecology raises little local interest. Nevertheless, contemporary watershed management and restoration more and more include the option of dam removal. The socioeconomic factors and stakeholder perspectives are variables that strongly influence the viability of management alternatives and must therefore be given more attention. PS

Changing landscapes in the world's first national park

Yellowstone and the Biology of Time: Photographs Across a Century

By Mary Meagher and Douglas B. Houston



A BOOK REVIEW BY DAVID L. PETERSON

"I wish I could have seen this place a hundred years ago." Nearly all of us have uttered that phrase at one time or another, and thanks to a creative photo-filled book, we can now take that step back in time for Yellowstone National Park (Wyoming, Montana, Idaho). *Yellowstone and the Biology of Time* is a landmark volume in the retrospective analysis of parks and protected areas. This chronology of landscape change trumpets the message that ecosystems are dynamic over a wide range of spatial and temporal scales.

Forest Service scientist George Gruell pioneered the use of repeat photography to document ecological change in his classic studies of Montana and Wyoming landscapes published in the early 1980s. Biogeographer Thomas Veblen also used this technique in an interesting analysis of the Colorado Front Range published in 1991. Biologists Mary Meagher and Douglas Houston, both retired federal scientists who spent most of their careers with the National Park Service, follow in this tradition with a heroic effort of repeat photography that provides good spatial coverage of Yellowstone over 120 years.

As Meagher and Houston tell us in the preface, the book had a gestation period of 25 years. They first compiled an impressive collection of photos from the Yellowstone archives, most of which were taken by W. H. Jackson, J. P. Iddings, F. J. Haynes, and J. E. Haynes during the late 1800s. Between 1971 and 1973, they relocated the scenes in the old photos and compiled a new set of photos. A number of logistical difficulties kept them from completing the project, then the fires of 1988 occurred, providing an opportunity to document the effects of large-scale disturbance. So they took another set of photographs. We were fortunate that the authors delayed the publication long enough to capture this critical milestone in ecological time!

The historical photos in *Yellowstone and the Biology of Time* are striking in their beauty and clarity. The cumbersome technology of a century ago must have posed considerable challenge for photographers working in the outdoors, particularly in the backcountry. It is therefore not surprising that many of the photos are adjacent to roads. But that also affords us the opportunity to see the effects of human activities, both historical and contemporary. It is heartening to see the restoration of many sites that were previously heavily grazed by cattle, cut for hay, and used for Army encampments. Conversely we can also see the degradation of modern-day sites by buildings and parking lots.

Brief, descriptive text interprets each photo set with ecological and historical context; on-ground examination of each site by the authors provides helpful information on plant species and other characteristics not apparent to the casual observer. The photos point out dramatic changes in many geothermal features. They also indicate that many of the aquatic systems are surprisingly dynamic in terms of extent, water level, and associated vegetation. Beavers, whose near-elimination has altered the aquatic ecology of Yellowstone, apparently act as a keystone species and may deserve more study with regard to effects that cascade to other species.

The photos also demonstrate that the magnitude of changes in vegetation are extraordinarily site-specific in Yellowstone. Change appears to be relatively fast at many low-elevation sites, but considerably slower at higher elevations (in the absence of fire). Variation in the distribution and abundance of big sagebrush over time is a striking feature in many photos. Reduced cover of quaking aspen and willows, which is cited by some as evidence of "overgrazing" by native ungulates, is apparent in many photos. However, there are also photos that indicate an increase in these species at some

locations in the park. The post-fire photos show a mosaic of effects to forest overstory and shrub-steppe species (see the three photos, below).

Photos give way to summaries of the physical and biological framework of Yellowstone, including geology, climate, soil, and vegetation, as well as discussion of the interaction of climate, fire, grazing, and human activities on the dynamics of present-day ecosystems. These sections are rather brief, but they cover the basics. Some readers will be disappointed that the authors do not include detailed discussion of the seemingly endless debates about management of the charismatic megafauna of Yellowstone. Indeed, Meagher and Houston were embroiled in these debates for many years. To their credit, the authors discuss wildlife management and alternative viewpoints even-handedly from a *scientific* perspective. Proponents on any side of current issues related to elk and bison management will not find much fodder for advocacy positions here.

The three photographs of the Tower Junction area, looking east across the Yellowstone River to Junction Butte, document changes in quaking aspen (foreground) from a low, dense stand that was present in 1900 (top photo), to a mature stand in 1972 (middle photo). Taken two years after the 1988 fires, the bottom photo reveals that the large aspen stems were killed by fire. In the background, Douglas-fir and probably big sagebrush increased over the same time period, while aspen declined. The authors conclude that "reduction in fire frequency undoubtedly had a role in vegetative change."

The book has few shortcomings. It would have been nice to see greater consideration of ecosystem dynamics outside the boundary of Yellowstone National Park, particularly given the long-standing existence of interagency assessments and management activities within the greater Yellowstone region. Appendix 2 summarizes temporal changes by vegetation type as seen in photos, but it is not particularly useful due to the high variability between sites. I was also hoping for some better maps, given the ready availability of GIS coverages for Yellowstone.

Yellowstone and the Biology of Time is intended for a general audience. It provides a solid background on basic ecology, natural history, and landscape dynamics for the layperson, and includes sufficient information to hold the interest of those with some technical training in biology. Scientists may be disappointed that the book simply summarizes resource management issues and scientific controversies, rather than shedding much new light on them. The most frequent users of the book will likely be Yellowstone aficionados–those who work in the park, visit it frequently, or otherwise have a strong connection to the park's resources. Fortunately the moderately priced paperbound version will make the book accessible to many readers.

Yellowstone and the Biology of Time...

1998 University of Oklahoma Press
www.ou.edu/oupress

304 pages
287 black-and-white photos,
13 maps, 5 figures, 3 tables, appendixes, notes, bibliography, index

Clothbound
ISBN 0-8061-2996-4
$80.00

Paperbound
ISBN 0-8061-3006-7
$32.95

I hope that some enterprising individual will now develop a Web-based archive to provide broader access to this important collection of photos. By having digital images catalogued by topic and geographic location, future photographers–or landscape detectives, as Meagher and Houston call them–will be able to locate particular scenes and add new photos to the archive. All parks and protected areas should consider developing this type of electronic archive, which would be a dynamic information source for scientists, resource managers, and the public.

If you are planning a trip to Yellowstone, buy a copy of *Yellowstone and the Biology of Time.* Read it before you go, then take it with you and note the photo points along the roads and trails. As a modern-day time traveler, you will be able to more fully experience the dynamic Yellowstone landscape. PS

David L. Peterson is Professor of Forestry and Field Station Leader with the USGS Forest and Rangeland Ecosystem Science Center; Cascadia Field Station; Box 352100; Seattle, WA 98195. His e-mail address is wild@u.washington.edu.

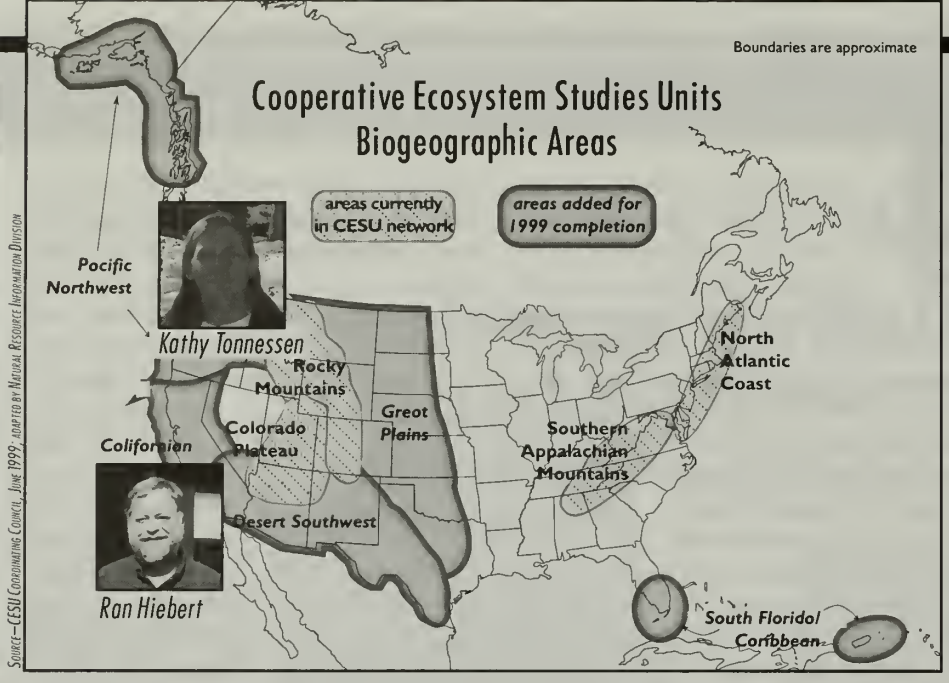


Figure 1 (map). The CESU network presently includes four biogeographic regions; the website www.cesu.org/cesu describes plans for five additional regions. Kathy Tonnessen (inset, top) is the new NPS research coordinator for the Rocky Mountains CESU and Ron Hiebert (inset, below) fills that role for the Colorado Plateau CESU. These positions are the first to be filled by the National Park Service in support of the new network.

Staffing CESUs in the Intermountain Region

Taking the first steps to success

By Bob Moon

In an effort to bring this country's brightest talents to bear upon increasingly complex land management issues, the National Park Service has joined with other governmental organizations to craft partnerships with academic and other nongovernmental science institutions that can provide land managers with access to research, technical assistance, and education. Known as cooperative ecosystem studies units (CESUs), these partnerships will provide support in biological, physical, social, and cultural sciences. (Establishment of the CESU network, a list of partners, and a summary of how they function are described on the Web at www.cesu.org/cesu and in the *Natural Resource Year in Review–1998* [pages 27–28]).

In June 1999 the first four cooperative ecosystem studies units became operational: Colorado Plateau, Rocky Mountains, Southern Appalachian Mountains, and North Atlantic Coast (figure 1). Two of these units are within the NPS Intermountain Region and coincide with our Rocky Mountains and Colorado Plateau Clusters.

The Intermountain Region is excited to participate in this new national network of CESUs. With the endorsement of superintendents of the cluster parks, the Intermountain Support Office created two positions to serve as full-time NPS research coordinators to be duty stationed at the host universities: Northern Arizona University for the Colorado Plateau Cluster, and the University of Montana for the Rocky Mountains Cluster. Combined, these two units represent partnerships between five governmental and 14 different partner institutions.

The Intermountain Region is proud to announce the recent selection of Dr. Ron Hiebert (Colorado Plateau) and Dr. Kathy Tonnessen (Rocky Mountains) as our CESU research coordinators (see figure 1 inset photographs). Both will report to their new positions in early December 1999. Many *Park Science* readers already know Ron and Kathy from their current NPS positions.

Ron served for 11 years as Chief Scientist and more recently as Associate Regional Director for Natural Resources for the Midwest Region. No stranger to parks, Ron spent six years as a plant ecologist and Chief of the Division of Science at Indiana Dunes National Lakeshore, Indiana. Ron is equally at home on campuses, having held positions as assistant professor, visiting fellow, and current adjunct professor at the University of Nebraska and Kansas State University. He also brings years of experience working with American Indian education as Chair of the Natural Resource Advisory Board for Haskell Indian Nations University.

Kathy has been Ecologist and Director of Biological Effects in the NPS Air Resources Division since 1991. Before coming to work for the National Park Service, she spent seven years administering air pollution research for the State of California. While there, Kathy designed and implemented field research of natural water geochemistry in Yosemite and Sequoia-Kings Canyon National Parks. Kathy is equally familiar with the university setting, having held affiliated faculty positions with the University of Colorado and Colorado State University.

The focus of the Intermountain Region's involvement in the CESUs will be service to parks and partners. In keeping with this commitment, park managers from each cluster and faculty from each host university participated in the selection processes. Additionally, park managers will participate in development of annual work plan priorities in addition to annual evaluations of the Intermountain Region's CESU research coordinators' accomplishments.

Committees craft cooperatives, which can look great on paper. However, in the end, the talents of individuals assigned to carry out the mission make the difference between success and failure. The Intermountain Region now has commitments from talented managers to support and help ensure the success of these CESUs. With the addition of Ron and Kathy, we are optimistic that these partnerships will flourish. With their help, our parks can expect significant improvement in access to research, technical assistance, and educational opportunities. PS

Bob Moon is the Intermountain Region Support Office Chief for Natural Resources, Research, and Technology. He can be reached at 303-969-2856; bob_moon@nps.gov.

Elm yellows

By James L. Sherald, Ph.D.

After successfully withstanding Dutch elm disease for over 50 years, the majestic elms of Washington, D.C., are now facing a new threat. Elm yellows, another systemic and lethal disease, is occurring 50 miles west of the nation's capital. The disease was first detected in eastern West Virginia in 1995, and is now occurring in epidemic proportions along a 75-mile front from Chambersburg, Pennsylvania, to Winchester, Virginia. In addition to the 2,700 elms managed by the National Park Service on the National Mall and throughout the monumental core, the epidemic threatens 9,000 city-street elms, and many other elms on private property. Hundreds of riparian elms along Rock Creek and the Potomac and Anacostia Rivers are also in jeopardy.

Cause of disease

Yellows was first reported in Ohio in 1918, but may have occurred as early as 1880 in Kentucky, Indiana, and Illinois, where elms with yellows-like symptoms were reported. Elm yellows, formerly known as elm phloem necrosis, was believed to be caused by a virus. We now know that it is caused by a phytoplasma. Phytoplasmas are unicellular obligate parasites that, lacking a rigid cell wall, occur in a variety of shapes from spheres to branching filaments. These organisms have not been cultured and are not well understood, yet they are responsible for a number of serious plant diseases including ash yellows, aster yellows, lethal yellowing of palms, pear decline, and X-disease of peach.

The elm yellows phytoplasma is transmitted by the white-banded elm leaf hopper, *Scaphoideus luteolus*, but many other leaf hoppers are probably also capable of transmission. The pathogen occupies the phloem sieve cells–tissue responsible for translocation of photosynthates and hormones–causing abnormal tissue proliferation and death of the current-season phloem.

Symptoms

Infected trees are noticeable by the appearance of bright yellow, drooping leaves (figure 1) in mid to late summer. Symptoms usually affect the entire tree, but sometimes only a portion may show symptoms initially. By the time leaf symptoms are obvious, the fine feeder roots have been destroyed and the tree will die very soon or early the next year. The most obvious diagnostic symptom is the scent of oil of wintergreen (methyl salicylate) that emanates from the inner bark, which has butterscotch to dark brown discoloration.

Five of our six native elms are susceptible to elm yellows: American or white elm *(Ulmus americana);* cedar elm *(U. crassifolia);* red or slippery elm *(U. rubra);* September elm *(U. serotina);* and winged elm *(U. alata).* The susceptibility of the sixth native elm, the rock elm *(U. thomasii),* is unknown. European and Asiatic elms are only mildly susceptible. They exhibit some leaf discoloration and "witches'-brooms," a common, abnormal growth of small branches caused by other phytoplasmas. The resistance of European and Asiatic elms suggests that the elm yellows phytoplasma, like the Dutch elm disease fungus, is nonnative and probably an introduction from Europe or the Orient.

On the move?

Elm yellows has the habit of quickly reaching epidemic proportions and then subsiding after most of the elms are gone. Until the 1970s, elm yellows was principally found in the Midwest. However, in the 1970s the disease began to appear in the East with outbreaks in New Jersey, New York, and Pennsylvania. Elm yellows has had a devastating effect in communities where Dutch elm disease has been under control. In central New York State, cities such as Syracuse have lost most of their elms. Recently the disease has resurfaced in the Midwest affecting elms in the Chicago suburbs. The current outbreak west of Washington, D.C., is the closest the disease has ever been to the nation's capital.

In 1998, the USDA Forest Service Northeastern Area State and Private Forestry Division conducted an elm yellows survey along the Potomac River following the towpath of the C & O Canal National Historical Park from western Maryland into Washington. Elms are prolific along the Potomac floodplain and may provide an avenue for the disease into Washington.

Figure 1. Bright yellow, drooping leaves and the development of butterscotch-brown inner bark, which has the aroma of oil of wintergreen, are symptoms of elm yellows, a serious disease that affects elms in the midwestern and eastern United States.

Fortunately, no infected trees were seen beyond the general area of infestation 50 miles away. The survey was repeated again in 1999 and no additional infested trees were located. The NPS National Capital Region participates with the Forest Service and the District of Columbia's Tree and Landscape Division in annual Dutch elm disease surveys throughout the city. The disease survey now includes close examination for elm yellows symptoms.

Prognosis

Sanitation, the rapid detection and removal of affected trees, is the only management approach available. Unfortunately, sanitation is not as effective as a management tactic for yellows as it is for Dutch elm disease. Trunk injections with tetracycline can sometimes bring a temporary remission of symptoms, but will not cure infected trees. Plant pathologists continue their search for elms resistant to Dutch elm disease; we are all hopeful that some of those that now show promise will also be resistant to elm yellows. Although the elms account for only 16% of the tree population in the monumental core, their contribution to the landscape is unsurpassed by any other species. Undoubtedly, an elm yellows epidemic would drastically alter the character of the monumental core and much of the landscape of our nation's capital. PS

James L. Sherald is the Natural Resource Officer with the NPS National Capital Region; jim_sherald@nps.gov.

DONNA SHAVER

Figure 1 (left). An 11-year-old from the Kemp's Ridley Seo Turtle Project returns to the Gulf of Mexico after laying eggs ot Podre Islond Notionol Seoshore in 1998. Note the living tag on the shell (orrow), on the right side behind the heod.

Figure 2 (right, top). Notionol Park Service ond U.S. Gealagicol Survey stoff releose Kemp's ridley seo turtle hotchlings ot Padre Island Notionol Seoshore. The public ond medio ore encouraged to attend these releoses.

Figure 3 (right, bottom). Kemp's ridley seo turtle hotchlings releosed on the beoch ot Podre Island Notionol Seoshore.

Kemp's ridley sea turtles return to Padre Island National Seashore

By Donna J. Shaver and John E. Miller

Projects to restore endangered species typically require years of patience and persistence. After two decades of effort, the project to establish a nesting colony of Kemp's ridley sea turtles *(Lepidochelys kempii)* at Padre Island National Seashore (Texas) is showing signs of success. In 1999, 17 confirmed Kemp's ridley nests were located in the United States, including 11 at Padre Island National Seashore. Sixteen of the 17 nests were located in south Texas, constituting the most Kemp's ridley nests documented on the Texas coast in a single year and an increase in the number of Kemp's ridley nests detected on the Texas coast for the fifth consecutive year (Shaver and Caillouet 1998).

Background

Kemp's ridley is the most critically endangered sea turtle in the world, with only about 3,000–5,000 (TEWG 1998) adults remaining in the population. Most Kemp's ridley sea turtles nest near the village of Rancho Nuevo, Tamaulipas, Mexico. In 1978, it was feared that Kemp's ridley would go extinct within a few years unless immediate steps were taken. An experimental, binational project involving the National Park Service (NPS), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Texas Parks and Wildlife Department, and Mexico's Instituto Nacional de la Pesca was undertaken to establish a secondary nesting colony of Kemp's ridley sea turtles at Padre Island National Seashore where nesting had previously been documented (Fletcher 1982; Shaver 1987, 1990, 1992). Scientists and resource managers from a variety of private, state, and federal agencies in the United States and Mexico recognized that establishing a secondary nesting colony would provide a safeguard for the species–if an environmental or political catastrophe were to occur at the primary nesting area in Mexico, an area in the United States would be protected where Kemp's ridleys could nest (Shaver 1990; USFWS and NMFS 1992).

From 1978 through 1988, approximately 2,000 Kemp's ridley eggs were collected each year (totaling 22,507) at Rancho Nuevo and incubated at Padre Island National Seashore. Hatchlings were experimentally imprinted on the beach at the national seashore and then reared in captivity for their first 9–11 months of life (head-started) at the NMFS laboratory in Galveston, Texas. Overall, 13,211 Kemp's ridley turtles from this project were tagged and released into the Gulf of Mexico and adjacent bays as yearlings, in hopes that they would return someday to south Texas to nest. Additionally, 1,097 untagged hatchlings and 300 tagged 2–16 year-old turtles from this project were released.

The first confirmed record of Kemp's ridley nesting in the United States was of an individual that laid eggs at Padre Island National Seashore in 1948, 15 years before it became a national seashore and 30 years before our project to establish a nesting colony began. From 1948-99, 61 Kemp's ridley nests were documented on the Texas coast (Shaver and Caillouet 1998). Additional nests could not be fully documented, while others certainly went unnoticed or unreported both before and after 1948. All 61 confirmed nests were found in south Texas, including 39 at the national seashore. In fact, during the last 50 years, more confirmed Kemp's ridley nests have been located at Padre Island National Seashore than anywhere else in the United States (Shaver and Caillouet 1998). Only eight Kemp's ridley nests have been found at other U.S. locations outside of Texas. Forty-eight of the 61 confirmed Kemp's ridley nests found in Texas were located from 1995–99. These 61 records resulted from turtles and tracks located by the public and, after 1994, by national seashore turtle patrollers. Although personnel from the seashore have been conducting patrols for nesting sea turtles since 1986, these patrols were not very comprehensive until the last two to five years. Thus, the recent increase in detected nesting may reflect increased nesting, improved detection efforts by national seashore turtle patrollers, increased awareness and reporting by the public, or a combination of all of these factors.

Program payoff

In 1996, the first two confirmed returnees from the project nested at Padre Island National Seashore. Through 1999, nine returnees were found nesting in south Texas (Shaver 1996a, 1996b, 1997; Shaver and Caillouet 1998). The returnees were identified by *living tags,* which were used to mark some individuals of the 1982 year-class (year hatched) and all individuals of the 1983–1988 year-classes. Living tags (figure 1) are tissue transplants of a small piece of light-colored plastron (bottom shell) implanted into the darker carapace (top shell). At 10–15 years of age, these turtles found their way back to south Texas, mated, nested at or in proximity to the beach where they were imprinted as hatchlings, and produced clutches containing viable offspring. These returns represented the first confirmed records of sea turtles experimentally imprinted on an area that returned to that area to nest; they are also the first confirmed records of head-started sea turtles nesting outside of captivity (Shaver 1996a, 1996b, 1997).

Before 1985, no turtles from the experimental imprinting and head-starting project that resided outside of captivity would have been mature and able to nest. Thirteen of the 52 confirmed Kemp's ridley nests found on the Texas coast from 1985–99 were conclusively linked to the project. Although we can not prove it, some of the other 39 nests found from 1985–99 may have originated from the project. This is possible because: (1) Kemp's ridleys from the earliest year-classes were released without living tags and would not have been identifiable as being from the project after just a few years of age, due to shedding of the metal identification tags placed on their flippers; (2) some nesting Kemp's ridleys were observed by beach visitors but were not examined for tags by trained biologists; and (3) some Kemp's ridley nesting observations were detected only from tracks left in the sand by the nesting females, whereas the species was confirmed by examination of the hatchlings.

The species' future

Although the Kemp's ridley population is now showing very promising signs of recovery on Mexican nesting beaches, the numbers are still far below former levels and levels at which the species could be down-listed or delisted (USFWS and NMFS 1992; TEWG 1998). Protection at the nesting beaches and in the marine environment must be continued to ensure that recovery continues. The Kemp's ridleys currently nesting in south Texas are probably a mixture of both returnees and turtles from the wild stock, with some individuals nesting both in Mexico and south Texas. As the Kemp's ridley population continues to increase and more turtles from the experimental project mature, we expect that nesting in south Texas will increase if the turtles survive after they arrive in the area.

Unfortunately, more adult Kemp's ridleys are found washed ashore (stranded) in Texas than in any other U.S. state (Shaver 1999), even though they forage in, and migrate through, near-shore waters of several other U.S. states. From 1995–99, when increased Kemp's ridley nesting was detected on the Texas coast, 88 adult Kemp's ridleys were found stranded on Gulf of Mexico beaches in south Texas; roughly half of these were located within the national seashore. All were found dead or dying; most were likely the victims of accidental capture during fishing activities. Much of this mortality occurred during the Kemp's ridley mating and nesting seasons, and the deaths of adults of the species in south Texas waters likely reduced nesting in this region these years (Shaver 1999).

The National Park Service and the U.S. Geological Survey (USGS) do not have jurisdiction over the waters in which the mortality is occurring but are coordinating with other entities to try to reduce these deaths. For example, during 1997 and 1999 we satellite-tracked the movements of 12 adult females that nested in south Texas to delineate areas in which they would be vulnerable to various threats in the marine environment and to help locate subsequent nesting sites.

Because only about one in 200 Kemp's ridley hatchlings survives to adulthood (TEWG 1998) and mortality of adults in south Texas is now relatively high, we must maximize survivorship of eggs laid in south Texas to help ensure the continuation of nesting here. Since beach visitors detect many of the Kemp's ridleys that nest in south Texas, we actively attempt to educate the public about our program through media interviews, educational programs, posters, brochures, and roving beach contacts. One of the most effective means is a semimonthly newspaper column that we write to provide information to locals about various aspects of the turtle program, such as hatchling release dates and other updates. Also, each summer NPS and USGS staff and volunteers search the 80-mile length of North Padre Island (including the 68-mile length of Padre Island National Seashore) via all-terrain vehicles to look for and protect nesting Kemp's ridley sea turtles and their eggs. Virtually all Kemp's ridley eggs detected on the south Texas coast are collected and incubated in a hatchery at the national seashore, and most emerging hatchlings are also released at the seashore (Shaver 1990, 1997 [figures 2 and 3]). Hundreds of visitors and numerous media personnel visit the park to view our hatchling releases each year.

We hope that increasing numbers of critically endangered Kemp's ridley sea turtles will nest at Padre Island National Seashore in the future, helping to ensure the survival of the species. If this occurs, more people will enjoy the opportunity to safely view these rare turtles. Additionally, the project to establish a nesting colony of Kemp's ridley sea turtles at Padre Island National Sea-

At 10-15 years of age, these turtles found their way back to south Texas, mated, nested..., and produced... viable offspring

"Ridleys" cont'd in right column on page 39

Figure 1 (left). Wildlife observation was one factor that shaped visitor attitudes positively regarding the Denali Visitor Transportation System (VTS).
Figure 2 (map). One of five transportation options at Denali National Park and Preserve (Alaska), the VTS operates on an 89-mile gravel road and includes trips from the main park visitor center to Toklat River, Eielson Visitor Center, and Wonder Lake.

An assessment of visitor satisfaction with public transportation services at Denali National Park & Preserve

By Craig A. Miller and R. Gerald Wright

National park system areas are increasingly confronted with problems associated with private vehicle use, and managers at many areas are actively seeking solutions to mitigate the impacts caused by vehicle use including congestion, parking, and potential resource degradation. Denali National Park and Preserve offers a unique example of a management solution directed at resolving traffic congestion, while at the same time maintaining a quality visitor experience and protecting the natural resources of the park. However, although this system has been in place for 25 years, the park administration has had, until the present study, little definitive knowledge regarding visitor attitudes toward and satisfaction with the transportation system. A brief questionnaire survey of visitor opinions toward park transportation policy conducted in 1972 by Harrison (1975) and a similar follow-up personal interview survey conducted by Singer and Beattie (1986) have provided the only insights into visitor attitudes toward the extensive transportation system.

Before 1971, park roads experienced limited private vehicle traffic, as visitors wanting to visit the park in their own vehicles had to travel the difficult, dirt "Denali Highway" connecting Cantwell with the Alaska Highway or ship their vehicles by rail from Anchorage. In late 1971 the George Parks Highway, linking Fairbanks to Anchorage, was completed, providing a direct paved route to the park. Anticipating a substantial increase in vehicle traffic, the park took a proactive approach by closing the park road the following summer to private vehicles past milepost 14. Beyond that point, only those visitors holding campground permits or those traveling to the private inholdings in the Kantishna region were permitted access in private vehicles. A transportation system was developed to replace the use of private vehicles in the park (figure 1).

At the time of its inception, the transportation system in the park was unique among the national parks in the United States and remains so today, as visitor access to the park's interior is controlled. This service, presently known as the Visitor Transportation Service (VTS), is now one of five transportation options available at the park. Two other transportation options are principally booked through private tour companies, while a fourth system is a camper bus that transports backcountry permit holders into and out of the park. The fifth transportation type is a private service that takes visitors to private lodges in the Kantishna region.

The VTS system includes trips to three locations within the park (figure 2). The first of these destinations is the Toklat River, a distance of 53 miles and duration of 6 hours. The second is the Eielson Visitor Center 66 miles into the park an 8-hour round trip. Wonder Lake is the third destination, requiring an 86 mile and 11-hour round trip. Tickets are available at the visitor center or through advanced reservations.

Study Design

We examined visitor satisfaction with the three VTS trips as part of a larger study of all the transportation options within the park. A survey examining visitor attitudes toward the transportation service was conducted in the park during the summer of 1996. Researchers boarded VTS buses before departure from the visitor center, explained the need for the study, and asked visitors to complete the 8-page survey on their return trip. Visitors were asked to rate: the quality of the bus as a means of viewing the park, their satisfaction with the wildlife viewing experience, and perceptions of crowding on the park road. In addition to these questions, visitors were also asked if they had visited Denali or other national park sites before their current trip. The questionnaire also asked for demographic information such as age and gender.

Results

Visitor response to the survey was very favorable. Of the 1,385 visitors using the VTS buses who were asked to participate in the survey, 860 returned usable questionnaires for a response rate of 69%. Spot surveys undertaken by researchers riding the buses at various times indicated that most of the passengers consisted of family groups and that the overall response rate was influenced by the fact that often only one member of a family group returned the questionnaire. Based on this observation, we are reasonably certain that there was probably a minimal non-response bias. Returns from the survey indicate the mean

age of VTS passengers was 46, 137 (16%) had visited the park in the past, and 109 (80%) of the visitors who had previously visited the park had used the VTS buses.

Visitors were asked to rate the quality of the bus seating, the bus as a platform for viewing wildlife, the driver's knowledge of the park, and the courtesy of the driver. These results, presented in table 1, show visitors to be satisfied with these aspects of their trip, as the majority of visitors rated each of these items as "good" or "excellent."

In order to assess what factors contributed to visitor satisfaction with the transportation service, the questionnaire asked each passenger to select from lists those items that either contributed to–or detracted from–their satisfaction with their park experience. Visitors responded that the freedom to view the park instead of focusing on driving, driver courtesy, and wildlife observations were each positive factors in providing a satisfactory experience. The responses to those factors that contributed to satisfaction and detracted from visitor satisfaction are presented in table 2.

To examine the effectiveness of the transportation service, the questionnaire asked visitors to respond to the three statements shown in table 3: "The transportation service buses enhanced my visit to Denali National Park;" "seeing buses or other vehicles detracted from my enjoyment of the park;" and "buses and other vehicle traffic interfered with my enjoyment of wildlife." The responses to these statements indicate the majority of visitors using the VTS buses see the buses as an enhancement to their park experience and do not feel the buses interfered with their reason for visiting the park, which was primarily to view wildlife.

Table 1.
Visitor ratings of quality for VTS buses

Item	Poor	Fair	Good	Excellent
	# responses (%)			
Comfort of bus seating (n=855)	13 (2%)	234 (27%)	523 (61%)	85 (10%)
Bus as a place for viewing wildlife (n = 838)	31 (4%)	208 (25%)	431 (51%)	168 (20%)
Driver's knowledge of the pork (n = 837)	1 (<1%)	21 (3%)	259 (31%0	556 (66%)
Courtesy of driver (n = 839)	2 (<1%)	6 (<1%)	141 (17)	690 (82%)
Overoll quality of transportatian service (n = 855)	11 (1%)	85 (10%)	568 (66%)	191 (22%)

Table 2.
Visitor attitudes toward the transportation system

Factors that contributed to visitor satisfaction	Yes	No
Freedom to view park instead of focusing on driving	623 (72%)	110 (28%)
Courtesy of transpartatian service driver	630 (73%)	230 (27%)
Wildlife observatians	749 (87%)	110 (13%)
Factors that detracted from visitor satisfaction	**Yes**	**No**
Uncamfartable ride	67 (8%)	795 (92%)
Traffic on the raad	76 (9%)	784 (91%)

Table 3.
Visitor attitudes toward the VTS buses

Statement	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
"The transpartation service buses enhanced my visit ta Denali Notional Park"	190 (23%)	466 (56%)	120 (14%)	41 (5%)	15 (2%)
"Seeing buses or ather vehicles detracted fram my enjoyment af the pork"	11 (1%)	84 (10%)	120 (14%)	441 (53%)	176 (21%)
"Buses and other vehicle traffic interfered with my enjayment of wildlife"	15 (2%)	68 (8%)	114 (14%)	440 (53%)	186 (22%)

Conclusion

The findings of this study indicate that visitors to Denali National Park and Preserve who use the VTS buses are very satisfied with the service. Visitors gave high ratings for the bus as a platform for viewing wildlife, and bus driver courtesy and knowledge of the park. In addition, visitors did not express negative attitudes toward other vehicles encountered in the park. One point of special interest is the ratings given to comfort of the buses. Visitors spend from 6–11 hours on the buses traveling over a gravel road. A negative experience in terms of uncomfortable bus seats could serve to undermine any other efforts to provide the visitor with a quality experience. Visitor satisfaction remains high, despite the length of the tours. Overall, visitors gave the transportation service high approval ratings, with 88% of the visitors rating the service good to excellent.

Denali National Park and Preserve offers an exciting wilderness experience for visitors, and the visitors contacted through our survey indicate that this experience is enhanced by the transportation service. Responses also suggest that this quality experience is to a large extent dependent on the courtesy and knowledge of the bus driver. This is an important consideration, as the visitors spend more time with the driver than any other park personnel. The transportation system in Denali not only allows visitors to experience the wild beauty of the park and its wildlife, but also affords a high degree of resource protection and visitor safety. PS

Literature Cited

Harrisan, G. S. 1975. The peaple and the park: reactians to o system of public transportotion in Mt. McKinley Notionol Park, Alaska. Journal of Leisure Research **7**:6-15.

Singer, F. J., and J. B. Beattie. 1986. The traffic contral system and ossociated wildlife responses in Denoli Natianal Park. Arctic **39**:195-203.

Craig Miller conducted the study as a research associate with the Dept. of Fish and Wildlife Resources, University of Idaho. He is now a scientist with the Illinois Natural History Survey in Urbana, Illinois. Gerry Wright is an ecologist with the USGS Idaho Cooperative Fish and Wildlife Research Unit and Professor in the Dept. of Fish and Wildlife Resources at the University of Idaho in Moscow; gwright@uidaho.edu.

"Pecan" continued from cover

and intervention when pest damage thresholds are reached and crop damage is imminent. This limited intervention protects the crop, while minimizing side effects.

IPM and the LBJ pecans

The national historical park represents a special environment for the development and implementation of pecan IPM. This is because the motives underlying conservation of this orchard differ from those of most other pecan operations where profit would represent the bottom line. At the outset, the standard pecan IPM program practiced by producers in the region was presented and discussed with park personnel to determine what could be adopted and what needed to be modified for use. As expected, the major modifications centered on pesticides, with minimizing impact on nontarget organisms emphasized to a greater extent than efficacy or maximizing profitability. The pesticides currently approved for use in the pecan orchard at LBJ National Historical Park are glyphosate for weed management, benomyl and propiconazole for pathogen management, and dormant oil, *Bacillus thuringensis* endotoxins, and carbaryl for insect management.

These pesticides are strategically used to conserve the annual production of pecan nuts in the orchard. The need for these pesticides is best understood by comparing and contrasting the wild pecan with the orchard pecan. The wild pecan grows in mixed-species riverine habitats with tree canopies often touching. Weed control is provided by dense shade, but the close spacing limits available sunlight above and nutrients available to the roots below. Wild pecan trees produce nuts synchronously at 2–7 year intervals (figure 2) and have never been shown to produce sizeable crops in consecutive years. Orchard pecans are vegetatively propagated at deliberately spaced intervals to allow ample sunlight between trees and root development well beyond the canopy of each tree to access water and nutrients. Left unchecked, weeds will readily colonize the orchard floor and outcompete the trees for water and nutrients. Thus, fertilizer is added (nitrogen, phosphorus, potassium, and zinc, as needed) to increase tree vigor and ensure sufficient food reserves are available to produce the current year's crop and establish a crop for the following year.

Natural enemies

Wild pecans survive pathogens through many mechanisms of which one of the most important is genetic diversity. Every wild pecan tree is genetically distinct from its neighbors. Pecan scab, a fungus and the worst disease of the orchard pecan, may become genetically entrained to attack specific genetic constructs. Additionally, vegetative propagation of orchard trees provides genetic uniformity that results in potential for disease epidemics. Disease development requires a susceptible host, a virulent pathogen, and a favorable environment. The relatively dry environment at the park limits the favorable environment for pecan scab to brief periods following rains when rapid leaf growth is occurring in the spring or nut growth is occurring shortly thereafter. Fungicide is needed under such conditions to prevent pecan scab epidemics.

Wild pecans survive insect depredations through many mechanisms, too. Foliage and root feeders are generally limited by natural enemies, the environment, and the intrinsic ability of the pecan to resist or recover from attack. Indeed, damage from insects is rare. However, careful monitoring is needed to detect and respond to these rare occurrences, if sustained nut production is to be achieved. Insects that feed on nuts are another matter. Recent research shows that the wild pecan survives the ravages of nut feeders in nature by producing a big crop followed by low production for one or more years. This "boom and bust" cycling of production starves nut feeders to low levels during bust years and produces so many nuts in boom years that nut feeders are satiated long before the big crop is consumed. The nuts left over survive to germinate the following year.

An integrated pest management plan has been developed at the park to allow the orchard to be agriculturally productive

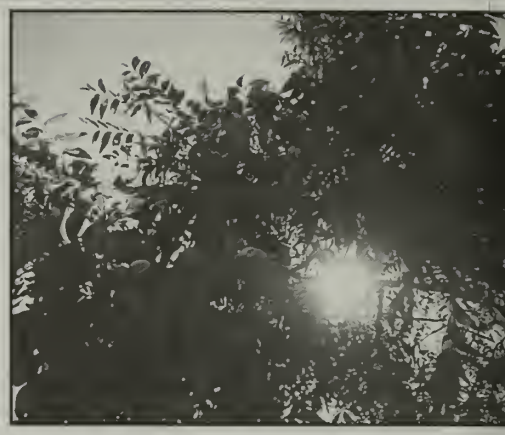


Figure 2. This pecan cluster represents a boom year for wild pecan trees, which occurs at 2–7 year intervals. In contrast, orchard pecans at the park are managed for continual production, and are fertilized and managed in other ways to ensure annual productivity.

Once in awhile a nut will survive to become a tree and form the beginning of the next pecan generation.

The pecan is not perfect in regulating this boom and bust production. Trees on especially good sites, where branches may have better access to sunlight, for example, have extra food reserves. These individuals produce enough flowers to yield up to 10% of a crop in a bust year, even though the remaining trees remain barren. If these pecan flowers continued to grow to maturity, late-season nut feeders like jays, squirrels, and especially the pecan weevil, *Curculio caryae* (Horn) (Coleoptera: Curculionidae), would use them to grow and reproduce, and their progeny would occur in much greater numbers to consume the boom year crop. However, the pecan nut casebearer, *Acrobasis nuxvorella* Nuenzig (Lepidoptera: Pyralidae), attacks nuts just after pollination and removes almost all the nutlets in years of low production. This leaves few nuts to mature in bust years. In years of high production, a similar amount of nutlets (2–10%) is removed by the casebearer, although this has little effect on the boom crop.

This competition between late-season nut feeders and the casebearer works great in nature, preserving the boom-bust cycle in the wild trees, but the pecan grower strives to produce nuts every year by keeping trees well spaced, watered, and fertilized. This practice increases pecan nut production in the orchard. Unfortunately, the pecan nut casebearer comes from nearby wild trees to this pocket of productivity and causes severe damage in the or-

Figure 3. An insect trap dangles from the branch of an orchard pecan and is indicative of the park's ongoing monitoring program for the casebearer moth. A forager of pecans when they are developing in the flower, the casebearer can severely damage the orchard pecan crop in years when wild trees have little or no production.

Figure 4. Insect traps of a different design are used by resource managers to track changes in the population of the pecan weevil. Although this insect species can potentially damage an orchard pecan crop of mature nuts, its numbers have not yet been of concern to resource managers.

chard in years when the wild trees have little or no production. The park IPM plan prescribes monitoring for casebearer activity in the orchard using a pheromone (figure 3). If damaging numbers of the casebearer occur, as determined by using a sequential sampling plan, a well-timed treatment with *Bacillus thuringiensis* endotoxin is recommended to conserve agricultural production. This also means abundant nuts will occur in the orchard in the fall when surrounding wild trees are barren. These nuts will often require protection from late-season nut feeders like the pecan weevil. Monitoring protocols have also been developed for the weevil (figure 4) to ensure that action to reduce their numbers is only taken when needed. If treatment is required, the least intrusive, but still effective, management possible is used. However, pecan weevil densities have not built up sufficiently to warrant treatment, despite the species' presence in the orchard.

A groundwater monitoring protocol has also been established in the park to detect runoff or leaching of pesticides used in the pecan IPM program. No runoff has been detected, and the minimal levels of chemical intervention are not expected to cause such problems. Insecticide use, for example, is never expected to require more than 21 days of pesticide protection on the foliage in a growing season of 220+ days. Additionally, the chemicals used are neither biologically magnified nor readily leached through soil. Plus, they are biodegradable. Routine water monitoring is an additional precaution designed to provide the highest quality of stewardship possible.

Conclusion

According to Brison (1974), the pecan is the most important horticultural crop native to the United States. Lyndon B. Johnson National Historical Park provides a setting for the public to enjoy the pecan in all its glory from the wild trees along the Pedernales River, to the semi-domesticated cattle and pecan environs reminiscent of the early 20th century, to the responsibly managed pecan orchard of today and the future. Most of the agriculturally important crops grown in the United States today originated elsewhere. The pecan is ours, and the opportunity to see the entire range of the pecan domestication process is a special legacy indeed.

The pecan at LBJ National Historical Park is a microcosm of the issues and responsibilities facing the National Park Service today. In and near the park, the wild pecan reflects nature preserved in a pristine form, inspiring us as only nature can. The thinned, native pecans show agricultural inroads into nature in order to produce more human-valued, physical resources like nuts and cattle to support more people than the same land could in Cabeza de Vaca's time. The managed pecan orchard shows responsible pecan production that optimizes availability of the human-valued nut resources using the Pecan IPM Plan. Our society needs food for thought as well as food for survival. The pecans at LBJ National Historical Park can help inform and engage the public in addressing these issues.

Routine water monitoring is an additional precaution designed to provide the highest quality of stewardship possible

Acknowledgments

Research support was provided by the Texas Agricultural Experiment Station, Texas A&M University System at College Station, a grant from the W. K. Kellogg Foundation, and a pecan IPM plan development grant from the National Park Service. Personnel at LBJ National Historical Park were instrumental in tailoring the plan to serve the needs of the park and agriculture on behalf of the public. PS

References & suggested reading

Brison, F. R. 1974. Pecan culture. Capital Press, Austin, TX. 294 pp.

Harris, M. K. 1983. Integrated pest management pecans. Annual Review of Entomology **28:**291-318.

Harris, M. K. 1989. Pecan domestication and pecan arthropods. Pages 207-255 *in* M. K. Harris and C. E. Rogers, editors. The entomology of indigenous and naturalized systems in agriculture. Westview Press, Boulder, CO.

Harris, M. K. 1991. Pecan arthropod management. Pages 6-15 *in* B. W. Wood and J. A. Payne, editors. Pecan Husbandry. Challenge and opportunities. First National Pecan Workshop Proceedings. U.S. Dept. of Agriculture. Agricultural Research Service. ARS-96.

Harris, M. K., and D. A. Dean 1997. Pecan IPM CD-ROM. Texas Pecan Growers Association (Distributor). College Station, TX.

Harris, M., B. Ree, J. Cooper, J. Jackman, J. Young, R. Lacewell, and A. Knutson. 1998. Economic impact of pecan IPM implementation in Texas. Journal of Economic Entomology **91:**1011-1020.

Marvin Harris is Professor of Entomology, Texas A&M University, College Station, TX 77843; 409-845-9757; m-harris@tamu.edu.

Figure 1 (left). Built for horse-drawn carriages in the early 1900s, the well-engineered, gravel carriage roads of Acadia National Park (Maine) are very popular among bicyclists and hikers today, creating the potential for crowding and conflict.

Figures 2 and 3 (right, far right). Visitors participating in the social carrying capacity study were asked to rate the acceptability of scenes depicted in 19 computer-generated photos, including these, that illustrated varying numbers and types of carriage road use. These photographs show a typical viewscape on the carriage roads—approximately 100 meters in length.

Crowding and conflict on the carriage roads of Acadia National Park:

An application of the Visitor Experience Resource Protection framework

By Charles Jacobi and Dr. Robert Manning

The carriage roads of Acadia National Park are a unique system of more than 50 miles of beautifully designed and highly engineered gravel roads built under the direction of John D. Rockefeller, Jr., in the early 1900s (figure 1). Although the roads were built for horse-drawn carriages, they are now used mainly by bicyclists and walkers, providing a welcome escape from automobile traffic and access to many undeveloped areas of the park. Equestrian use is low. Longtime observers agree that carriage road use increased greatly with the rise in popularity of the mountain bike in the 1980s, although no data on carriage road use were collected during this time period. However, the park fielded an increasing number of complaints from visitors and area residents during this time about "crowding" and "conflict" on the carriage roads.

In response to these threats to the quality of the visitor experience, park managers decided to apply the Visitor Experience Resource Protection (VERP) framework to carriage road use (National Park Service 1997). VERP addresses carrying capacity and visitor use management of national park areas through nine elements in a generally linear but also iterative process. VERP is one of several frameworks that provide a logical and rational basis for decision-making, and it is becoming more commonly used throughout the national park system.

The VERP framework can also include a natural or cultural resource component for determining carrying capacity. However, we determined that resource impacts at Acadia were minimal. Social trails, erosion, and trampling of vegetation are potential natural resource problems, especially around bridges, ponds, and viewpoints. However, bicyclists, the main users of the carriage roads, are not now causing these problems. Bicyclists are also not using the carriage roads to access hiking trails (biking is not allowed on hiking trails) and thus adding to trail erosion. Nesting peregrine falcons were located well above the carriage road at Jordan Pond and their productivity suggests they were not affected by visitor use. Although the park does not formally monitor natural resources adjacent to the carriage roads, the best professional judgment of park staff was that current impacts were not significant enough to warrant a natural resource component to the carrying capacity process.

As long as the carriage roads are properly maintained (a private endowment now ensures this) visitor use is also unlikely to degrade the road or the bridges (the cultural resource). Only increased equestrian use might pose a threat, and only then if road maintenance is unable to keep up with damage caused by horse use. Thus, this application of VERP is limited to social science and the visitor experience. Through VERP, park managers sought to understand, define, and maintain high quality experiences on the carriage roads.

Park staff received training in applying VERP through a three-day workshop conducted by Marilyn Hof of the NPS Denver Service Center. Based on this workshop, we recognized that more information about carriage road use and users was needed. A three-phase research program was planned, and Dr. Robert Manning of the University of Vermont served as lead investigator.

This paper describes the application of the VERP framework to carriage road visitor use. It begins with a brief description of the supporting research program, and then outlines the application according to the nine elements of the VERP framework[1].

Research program

Phase I

Phase I research was designed to identify potential indicators of quality for the carriage road experience through a survey (questionnaire) of carriage road visitors and

[1]This application started with an earlier draft version of VERP consisting of nine steps that are slightly different than the nine elements in the latest version (National Park Service 1997). The team continued to follow the nine steps of the earlier version of VERP and they are referred to as steps in this paper.

focus group sessions with representatives of major user groups (Manning et al. 1996a; Stillwater Assoc. 1995). Indicators of quality are specific, measurable variables that are important in determining the quality of park resources and visitor experiences. Study findings suggested that most carriage road visitors enjoyed their experience.

However, visitors also suggested that problems with too many people using the carriage roads were emerging, and that selected behaviors experienced on the carriage roads were a problem. These variables–crowding and problem behaviors–were selected as the best indicators of a quality visitor experience. Estimates of visitor use levels using electronic trail counters and a census of carriage road use were also conducted as part of phase I research.

Phase II

Phase II research focused on identifying *standards of quality* for crowding and problem behaviors (Manning et al. 1998a; Manning et al. 1999). Standards of quality define the minimal acceptable condition of indicator variables (Manning, et al. 1996c). Research indicates that visitors often have normative standards concerning acceptable conditions in parks and related areas (e.g., Vaske et al. 1986; Shelby and Heberlein 1986; Hof et al. 1994; Manning et al. 1996b; Manning et al. 1996c). Thus, we administered a second survey to carriage road visitors to determine standards of quality for crowding and problem behaviors.

We identified crowding norms using numerical and visual methods. In the visual approach, a representative sample of carriage road visitors rated the acceptability of 19 computer-generated photos of carriage road use. These photos illustrated varying numbers (0-30) and types (hikers and bikers) of carriage road visitors. Sample photos are shown in figures 2 and 3. The viewscape in the photos represented a typical 100-meter carriage road segment. In the numerical approach, visitors reported the maximum number of people they would find acceptable to see at one time (per viewscape) on the carriage roads. The number of persons-per-viewscape (PPV) then became the measure for crowding and eventual standards of quality. Study findings suggested the maximum acceptable PPV ranged from 11 to 18 based on the various numerical or visual methods used. Visitors reported they now typically see about 5 PPV, suggesting that the carriage roads have not yet reached carrying capacity. Visitors also reported that they would accept seeing the maximum PPV level for about 40% of their visit. This temporal element of crowding norms was a new element of research, and it was addressed more fully in Phase III.

We also developed numerical norms for the four most important problem behaviors–bicycles passing from behind without warning, excessive bicycle speed, obstructing the road, and dogs off leash–from visitor surveys. Visitors reported that existing conditions were close to exceeding their maximum level of acceptability for only one behavior (obstructing the road).

We continued to estimate visitor use with trail counters and censuses in phase II and also developed a computer-based simulation model (see sidebar at end of article on page 26) of carriage road use. Daily carriage road use in the summer of 1995 ranged between 1,000 and 2,000 visitors. These daily estimates can be used as the primary input for the simulation model. For any total use level, the model estimates the number of minutes visitors see various PPVs, informing managers when standards of quality are violated.

Phase III

In phase III research, a representative sample of residents of surrounding communities was asked about their standards of quality using the same questions as phase II research (Manning et al 1998b). Residents also rated the quality of five hypothetical one-hour carriage road visits representing different total carriage road use levels (table 1). These scenarios were developed using the simulation model, and were designed to measure the temporal component of crowding norms in a more detailed way than was done in Phase II research. For comparison purposes, another representative sample of carriage road *visitors* also rated the same five scenarios. Residents were also asked how they had changed their carriage road use over the past several years because of increased use and problem behaviors. Concern about displacement of longtime users was a major reason for administering a survey to local residents.

Findings showed residents have adjusted their personal carriage road use substantially in recent years because of the changes in overall carriage road use. These adjustments include using the carriage roads less often, and shifting use to less-used times and places. Acceptability ratings of both residents and visitors for the five scenarios

Table 1.
Average number of minutes per hour visitors see selected numbers of persons per viewscape (PPV) for five carriage road total use scenarios

PPV	Scenario 1 Total Use=750	Scenario 2 Total Use=1,500	Scenario 3 Total Use=3,000	Scenario 4 Total Use=6,000	Scenario 5 Total Use=12,000
0	55	48	40	28	17
1-5	5	11	18	26	28
6-10	0	1	2	5	10
11-15	0	0	0	1	3
16-20	0	0	0	0	1
21-30	0	0	0	0	1

"Carriage Roads" continued on page 24

"Carriage Roads" continued from page 23

are shown in figure 4. These data suggest that at current use levels, most visitors are having a high quality experience.

However, visitor and resident standards of acceptability for the four problem behaviors differed significantly. Residents were considerably less tolerant of problem behaviors than were visitors. This may be because most residents are walkers and most visitors are bikers. Residents reported that existing conditions of these behaviors are very close to violating their standards of quality.

Application of VERP

Step 1 of the VERP framework calls for appointment of an interdisciplinary planning and management team. The VERP team for the carriage roads included the superintendent, deputy superintendent, several division chiefs, a recreation specialist (team leader), and supervisor of carriage road rovers (interpretive ranger). Marilyn Hof and Robert Manning served as consultants to the team.

Steps 2-3 of the VERP framework prompted a statement of purpose and significance for the carriage roads and the production of maps of resource and social conditions on the roads. This was important because the carriage road system is set amidst a great diversity of natural resources, and use levels and patterns on the roads are also diverse.

In *step 4,* a range of appropriate resource and social conditions was considered for the carriage roads. As already discussed, no natural or cultural resource issues were considered to be significant, although the potential for them exists. Thus, we focused on social conditions only for this application of VERP. In step 4, we also established the major carriage road management goals: shared recreation use of the carriage roads by all types of visitors, a diversity of experiences based on visitor use levels and behaviors, and a high quality visitor experience.

The VERP team zoned the carriage road system in *step 5* and established peak and nonpeak zones based on existing levels and patterns of use. Zones were defined by location, time of day, and time of year.[2] We decided to use the same *indicators of quality* for each zone, but we set different *standards of quality.*

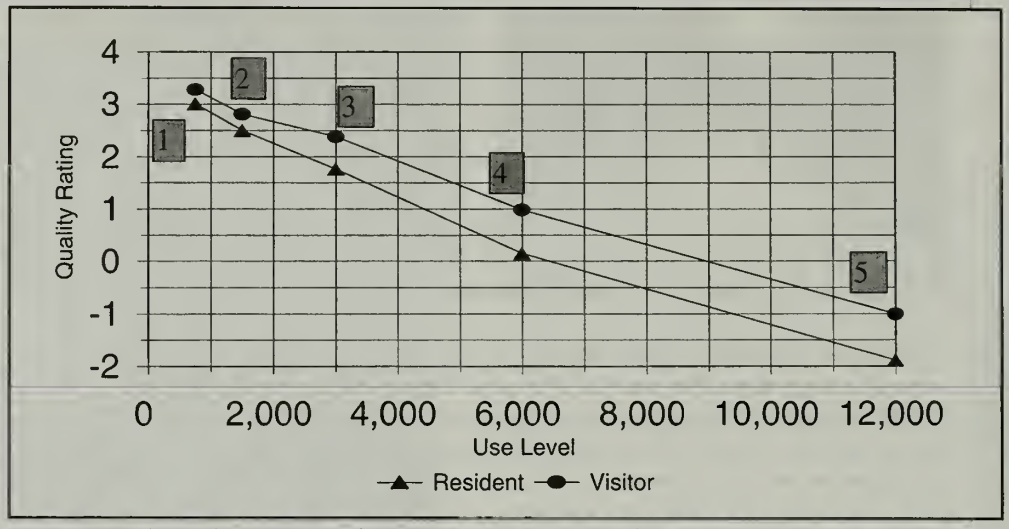


Figure 4. Resident and visitor acceptability (quality) ratings for the five visitor use scenarios were very similar, indicating there was little difference in tolerance for crowding.

Table 2.
Percent of visitors experiencing selected quality ratings (or higher) for selected total carriage road use levels

Carriage Road Use Level (people/day)	Quality Rating 1	Quality Rating 2	Quality Rating 3
1,500	91	85.7	74.2
2,000	91.2	83.4	68.6
2,500	91.5	81.2	62.9
3,000	91.7	**79** (quality standard)	57.2
3,500	87.2	73.5	51.7
4,000	82.8	68.1	46
4,500	78.4	62.7	40.3
5,000	74	57.3	34.6
5,500	69.6	51.9	28.9
6,000	65.2	46.5	23.2

Table 3.
Average number of minutes per hour visitors see selected numbers of persons per viewscape (PPV) in peak and nonpeak zones for four total carriage road use levels

	Carriage Road Total Use Level (people per day)							
	Use=2,500		Use=3,000		Use=3,500		Use=4,000	
PPV	Nonpeak	Peak	Nonpeak	Peak	Nonpeak	Peak	Nonpeak	Peak
0	50	36	48	31	45	29	45	26
1-5	9	22	11	27	14	28	14	29
6-10	1	2	1	2	1	3	1	4
11-15	0	0	0	0	0	0	0	1
16-20	0	0	0	0	0	0	0	0
21-30	0	0	0	0	0	0	0	0

[2]The following three conditions *occurring together* defined the peak zone: a location between intersections 1 and 10 and between 14 and 17, a time between 10:00 a.m. and 5:00 p.m., and a day between June 20 and Labor Day or any of the three days of the Memorial Day and Columbus Day holidays. All other times and places were in the nonpeak zone. Thus, even on July 4, if someone were biking between intersections 1 and 10 after 5:00 p.m., they would be in the nonpeak zone.

Step 6 required formulating standards of quality for each zone. Study findings from the research described earlier were used to help set standards of quality for crowding and problem behaviors. These findings and the standards are outlined here.

Crowding standards

Formulation of crowding standards relied heavily on visitor and resident norms and findings from the computer simulation model. Table 2, developed from the frequency distributions of visitor acceptability ratings of the five carriage road use scenarios, shows the percent of visitors experiencing selected quality ratings (or higher) for selected carriage road total use levels. These data show the relationship between quality and total use, and empirically represent the trade-offs inherent in managing the carriage roads.

While the data in table 2 were helpful, they raised two challenging questions. What quality rating should the park manage for (i.e., what point on the y-axis in figure 4 should be selected)? What percentage of visitors should have an experience of that quality rating or higher? Insight into answering these questions was provided through development of table 3. This table shows computer simulation estimates of PPVs for the peak and nonpeak zones for a range of four likely use levels. For all four use levels, a wide difference exists between the peak and nonpeak zones for the number of minutes visitors see 0 and 1-5 PPV. Establishing and maintaining this diversity of use conditions was a goal set in step 4.

Based on research findings as reported in the tables and figures, the VERP team established three crowding-related standards of quality:

1. Eighty percent of visitors should have a high quality experience (defined as quality rating 2 or higher from table 2). This standard of quality is consistent with the management goal of providing a high quality visitor experience as defined in step 4 of the VERP framework.
2. Total use for the carriage roads should not exceed 3,000 visitors per day. This figure is taken from table 2, which indicates that roughly 80% of visitors have an experience of quality rating 2 or higher at this use level.
3. PPV-related standards of quality for peak and nonpeak zones are as follows:

Total use for the carriage roads should not exceed 3,000 visitors per day

- In the *peak zone,* visitors should see 0 PPV *at least* 31 minutes out of each hour; 1-5 PPV *no more than* 27 minutes of each hour, 6-10 PPV *no more than* 2 minutes out of each hour, and never more than 10 PPV.
- In the *nonpeak zone,* visitors should see 0 PPV *at least* 48 minutes out of each hour; 1-5 PPV *no more than* 11 minutes of each hour, 6-10 PPV *no more than* 1 minute out of each hour, and never more than 10 PPV.

These figures are taken from table 3, which shows PPV estimates for a total carriage road use level of 3,000 visitors per day.

Formulation of standards of quality for crowding and other indicators of quality will always involve an element of value judgment by park managers. However, these research findings, along with the decisions made within the context of the VERP framework, provide an informed, empirical, and defensible basis for such decisions.

Behavior standards

Standards of quality for problem behaviors were established by using the norms described earlier and by trying to balance the divergence in such norms between residents and visitors. Based on this analysis, the VERP team established the following behavior-related standards of quality.

For a two-hour visit in the peak zone, visitors should experience no more than:

- Two instances of bicyclists traveling at excessive speed
- Two instances of bicyclists passing from behind without warning
- One instance of visitors obstructing the road
- Zero instances of dogs off leash

For a two-hour visit in the nonpeak zone, visitors should experience no more than:

- One instance of bicyclists traveling at excessive speed
- One instance of bicyclists passing from behind without warning
- One instance of visitors obstructing the road
- Zero instances of dogs off leash

Step 7 of the VERP framework requires monitoring of indicators of quality. Monitoring of crowding-related indicators of quality will rely on the computer-based simulation model and estimations of systemwide use derived from the electronic trail counter. If estimations of systemwide use exceed 3,000 visitors per day, PPV standards are assumed to be violated. Some direct counts of PPVs will be made as a field-check on the simulation model. Monitoring of behavior-related indicators of quality will be accomplished by administering brief surveys, identical to those used in phase II research, conducted once every three years. Based on monitoring results, crowding standards were not violated in 1997 or 1998. The highest daily use, however, was nearly 2,800 visitors. Behavior standards were not violated in 1997; they will be monitored again in 2000.

Assumptions and conditions on which the simulation model was built must also be monitored for changes. Major changes in use patterns, such as an increase in the number of one-way trips taken, might require adjustment of the model.

If monitoring determines that standards of quality are violated, then *step 8* requires analysis of the root cause of such discrepancies. Research and monitoring suggest that current use of the carriage roads meets all standards of quality. However, the VERP team has considered potential causes of such discrepancies. A new transportation system for the park and surrounding communities began in 1999. Visitor use of this transportation system may change visitor use patterns on the carriage roads enough to cause standards of quality to be violated. The park must preserve the quality of the carriage road experience by managing the transportation system schedule (access) to the carriage roads. Parking enforcement, changing visitor demographics, increased use, a new visitor use, or a failure or lapse in visitor education are also potential causes of discrepancies.

Step 9 requires management action to address any discrepancies between existing conditions and standards of quality. Again, no such discrepancies currently ex-

"Carriage Roads" continued on page 26

"Carriage Roads" continued from page 25

ist on the carriage roads. However, in phase II and phase III research, visitors and residents were asked the degree to which they supported or opposed a range of possible management actions. Based on these findings, the VERP team has identified four potential management actions in decreasing order of priority: further visitor education, parking control and mass transit, visitor permits, and enforcement patrols.

Conclusions and recommendations

VERP provided a systematic, rational, and, where possible, empirically based approach to developing a management plan for the carriage roads. Carriage road experiences were defined through indicators and standards of quality. Indicators of quality will be monitored to ensure that standards of quality are not violated. Finally, a series of management actions is available if and when needed.

Successful application of VERP was due to: (1) obtaining research funding thanks to the relatively high profile of the issue; (2) a peer-reviewed research program that allowed for informed decision-making; (3) thinking ahead about how monitoring would be accomplished; and (4) the dedication of the VERP team.

Several recommendations for applying VERP emerged from our experience. Moving fast was sometimes helpful, especially through steps 1-3. It also helped to push the application as far as possible and recycle through it often; VERP should be considered an iterative process with many feedback loops. The VERP team struggled with steps 4 and 5, and preferred not to dwell on them when they could be revisited. Furthermore, reliable, quantitative information based on peer-reviewed research was critical to the process. Finally, for the purposes of monitoring, the application should be kept as simple as possible. Fewer indicators, standards, and zones make monitoring more feasible.

Park managers now have a sound understanding of carriage road visitor use issues and a plan for managing the visitor experience. A carrying capacity has been established and monitoring is in place. Management challenges lie ahead as the park tries to maintain a high quality carriage road experience.

Acknowledgments

We extend our thanks to Bill Valliere and Ben Wang, research staff at the University of Vermont, for their help in this project, and to Dave Lime, University of Minnesota, and Wayne Freimund, University of Montana, for their help in study design. PS

Literature Cited

Haf, M., J. Hammett, M. Rees, J. Belnap, N. Pae, D. Lime, and R. Manning. 1994. Getting a handle on visitor carrying capacity: A pilot project at Arches National Park. Park Science **14(1):**11-13.

Manning, R., D. Lime, W. Freimund, and D. Pitt. 1996b. Crowding norms at frontcountry sites: A visual approach to setting standards of quality. Leisure Sciences **18:**39-59.

Manning, R., D. Lime, and M. Haf. 1996c. Social carrying capacity of natural areas: Theory and application in the U.S. national parks. Natural Areas Journal **16:**118-127.

Manning, R., C. Negra, W. Valliere, and C. Jacobi. 1996a. Acadia National Park carriage road study: Phase I research. Technical Report NPS/NESO-RNR/NRTR/96-07. January. Department of the Interior. National Park Service. 61pp.

Manning, R., W. Valliere, N. Ballinger, and C. Jacobi. 1998b. Acadia National Park carriage road study: Phase III research. Technical Report NPS/NESO-RNR/NRTR/98-1. October. Department of the Interior. National Park Service. 74pp.

Manning, R., W. Valliere, B. Wang, N. Ballinger, and C. Jacobi. 1998a. Acadia National Park carriage road study: Phase II research. Technical Report NPS/NESO-RNR/NRTR/98-3. July. Department of the Interior. National Park Service. 93pp.

Manning, R., W. Valliere, B. Wang, and C. Jacobi. 1999. Crowding norms: Alternative measurement approaches. Leisure Sciences **22(2):**97-115.

National Park Service. 1997. The visitor experience and resource protection (VERP) framework: A handbook for planners and managers. NPS D-1215. Denver Service Center. Denver, Colorado.

Shelby, B., and T. Heberlein. 1986. Carrying capacity in recreation settings. Oregon State University Press. Corvollis, Oregon.

Stillwater Associates. 1995. Qualitative research findings: Assessment of management alternatives for Acadia National Park carriage roads among local hikers, bicyclists, and equestrians. Orono, Maine. July 1995. 26pp.

Vaske, J., A. Graefe, B. Shelby, and T. Heberlein. 1986. Backcountry encounter norms: Theory, method, and empirical evidence. Journal of Leisure Research **18(2):**137-153.

Wang, B., and R. W. Manning 1999. Computer simulation modeling for recreation management: a study on carriage road use in Acadia National Park, Maine, USA. Environmental Management **23(2):**193-203.

Charles Jacobi is a Recreation Specialist in the Resource Division of Acadia National Park. He can be reached at P.O. Box 177, Bar Harbor, ME 04609; 207-288-5463, fax 207-288-5507; charlie_jacobi@nps.gov. Robert Manning is a Professor in the Recreation Management Program at the University of Vermont. He helped conduct research for the application of VERP at Arches National Park, Utah (as reported in Park Science *4(1):11-13), and is involved in similar work at other parks now. He can be reached at the University of Vermont School of Natural Resources, George D. Aiken Center, Burlington, VT 05405-0088; 802-656-2684, fax 802-656-2623; rmanning@nature.snr.uvm.edu.*

Computer simulation model

A computer-based simulation model of carriage road visitor use was developed using the simulation software package Extend by Imagine That, Inc. (Manning et al 1998a, Manning and Wang, 1999). Model inputs came from visitor surveys and census results. Phase II visitor surveys provided information about visitor types, group sizes, and travel routes. Six censuses of carriage road use conducted from 9:00 a.m. to 6:00 p.m. at 11 major access points provided data on carriage road entries distributed in time and space. The model was verified through sensitivity analysis and comparison with data on actual carriage road use. Model output can take several forms, including density of use, numbers of encounters between visitors, and persons-per-viewscape (PPV). For the application of VERP described in this paper, PPV proved to be useful. PPV indicates the number of visitors within any 100-meter viewscape, the approximate typical distance that can be seen along the carriage roads. For any daily total use level of the carriage roads, the model estimates the number of minutes out of an hour that selected PPVs occur. Examples of these data are shown in tables 1 and 3. These data helped formulate standards of quality for the carriage roads. The simulation model can also assist with monitoring indicators of quality. Finally, the model can be a useful management tool by predicting the effect on PPV levels of changes in spatial and temporal use patterns.

Rare plant survey at Capitol Reef National Park

By Deborah Clark and Thomas O. Clark

In 1997 and 1998, Capitol Reef National Park received a research and inventory grant from the National Park Foundation and Canon U.S.A., Inc., through their "Expedition into the Parks" program. This grant enabled National Park Service staff, researchers, and volunteers to collect critical data on several of the rarest plants occurring in the park.

Capitol Reef National Park is located in south-central Utah (figure 1), in the Colorado Plateau region, 72 km (45 mi) west of Hanksville on U.S. Highway 24. It was established to protect the longest exposed monocline in North America and is approximately 97,000 ha (241,903 acres) in size. This wrinkle in the earth's crust runs about 160 km (100 mi) north to south and is named the Waterpocket Fold. Unique geological conditions within the fold have created microhabitats that support over 40 rare and endemic plant species.

The six plant species selected for this study were ones most likely to be impacted by increased park visitation around the headquarters or Fruita area. Capitol Reef is primarily a backcountry park and receives about three-quarters of a million visitors each year. Many of these visitors hike the trails within the Fruita area and many of these trails have rare plant populations adjacent to them. Therefore, information on the whereabouts of rare plants in these high use areas and whether they are being affected by visitation is essential for park management.

Three of the six species are federally listed as endangered or threatened: Barneby reed-mustard (*Schoencrambe barnebyi*–endangered), Maguire's daisy (*Erigeron maguirei*–threatened), and Wright's fishhook cactus (*Sclerocactus wrightiae*–endangered). One species, Rabbit Valley gilia (*Gilia caespitosa*–figure 2), was a candidate for federal listing, but is now being managed under a conservation agreement and strategy that precludes the need to list it[1]. The remaining two species are NPS sensitive: Harrison's milkvetch *(Astragalus harrisonii)*, occurring only within Capitol Reef National Park, and pinnate spring-parsley *(Cymopterus beckii)*.

[1]The conservation agreement and strategy was written by BLM, FWS, USFS, and NPS staff in 1996. This agreement addresses protection measures designed to achieve long-term conservation of the species so that listing under the Endangered Species Act would not be necessary.

The study

The primary purposes of this project were to (1) conduct intensive surveys for the target species within the heavily visited Fruita area, and (2) develop monitoring protocols for each species that would detect changes in plant numbers due to visitor impacts. The study area encompassed approximately 10,000 ha (25,000 acres), with about 6,400 ha (16,000 acres) containing suitable habitat for one or more of the target species (figure 3, page 28). Particular emphasis was focused on areas currently being impacted by visitors and on areas where future increased use is expected.

The study began during the 1997 field season when the interagency botanist mapped known locations using a global positioning system (GPS). These locations were entered into the geographic information system (GIS) and were overlaid with soil types, geologic formations, slope, aspect, and elevations to create a profile of potential habitat by species. In addition to accurately depicting known and potential habitats, this refined the range of each of the six species and helped resource managers plan how many people would be needed to accomplish the tasks.

After completing this initial work, field crews conducted surveys in potential habitat for each species (figure 4, page 28). By surveying from April through late June when the majority of plants were in full bloom crews ensured proper plant identification and increased survey accuracy. Each area was systematically surveyed both by walking transects through all accessible areas and by using binoculars to search cliffs. The crews hiked every established hiking trail and other well-used foot route in the Fruita study area during the appropriate blooming time for each species. If a trail or route passed through potential habitat for two or more species and those species bloomed at different times, then those trails and routes were hiked multiple times to ensure surveys were as thorough as possible for each species. Once all maintained trails were surveyed, then routes and areas receiving off-trail use were surveyed. For future reference, crews noted on maps all areas surveyed.

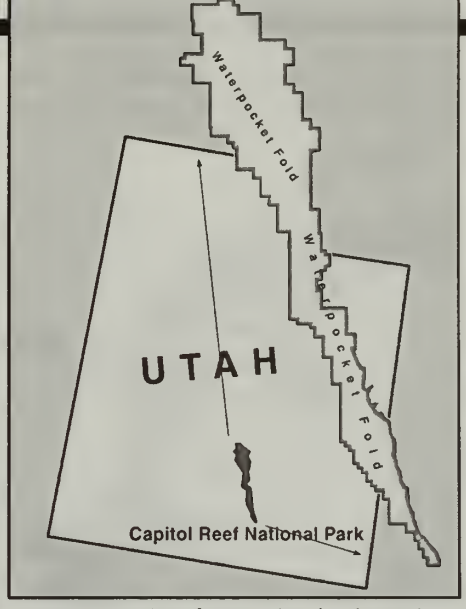


Figure 1. Capitol Reef National Park is located in south-central Utah and encompasses the Waterpocket Fold, a 100-mile-long geologic formation known as a monocline that provides numerous microhabitats for rare plants.

For each new occurrence of a species, crews completed a modified version the Utah Natural Heritage Division Site Visit Account Survey Form, took photographs, and mapped its location on 7.5' quadrangle maps. Wherever possible, a GPS was used to map the precise location of each new occurrence.

Localities found on or adjacent to hiking trails and routes were recorded and

Figure 2. Robbit Volley gilia, a candidate for federal listing, is now being managed under a conservation agreement and strategy.

"Plant Survey" continued on page 28

"Plant Survey" continued from page 27

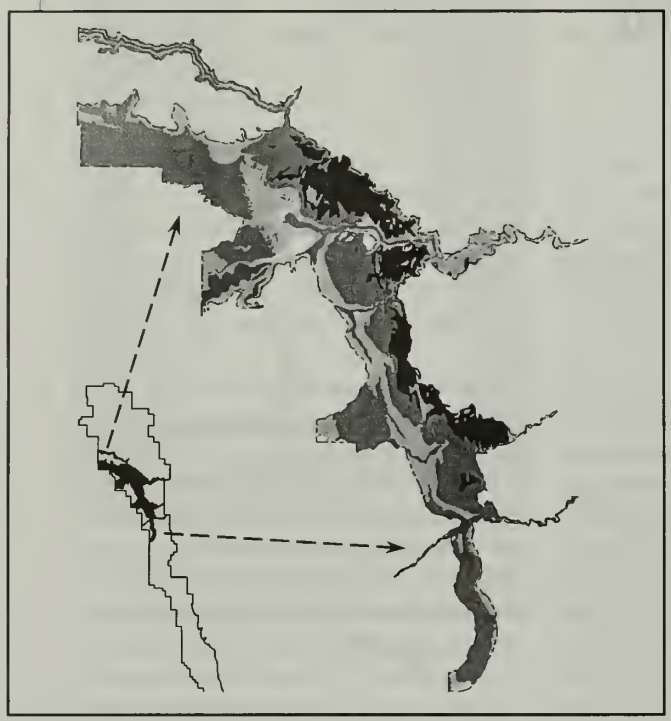


Figure 3. The study area within Capitol Reef National Park encompasses Fruita, an area that contains the majority of visitor use. Darker areas depict potential habitat for a greater number of the target species.

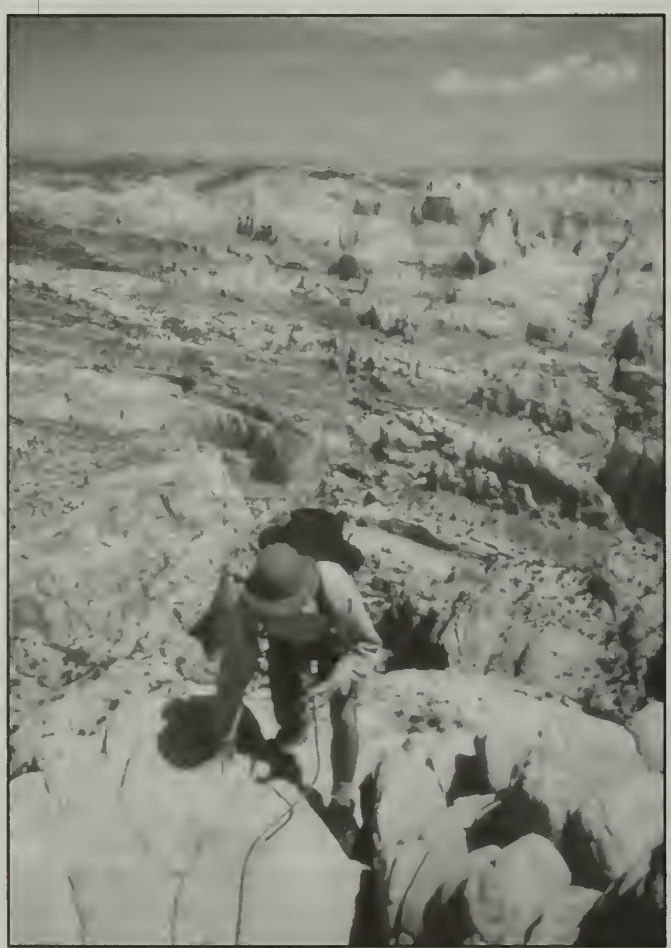


Figure 4. Field survey crews searched for Maguire's daisy, a federally endangered species, in rugged, steep terrain.

mapped so park managers would know about the potential for visitor-related impacts to these populations. All new localities were entered into the park's GIS along with a summary of data about the locality. This ensures long-term retrieval capabilities for future resource managers.

In 1998, the study progressed into the monitoring phase. Resource managers selected monitoring sites where at least 100 individuals of the target species occurred in areas of current or potential visitor impact. The interagency botanist visited each of these areas to determine whether a monitoring plot could be established without impacting the species of concern. Since all these species grow in rugged, steep terrain, some sites had to be abandoned since any monitoring efforts would have disturbed the plants, or the location was deemed too difficult to access repeatedly.

Once resource managers determined the logistical feasibility of establishing a plot at a given site, field crews set up the plots, then tagged individual plants and took their measurements. Measurements included precise location by distance along and from an established meter tape (to enable new crews to relocate individual plants during successive years), plant height, size class, number of flowering stems, and condition of plant. Since almost nothing is known about the life history of these plants, the monitoring method is designed to gather some of that information.

The crews established plots near hiking trails to measure visitor impacts and tagged plants growing within one meter of the edge of trail by burying numbered nails. A second control plot away from trail impacts was established near the "trail" plot. These control plots were located on the same slope, aspect, and soil type to reduce the number of variables that could affect monitoring results.

Survey results

Crews surveyed the twelve maintained hiking trails and four well-used routes within the Fruita area for each of the target species. They completed 87 site visit accounts, documenting information on all known and new populations of the six selected species in the Fruita study area.

Calendar year 1997 was excellent for botany work in Capitol Reef because winter and spring rainfall was above average, creating a superb year for wildflowers. A long, cool spring prolonged the bloom of several of the target species, enabling survey crews adequate time to cover thoroughly all areas of concern. This also ensured a high degree of accuracy for survey results, since plants tended to be well developed and in full bloom for a longer than average time period.

Findings by species

Barneby reed-mustard

The recovery plan for Barneby reed-mustard reports an estimate of 2,000 total plants known from two locations, one in Capitol Reef. Prior to this study, only one locality in Capitol Reef could be confirmed by botanists. This species occurs only in two geologic formations, Moenkopi and Kaibab limestone. Approximately 3,360 ha (8,400 acres) of these formations occur within the study area, however, only about one-quarter of that area is potential habitat. During this study, all potential habitat for Barneby reed-mustard within Capitol Reef was surveyed, resulting in the discovery of nine new localities and approximately 1,630 individual plants.

Maguire's daisy

The recovery plan for Maguire's daisy reports an estimates of 5,000 individual plants known from 33 locations, representing seven separate populations. Three populations totaling 12 locations (five outside the study area) were known in Capitol Reef before the study. This species occurs only on Navajo sandstone between 1,600 and 2,500 meters elevation. There are approximately 1,920 ha (4,800 acres) of Navajo sandstone within the study area.

Surveys for Maguire's daisy focused on potential habitat adjacent to trails and routes and resulted in 20 localities being recorded (13 new ones) and approximately 1,650 individual plants being found.

Wright's fishhook cactus

The recovery plan for Wright's fishhook cactus reports an estimate of 13 locations in Emery and Wayne Counties, Utah. Only two locations were known within Capitol Reef before this study, both outside the study area. This species occurs on numerous geologic formations, and has a much wider distribution than the two previously discussed species. About 960 ha (2,400 acres) of potential habitat were estimated to be in the study area; however, very little of that acreage occurs near areas of concern. Thus, surveys focused on areas of concern and resulted in the discovery of seven new localities totaling 60 individual cacti.

Rabbit Valley gilia

Rabbit Valley gilia was a candidate for federal listing in 1997, but a conservation agreement and strategy was developed, thereby precluding the need to list it. Before the survey 13 locations for the species were known (nine in Capitol Reef) containing approximately 4,700 individual plants. This species grows only on Navajo sandstone, of which approximately 1,920 ha (4,800 acres) occurs within the study area. Surveys conducted during this study found three new occurrences containing 435 plants.

Harrison's milkvetch

This species is an NPS sensitive species. Until 1998, no extensive surveys had ever been conducted for Harrison's milkvetch. It was thought to occur at four locations in Capitol Reef, totaling about 200 individual plants. Harrison's milkvetch occurs only in Navajo sandstone. About 1,920 ha (4,800 acres) of this formation occurs in the study area, although very little of this area is actually potential habitat. Surveys confirmed the four known locations and added 14 new localities, totaling about 5,000 plants.

Pinnate spring-parsley

This species is an NPS sensitive species. Only nine localities (three in Capitol Reef), containing less than 2,000 plants were known before this study. Pinnate spring-parsley occurs in four formations: Navajo, Wingate, Kayenta, and Cutler limestone. About 3,800 ha (9,500 acres) of these formations occur within the study area; however, only about one-eighth of the area is potential habitat. This study confirmed the three known locations and added 13 new localities, totaling about 1,250 plants. However, the majority of new localities contain 20 or fewer plants. Often, one isolated plant was found in a slot canyon far from other known locations.

Monitoring plots

Crews established twelve monitoring plots for five of the target species. Resource managers determined that no monitoring plots were necessary for Wright's fishhook since the few occurrences were in areas not likely to be directly impacted by visitor activities. Monitoring plots will be maintained with annual monitoring for at least the first three years. Thereafter, the park will determine whether annual or biennial monitoring should be continued. Additional plots may be established in the future if deemed necessary.

Partnerships and products

Volunteers donated approximately 1,070 hours to this project, representing an approximate monetary worth of $10,900. Partnerships with Capitol Reef National Park for this project included seven organizations. Capitol Reef Natural History Association managed the grant budget and provided its science projects coordinator (now the interagency botanist) as staff for the project, and Zion National Park detailed one of its seasonal staff in 1997. Four universities sponsored student volunteers (Utah Valley State College, Southern Utah University, Utah State University, and Northern Michigan University), three of whom had specific internship programs through their universities. In 1997, Worthington High School in Ohio sponsored one "walkabout" high school student who assisted with GPS mapping.

The interagency botanist and interpretive staff produced two interpretive exhibits for display in the visitor center. One specifically details Canon's and NPF's role in the project, and the other describes rare plants and geology within Capitol Reef National Park. Additionally, the park installed signs at appropriate trailheads explaining the presence of rare plants along trails and encouraging visitors to stay on the trail. A leaflet educating visitors about rare plants growing in Capitol Reef National Park was developed and is being distributed in the visitor center.

Conclusions

Work accomplished by this study resulted in the discovery and documentation of several new localities for each of the target species. It also reconfirmed that each of these species is indeed very rare. Each species has its own microhabitat niche requirements that restricts it to very limited areas within the Waterpocket Fold and surrounding area. The largest increase in known localities and number of individual plants was for Harrison's milkvetch. This is because no surveys for this species had ever been conducted. Because of their extremely restricted microhabitat requirements, Barneby reed-mustard and pinnate spring-parsley were found to be the most limited species.

The timing of this grant was excellent since Capitol Reef National Park was in the process of revising its general management plan. Information gained from the 1997 portion of this project was directly applicable to the planning effort. Information gathered during this study also enabled the park to meet legal requirements of the Endangered Species Act, comply with NPS management policies, and address Government Performance and Results Act goals. Conducting surveys and establishing monitoring plots were some of the park responsibilities identified in three recovery plans and a conservation agreement. Knowledge gained about these species and their specific habitat requirements will enable park staff to ensure that these plants are protected and will assist in predicting which areas may contain additional occurrences. Future results from the monitoring plots will provide the means for park managers to make better decisions concerning visitor use and its impacts to park natural resources. PS

Deborah Clark is Interagency Botanist for the Bureau of Land Management (Richfield Field Office) Fishlake and Dixie National Forests and Capitol Reef National Park; she is stationed at Capitol Reef National Park; 435-425-3791 x 142; deb_clark@nps.gov. Thomas O. Clark is Chief of the Division of Resources Management and Science, Capitol Reef National Park; 435-425-3791 x 144; tom_o_clark@nps.gov.

© Laura D. Wilson www.LauraWilson.com

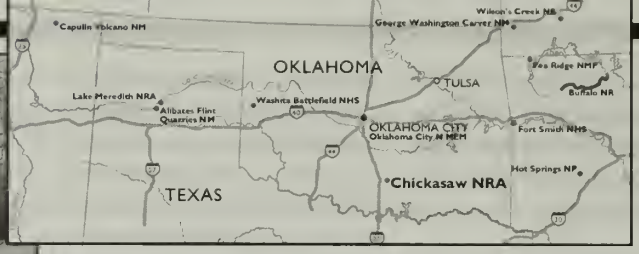


Figure 1 (photo). Concern over the decline in flow of Vendome Well and the possibility that its unregulated flow might be detrimental to other artesian wells and springs in the region led the National Park Service to renovate it in 1997. A new well was drilled, supplying water to the historic fountain and doubling its flow, and the old well was plugged.

Figure 2 (map). Named in honor of the Chickasaw Indian Nation, Chickasaw National Recreation Area is located in south-central Oklahoma.

Water quantity issues at Chickasaw National Recreation Area

As historic springs diminish in flow, provisions of a water resources management plan aim at understanding the causes and mitigating the decline

By M. Nicholl[1], T. Wikle[2], T. Brown[2], J. Nord[1], and R. Parker[3]

The resource management mission of Chickasaw National Recreation Area combines facilitating public recreation with protecting historically significant artesian waters (figure 1). Located in south-central Oklahoma (figure 2), midway between Oklahoma City and Dallas, Texas, the recreation area attracts over 1.5 million visitors annually for picnicking, camping, nature study, and water-based recreational activities. The area is also historically important as a source of fresh and mineralized spring waters that has been used by generations of visitors for drinking and the purported curative powers of the mineralized waters (Brown 1998).

As a means of guiding management activities pertinent to Chickasaw's unique water resources, NPS staff initiated the development of a water resources management plan that began with an "Issues Scoping Workshop" held in December 1996. Among the critical management issues identified by the National Park Service and other stakeholders were the historical and potential future decline in flow from the area's natural springs. Quality of the spring waters was also a concern, but is beyond the scope of this article (see sidebar, page 32). Here we present an overview of the unique water quantity problems associated with maintaining springs as both natural and historical resources at Chickasaw National Recreation Area.

[1] School of Geology, Oklahoma State University (OSU), Stillwater, Oklahoma.
[2] Department of Geography, OSU.
[3] National Park Service, Chickasaw National Recreation Area, Sulphur, Oklahoma.

Historical background

Before its designation as a national recreation area in 1976, Platt National Park (now the Platt District of Chickasaw National Recreation Area–see figure 4) held the distinction of being both our nation's smallest national park and the only unit in the national park system set aside to protect resources at the request of American Indian tribes. Long before NPS management, the region containing the springs was a sacred site and hunting area for resident tribes such as the Wichita and the Caddo and nonresidents such as the Comanche. An 1855 treaty with the U.S. government placed the area containing the present-day Chickasaw National Recreation Area under the control of the Chickasaw Nation.

In the late 1880s, development pressures rising from the popularity of the springs prompted the Chickasaw to cede the area to the U.S. government for protection. In 1902, Congress created the Sulphur Springs Reservation; four years later, it was renamed Platt National Park in honor of Connecticut Congressman Orville Hitchcock Platt. Included within its boundaries were 33 springs used by both local residents and visitors.

During the 1930s, the Civilian Conservation Corps constructed a number of improvements within the park, including pavilions, bridges, and weirs (figure 3). While the springs remained popular, visitor activities in the area were beginning to shift towards recreational pursuits. Recognizing the change in visitor interests and seeing an opportunity to better serve the demand for water-based recreation, the Congress redesignated Platt National Park as a national recreation area in 1976. With its change in status, the new Chickasaw National Recreation Area was enlarged to include the nearby Lake of the Arbuckles. In addition to providing recreational boating, swimming, and fishing opportunities, the lake serves as a flood control reservoir and water supply for surrounding communities. The recreation area was enlarged again in 1983 to its present size of 4,050 hectares (10,000 acres) through the acquisition of Veterans Lake (27 hectares; 67 acres) from the city of Sulphur (figure 4).

Groundwater at Chickasaw

A significant problem facing resource managers at Chickasaw National Recreation Area is that the underlying rock formations have yet to be studied in sufficient detail to fully understand the subsurface flow system that feeds the natural springs. South-central Oklahoma has a very complex geologic history that includes the building and subsequent erosion of the Arbuckle Mountains, located to the south of the recreation area. As a result, rock for-

© Laura D. Wilson, www.LauraWilson.com

igure 3. During the 1930s, the Civilian Conservotion orps constructed several improvements ot whot is odoy Chickosow Notionol Recreotion Areo. These ncluded the povilion, shown here, ot Povilion Spring.

mations in the vicinity of Chickasaw also show a high degree of complexity, exhibiting numerous folds, faults, and abrupt changes in rock type, much of which has not been studied.

The majority of the near-surface rocks in the recreation area belong to a geologic unit known as the Vanoss Formation. This well-cemented conglomerate is extremely dense and mostly impervious to the flow of water, except where it is fractured. Rock units that are impervious to water are known as confining layers, because they "confine" the flow of water to the underlying aquifer. Below the Vanoss Formation lie the Arbuckle (freshwater) and Simpson (mineralized) aquifers, which permit water to pass through fractures and pore spaces. Mountain building and erosional processes have left portions of the Arbuckle and Simpson aquifers exposed near the earth's surface in a region that is higher in elevation, and generally to the east of the recreation area. Rainwater percolating into the aquifers flows toward the recreation area beneath the confining Vanoss Formation.

Just like water flowing through a pipe, water in confined aquifers is under pressure. In the Arbuckle and Simpson aquifers, water pressure is sufficiently high to raise water to the surface at breaks in the confining layer (Vanoss Formation). Artesian springs form at natural breaks in the confining layer, and wells drilled into the aquifer will flow freely without the aid of pumps (artesian wells). At any given time, the amount of water that flows from artesian wells and springs is a direct function of pressure within the aquifer. If pressure goes up, flow will increase, and vice-versa. An illustrative example of a typical artesian aquifer is shown in figure 5 (page 32), although insufficient information exists to produce a diagram that accurately depicts conditions at Chickasaw National Recreation Area today.

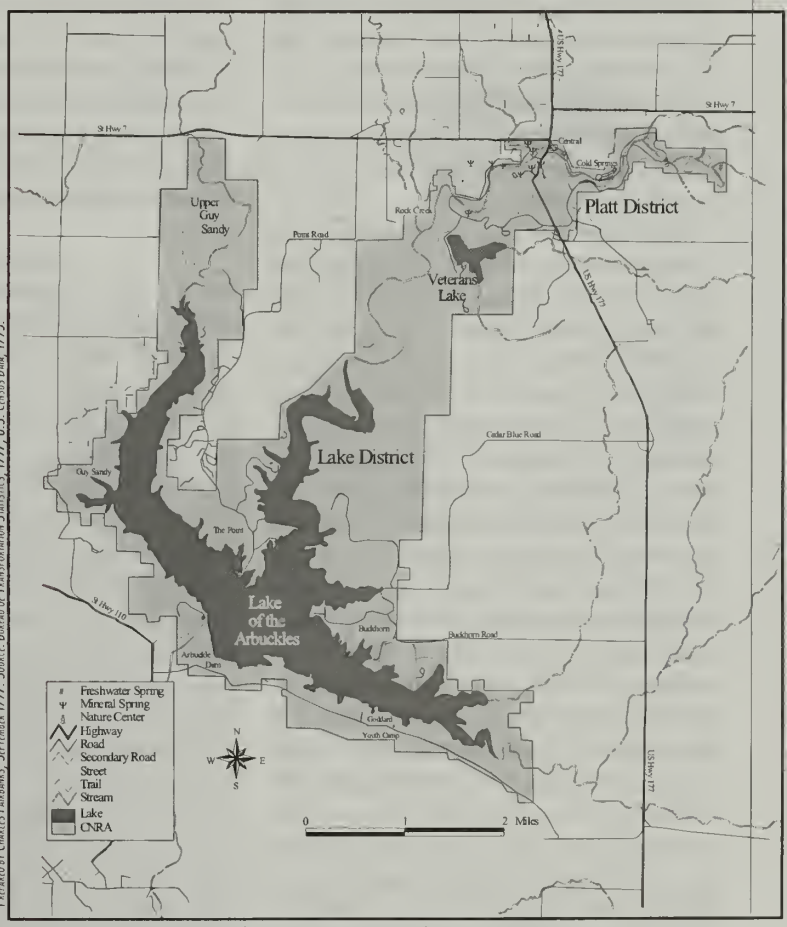
As water flows through an aquifer, it dissolves minerals in the rock. The amount of dissolution is a function of rock type and the amount of time that the water remains in the aquifer. In rocks of normal to low solubility, water that moves slowly becomes mineralized, while water that moves more quickly remains fresh. Each spring at the recreation area is connected to the underlying aquifer in its own way; therefore, the chemical makeup of the mineralized waters differ from spring to spring. Chemical species found in the mineralized springs at Chickasaw include sodium, calcium, magnesium, chloride, bicarbonate, and sulfate (Hanson and Cates 1994). Chemical makeup of the spring water is also dependent on that of the rainwater that initially percolates into the aquifer in the upland areas. Therefore, land uses in these upland areas may potentially impact water quality within the aquifer, and hence the springs (see sidebar, page 32).

Water quantity issues

Although a field survey conducted in 1906 identified 33 active springs within what is now the Platt District of Chickasaw National Recreation Area, a more recent survey in 1987 identified only 21 springs, some of which were barely noticeable due to low flow (Taylor 1988). Among springs that have ceased to flow are two of the most popular, Bromide and Medicine Springs. Estimates in 1939 suggested that total spring discharge had declined approximately 80% from a 1906 estimate of 14,160 liters per minute (3,741 g/min). Several springs had ceased to flow entirely by that time (Hanson and Cates 1994).

The observed decline in spring flow has become one of the most troubling questions facing resource managers at the recreation area. Spring flow is determined by pressure within the Arbuckle and Simpson aquifers, as discussed, which in turn is controlled by the balance between inflow (recharge) and outflow (discharge). The source for recharge is precipitation, which has remained relatively constant over the past 90 years. However, land use has changed dramatically within this same time frame, possibly influencing the fraction of precipitation that percolates through the soil to recharge the aquifers. In addition, a significant number of artesian wells have tapped the aquifer system since the area was first developed. The extent to which withdrawals from these wells may have reduced pressure within the aquifer system is currently unknown.

The water quantity issues illuminated during the 1996 workshop resulted in publication of the water resources manage-



Prepared by Charles Fairbanks, September 1997. Source: Bureau of Transportation Statistics, 1997; U.S. Census Data, 1995.

Figure 4. Detailed map of Chickasaw National Recreation Area.

"Chickasaw" continued on page 32

"Chickasaw" continued from page 31

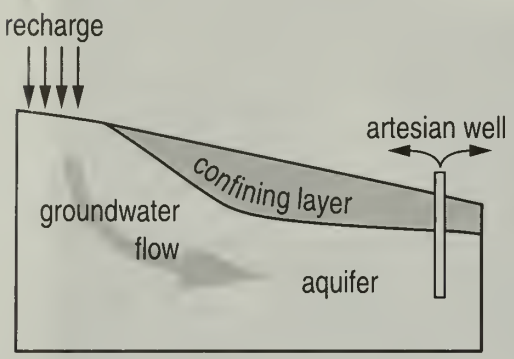


Figure 5. Generic geologic cross-section showing confined aquifer, spring, and artesian well.

ment plan (Wikle et al. 1998) for the recreation area. Through resource management project statements, the plan details strategies for, among many others, investigating the dynamics of the aquifer flow system, restoring flow to Bromide Spring, and controlling the flow of Vendome Well, the first project to be completed.

Regulation of Vendome Well

The best known artesian well in the region is Vendome Well (see fig. 1, page 30), located on Highway 7 just south of Sulphur. Drilled outside of park boundaries in 1922 and purchased by the National Park Service in 1980, Vendome remains a popular tourist attraction and cultural landmark for Sulphur residents.

Discharge rates for Vendome have declined from approximately 9,500 liters per minute (~2,500 g/min) in 1922 to around 1,900 liters per minute (~500 g/min) in 1992 (Hanson and Cates 1994). Factors believed to be responsible for the declining flow of Vendome include a general reduction in aquifer pressure and deterioration of the well casing. Park staff suspect, too, that uncontrolled discharge from the well and leakage from the subsurface well casing may have contributed to the decline in discharge rates of mineralized springs elsewhere in the recreation area.

Because of the interest in preserving the discharge of all artesian wells and springs in the region, the National Park Service has recognized the importance of regulating the discharge of Vendome Well without compromising the cultural or historical integrity of the site. To that end, renovation of Vendome Well began in October 1997.

A new well was drilled to a depth of approximately 229 meters (750 feet) at a location approximately 9 meters (30 feet) to the west and south of the original well (Christensen 1998). The new well produced water at a rate of around 3,800 liters per minute (~1,000 g/min); taste and smell of the water was similar to that issuing from the original fountain. After ascertaining the suitability of the new well, the original was plugged. In 1998, flow was routed from the new well into the existing fountain. Valves installed in the new well will allow flow to be controlled in accordance with management goals.

Long-term monitoring

In order to provide better information for decision-making, the water resources management plan recommends that the National Park Service implement a water quantity monitoring program that includes installation of flow gauges at each of the recreation area's springs. Although the U.S. Geological Survey maintains recording gauges to measure stream flow, the location of their equipment does not allow data collection for individual springs. Such data will be useful in determining a baseline flow for each spring, establishing trends relative to precipitation and other climatic factors, and evaluating potential mitigation measures that can be initiated by the National Park Service and surrounding water users. Information concerning withdrawal rates corresponding to artesian wells will also be needed in order to create a comprehensive water budget for the region. PS

References

Brown, T. 1998. Chickasaw National Recreation Area: societal preference and rationale for collection and consumption of spring water. Unpublished master's thesis. Department of Geography, Oklahoma State University.

Christensen, P. K. 1998. Vendome Well and springs at Chickasaw National Recreation Area. [www.aqd.nps.gov/wrd/vwcnra.htm]. Water Resources Division, National Park Service.

Fairchild, R. W., R. L. Hanson, and R. E. Davis. 1981. Hydrology of the Arbuckle Mountain area, south-central Oklahoma. U.S. Geological Survey. Open File Report 83-775.

Hanson, R. L., and S. W. Cates. 1994. Hydrogeology of Chickasaw National Recreation Area, Murray County, Oklahoma, Oklahoma City, Oklahoma. USGS, Water-resources Investigations Report 92.

National Park Service. 1997. Baseline water quality data inventory and analysis for Chickasaw National Recreation Area. Washington, D.C.

Taylor, T. 1988. Survey of Springs at Chickasaw National Recreation Area. Unpublished field notes.

Wikle, T., M. Nichall, T. Brown, J. Nord, and R. Parker. 1998. Water resources management plan for Chickasaw National Recreation Area, National Park Service, 121 pp.

Michael Nicholl is Assistant Professor, School of Geology, Oklahoma State University, Stillwater, Oklahoma. He can be reached at nicholl@okway.okstate.edu. Thomas Wikle is Professor and head of the Department of Geography at Oklahoma State University; geogtaw@okstate.edu. Tonia Brown is Supervisor at DataMetrix in Tulsa; Ctf021498@aol.com. Jason Nord is a graduate student in the School of Geology at Oklahoma State; jaynord@yahoo.com. Ron Parker is Resource Management Specialist at Chickasaw National Recreation Area, Oklahoma; 405-622-3161; ron_parker@nps.gov.

Water quality issues

According to a 1997 report by the National Park Service, surface waters within Chickasaw National Recreation Area and the surrounding region have been significantly impacted by human activities. The report noted that potential sources of contaminants include municipal and industrial wastewater discharges; storm water runoff; agricultural, livestock, and fish hatchery operations; oil and gas development and residential development; quarrying operations; recreational use; and atmospheric deposition.

Screening tests performed on surface waters in the Chickasaw NRA region since the 1950s suggest that fecal coliform, dissolved oxygen, copper, and chloride are the parameters that fail to meet EPA drinking water quality standards most often (Wikle et al. 1998). Additionally, Hillside Spring has had a long history of intermittent bacterial contamination from fecal coliform and fecal streptococci (Wikle et al. 1998).

As with the water quantity concerns, water quality issues are being addressed through several project statements outlined in the Chickasaw Water Resources Management Plan.

Profile of the USGS Columbia Environmental Research Center

By Marcia Kelly Nelson

Editor's Note: This is the third profile to appear in Park Science *of a science and technology center operated by the USGS Biological Resources Division (see also* **18(1)**:13-14 *and* **15(3)**:12-13*). The nationwide network of 16 centers (a 17th is soon to be added) was described in* **15(2)**:24-26 *of this publication and is detailed on-line at http://biology.usgs.gov/pub_aff/centers.html. Park managers with research and technical assistance needs related to environmental contamination and its effects on habitat will find useful expertise and research activities described below.*

Figure 1. Known as a semipermeable membrane device or SPMD, this sampling tool was invented at the Columbia Environmental Research Center and is deployed to collect in situ contaminants. The device is a "virtual fish," mimicking the parts of animals that cause contaminants to bioaccentrate. It is a long, flat, plastic tube that contains oil that allows contaminants to pass through, like membranes of animal cells. The oil is similar to a highly purified fish fat in which most contaminants readily dissolve and become concentrated, as if in the fat of a fish.

Clean water resources and habitat quality are essential for the health of all living organisms, a fundamental concept in the mission of the Columbia Environmental Research Center (CERC). The center provides scientific information and data for the U.S. Geological Survey and its clients, including the National Park Service, needed to address national and international environmental contaminant issues and to assess effects of habitat alterations on aquatic and terrestrial ecosystems. The center has a unique capability for conducting both focused and large-scale multidisciplinary research that includes, but is not limited to, large-river floodplains, coastal habitats, wetlands, and lakes. Emphasis is on projects that integrate scientific disciplines to address complex environmental issues on large geographical scales. Scientists at CERC form partnerships with national, state and local agencies, nongovernmental organizations, and universities to enhance scientific information needed for management of the nation's resources.

CERC is one of 16 science centers in the U.S. Geological Survey's Biological Resources Division. Historically, the center was established in 1959 at the Denver Wildlife Research Center of the U.S. Fish and Wildlife Service and was called the Fish Pesticide Research Laboratory (FPRL). In 1966, the University of Missouri deeded 33 acres to the Fish and Wildlife Service and the FPRL moved to its present location. The partnership initiated between the university and the laboratory in 1966 remains strong today through a number of cooperative research programs. The center was incorporated into the U.S. Geological Survey Biological Resources Division in 1996. The name of the laboratory was changed to CERC in 1998. In addition to the main facility in Columbia, Missouri, CERC administers seven field research stations located across the nation.

Center organization

About 150 federal and contract employees, with an extensive range of scientific and technical expertise, staff CERC. Research areas and services cover broad aspects of environmental toxicology and chemistry, ecology, ecogeography, large-river ecology, and information and technology transfer. The center's science program is organized into seven branches: Toxicology, Ecology, Ecogeography, Environmental Chemistry, Biochemistry and Physiology, Field Station Research, and Information Transfer.

Environmental toxicology, is the functional responsibility of the Toxicology Branch. The branch scientists develop, apply, and validate methods for assessing the effects of contaminants and other environmental stressors on aquatic organisms. Research focuses on bioaccumulation and toxicity of contaminants from water, sediment, and food; the physical, chemical, and biological factors affecting these processes; and relationships between laboratory responses and characteristics of contaminated aquatic ecosystems. Disciplines include invertebrate and vertebrate toxicology, limnology and benthic ecology, and culture of aquatic organisms.

Research of the Ecology Branch focuses on understanding the effects of habitat alteration caused by environmental contamination, physical destruction, eutrophication, exotic species, and climate change on aquatic systems. The ecological investigations are integrated with other biological, chemical, and physical science programs at CERC to provide a comprehensive understanding of habitat alteration on aquatic populations and communities. The Ecology Branch has laboratory, field, and mobile facilities to conduct ecological assessments under controlled and natural environments. The branch is extensively involved in cooperative research with other federal, state, and private institutions to meet the research needs of client agencies, to develop standardized methods and guidelines, and to

Two CERC field research stations are closely allied with national park research needs, and are located at NPS facilities

"CERC" continued on page 34

"CERC" continued from page 33

contribute to the basic scientific knowledge concerning human impacts to natural systems.

The Ecogeography Branch investigates the spatial and quantitative relationships among the biotic and abiotic components of the environment. The branch has expertise in landscape analysis, landscape ecology, fisheries biology, geographic information systems (GIS) analysis, collection of geographic positioning systems (GPS) and bathymetric data, hydraulic modeling, statistical consultation, geomorphology and surficial processes, environmental monitoring and risk assessment. Ecogeography scientists are responsible for providing information and technical support for the development and use of digital databases for natural resource planning and management, and for conducting research at an ecosystem scale. The USGS River Studies Station (RSS), located at the center, is included in the research program of the Ecogeography Branch. The station's mission is to increase the understanding of how management and restoration activities function on large-river systems through a comprehensive and integrated science approach. River studies research emphasizes how management changes in the physical and chemical condition of rivers affect habitat and ecological conditions. Areas of expertise RSS include expertise in fisheries biology, aquatic and terrestrial ecology, hydrology, hydraulics, floodplain configuration and evolution, remote sensing, and GIS.

The Environmental Chemistry Branch is critical to the integrated approach of chemical discovery and biological cause and effect (figure 1, page 33), the basis of environmental contaminant research in the USGS. Environmental chemistry research encompasses all areas relating to environmental pollution, including analytical methods development, fate of environmental contaminants, development of techniques for defining bioavailability, bioconcentration potential, and determining toxicological significance of exposure to contaminant residues. The branch conducts aquatic, terrestrial, and atmospheric ecosystem research and collaborative projects with other CERC scientists as an integral part of the center's anticipatory research approach. The branch provides environmental science information to the public, other Department of the Interior agencies, and the scientific community through presentations and scientific publications. The branch's scientists are nationally and internationally known for their research and are often consulted by other researchers in environmental science.

The Biochemistry and Physiology Branch conducts basic and applied research at the cellular, organ, and organismal levels in fish and wildlife. Emphasis is on the sublethal effects of chemicals that lead to behavioral, developmental, and population changes that may ultimately influence ecosystem health. Scientists in the branch identify biochemical and physiological indicators of individual toxicant stressors in addition to overall physiological effects and toxicity of complex chemical mixtures. Research focus includes reproductive, developmental, and neurotoxic effects of stressors. The branch develops and uses analytical techniques such as microscale assay, cell bioassay, and immunoassay, to quantify exposure and estimate toxicity in both lab and field studies. In addition, branch scientists study the mechanism(s) of action of contaminants to develop and validate sublethal indicators of chemical stress.

The Field Station Research Branch specializes in ecological and toxicological research that is relevant to natural resource issues in the Texas/Gulf Coast, intermountain West, and Great Lakes/Great Plains regions of the United States. Research stations are located in Corpus Christi, College Station, and Padre Island, Texas; Jackson, Wyoming; Yankton, South Dakota; and International Falls, Minnesota. Scientific expertise at the research stations includes marine ecotoxicology; sediment toxicology; waterfowl and avian ecology; wildlife ecology; ecotoxicology of mammals, reptiles, and amphibians; sea turtle ecology; assessment of acid or metals effects in native western fishes; natural resource damage assessments; agricultural irrigation drainwater assessment; and aquatic community evaluations of endangered, native, and invasive fish species. Capabilities include both laboratory and on-site field assessments. Research activities are conducted in collaboration with a wide variety of federal, state, university, international, and nongovernmental cooperators.

The Information Technology Branch is dedicated to providing traditional and contemporary data distribution and management systems to retrieve the most current scientific information. An emphasis is placed on the discovery, access, and full use of information sources available through the Internet and World Wide Web. The center plays an active role in developing the National Biological Information Infrastructure, a network of distributed databases and information sources for biological information. The branch organizes the analyzed and reported data collected in research investigations and ensures rapid dissemination of research metadata into national databases. Emphasis is placed on training and keeping research staff abreast of rapid changes in computer technology, coupled with increasing emphasis on interdisciplinary science, information exchange, and multimedia presentations, particularly over the World Wide Web. The center's homepage can be viewed at http://www.cerc.usgs.gov/.

Field stations located at national parks

Two CERC field research stations are closely allied with national park research needs, and are located at NPS facilities. Sea turtle ecologist, Donna Shaver-Miller, conducts sea turtle research along the Texas coast at Padre Island National Seashore (see story on page 16, this issue), and fisheries biologist, Larry Kallemeyn, conducts fisheries research on native and exotic fishes in lakes of Isle Royale National Park, Michigan, and Voyageurs National Park, Minnesota.

Obtaining assistance

The Columbia Environmental Research Center offers technical assistance in all of its areas of expertise. If you have an environmental problem you would like to discuss or need any information related to our research efforts, we want to hear from you. If you have a national park research project in which CERC can offer some expertise, do not hesitate to contact us. For more information on contacts or on the areas of expertise at CERC, consult table 1 or visit the center's website. PS

Marcia Kelly Nelson is the Outreach Coordinator for the Columbia Environmental Research Center. In addition to handling many aspects of external affairs for CERC, which includes intergovernmental affairs, she promotes science education and awareness of the center's role and activities. She can be reached at CERC; USGS Biological Resources Division; 4200 New Haven Rd.; Columbia, MO 65201; 573-876-1875; marcia_nelson@usgs.gov; http://www.cerc.usgs.gov/.

Table 1.
USGS Columbia Environmental Research Center contacts

Branch	Research Areas or Services	Ongoing/Recent NPS-Related Projects
Center Director Wilbur "Bill" Mauck 573-876-1900 bill_mauck@usgs.gov	Research and development planning and coordination.	
Toxicology Christopher G. Ingersoll, Branch Chief 573-876-1819 chris_ingersoll@usgs.gov	Assessing biological effects of contaminants and other environmental stressors on aquatic organisms.	
Ecology Edward E. Little, Branch Chief 573-876-1817 edward_little@usgs.gov	Understanding effects of habitat alteration caused by environmental contamination, physical destruction, eutrophication, exotic species, and climate change on aquatic systems.	Evaluation of ultraviolet radiation as a factor in amphibian decline in montane habitats in Glacier, Rocky Mountain, Sequoia, and Olympic National Parks (Ed Little).
Ecogeography Pamela S. Haverland, Branch Chief 573-876-1841 pamela_haverland@usgs.gov	Investigations of spatial and quantitative relationships among the biotic and abiotic components of the environment.	Evaluating the links between tributary land use and aquatic habitat quality on the Buffalo, Jacks Fork, and Current Rivers within park boundaries in the Buffalo National River and Ozark National Scenic Riverways (Robb Jacobson).
Environmental Chemistry Jim D. Petty, Branch Chief 573-876-1824 jim_petty@usgs.gov	Encompasses all areas relating to environmental pollution, including contaminant fate, development of analytical methods, techniques for defining bioavailability, bioconcentration potential, and determination of toxicological significance of exposure to contaminants.	
Biochemistry and Physiology Donald E. Tillitt, Branch Chief 573-876-1886 donald_tillitt@usgs.gov	Conducts research on the sublethal effects of chemicals that lead to behavioral, developmental, and population level effects that ultimately influence ecosystem health.	
Field Station Research Laverne Cleveland, Branch Chief 573-876-1874 laverne_cleveland@usgs.gov	Specializes in ecological toxicological research relevant to natural resource issues in the Texas/Gulf Coast, Intermountain West, and Great Lakes/Great Plains regions of the United States.	Sea turtle ecology/recovery at Padre Island NS (Donna Shaver-Miller); aquatic community evaluations of endangered, native, and invasive species at Isle Royale and Voyageurs NPs (Larry Kallemeyn); effects of geothermal additions on the biology and distribution of trout in the Firehole River of Yellowstone NP (Dan Woodward); water quality investigations in Garnet Canyon and lower Cascade Canyon, and winter movements and habitat use of Snake River cutthroat trout in Grand Teton NP (Dan Woodward), contaminant investigations in the food chain of peregrine falcons in Big Bend NP and other areas of the Chihuahuan Desert (Miguel Mora).
Information Technology Ted R. Schwartz, Branch Chief 573-876-1832 ted_schwartz@usgs.gov	Information management, library, technical editing, and computer support and applications.	

Developing a plan for long-term ecological monitoring: A focused workshop approach

By Bruce Freet and Kent Turner

Every day, resource managers throughout the national park system endeavor to fulfill the NPS mandate to preserve park resources. Yet, how do we measure and assess our success in meeting this charge? Resource conditions change over time due to the normal variation in the biophysical environment, but are the resources in better or worse condition during our tenure as stewards? Was the change induced by human activities or by "natural" processes?

Long-term ecological monitoring (LTEM) is attempting to answer such questions. Embraced by the National Park Service under its Inventory and Monitoring Program, LTEM is a fundamental aspect of park resource management as it ultimately helps us understand resource conditions. Parks designated as LTEM prototype parks have long recognized the importance of developing conceptual plans as an important first step in determining what to monitor. Since we cannot afford the time and money to monitor everything, we need to identify the key indicators of change or "vital signs" that we should concentrate on and which attributes to measure.

Recently, the LTEM concept has been combined with the Pacific West Region's initiative to identify and monitor natural and cultural resource vital signs. Vital signs are reliable, early warning signals by which we can measure and detect changes that will impair the structure and functions of ecosystems. During 1998, North Cascades National Park Service Complex (Washington) and Lake Mead National Recreation Area (Nevada and Arizona) conducted workshops with the goal of determining methods for taking vital signs of resource condition and detecting change over time. This effort can also assist us in promoting a teamwork approach to resource stewardship.

The North Cascades approach

North Cascades NPS Complex (includes North Cascades National Park and Lake Chelan and Ross Lake National Recreation Areas) began the LTEM conceptual plan as a logical step-down chart process, beginning with the NPS mandate. Based on the mandate and a guiding statement from the park's enabling legislation "to preserve ... certain majestic mountain scenery, snow fields, glaciers, alpine meadows, and other unique natural features," we focused primarily on the relationship of monitoring (figure 1) to broad management responsibilities to conserve and protect the scenery, natural resources, and public use and enjoyment. A draft outline of the conceptual plan was completed before the workshop to provide the vision and foundation for our deliberations.

To ensure that our LTEM workshop in March 1998 was as productive as possible, we formulated clear, concise objectives and desired products before the gathering. Reed Glesne, an aquatic ecologist on our staff, and Dave Peterson, an ecologist with the USGS-BRD Forest and Rangeland Ecosystem Science Center, developed four goals for our conceptual step-down model and plan:

- Enhance basic resource knowledge (baseline resource inventories)
- Determine status and trends in resource condition (change over time)
- Utilize multiple indicators and metrics for early detection
- Maximize the utility of existing monitoring protocols and results

The specific workshop objectives were:

- Workshop participants will provide relevant information and scientific literature
- The North Cascades NPS Complex staff will review resource inventories and issues
- Scientists and resource management staff will jointly select indicators (*what*) for the early detection of change
- Workshop participants will justify *why* indicators were selected and prioritize them, quantify appropriate spatial and temporal scales (*where* and *when*), and (3) recommend strategies and metrics for implementation (*how*).

The workshop outcomes and products were used to develop the LTEM conceptual plan with prioritized resource management plan project statements, update the park's LTEM bibliography, and document workshop recommendations. This focused, product-oriented approach allowed us to develop a substantial amount of written documentation over a short period of time, while directly integrating the LTEM plan with the park's resource management plan.

Although most components of the LTEM program emphasize natural resources, we also included human resources and cultural resources because of their direct link to natural resources. Inventory, monitoring, assessment of resource conditions, and refinement of management strategies are adaptive management tools that the entire park staff–including human and cultural resource specialists–should be using. Federal monitoring programs are often not viable, because political and managerial priorities vary over time and divert funding from critical monitoring activities. If we incorporate LTEM programs with other park operations, we hope that long-term monitoring can become institutionalized and survive, thereby producing useful time series of data. For example, the trail maintenance crew in North Cascades has a strong environmental ethic but no monitoring responsibilities. They could monitor *limits of acceptable change* for designated trails and backcountry campsites (e.g., width of trails, number of social trails, soil bulk density). We anticipate that our entire Resource Management Division will have responsibilities in the LTEM program, rather than having a separate LTEM workforce. In fact, everyone in the division *wants* to be involved, which ensures ownership of the program by park staff.

The direct interaction of park staff and scientists before and during the workshop helped to focus workshop activities on a predetermined model for the LTEM plan and minimized discussions that were tangential to objectives for developing the plan. To facilitate an efficient workshop, we spent considerable time compiling information for workshop participants, including summaries of park resource issues, ecological processes potentially affected by environmental stress, potential monitoring parameters, criteria for monitoring components, and criteria for meeting monitoring goals. A conceptual model for LTEM at the watershed scale was developed and included in the workshop packet. Since then, Dave Peterson and Paige Eagle have helped us develop and publish on-line (www.nps.gov/noca/Ltem/Index.htm) the entire LTEM conceptual plan, including step-down charts, templates, and descriptions of natural and cultural resources.

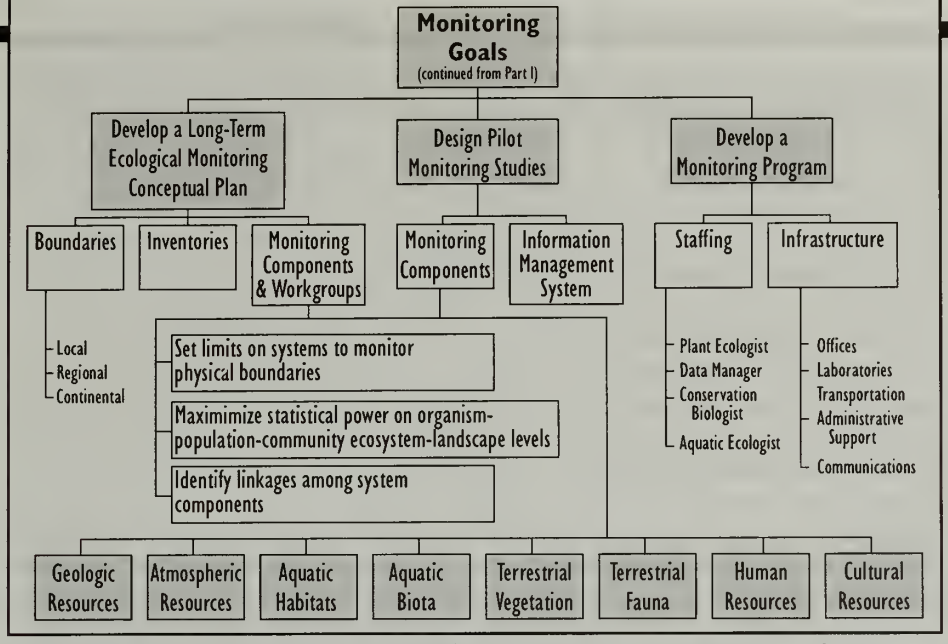


Figure 1. Development of on LTEM conceptuol plon for the North Coscodes complex grew out of the NPS mondote ond the pork's originoting legislotion (port I—not shown). The step-down process led to evolving criterio for meeting monitoring gools, shown in the chort (port II), ond to identificotion of eight principol resource components requiring long-term ecologicol monitoring.

Resource specialists on the park staff led off the 2½–day workshop with brief overviews on specific park resources, including summaries of existing inventories and data. Workshop participants were divided into eight work groups, each of which addressed a different topic: aquatic biota, aquatic habitats, atmospheric resources, cultural resources, geologic resources, human resources, terrestrial biota, and terrestrial habitats (fig. 2, page 38). We employed facilitators–scientists Gary Davis (Channel Islands National Park) and Dave Peterson–who provided oversight of workshop proceedings, kept discussions on track, and ensured consistent output among work groups. They also encouraged discussions between work groups to ensure that appropriate resource linkages were recorded. Each work group had a subject-matter specialist as its team leader and a park staff member as its recorder. This organization gave specific individuals responsibility for group dynamics, focus, products, and documentation.

The work groups efficiently completed the component identification template designed by Lake Mead staff and developed them into draft conceptual models. Each template addressed a single monitoring component and detailed related information: (1) the monitoring/research questions to be addressed; (2) stressors on the resource and any related factors; (3) what to inventory; (4) what to monitor; (5) where to monitor; (6) justification for monitoring the resource and other information; and (6) potential partners. These draft materials were subsequently sent to every workshop participant for review and revision, and the resulting draft was sent to subject-matter experts for further review. We also placed the draft LTEM plan on a website to facilitate wider review. The entire process, from planning through final product required approximately a year. We may establish an LTEM scientific review committee to help us to stay focused on the vital signs, improve data management and analysis, assure connection to management issues, and promote integration between various monitoring components. Our resource management staff should work closely with any committee to assess how well the LTEM program is meeting its objectives.

The Lake Mead approach

To guide the Lake Mead LTEM program, we adopted the goal of maintaining vital signs of ecosystem health within their "normal range of variation." The goals of our vital signs workshop in January 1998 were:

- Provide a peer review of the current resource management program
- Ensure that staff are knowledgeable of all functions and processes necessary to maintain ecosystem integrity
- Provide direction for a long-term monitoring program for the assessment of resource conditions and ecosystem health

Similar to the North Cascades approach, we spent considerable time planning for the workshop. The planning team–Gary Davis; USGS-BRD scientists Bill Halvorson, Kathryn Thomas, and Peter Stine; and Dave Van Cleeve (Superintendent, Colorado Desert District, California State Parks)–met with us to define goals, objectives, and products for the workshop and LTEM program.

Approximately 50 scientists and resource managers from a variety of disciplines around the Mojave Desert attended the workshop. Before the meeting, we provided each participant with an informational package that included a narrative on the workshop process; park resource information; the Lake Mead NRA conceptual ecological model; a model of the recreation area's resource management program; a sample component identification template; examples of vital signs and criteria for their selection; and the final templates to be completed during the workshop.

Resource management staff described the ecosystem model, outlining ecosystem components, drivers (e.g., climate, fire, geologic events), and stressors. We also presented a model of the resource management program at the recreation area, based on a previously developed step-down chart. Invited scientists gave presentations on selected features of the ecology of the Mojave Desert and limnology of Lake Mead.

We then divided into work groups that focused on air quality; groundwater hydrology; the lake ecosystem; soils and related microbiota; vegetation; and wildlife. The groups were asked to identify (1) significant ecosystem components not addressed in the park's conceptual model; (2) anthropogenic stressors affecting the ecosystem; (3) monitoring questions related to the stressors; and (4) vital signs related to the stressors. Next we prepared the standard template, documenting over 80 vital signs during this process.

The meeting summary was provided to each participant for review. Following the first comment period, the eight participating scientists provided a peer review of the results. We met with the peer review team in May 1998 to synthesize and integrate results, and developed priorities and strategies for implementing the long-term, vital signs monitoring plan. With the help of the review team, we established a framework for vital signs monitoring, goals for the monitoring program, an initial list of 15 high-priority vital signs, and strategies for implementation.

This progression led us to establish three major goals for long-term, vital signs monitoring:

"LTEM" continued on page 38

"LTEM" continued from page 37

- Preserve underlying ecosystem integrity (ecosystem health)
- Understand the ecosystem, based on knowledge of resources
- Practice management performance monitoring (expected vs. actual results, refined through adaptive management). This goal includes compliance monitoring (mandated or special interest species), and monitoring to maintain the quality of visitor experiences (e.g., dark night sky, water clarity)

To implement long-term monitoring, we outlined a four-tier framework where tier 1 addresses those functions or processes related to maintaining ecosystem productivity (e.g., soil fertility, hydrological functions). Tier 2 applies to the maintenance of ecosystem health (e.g., plant community structure), and tier 3 relates to maintenance of biodiversity (species distribution and abundance). The quality of the visitor experience, and visitor interactions with the resource are outlined in tier 4.

Implementation strategies blended various approaches to monitoring with opportunities for interdisciplinary monitoring. They include monitoring a transect of intensive plots (leading to greater understanding and indices for predictive modeling) and extensive plots (greater spatial coverage); stratification of the park by soils and vegetation maps; change-detection monitoring (rapid assessment); and employing variable-return intervals. The use of interdisciplinary monitoring leads to the integration of vital sign components, providing more detailed understanding and greater efficiency. For example, we are considering establishing intensive plots that would combine monitoring of soil properties, nitrogen deposition, alien flora, invertebrates, and small mammals.

We are working with USGS-BRD staff to develop monitoring protocols for soils monitoring. We are also seeking funding to develop an interdisciplinary monitoring protocol (including hydrology, vegetation, birds, invertebrates, and amphibians) and a lake ecosystem/limnology protocol as our highest priorities.

Lessons and recommendations

North Cascades NPS Complex and Lake Mead NRA agree on the general approach to developing a long-term ecological monitoring plan, despite differences in biogeographic setting and in monitoring objectives. Both parks used a similar approach for planning, conducting, and summarizing the results of workshops. Each park ended up with a detailed, scientifically based plan that will guide future monitoring efforts.

We found that a 2½–day, focused workshop is a time-efficient and cost-effective means of developing a long-term monitoring plan. However, workshops are successful only if they are highly structured and well organized. We attribute the success of our workshops and subsequent monitoring plans to:

- extensive planning before the workshop, in which existing inventories, data, and issues were compiled;
- development of conceptual models to represent various park ecosystem functions and potential monitoring strategies;
- assemblage of all resource baseline inventories and selected presentations;
- clear statements of objectives and expected products for the workshop and monitoring plan, as well as a statement of management objectives and priorities;
- use of facilitators and focused work groups;
- use of a component identification template, which provided a consistent format for recording information and ideas;
- thinking in terms of monitoring suites of species, attributes, or their habitats;
- prompt synthesis and integration of workshop results, followed by additional scientific review;
- long-term commitment by park staff and a scientific-review team.

The importance of long-term commitment cannot be overstated. Monitoring responsibilities must be formally integrated with the resource management plan and operationally integrated with day-to-day resource management activities. Personnel and priorities may change over time, but park staff must have full participation in the development and implementation of the monitoring plan and data collection.

North Cascades NPS Complex included cultural resources and human resources work groups within its LTEM program, while Lake Mead NRA did not. Although the concept of vital signs monitoring is better suited to natural resources, we need to consider how assessments of cultural and natural resources can be integrated in a common framework. Parks that are planning long-term monitoring programs need to develop means to consider both cultural and natural resources in order to meet NPS Organic Act, General Authorities Act, National Historic Preservation Act, and Government Performance and Results Act requirements.

With the threat of increased environmental stress in many of our parks and protected areas, a long-term monitoring plan is one of the cornerstones of a sound resource management program. While there are many ways to develop a monitoring plan, our successful application of a similar workshop-based strategy suggests that this approach may lead to a favorable outcome, the development of a plan, and ultimately implementation of a monitoring program. Since our workshops in 1998, an additional six parks in the Pacific West Region have held similar vital signs workshops, with five more planned in fiscal year 2000. We offer our approach as a potential model for application in other parks that are interested in developing monitoring plans. We solicit your comments on how this approach can be improved. PS

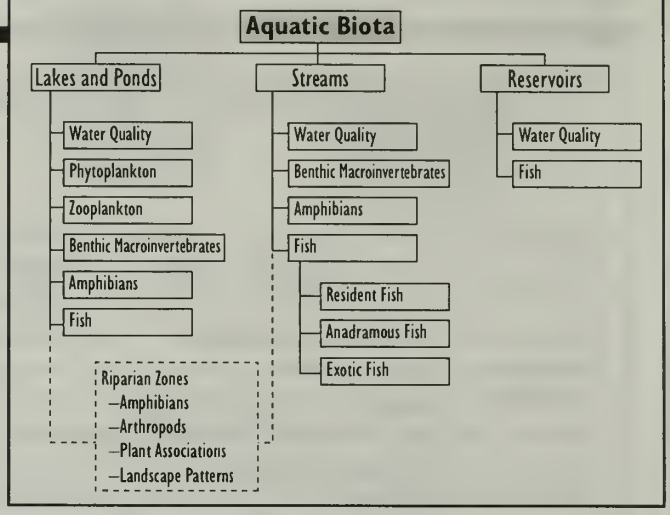


Figure 2. The North Coscodes work groups developed o complete set of conceptuol models for monitoring vorious pork resources, including oquotic bioto. The entire set of models is posted on the North Coscodes website (www.nps.gov/noco/Ltem/Index.htm) olong with the component identificotion templotes. The templotes identify whot to monitor for eoch resource. For exomple, the key indicotors or vitol signs for phytoplonkton ore obundonce, species composition, ond chlorophyll.

Bruce Freet is Chief of Resource Management at the North Cascades NPS Complex and can be reached at 360-856-5700, x 376; bruce_freet@nps.gov. Kent Turner is Chief of Resource Management at Lake Mead National Recreation Area (702-293-8941); kent_turner@nps.gov).

Protected areas, science, & the 21st century

By John J. Reynolds and Christine M. Schonewald, Ph.D.

Editor's Note: *The following is an edited excerpt from a presentation by John Reynolds, Pacific West Regional Director, given at the Third International Conference on Science and the Management of Protected Areas (SAMPA III) in Calgary, Alberta, on 16 May 1997. Coauthored by Christine Schonewald, Research Scientist with the USGS Biological Resources Division, these thoughts, as the title suggests, are relevant at the millennium.*

Science will and must occupy a crucial center in the management of protected areas in the future. Our paper does not focus on the biological or physical sciences. It would have, even a decade ago, maybe even five years ago. Rather, it focuses on the interests of people and their values, and the need to bond protected areas to the societies within which they exist. This turns the early 20th century idea of "boundary" inside out–no longer is a boundary a line of certain demarcation (i.e., if a resource lies inside the boundary, it is protected and we will do the protecting). No, today a boundary must be seen as something like a "diffusion filter." But what a change! To a traditionalist, this sounds weak, puny, almost like giving up.... But our societies interact with our protected areas in ways Frederick Law Olmsted might not be surprised about, but many protected area managers would be. What a change!

There is a paper at this conference that's different than all the rest. There's a brave soul out there who's on to something and has guts enough to face his peers with it. The title is "A fuzzy framework for managing landscape modeling concepts." Fuzzy logic in protected area management? What's next?

Well *that's* next. Listen to some of his abstract: "Imprecision, nonspecificity, vagueness, and inconsistency are considered undesirable features when trying to define policies or implementations," and "much of the logic used in human reasoning is a logic with fuzzy truths and fuzzy rules of inference."

Does that ring true for managing protected areas? Having just finished three years as Deputy Director of the National Park Service, it sure rings true for me! There wasn't a park issue that I dealt with that was precise, specific, defined, and consistent, and the superintendents didn't think so either.

So what about science in this kind of world with fuzzy logic, chaos theory, and diffusion filters? We need an explosion in capability. Our technical knowledge must get better. We have to define our technical research more clearly. We must monitor well, keep records well, and analyze the changes well–no difference from a decade ago. We have to do it better, not only so we know what we are talking about, but also so those through the diffusion barrier receive us with credibility, and we communicate results so that they can understand them.

Who's out there through the diffusion filter? What are their values? Do we understand them? Do they understand us? After all, what Teddy Roosevelt's peers thought about parks may not be what the population today feels. We have to know, and we have to relate our values to their needs for the future, and help them have the range of information so they can choose wisely. So, science about people, about vox populi, and the science of education of those whom we serve are essential.

If we are interested in protecting biological diversity and in ecosystem management, the Organic Act (1916) provides a good reminder. It reminds us that protection is associated with some sort of social pleasure, and that social pleasure, or satisfaction, is essential to the survival of these areas. Social pleasure or satisfaction includes, but is more than just direct interaction with, park resources. In a larger sense, it directly implies a cohesive acceptance throughout society that parks are of value. Can there be any doubt that the 21st century will bring more controversies and problems? We will still be asking: how do we interpret the protection process, how does it affect human behavior, and how does it affect our ecosystems and cultures? Finally, we need protected area managers who are creative and can take good biological, physical, landscape, ethnographic, historical, paleontological, social, economic, and political sciences and use them in ways that few have the temerity, guts, or intellect to even try today.

Creativity based on good information of all kinds will be the basic requirement of the future. The logic will be fuzzy, the issues imprecise and vague, and the boundaries more diffuse than ever.

It's a huge challenge, but an exciting world, don't you think?

"Ridleys" continued from page 17

shore could someday become one of the most successful endangered species restoration projects ever conducted by the National Park Service and its partners. PS

Donna J. Shaver (donna_shaver@usgs.gov) is the Station Leader of the U.S. Geological Survey Padre Island Field Station at Padre Island National Seashore. John E. Miller (jemiller@trip.net), is the former NPS Chief of Science, Resources Management, and Interpretation at Padre Island National Seashore.

Literature Cited

Fletcher, M. R. 1982. Atlantic ridley turtle reintraduced at Padre Island. Park Science **2(2):**3-4

Shaver, D. J. 1999. Kemp's ridley sea turtle project at Padre Island National Seashare, Texas. Pages 342–347 in University af New Orleans, campiler. Praceedings: Seventeenth Annual Gulf af Mexica Infarmatian Transfer Meeting. Minerals Management Service, Gulf af Mexica OCS Regian, MMS 99-0042.

Shaver, D. J. 1987. Padre Island Kemp's ridley sea turtle project update. Park Science **7(4):**8-9.

Shaver, D. J. 1990. Kemp's ridley project at Padre Island enters a new phase. Park Science **10(1):**12-13.

Shaver, D. J. 1992. Kemp's ridley research cantinues at Padre Island Natianal Seashare. Park Science **12(4):**26-27.

Shaver, D. J. 1996a. Head-started Kemp's ridley turtles nest in Texas. Marine Turtle Newsletter **74:**5-7.

Shaver, D. J. 1996b. A nate abaut Kemp's ridley nesting in Texas. Marine Turtle Newsletter **75:**25.

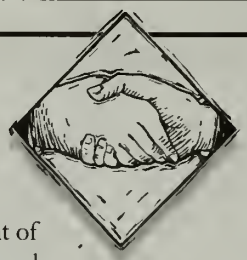
Shaver, D. J. 1997. Kemp's ridley turtles fram internatianal project return ta Texas ta nest. Pages 38-40 in University af New Orleans, campiler. Praceedings af the Sixteenth Annual Gulf af Mexica Infarmatian Transfer Meeting. Minerals Management Service, Gulf af Mexica OCS Regian, MMS 97-0038.

Shaver, D. J., and C. W. Caillauet, Jr. 1998. Mare Kemp's ridley turtles return ta sauth Texas ta nest. Marine Turtle Newsletter **82:**1-5.

TEWG (Turtle Expert Warking Graup). 1998. An assessment af the Kemp's ridley *(Lepidachelys kempii)* and laggerhead *(Caretta caretta)* sea turtle papulatians in the western Narth Atlantic. NOAA Technical Memarandum. NMFS-SEFSC-409. 96 pp.

U.S. Fish and Wildlife Service and Natianal Marine Fisheries Service. 1992. Recavery plan far the Kemp's ridley sea turtle *(Lepidachelys kempii)*. Natianal Marine Fisheries Service. St. Petersburg, Flarida. 40 pp.

Meetings of Interest*



March 13-17, 2000

The NPS Pacific West Region will host *West by Northwest 2000* in San Diego, California. The gathering will explore interdisciplinary management of parks and their resources with a specific look at natural and cultural resources stewardship and interpretation. Workshop themes include innovative program resolution, park futures and a changing public, and leading the way in resource stewardship. Contact Erv Gasser (206-220-4263), conference chair, for further information.

May 14-19

The Fourth International Conference on Science and the Management of Protected Areas (SAMPA IV) will be held at the University of Waterloo, Ontario, Canada. Held every three years, the international conference attracts a diverse group of parks and protected areas professionals, academics, researchers, managers, and members of nongovernment groups. Entitled *Learning from the Past, Looking to the Future,* SAMPA IV offers international plenary speakers, a wide variety of presentations and posters on contemporary issues, and educational field trips. Two major themes are planned: (1) regional approaches to planning and (2) research on both land-based and marine protected areas. Details of the conference, its programs, field trips, accommodations, and registration are available on the SAMPA website at http://landscape.acadiau.ca/sampaa/confpage.htm or by calling 519-622-9362.

May 16-18

The Third Conference on Research and Resource Management in the Southwestern Deserts will be held in Tucson, Arizona. Exploring the theme *Creative Cooperation in Resource Management,* the conference will feature papers and posters that tell of interagency collaboration in land use, research, resource management, and interpretation. Goals of the event are (1) to improve the preservation of natural and cultural resources through enhanced understanding of contemporary research and resource management challenges and (2) to achieve better cooperation through discussion of both ongoing and needed research. Abstracts for papers and posters will be accepted until January 14. Further information is available at www.srnr.arizona.edu/nbs, the home page of the USGS Sonoran Desert Field Station. Conference chair is Bill Halvorson (halvor@srnr.arizona.edu; 520-670-6885); registration coordinator is Lee Benson (602-640-5250, x 236; lee_benson@nps.gov).

October 16-20

The Natural Areas Association is planning its 27th annual conference, *Managing the Mosaic: Connecting People and Natural Diversity in the 21st Century,* to be held in St. Louis, Missouri. Celebrating the bicentennial of the Lewis and Clark Expedition, the banquet address will explore the historical and future implications of their trip, while plenary and concurrent sessions will focus on different aspects of biodiversity and how humans fit into the new century of management. Session topics planned include: insects in natural communities; economic values of natural diversity; monitoring; ecoregional planning; conserving caves, streams, and urban lands; partnerships; and many others. Further information is available from the Natural Areas website at www.natareas.org ("conferences" link) or from conference coordinator Kate Leary (573-751-4115, x183; learyk@mail.conservation.state.mo.us).

*Readers with access to the NPS Natural Resources Intranet Website can view a comprehensive listing of conferences and meetings at http://www1.nrintra.nps.gov/ (click "conferences and meetings").

BULK RATE
POSTAGE & FEES PAID
U.S. Department of the Interior
Permit No. G-83

PARK SCIENCE
Integrating Research and Resource Management
National Park Service
Natural Resource Information Division
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287

*GPO 773-055

PARK SCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT
Volume 20 • Number 1 • Spring 2000
U.S. Department of the Interior • National Park Service

A socioeconomic atlas for park management

By Jean McKendry and Nina Chambers

The natural and cultural landscapes adjacent to national park system units are experiencing dramatic change. Many parks once considered remote and distant from cities are now surrounded by an expanding urban and suburban matrix; parks in rural areas often attract gateway community development. For example, the Seattle, Washington, metropolitan area has expanded eastward toward Mount Rainier National Park; Tucson, Arizona, abuts Saguaro National Park; roads through Manassas National Battlefield Park in Virginia have become key commuter routes to and from Washington, D.C.; and Jackson Hole, Wyoming is a growing gateway community adjacent to Grand Teton National Park.

Changing activities and socioeconomic conditions in regions adjacent to park units can affect resources and visitor use within these parks. For example, increased development can lead to habitat fragmentation, contribute to degraded air and water quality, and intrude on historic settings and scenic values. Approximately half of the 62 park units that requested new general management plans in FY1999 were "seriously concerned about changes in surrounding land use" (Associate Director 1998). Population changes related to growth, aging, immigration, and mobility can alter traditional visitor use patterns and shift impacts on resources and demands for interpretive and recreation services.

Hence, park managers need systematic information about contemporary conditions and trends in human activities–socioeconomic trends–in the regions that surround individual units. Such information can be used to anticipate and help address complex park management challenges that originate outside park boundaries. Maps are powerful tools to help managers visualize spatial patterns related to these socioeconomic trends (Machlis and McKendry 1996). For example, a map that shows projected population change in a broad region surrounding a national park also reveals where development will likely occur, and where park managers might actively collaborate in land-use planning decisions. A *collection* of maps of regional socioeconomic trends (i.e., related to population, resource use, commerce, land use, and so forth) can be organized into an atlas. Such an atlas can contribute to a better understanding of the changing character of adjacent lands and potential impacts on national parks, and provide managers with a critical planning, management, and public participation tool.

Regional socioeconomic atlases for park management may be valuable and necessary. This article describes a project that was recently initiated by the NPS Social Science Program to develop such an atlas.

Objectives and criteria

The objectives of the atlas project are to: (1) develop a *prototype* atlas of regional socioeconomic trends; (2) test the atlas at four units of the national park system; and (3) evaluate the usefulness of the prototype atlas through a review by superintendents, resource managers, and others.

Each atlas should: (1) provide usable knowledge to park managers; (2) be cost-effective and efficient, with limited impact on park staff; (3) include the best available data sets from public and private sources that are easily updated in the future; and (4) include standard data sets that will allow comparisons among parks at the cluster, regional, and national levels. Using these criteria, a regional socioeconomic atlas for park management could potentially be developed for any unit.

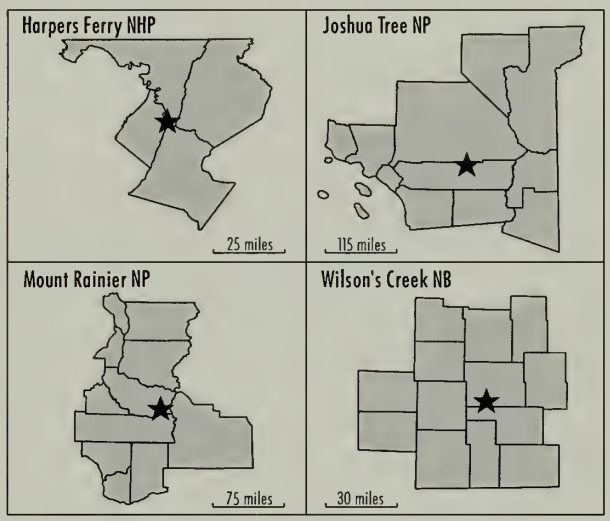


Figure 1. Regions of interest for the four pilot parks include aggregates of counties and were selected by park staff.

Progress in developing the atlas

Four units were invited to serve as pilots for the project: Harpers Ferry National Historical Park (West Virginia), Joshua Tree National Park (California), Mount Rainier National Park (Washing-

See "Atlas" on page 13

PARK SCIENCE

ISSN-0735-9462

Integrating Research and Resource Management

Volume 20 – No. 1 • Spring 2000

www.nature.nps.gov/parksci

Published by
U.S. Department of the Interior
National Park Service

Director
Robert Stanton

Associate Director, Natural Resource Stewardship & Science
Michael Soukup

Editor
Jeff Selleck

Editorial Office
National Park Service
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287
Phone 303-969-2147
FAX 303-969-2822
E-mail: jeff_selleck@nps.gov

Park Science is a research and resource management bulletin of the National Park Service that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. It is published twice annually, usually in the spring and summer, by the Natural Resource Information Division of the Natural Resource Program Center. Additional issues, including thematic issues that explore a topic in depth, are published on occasion. Content receives editorial review for clarity, completeness, usefulness, basic scientific soundness, and policy considerations; materials do not undergo anonymous peer review. Deadline for submissions is January 15 for the spring issue and April 15 for summer. Letters that address the scientific content of an article are welcome; they may be edited for length, clarity, and tone. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Park Science is also published on-line (ISSN-1090-9966). All back issues of the publication, article submission guidelines, and other useful information related to the publication can be viewed and downloaded from the website www.nature.nps.gov/parksci.

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Checks should be made payable to the National Park Service and sent to the editor.

Contributors—Elizabeth Rockwell (Information Crossfile)

Contents

Departments

Features

In the next issue...

Look for articles on the continuing fossil discoveries at Curecanti National Recreation Area, an interview with Point Reyes Superintendent Don Neubacher, additional social science features, and others.

*Other than the departments, this article stands alone this issue as the only one that is not part of the special emphasis on the social sciences.

Special issue, guest editor

This is the first issue of *Park Science* in nine years to explore in depth a specific resource management issue or related field of research. Let me thank our guest editor, Jared Ficker, for pulling together the feature articles for this issue and presenting several contemporary applications of the social sciences in park management. You'll note, however, that the publication's departments and the update on the National Natural Landmark Program represent *Park Science* "business as usual" and have not been tailored to reflect the social science emphasis. If you have a proposal for a special issue and would like to serve as guest editor in the future, please let me hear from you. Happy reading!

–Jeff Selleck, Editor

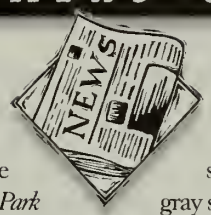
Applying the social sciences

This special issue of *Park Science* demonstrates the diversity of the social sciences and their contribution to park management. Increasingly, park and resource managers are faced with issues that require social science research. Such issues include development adjacent to parks, public participation in park management decision making, visitor perceptions of their experience, socioeconomic impacts of park management decisions, urban park problems, demographic trends, and program evaluation, among others. There are a growing number of social science researchers, primarily at universities, who are working closely with managers to deliver "usable knowledge" to address these issues. Social science disciplines such as economics, geography, political science, psychology, and sociology are providing useful insights to managers. This special issue highlights ongoing social science research in the national park system and discusses opportunities for new research.

Balancing use and preservation are decisions made by park personnel everyday. Park managers can attest to the growing complexity of the National Park Service mission– to preserve park resources unimpaired and provide for public use and enjoyment. This balance is often controversial and difficult, especially with limited information and increasing threats to the quality of park resources. Understanding the relationship between people and parks is essential. Social science research is a tool park managers can use to help provide useful information to achieve their goals. This issue of *Park Science* is intended to familiarize readers with the breadth of social science contributions to park management. It contains a sampling of social science research; however, there are many other social science projects occurring throughout the national park system.

I encourage you to consider how the research presented in this issue can be applied to your park or program. The National Park Service Social Science Program can assist in connecting park managers with researchers to address social science research needs. As park managers are faced with increasing controversy, particularly in working with diverse stakeholders, social science research will likely play an important role in decision making. I recall a conversation I had with Wayne Brewster (Yellowstone National Park) last year. Brewster attributed much of the success of the wolves reintroduction in Yellowstone to an early investment in social science research. At Yellowstone, the biological research of the reintroduction program was complemented by social science. Perhaps other natural science research efforts could also benefit from such a social science complement. I hope you enjoy this social science special issue of *Park Science*. While I served as guest editor, the efforts and contributions of Nina Chambers, Gary Machlis, and Jeff Selleck were all essential to this special issue.

–Jared D. Ficker
NPS Social Science Program
(jared_ficker@nps.gov)



Correction

The website address given for the white-tailed deer bibliography in the December 1999 issue of *Park Science* (19[2]:9) was in error. The "c" was left off "pwrc," which stands for Patuxent Wildlife Research Center, the website host. The correct address is www.pwrc.usgs.gov/library/bibs.htm.

Tumor rumor

The editor received a brief, unsigned note that pointed out an error two issues ago in the article entitled "Persistent expression of tumors in Lake of the Arbuckles gizzard shad" (19[1]:34-36). The note refuted the claim that "cancer in fishes has been previously reported at various locations in North America … but never in a national park." It asserted that gray (mangrove) snapper with tumors have been recorded in the waters of Dry Tortugas National Park.

Dr. Robert Wemer, Director of the Department of Laboratory Animal Resources at Florida State University, has been studying fish with tumors and other abnormalities from south Florida waters, and elaborated on the facts in an e-mail exchange with the editor. Dr. Werner reports that subcutaneous tumors, primarily single, but occasionally multiple, have been tentatively diagnosed as neurofibroma in gray snapper *(Lutjanus griseus)* from Florida waters, including those of Dry Tortugas National Park. A moat surrounding Fort Jefferson in the national park that harbors a semi-isolated population of the fish species was monitored every six months from August 1995 to August 1997. The tumor prevalence at this site ranged from 0 - 4.9% over the three-year study.

Dr. Michael Schmale of the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences also participated in the study. He reports that gray snapper with tumors have also been documented in Biscayne National Park. While this study has not been published in a scientific journal, Schmale has published in several journals about his work on cancerous tumors in bicolor damselfish that were collected in both Biscayne and Dry Tortugas National Parks[1]. Regarding the geographical error in *Park Science*, Schmale stressed that "oftentimes scientists do not realize which published studies were carried out in national parks because [this information] is not normally mentioned in the professional literature."

William B. Robertson II

Pioneering Everglades scientist and ornithologist, William B. Robertson II, died at his home in Homestead, Florida, in January. He was 75.

Robertson was a graduate student in 1950 when he came to the Everglades to study the park's breeding birds. The following year, he was hired by the Park Service and began a 46-year federal career studying the ecosystems of south Florida. His research on wildfire during the 1950s was revolutionary and paved the way for incorporating fire in the management of the park's pinelands and grasslands. His work was also influential in changing the way park managers across the nation view the ecological role of fire.

Robertson was dear to his colleagues, who often called him, simply, "Dr. Bill." Gary E. Davis, NPS Senior Scientist at Channel Islands National Park (CA), summed up his passing this way: "We can all learn from his farsighted examples of thoughtful study and compassion for nature. The clarity of his vision and depth of his understanding will be missed." PS

[1]For example: Schmale, M. C. 1991. Prevalence and distribution patterns of tumors in bicolor damselfish *(Pomacentrus partitus)* on south Florida reefs. Marine Biology 109:203-12.

ALLEGHENY-CHESAPEAKE

Fort Necessity restoration begins

Tucked away in the Allegheny Mountains of western Pennsylvania is a small patch of land where the first shots of the French and Indian War were fired. Today the site is known as Fort Necessity National Battlefield, and a new effort is under way to restore the park to its 1754 historic scene.

The National Park Service is assisted by Peggy Johnson (paj6@psu.edu), Associate Professor of Civil Engineering at Pennsylvania State University, who will lead the portion of the project that involves restoration of the stream that runs through the park. "Over the last 200 years there have been a lot of changes made to that piece of land," Johnson says.

John Karish, Chief Scientist with the NPS Philadelphia Support Office, says, "A lot has happened to that land since the battle was fought in 1754. It became a farm, the stream was dredged and straightened, and some land was drained."

Johnson explains that the site was originally a natural meadow fed by a winding stream. When the land was turned into a farm, the stream was straightened and drain tiles were installed to dry out the marshy stream.

Johnson's yearlong mission will be to assess the park's current conditions and make recommendations on how best to restore the meadow so that it will look more like it did in Washington's time.

The battle at Fort Necessity occurred on July 3, 1754, marking the beginning of the French and Indian War where the English and French battled for control of the North American continent. The war ended with the French expulsion from North America in 1763.

"Washington originally chose that site because it was one of the few areas where he could build a fort and see the area around him," Karish says. The site, also known as the Great Meadows, was described by Washington as "a charming field for an encounter."

The fight marked Washington's first major military engagement and the only time he ever surrendered to an enemy.

Birds surveyed at Pennsylvania parks

Large tracts of public land, such as national parks, have become more isolated because of increased development and urbanization, changing land uses, and habitat fragmentation within the eastern United States. These tracts of land are valuable for the long-term maintenance of biological diversity and the functional integrity of ecosystems. Therefore, the National Park Service has determined the need for in-depth inventorying and monitoring of animals and plants within national parks and historic sites in Pennsylvania. The Park Service, in conjunction with Pennsylvania State University, is conducting a comprehensive inventory program for birds at Allegheny Portage Railroad National Historic Site, Eisenhower National Historic Site, Gettysburg National Military Park, Hopewell Furnace National Historic Site, Johnstown Flood National Memorial, and Valley Forge National Historical Park.

The objectives of this research project are to obtain a comprehensive inventory data set on birds at the parks and to develop guidelines for establishing a long-term sampling plan to monitor birds at the parks. To meet these objectives, two years of bird surveys are being conducted at the parks using standard methodology. Bird surveys will be based on special needs, taxonomic groups of interest, habitats, and the infrastructure of each park. Ultimately, guidelines for establishing long-term sampling plans to monitor birds based on these inventories will be developed. Selecting protocols to survey birds, establishing permanent sampling points, and collecting data on bird populations will lay the groundwork for developing a long-term sampling plan to monitor birds at the parks.

Researchers completed breeding season and fall-migratory bird surveys between 25 May and 10 October 1999 (table 1), and also conducted inventories of winter bird communities at the six parks. Researchers also recorded a total of 15 species during the breeding season and 14 species during fall migration that have been identified as birds of management concern by the National Audubon Society and the U.S. Fish and Wildlife Service (table 2). Bird inventories for the research project will continue to be conducted during all seasons through spring of 2001. Information on bird communities obtained from the research and guidelines for continuing the bird inventories will be valuable for monitoring bird populations and for sampling specific taxonomic or functional groups of birds within units of the national park system in Pennsylvania in the future.

Reptiles, amphibians, and invertebrates inventoried

Researchers at Penn State University–Katharine L. Derge (kld8@psu.edu), Richard H. Yahner, Ke Chung Kim, and John R. Grehan–in cooperation with NPS natural resource staff, are conducting a two-year inventory of reptiles, amphibians, and terrestrial invertebrates at Gettysburg NMP and Eisenhower NHS. The inventory is part of the NPS Inventory and Monitoring Program, and is being funded both by it and Eastern National Parks and Monuments Association. The data will be used to evaluate the impacts of proposed landscape rehabilitation outlined in the new general management plan for Gettysburg.

Table 1.
Number of bird species detected during the 1999 breeding and fall season surveys at six units of the national park system in Pennsylvania

Park Unit	Number of Bird Species	
	Breeding Season	Fall Migration
Allegheny Portage NHS	53	45
Eisenhower NHS	65	48
Gettysburg NMP	82	74
Hopewell Furnace NHS	64	46
Johnstown Flood NM	47	33
Valley Forge NHP	83	74

Inventory sites for reptiles and amphibians are distributed throughout the parks in a variety of habitat types. These sites have been and will continue to be visited regularly over the two-year period and surveyed using standardized methods in order to calculate relative abundances of species found and analyze habitat relationships. Methods of inventory include natural substrate searches, artificial cover boards, trap and release, and frog and toad calling surveys. In addition to the standardized sites and methods, researchers are canvassing the parks with general searches to document the presence of as many species as possible. In the first year (1999) of the survey, researchers documented 26 species of reptiles and amphibians. One species of frog was not previously recorded in the park or the county.

Lepidopterists from Penn State collected butterflies and skippers from a series of sites in the parks in 1999. The collection contains 28 species of butterflies, one of which, the Baltimore (*Euphydryas phaeton* Drury 1773), is found only in wetland habitats. Surveys in the second year will target additional areas and particular species that have not yet been documented but are likely to occur.

At two forested sites, the researchers spent a week collecting invertebrates from as many microhabitats as possible. They used a combination of 12 different trapping methods in order to capture invertebrates from each part of the forest, including the soil, leaf litter, trunks of trees, air, and canopies of trees. Work is now concentrated in the museum, where entomologists are identifying the more than 22,000 specimens collected, representing 30 orders.

At the conclusion of data collection and analysis, the parks will have species lists, distributional data and maps, recommendations for long-term monitoring strategies, as well as comments on the impacts of landscape management on the targeted fauna. Results from the inventory will be submitted for publication in a future issue of *Park Science*.

Table 2.
Bird species of management concern identified during the 1999 breeding and fall seasons at Allegheny Portage Railroad National Historic Site (ALPO), Eisenhower National Historic Site (EISE), Gettysburg National Military Park (GETT), Hopewell Furnace National Historic Site (HOFU), Johnstown Flood National Memorial (JOFL), and Valley Forge National Historical Park (VAFO)

Bird Species	Breeding Season	Fall Migration
Black-throated blue warbler[1]	ALPO	ALPO, GETT, HOFU, VAFO
Blue-winged warbler[2]	GETT, VAFO	— —
Canada warbler[1]	— —	ALPO
Cerulean warbler[1,2]	— —	HOFU
Chestnut-sided warbler[2]	ALPO, JOFL	ALPO, EISE
Eastern meadowlark[2]	EISE, GETT, JOFL, VAFO	EISE, GETT, VAFO
Field sparrow[1,2]	All parks	ALPO, EISE, GETT, JOFL, VAFO
Grasshopper sparrow[2]	EISE, GETT, VAFO	GETT
Kentucky warbler[1]	VAFO	— —
Loggerhead shrike[2,3]	EISE	— —
Louisiana waterthrush[1,2]	ALPO, HOFU, VAFO	— —
Northern flicker[2]	Allparks	ALPO, EISE, GETT, JOFL, VAFO
Prairie warbler[1]	GETT	GETT, VAFO
Red-headed woodpecker[2]	EISE, GETT, HOFU	EISE, GETT
Red-shouldered hawk[2]	— —	EISE, JOFL
Veery[2]	HOFU, VAFO	ALPO, EISE
Wood thrush[1,2]	All parks	ALPO, GETT, HOFU, JOFL, VAFO
Worm-eating warbler[1,2]	EISE, HOFU, VAFO	HOFU, VAFO

[1] Listed on the 1999 State Watchlist for Pennsylvania by the National Audubon Society.
[2] Listed as a species of management concern in the Migratory Nongame Birds of Management Concern for 1995 released by the United States Fish and Wildlife Service.
[3] Listed as state endangered by the Pennsylvania Game Commission.

National Capital

Interagency cleanup of a former Army camp at Oxon Run

Bullets, munitions, and lead-contaminated soils are part of the World War I Camp Simms legacy for Oxon Run Parkway in Washington, D.C. To address this restoration challenge, a joint effort by the National Park Service, U.S. Army Corps of Engineers (COE), and USDA National Resource Conservation Service (NRCS) utilized restoration techniques to mitigate soil contamination and erosion in a rare and sensitive natural area. Oxon Run Parkway is a stream corridor park that contains several northern magnolia bogs and a rare wetland complex, the only such example in the national park system.

The discovery of an unexploded mortar shell during a 1994 survey for a city subway began a two-year effort by the Corps of Engineers that located and removed over two dozen unexploded ordnances. Careful coordination with National Park Service, community leaders, and local emergency preparedness organizations protected public safety and sensitive natural areas.

The National Park Service contracted the Natural Resource Conservation Service to propagate plants from seed, spores, and cuttings taken from the site. Munitions re-

See "Highlights" on page 6

"Highlights" cont'd from page 5

moval holes were refilled with their soil, and the vegetation recovered passively. However, the restoration of larger disturbances, such as access roads and construction areas, required planting with site-collected materials grown by the Natural Resource Conservation Service.

One ongoing 1999-2000 restoration project involves an approximately 0.5-ha (1-acre) former rifle range with substantial lead-contaminated soils left from years of target practice. Bullet casings wash down slope where they are easily collected by local children, creating a primary public safety problem. Standard EPA mitigation procedures for this steep, eroded hillside would involve trucking away tons of contaminated soil, which would threaten rare plant communities. However, the EPA analysis found that the lead was tightly bound to the soil with little migration through groundwater to the adjacent creek and sensitive wetlands. It supported the NPS decisions to stabilize and revegetate the eroding area despite the proposed COE engineering solution of cement and stone terraces. A cap of coconut "bio-logs" and matting sculpted to fit tightly over the site's topography holds down imported topsoil and covers the bullet casings (figure 1). The local rain of seeds from the surrounding native communities will contribute to the natural revegetation and stabilization of the area. In order to assist establishment of the vegetation and its ability to outcompete and shade out possible exotic species, the Natural Resource Conservation Service is growing and installing site-collected cool and warm season grasses.

Catoctin addresses exotics

Catoctin Mountain Park (Maryland), in cooperation with Hood College, initiated an exotic plant research project funded by a Canon-National Park Foundation Expedition Into the Parks grant awarded during 1999. The goal of this project is to develop a park management plan for exotic plants. During the 1999 field season, extensive survey work was completed of the park boundary, roadsides, and interior areas with the assistance of the Youth Conservation Corps. Permanent vegetation plots were established to monitor the spread of exotics.

Four experimental plots were also established to evaluate control measures of hand pulling, herbicide treatment, and torching for three invasive species; Japanese barberry, garlic mustard, and Japanese stilt grass. Data analysis is underway, and the success of the control techniques will be assessed in 2000 following the next growing season. Preliminary results indicate a strong correlation between the spread of Japanese stilt grass and disturbance in the form of roads and trails.

Figure 1. The site at Oxan Run was stabilized with cacanut "bio-logs" and matting.

PACIFIC WEST

Alcatraz bird census... or the ABC program

Alcatraz Island, part of the Golden Gate National Recreation Area in San Francisco, California, attracts 1.5 million visitors each year who come from around the world to visit the famous prison (figure 2). Far more than a cultural resource, Alcatraz is home to many colonial nesting birds in the spring and summer, and a refuge to migrating or over-wintering birds in the fall and winter.

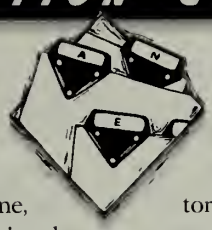
In 1993, Park Ranger Brett Woods initiated a program where volunteers conducted a census of these fall and winter birds. However, Ranger Woods moved on and the program languished. In 1998, new Park Ranger and Natural Resource Coordinator Brett Carré revitalized the program. First, a major recruitment obtained 40 volunteers. Then, methods were changed in order to conduct a systematic area search of the 22-acre island. Each census day a pair of volunteers surveyed the island, moving clockwise one day, counter clockwise the next. The island was divided into 12 sections of roughly equal countability with each section being censused for exactly 10 minutes. This allowed presence and frequency data to be obtained (i.e., percent of census days that a species was detected on the island, by month, or by island section). Abundance data (number of birds per section by species), while not accurate because of the possibility of multiple counting of birds between sections, was still recorded for potential use as very general year-to-year trend data.

Figure 2. Alcatraz Island.

Figure 3. Black oystercatcher.

Of the 108 census days during the 1998-99 season (mid-September through January), 89 bird species were detected. Bird species that made up the 20 highest frequencies of detection were as follows (in decreasing order): western gull, white-crowned sparrow, song sparrow, double-crested cormorant, common raven, Anna's hummingbird, black phoebe, fox sparrow, European starling, yellow-rumped warbler, house finch, hermit thrush, black oystercatcher (figure 3), golden-crowned sparrow, black turnstone, wandering tattler, Heerman's gull, Brandt's cormorant, western grebe, American kestrel, brown pelican, and golden-crowned Kinglet.

The data were useful in writing the Alcatraz Environmental Impact Statement, due out this year. Park staff hope that the ABC program can continue for years as it provides an excellent opportunity to collect meaningful wildlife data and provides a meaningful recreation experience for the volunteers. PS



Paleo volume published

The Fourth National Park Service Paleontological Research Volume, edited by Vince Santucci and Lindsay McClelland, has been published. The volume includes 20 original papers representing 12 different units in the national park system (Badlands, Bighorn Canyon, Canyonlands, Channel Islands, Chesapeake and Ohio Canal, Curecanti, Denali, Florissant Fossil Beds, Fossil Butte, Petrified Forest, Timpanogos Cave, and Walnut Canyon), plus one multipark article describing the Morrison Ecosystem Project. The volume is a Geologic Resources Division (GRD) technical report (NPS/NRGRD/GRDTR-99/03) and is dedicated to Dr. Michael Soukup, NPS Associate Director for Natural Resource Stewardship and Science, whose leadership in building support for science-based decision making has strengthened the management and protection of all park natural resources. Fossils have been key beneficiaries of these policies as parks increasingly recognize the value of these resources and the importance of paleontological research. The volume will soon be available electronically on the GRD Paleontology website at www.nature.nps.gov/grd/geology/paleo.

Proceedings available

The George Wright Society recently published proceedings of its biennial conference held during March 1999 in Asheville, North Carolina. Like the conference, the volume is entitled "On the Frontiers of Conservation" and presents 87 papers given at the gathering. The papers address many topics of importance in resource management and include partnerships, restoration, visitors and impacts, ecosystem management, coastal environments, building an inventory and monitoring program, vegetation dynamics, and managing scientific research, among others. The proceedings are available on-line at www.georgewright.org.

Calling all panthers

Numbering less than 100 in south Florida, the Florida panther *(Puma concolor coryi)* is one of the most endangered mammals in the world and presents numerous research challenges. The species' recovery and management depend on data from radio-collared individuals, particularly data about productivity and survival of kittens. Obtaining such information is tricky, because kittens must be examined in dens during the absence of their mothers. Mothers are usually in the den during daylight hours and depart and arrive during dusk or dawn. Formerly, an investigator had to be stationed near a den to detect the departure of the mother before data on the kittens could be collected. The amount of time and effort required for this made monitoring remote dens impractical. However, three researchers put cellular phone technology to work to remotely detect the absence of a mother lion in a den.

Writing in the Wildlife Society Bulletin (26[1]:29-31), E. D. Land, D. R. Garman, and G. A. Holt mounted an auto-answering cellular telephone in a listening post near a den. Also in the listening post were an antenna and receiver used to pick up the signal pulse from the radio-collared female. The receiver, cellular phone, and the battery that supplied power for the telephone were placed inside a weatherproof case and located within 200 m of the den. A caller to the listening post heard either the signal pulse generated by the collar of the mother lion in the den or background static if the mother was out of radio range, i.e., away from the den.

The researchers used listening posts at four dens of radio-collared mothers and examined seven 2-3-week-old kittens. The listening posts substantially decreased the time in the field to examine neonatal kittens and maximized the efficiency of limited field staff. The cost of travel and labor by 2-3 researchers for one unsuccessful trip to a den could exceed the cost of developing one cellular listening post.

Listening posts with cellular phones may be used for monitoring radio-collared animals in nests, foraging grounds, breeding areas, or other known areas of visitation.

Pepper spray: an attractant?

People in brown bear *(Ursus arctos)* country have long sought nonlethal repellants for protection from bear attacks. A liquid spray with the chief irritant in red pepper (oleoresin capsicum) was developed in the 1970s and since then has been commercially manufactured. It is known under the generic name *red pepper spray* and carried by many hikers, campers, and other outdoor enthusiasts. Some states and many national parks recommend that backcountry users carry the spray for self defense in encounters with aggressive bears. Although aggressive spraying of the compound has been an effective repellant in encounters with bears, Smith (1998. Attraction of brown bears to red pepper spray deterrent: caveats for use. Wildlife Society Bulletin 26[1]:92-94) demonstrated that bears are attracted to objects with red pepper spray residue.

Smith treated one-square-meter areas of beach gravel in nine locations with four-second bursts of commercially available bear deterrent spray (two different concentrations) and observed the treated areas from blinds at 10-200-m distances. During his observations, 13 independent brown bear groups approached the sites a total of 40 times (seven single bears of unknown sex, three adult boars, one sow with two dependent yearlings, one sow with three cubs of the year, and one sow with two cubs of the year). Interest in the spray of both concentrations ranged from no response (40%) to slight (20%), moderate (12%), and high (28%). None of the bears was ever repelled by the spray residues. Responses included 25 bouts of sniffing, nine pawing bouts, 10 licking bouts, 16 head rubbing bouts, and 11 bouts of bears rolling their entire body on the spray residues. The bouts lasted for 0.1-2.5 minutes.

Smith explains that bears rely on olfaction to locate food. A pungent odor such as that of red pepper spray would therefore be of interest to bears. The relatively high percentage of no response to the spray in Smith's study may be explained by strong winds that carried the scent of the spray away from the location of the

See "Crossfile" on page 8

"Crossfile" cont'd from page 7

bears. Smith and his field crew had observed bears in the area of the test sites during more than 750 hours and had not seen bears rubbing their heads on the ground, pawing and licking soils, or rolling on their backs as in the red-pepper-spray test sites. He therefore attributed such novel behavior directly to the exposure to red paper spray.

Smith's findings suggest that people should not test spray in hiking or camping areas, should carefully remove all residues from fired canisters, and should not store canisters in sleeping areas. The attraction of bears to red pepper spray warrants prudent use and storage of canisters.

Rock climbing and nesting birds at Joshua Tree

A recent study at Joshua Tree National Park (California) recommended that "in areas of widespread climbing activity, monitoring programs should be instituted to evaluate spatial and temporal fluctuations of bird species and changes in numbers of invasive species that may threaten the integrity of native bird communities" (Camp, R. J., and R. L. Knight. 1998. Rock climbing and cliff bird communities at Joshua Tree National Park, California. Wildlife Society Bulletin 26(4):892-98). The study revealed that bird species and bird behavior differed among moderately climbed cliffs, cliffs with many popular climbing routes, and cliffs that were not climbed. The study sites did not differ in height, length, verticality, or exposure. However, the unclimbed cliffs were at greater distances from parking lots and campgrounds than the climbed cliffs.

Four bird species were seen on cliffs where no one climbed, five on moderately climbed cliffs, and three on cliffs with many popular climbing routes. Species with broad ecological niches such as the American robin and invasive species such as the house finch, the European starling, and the brown-headed cowbird were seen only on climbed cliffs. For example, house finches were 69% more numerous on popular cliffs than on unclimbed cliffs. The distribution of birds in front of cliff faces was not uniform. The percentage of birds on cliff faces was higher on unclimbed cliffs than on popular cliffs. On unclimbed cliffs, birds more often were seen perched on the cliff face. On popular cliffs, birds were seen flying regardless of the presence or absence of humans. In the presence of humans, more birds were at a distance from the cliff faces, suggesting anthropogenic changes in the spatial distribution of the birds and anthropogenic disruption of breeding, foraging, and predator detection by nesting birds and their fledged young.

Vegetation trampling by hikers and pack stock

Disturbance by trampling of protected areas is a concern in national parks. But little is known about the variation of such disturbance by type, and this lack of information keeps managers from applying appropriate restrictions. In backcountry and wildernesses without motorized traffic, hiking groups and groups with pack stock are the two primary users. Pack stock have been horses, mules, donkeys, and more recently llamas. Trampled areas are trails, campsites, and off-trail areas.

To obtain more information about the effects of trampling, Cole and Spildie (Hiker, horse, and llama trampling effects on native vegetation in Montana, USA. 1998. Journal of Environmental Management 53: 61-71) studied the relative effects of hiker, horse, and llama traffic on vegetation and ground cover at two trampling intensities (25 and 150 passes at one time) on two previously undisturbed forested vegetation types (forest with understory of predominantly erect forbs and forest with understory of predominantly low shrubs). These types were selected because they are widespread in the northern Rocky Mountains, are not highly resistant to trampling, and may be widely divergent in their responses to trampling.

The effects were assessed immediately after application and one year later. Trampling by horses caused the greatest disturbance. The effects of trampling by llamas and hikers could not be differentiated statistically. The forb understory was highly vulnerable to trampling but recovered rapidly. The shrub understory was more resistant to disturbance by trampling but lacked resilience. Differences between effects from trampling by horses and llamas or hikers persisted for at least one year.

Managers may use this information variously. For example, they can zone-protect areas to separate different types of users or to confine the more damaging user types to more durable areas, or they can make the difficulty of obtaining a permit proportional to the specific environmental impacts by a user group.

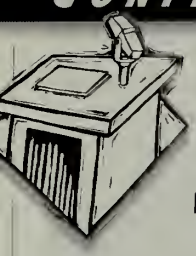
Vanishing night skies

Like clean air, clean water, wildlife, and the sounds of nature, a clear, dark, night sky and, weather permitting, the view of more than 2,500 stars and the Milky Way should be a part of a visitor's experience in national parks now and in the future. Overnight visitation is permitted in 130 national parks. However, light pollution increasingly obscures clear views of night skies even in parks. Such pollution is often from excessive or misdirected outdoor lighting and from highways, homes, office buildings, and other developments that can be as far away from a park as 100 miles. Some concession facilities in national parks may also add glare to the night sky. Unless light pollution is remedied, views of dark night skies may disappear from national parks.

Concerned about the issue of vanishing night skies, the National Parks and Conservation Association conducted a survey of National Park Service managers to obtain more information about problems with light pollution in parks. The responses from 189 of 376 national park system units, assumed to be representative, are profoundly disturbing.

Most of the 94% of the parks that offer overnight visitation and consider dark night skies an important resource offer some type of night-sky interpretive program. Nearly two-thirds of the units that offer overnight visitation consider light pollution a problem, and nearly 70% of the parks in four of five U.S. regions report

See "Crossfile," rt. column, pg. 12



West by Northwest workshop restores spirit

Biennial gathering unites far-flung staff, inspires problem resolution in the 21st century

BY THE EDITOR

Note: *Transcriptions of all plenary presentations at the West by Northwest 2000 conference will be made available on the Web at www.nps.gov/pwro/wxnw2000.htm as they are transcribed.*

San Diego, California, provided a relaxing venue for more than 350 resource managers, interpreters, superintendents, and other NPS staff and partners to come together for a lively discussion of what it takes to preserve and interpret park resources in the new millennium. Held twice previously in 1996 and 1998 by the Pacific West Region, this workshop was cosponsored by the Alaska Region and was held in mid-March several miles from Cabrillo National Monument. By joining with Alaska, the workshop presented a much wider variety of resource management and interpretation issues, solutions, and discussions, and provided greater opportunity to interact with colleagues on these issues. Similarly, participation by staff from several Pacific island parks, including their performance of traditional island music, enriched the gathering and gave it a distinct regional flavor.

The week opened with presentations by Regional Directors John Reynolds and Bob Barbee, who charted the challenge of the conference–to get to know one another and to listen, learn, and exchange new and better ideas as resource stewards. Reynolds also charted the challenge of the coming century, explaining that parks must be relevant to all Americans, important to their personal well-being, and perceived as valuable to American society "if we are to have a national park system 100 years from now that means as much to us as it does today." Talk soon turned to sustainability, a familiar theme at recent conferences, which was addressed by Shawn Norton and George Turnbull in their very provocative plenary presentation on environmental leadership.

But the big buzz for the week was the Natural Resource Challenge, launched last August at Mount Rainier National Park by Director Stanton. Deputy Director Galvin explained that "the challenge for the 21st century is to preserve resources." The Natural Resource Challenge is necessary to help us meet these responsibilities; it is a catalyst for change. We must begin to "see the parks as part of a system" and "make them more useful to society at large," he said. Certainly, we must engage science for the answers it can provide us in making better management decisions. But, he explained, we must also come to see scientific information about parks as valuable to society, and we must develop institutions for sharing that information. We need to develop a web of cooperators and capitalize on their influence. And we must bring science and education together to build a constituency of support for resource management.

A dinner gathering and festive ballet folklorico dance performance at Cabrillo closed out the day, setting the stage for the approximately 150 individual presentations, plenary sessions, posters, training sessions, or field trips that followed over the next four days.

For the concurrent sessions, the workshop organizers opted for broad themes as a way to integrate park operational and scientific disciplines in the discussions. For example, the week-long theme exploring "innovative problem resolution" brought together presentations about natural and cultural resource management, interpretation, wildland fire, archeology, hydrology, geology, exotic species management, paleontology, and many others aimed at improving resource preservation and interpretation. "Park futures and a changing public" focused on exploring ways to develop constituencies through education programs designed for diverse audiences. "NPS leading the way" reviewed park management techniques that embody the spirit of recent NPS resource stewardship and education initiatives. This thematic, organizational strategy fostered interaction between attendees regardless of technical specialty. Additionally, starting times for individual presentations were intentionally not published, which encouraged the audience to stick with entire two-hour sessions, rather than hop from room to room. In the sessions I attended, the moderators did a good job of holding presenters to their appointed time limits, benefiting everyone. Future improvements can be made in the more widespread and competent use of microphones so that all can hear the substance of the sessions and in the computer-setup skills

See "Conference Corner" on page 10

"Conference Corner" continued from page 9

required for Microsoft PowerPoint presentations, several of which failed or were delayed because of technical problems.

Were the ideas new? Were the sessions valuable? Certainly, many resource management problems and the disciplines needed to deal with them are now routine parts of our discussions at these kinds of gatherings, albeit with new circumstances or other advancements being reported. Dealing with nonnative vegetation and animal species, for example, were common and familiar subjects during the week as were various ecological restoration activities and fire management. However, a new concept for many was the significance of park soundscapes and how to go about preserving them. Sounds not only have ecological significance, such as communication among whales, but they also signify physical processes that shape a park, such as surf and wind. And they represent cultural values to humans. In a time when human-caused noise is on the rise, many park soundscapes are threatened and their protection is fast becoming another responsibility for resource managers. The provocative presentation went on to describe a sound recording and inventory technique and a related database structure that may be useful in documenting, understanding, and raising the awareness of the significance of park sounds. Another novel idea at the conference was the management of hazard trees by converting them into safe, but standing, natural-looking snags that preserve valuable wildlife habitat.

Some of the other things we heard about were the need to establish "vital signs" monitoring strategies that show accelerated or unacceptable ecological change and some approaches being taken in this regard in various parks. Determining what is natural as a baseline to manage for can be problematic as one presentation pointed out, but some parks are figuring this out and are devising useful vital signs monitoring approaches. We also heard about computer software and modeling applications and Web-based technologies, including resource databases and GIS, that are in the works or are being refined as ways of sharing information broadly. Many other themes related to natural and cultural resources, NPS history, and interpretation emerged, too, and showed new twists in the ways in which familiar disciplines are being applied in solving both common and new problems.

Out of this rich collection of presentations and interactions emerged a few trends. Not long ago, we were talking about the need to reduce divisions in park operations and encourage cooperation among all park staff for resource preservation. This gathering demonstrated that in many parks we are practicing what we preach. For example, strategic planning sessions have helped some parks unite behind resource preservation goals. Additionally, the "greening" of the National Park Service is a very good sign of the integration of all park operations toward a goal of resource sustainability, led, perhaps, by facility managers and administration staffs in parks. Conference organizers recognized the need to integrate park operational disciplines at this workshop; they coupled interpretation with natural and cultural resource management this time around. Next time, they plan to pair either the maintenance or visitor and resource protection function with resource management to stimulate discussion on such things as resource-sensitive facility management practices or technical aspects of resource law enforcement.

Another observation is that geology, not long ago perceived widely as irrelevant to park management by many, has come to a focal point at these gatherings. In San Diego, participants were given several opportunities to consider the role of geology in providing the foundation for ecological processes in many parks. Additionally, during a plenary session on closing day, a panel of U.S. Geological Survey western regional managers seemed painfully aware of the need for their services to become more relevant to park managers. They offered parks their assistance in developing useful mapping products, providing biological technical assistance and research, conducting hydrological work, and sharing geological research results in formats well-suited to management application and public consumption. Additionally, a conference poster by the U.S. Geological Survey and a presentation by a geology professor from Oregon State University highlighted ways in which they have helped parks to tell their geological stories in simple, compelling ways.

A change of pace to the productive sessions at the West by Northwest workshop was offered by both the excellent field trips on Wednesday and a banquet held Thursday evening to honor, in part, resource stewards from the Pacific West Region and interpreters from both regions for their achievements during 1999. Director Stanton was on hand to pass out the awards and Regional Directors John Reynolds and Bob Barbee made the presentations.

The conference closed with a plenary session on what it will take to be effective in managing and interpreting parks this century. Bryan Harry, Superintendent of the Pacific Islands Support Office, offered the "ranger mystique," or that unwavering commitment, enthusiasm, and can-do attitude common to so many NPS employees, as an essential element in attacking the problems of the future. Alaska Associate Regional Director Judy Gottlieb described a complex era to come with its contingent predictable challenges and numerous surprises that will require anticipation and the rational, professional application of science. Point Reyes Superintendent Don Neubacher reminded us that the best opportunity to improve our lot as resource stewards is at our doorstep right now in the Natural Resource Challenge. If we succeed in getting the proposed $100 million over five years, the National Park Service will be able to do its natural resource protection job much more effectively. "It's ours to lose," he said, stressing that we need to put aside any jealousies about which parks or programs will see the greatest increases and give the Challenge our full, unified support. Finally, Director Stanton closed out the week by reiterating this point and by revealing plans for the development of a Cultural Resource Challenge over the next several years.

At West by Northwest, I refueled my internal fire. I made new professional contacts and visited with old friends. I reflected on how my job affects others and how I can improve at it. I thought new thoughts, made new plans for work, renewed my commitment, and considered my place in this organization as a resource steward. Where do good ideas come from? Anywhere and everywhere, of course, but West by Northwest was certainly a potent source of them. Now, to take action on the many good ideas! PS

Figure 1. Located 49 miles southeast of Bend in Central Oregon, Fort Rock State Monument was designated a national natural landmark in 1976 for its "striking...circular, fort-like volcanic outcrop." The site is owned by the State of Oregon and administered by the Oregon Parks and Recreation Department.

The National Natural Landmarks Program: A progress report

By Craig L. Shafer

Administered by the National Park Service and established in 1962, the National Natural Landmark (NNL) Program recognizes and encourages protection of nationally significant natural areas in the United States (figure 1). Sites must exemplify a biotic community or geologic feature that is one of the best of its type in its physiographic region. Sites are designated on both public and private lands.

As many readers know, site designations were under an NPS-imposed moratorium from November 1989 to May 1999. The moratorium was lifted on May 12, 1999, when new NNL program regulations were published in the *Federal Register*. The moratorium had been expected to last only a few years. Why did it last ten? Primarily because obtaining all essential, official sign-offs was impossible. This delay was a reaction to pervasive private land rights political ideology. Officials who are mindful of the potential political consequences of actions of the Department of the Interior apparently did not wish to add fuel to this fire.

The decade needed to finalize program improvements was tumultuous. Public hearings on the regulations were held, new administrations with differing ideologies came on board, successive freezes on government regulations were imposed, new regulation writing requirements were put in effect, and so on. Park Service staff, in coordination with the Office of the Solicitor, the Department of the Interior, the Office of Management and Budget, the Secretary's Advisory Board, and others, considered public comments and revised the regulations. Anne Frondorf, now with the U.S. Geological Survey, and Bill Commins, with the National Park Service, were key to summarizing public comments, achieving consensus on most regulation decisions, drafting regulation language, and initiating other program improvements. By 1993, program staff had prepared a handbook, contacted NNL owners and verified their names and addresses, improved the electronic database, and had gotten program controls approved. Additionally, hundreds of Congressional inquiries and Freedom of Information Act requests were answered; eight annual *Section 8 Reports,* required by legislation (HR 94-458), on threatened and damaged national natural landmarks were sent to the Congress and distributed around the country; six NPS national program meetings were held; program files were organized and archived; natural region theme study inventories were made available through the National Technical Information Service; program literature was updated; a *Section 9 Report* (surface mining threats) was prepared; and more.

The program also made progress in FY1992 when the National Park Service secured an additional $775,000 and four FTEs (i.e., full-time staff) for the program. The program was then able to pay the salaries of two Washington Office staff and 10 regional coordinators. The regional coordinators oversee the annual *Section 8 Report* inspections, fund some special projects using the NPS Challenge Cost Share Program, assure that development planners consider NNLs, publish newsletters, convene public meetings, participate in NNL ceremonies and media events, testify at public hearings, write responses to newspaper editorials, draft news releases, enlist support for endangered species issues, guide EIS preparation, present NNL plaques to landowners, and communicate with NNL property owners. They also assisted with key moratorium tasks–the handbook, owner identification, and database improvement. When the Park Service reorganized in 1995, the future of the program was unknown. After the dust settled, the program budget and all 12 support positions remained intact.

After being published last May, the new NNL regulations were mailed to approximately 2,279 NNL landowners, mostly private. Another mailing went to those holding multiple NNL properties, such

See "Landmarks" on page 12

"Landmarks" continued from page 11

as federal and state agencies and private conservation organizations. (For those NNLs with more than 50 owners, staff notified landowners using local newspaper announcements.) The mailings included the regulations, a brochure, and a letter from the Director of the National Park Service. The letter encouraged continued participation in the program but informed landowners of a 90-day opportunity to withdraw their property from NNL designation. In all, the Park Service received 971 requests for withdrawal of properties from NNL designation a month after the September 9 deadline, and they continued to be received. The vast majority of these requests, some 741, occurred in just three areas (Baraboo Range, WI; Lance Creek Fossil Area, WY; and Canaan Valley, WV), and were the result of locally generated misinformation about the NNL Program coupled with existing local resentment stemming from other past or present government activities. Withdrawal requests are being processed. Because not all NNL landowners could be reached, additional withdrawal opportunities and mailings are being considered.

The new regulations clarify the role of the federal government in designating NNLs and managing the program. They also address landowner concerns. For example, three owner notifications will occur including the opportunity to voice concerns during a public comment period; no owner need have the designation against his or her wishes, any possible land use ramifications are discussed; benefits of the designation are outlined; written permission from the landowner must be secured before evaluating a site on private property; and so on. After all withdrawal requests have been processed and boundary alterations made, the program can resume designations. This is the method used to pursue the program goals established in 1962: identifying, recognizing, and encouraging preservation of special ecological and geological sites, enhancing their scientific and educational value, strengthening cultural appreciation of natural history, and involving individuals, private organizations, and all levels of government in a cooperative undertaking to conserve the country's natural heritage.

The 1996 "sunset legislation" targeted dozens of "unnecessary" government reports for elimination, including the *Section 8 Report.* Sent annually to Congress, this report identified NNLs (and National Historic Landmarks) that were threatened or damaged. Since the New Year, the legal mandate to send the *Section 8 Report* to Congress has expired. This report, given to the Congress 20 times since 1977, helped prevent many NNLs from being damaged or lost. Few realize that four NNLs, reviewed in the *Section 8 Report,* were later added to the national park system. Without this formal reporting mechanism, future problems with NNL sites may not come to the attention of as many parties as occurred in the past. Fortunately, the mandate was reinserted in HR 3002, being considered by the Senate. Without this mandate, many of the last, best examples of the country's various ecological and geological features may vanish because of pressing demands for "progress."

In 1987, Edward O. Wilson, a famous Harvard biology professor, became the academic community's leading advocate for preserving "biodiversity." In his 1992 book *The Diversity of Life,* Wilson argued that the day will come when the flora and fauna of a country will be thought part of its natural heritage, just as important as its art or language. The founders of the National Natural Landmarks Program in 1963 were not so eloquent, simply noting the importance of preserving sites that illustrate the ecological and geological character of the country. However, they apparently recognized that retaining NNLs, which by definition possess "national significance," provided a benefit to all citizens. Program staff will continue to address problems with the program as they arise and encourage landowners to preserve their NNL properties. PS

Craig Shafer coordinates the National Natural Landmark Program from the NPS Washington Office. He is an ecologist under the Associate Director for Natural Resource Stewardship and Science. He can be reached at craig_shafer@nps.gov.

"Crossfile" continued from page 8

light pollution. More than 35% of parks with such problems considered the problems to be moderate or very serious. The source of light pollution in 70% of such parks is from both specific and diffuse sources.

Actions to reduce light pollution by the National Park Service and by adjacent communities have been extremely limited. Few parks have reduced light pollution in all their areas. The National Park Service has done nothing in nearly 21% of the units that report problems. In addition, communities are not supporting the protection of night skies. Only 10% of the parks that offer overnight visitation have reported helpful ordinances in nearby communities.

Yet, parks that offer overnight visitation could increase public awareness about light pollution and reduce light pollution within their own boundaries. Solutions to the problems may not require simply shutting off all lights. For example, low-pressure sodium lamps can reduce glare, and cutoff shields can eliminate horizontal and upward projections. Changing lighting systems may be cost-effective. For example, park officials at Chaco Culture National Historical Park in New Mexico cut energy costs by 30% by changing the lighting system in the unit.

Additional impacts from light pollution in the parks and potential solutions to the problem are discussed in the report on the NPCA website at www.npca.org/readaboutit/nightskies.html.

Yellowstone publishes state of the park report

Yellowstone National Park recently published its "State of the Park 1999" report, an ambitious effort to analyze the status of the park's natural and cultural resources and the ability of the National Park Service to properly manage them and public use. At 285 pages, the handsome report features eight chapters that examine wildlife, science and technology, public use, infrastructure, staffing and funding, and aspects of the Yellowstone landscape such as the physical environment, water resources, vegetation, the role of fire, and preserving the natural regime. Each chapter, and an executive summary, is available in PDF format from the Yellowstone website at www.nps.gov/yell/stateofthepark.htm. PS

"Atlas" continued from cover

ton), and Wilson's Creek National Battlefield (Missouri). These parks are diverse in size, geography, and type of unit. Superintendents at these parks expressed interest in the project and agreed to participate.

An inventory of socioeconomic indicators has been developed. Data for these indicators, available at the county level, have been collected from a variety of public sources, such as the U.S. Census Bureau. Data sets that include projections to the year 2020 have also been purchased from a private firm. Where possible, census tract-level data have also been collected.

The socioeconomic indicators are divided into two groups: a standard *core* set and *additional* indicators. The core indicators will be mapped for all four pilot parks. Staff at each park have selected additional indicators of interest from another list. The goal is to create a total of approximately 30 maps for each atlas.

The core and additional indicators are organized into six broad categories: general population characteristics, social and cultural characteristics, economy and commerce, administration and government, land use, and recreation and tourism. Examples of core and additional indicators by category are provided in table 1.

The staff at each of the pilot parks have identified a "region of interest" around their park (i.e., the geographic area around the park that may influence or impact the park's management). Regions of interest include aggregates of one or more contiguous counties and represent the area for which the core and selected additional indicators will be mapped. The regions of interest for the pilot parks are presented in figure 1 (cover).

A draft version of the prototype atlas will be developed for each pilot park and reviewed by park staff and others. Figure 2 provides a preliminary example of what an atlas page might look like in one of the prototypes. The draft will be revised and 10-20 copies of a bound, color atlas of regional socioeconomic trends will be distributed to the pilot parks along with a brief technical report describing the project.

The staff at each of the pilot parks will provide a written evaluation of the atlas that describes: (1) its overall utility to the park, (2) the usefulness of the socioeconomic data presented and atlas format, (3) how the atlas could be improved, and (4) the potential benefits of such an atlas for other parks.

Table 1. Examples of core and additional indicators
(Core indicators will be mapped for all pilot parks, and park staff will select 15 additional indicators.)

Category	Core Indicators	Additional Indicators
General Population Characteristics	• total population • projected population change	• elderly population • rural population
Social and Cultural Characteristics	• ethnic diversity • educational attainment	• projected ethnic diversity • crime
Economy and Commerce	• employment by industry • poverty	• change in employment by industry • unemployment
Administration and Government	• congressional districts • federal expenditures	• local government revenues • local government expenditures
Land Use	• ecoregions • change in farmland	• domestic water use • growth
Recreation and Tourism	• recreation/tourism employment • recreation/tourism revenue	• recreation/tourism establishments • seasonal housing

Based on these evaluations, additional and improved atlases may be created for other units.

Conclusion

The prototype atlas of regional socioeconomic trends will benefit each park in tangible ways. Through the use of selected socioeconomic indicators, the atlas can provide systematic information about the spatial character of human activities and changing land use in the region of interest surrounding a park. There are several potential uses. The regional socioeconomic trends information and maps could be integrated into the general management planning process. The atlas could be used as a tool to educate new park staff (and central office staff) about the region surrounding the park, and share information about socioeconomic trends with the public, gateway communities, media, and Congress. The atlas could be an important public participation tool, helping park staff work with local communities on planning and management decisions that affect both the park and the adjacent region. Using the methods described above, an atlas of socioeconomic trends could be developed for any unit, leading to an atlas *series* for the entire national park system. PS

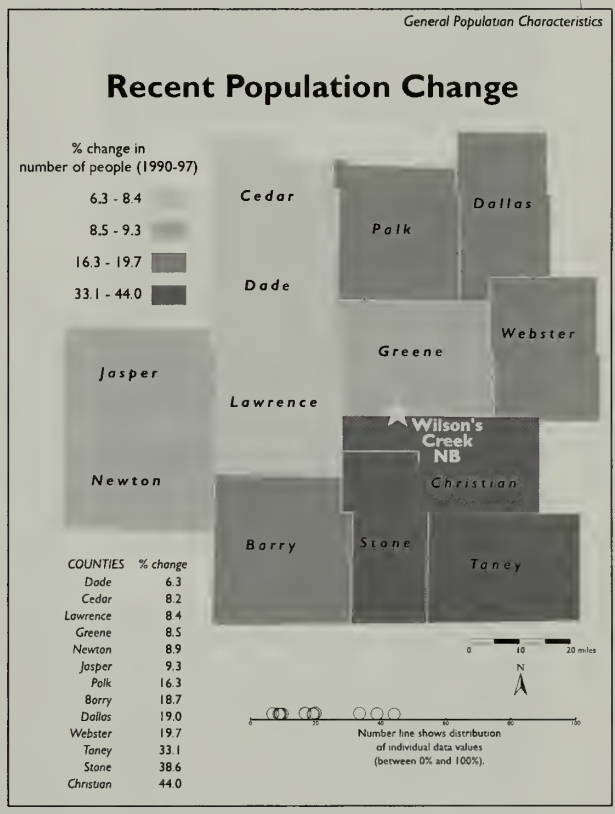


Figure 2. A preliminary example of an atlas page (showing population change for the region near Wilson's Creek National Battlefield).

References Cited

Associate Director, Professional Services to National Leadership Council, memorandum, 10 August 1998. National Park Service. Washington, D.C.

Machlis, G. E. and J. E. McKendry. 1996. Maps and models for natural resource management: powerful tools from the social sciences. Pages 195-226 in A.W. Ewert, editor. Natural Resource Management: The Human Dimension. Westview Press, Boulder, Colorado.

Jean McKendry is Research Support Scientist with the NPS Social Science Program and the University of Idaho Cooperative Park Studies Unit (UI-CPSU). She can be reached at jeanm@uidaho.edu. Nina Chambers is Research Associate with the NPS Social Science Program and the UI-CPSU. She can be reached at ninac@uidaho.edu.

Thinking outside the lines:
Parks and the quality of life in area communities

By Jonathan G. Taylor, Nina Burkardt, Lynne Caughlan, and Berton Lee Lamb

Many national parks, national forests, and other public land units exist in highly changeable regional environments. Often the parks and forests themselves serve as important catalysts of change in the levels of tourism, outdoor recreation participation, and contribution of traveling publics to local and regional economies. Resource managers are called upon to protect lands in their jurisdictions while juggling a variety of inputs and expectations. In each agency, resource decisions are bound by law and agency policy. In this context, the decision space of the national park manager is quite different from that of those in the multiple-use land management agencies. Management actions must stand up, not only to law and policy and to scientific scrutiny, but they must also be sensitive to the needs of residents in surrounding communities, to county and state governing bodies, and to visitors from across the nation and around the world. Balancing these needs while protecting resources is an ongoing challenge made more difficult as the mix of stakeholders grows.

Increasing tourism adds to the challenge. As new players emerge and existing players become more intensely involved–complicating communication networks and altering balances of power–the workload of management agencies increases markedly. For example, explosive growth in tourism has led to rapid population growth and economic change in southeast Utah. Recreational activities are often in conflict with traditional uses such as grazing and mining. Impacts from all these land uses contribute to deterioration of the region's sensitive natural resources, and potentially diminish residents' quality of life, especially in areas where such uses are concentrated.

Understanding how "what I do on my patch" affects interdependent interests requires an intensive, focused effort to discover what is at stake, and how internal decisions influence those surrounding factors. Managers need to know, first, how actions interrelate with other institutional jurisdictions and authorities; second, what local values really are (what is held dear by the area resident population); and third, how rapid changes in tourism and outdoor recreation affect the economy of surrounding populations, and how land and resource management decisions affect those changes.

Institutional analysis, public preference measures, knowledge and value assessment, and economic effects modeling can provide valuable insights into interactions between human communities and national lands and resources. A five county area of southeast Utah: Carbon, Emery, Wayne, Grand, and San Juan Counties; was one of two Colorado Plateau areas selected for coordinated social science investigations from 1996 to 1998.

Institutional Atlas

Analysis of participating institutions, their structures and authorities, helps land managers answer the question: "What are the institutional opportunities and obstacles for local, state, and federal agencies to manage for sustainable ecosystems and commerce?" This question is important because land management on an ecosystem scale implies–in fact, requires–coordination among land managers, property owners, and other stakeholders. When agencies and institutions with differing goals and processes work together, the results can be disappointing, especially if there is a lack of understanding about the involved players, their goals, and how they are likely to go about achieving their goals. Our hypothesis in beginning this research project was that overlapping jurisdictions and mandates for recreation management are associated with reduced ability of local, state, and federal land managers to implement these policies. The tool we used to analyze this problem is the Institutional Atlas.

We created an institutional atlas of the Colorado Plateau using ArcView GIS (geographic information system) software. The atlas shows county boundaries, cities, land ownership, hydrology, and other standard map features. In addition, the atlas displays map layers depicting parties with a role in recreation management decision processes, although many of these parties do not actually own or manage land. The sheer size of their land jurisdictions in southeast Utah lend government land management decisions great weight in the region. Federal agencies manage nearly 70% of the total land area (Bureau of Land Management more than half), the State of Utah manages 10%, and an additional 12% is in Indian reservations (figure 1). Private deeded lands make up only 9.5% of the land surface area. Therefore, every local federal agency decision–especially those of the Bureau of Land Management (BLM), National Park Service (NPS), or U.S. Fish and Wildlife Service (USFWS)–has enormous influence on area economies and ecosystems.

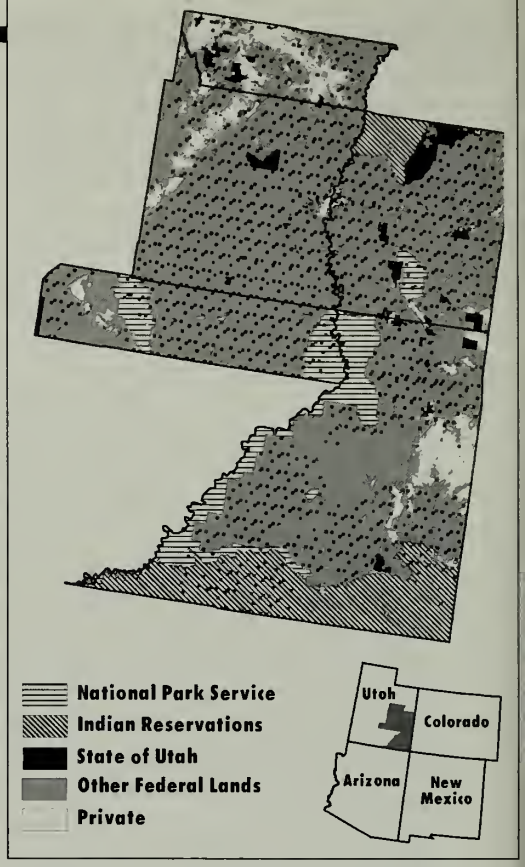


Figure 1. Map of land ownership in southeast Utah.

In the southeast Utah subregion, the National Park Service alone is quite complex: it has three national parks (Arches in Grand County, Capitol Reef in Wayne County, and Canyonlands in San Juan and Wayne Counties); the Glen Canyon National Recreation Area; plus three national monuments (Hovenweep, Natural Bridges, and Rainbow Bridge in San Juan County), all reporting to the same regional or cluster office in Denver, but under the jurisdiction of three superintendents.

The National Park Service is not alone in its organizational complexity. Within the five county area we studied are four BLM field offices, each reporting to the state office in Salt Lake City; two Indian reservations, dealing with two different area offices for the Bureau of Indian Affairs; and three na-

Figure 2. Community aesthetics photo.

Figure 3. Public facilities photo.

Figure 4. Landscape vista photo.

tional forests, with the Manti La Sal National Forest divided into three separated land areas. On the state level there are two regions of the Department of State Parks and Recreation reporting to the Utah Department of Natural Resources (DNR) in Salt Lake City; two regions of the Department of Forestry, Fire, and State Lands, also reporting to the DNR in Salt Lake City; and two districts of Region 4 of the Utah Department of Transportation. At the next level are five counties with their associated governance; several towns and municipalities; and approximately 32 special districts. Add to this list the Utah Travel Council, reporting to the Economic Development Appropriations Committee in the state legislature; the San Juan County Economic Development and Tourism Board; the Utah Association of Counties; and the Utah League of Cities and Towns. Still more groups become involved when issues close to their missions are under discussion.

The key is to understand who is likely to be involved in specific issues and how the mix of players is likely to affect both process and outcome. The next phase of the Atlas project will involve an analysis of the groups in southeast Utah to determine likely strategies, obstacles, and opportunities for setting and implementing recreation management policies. We anticipate that the complexity of the recreation management decision arena, coupled with the large value differences about appropriate land uses and economic development issues, will support our hypothesis that overlapping and conflicting jurisdictions hamper the development of recreation management policy. One point of conflict that we expect to be of paramount importance in this analysis is the debate about the proper level of decision-making authority and the distribution of costs and benefits among federal, state, county, and local governments.

Quality-of-life photograph elements

A critical element of the lifestyles of residents of local communities is their *quality of life*. Just what area residents mean by that term, however, has not been readily discernable up to this point. To operationalize the meaning of quality of life, we administered a camera survey, using "resident-employed photography." This involved giving one-time-use cameras to residents of southeast Utah, and asking them to *show us* which places and features of their communities and of the surrounding landscape were essential to their quality of life. That exercise was followed up by a short mail-back survey.[1]

The majority of quality-of-life photographs (57%) were taken in the towns while 43% were taken in the surrounding countryside. Two-thirds of the respondents took pictures of community aesthetics: positive elements such as homes, subdivisions, yards and gardens (figure 2) and a few negative attributes such as junk cars and run-down property. Nearly two-thirds of the participants took photos of public buildings and facilities (figure 3), in particular schools and libraries. Open places of business, public parks and open space, cultural facilities such as museums, churches, and the people of this region were also identified as important community quality-of-life elements.

Over 60% of the participants took pictures of landscape vistas (figure 4), the most frequently photographed *positive* quality-of-life category, which includes mountains, canyons, desert, and red-rock formations. Water bodies (figure 5) were important in the landscape, and so were farms and ranches, outdoor recreation areas and activities. Nearly three-quarters of all photos were of positive elements and fewer than 20% were focused singly on negative quality-of-life elements.

Diverse values were used to describe *why* these features or places were important to quality of life. The most predominant value (150, 19% of all statements) was "anything

Figure 5. Water body photo.

Figure 6. Value: children.

to do with *children*:" (figure 6) safe for children, good schools for children, children growing up with nature, etc. The next value was "*beauty,*" nearly three-fourths describing the landscape or countryside. Values of "education and learning," frequently related to children, were third, followed by "family"–living and recreating together, and family connections nearby and across generations.

Specific elements or locations that were selected by 10% or more of each county sample were identified as perceptually important nodes, or "PINs." PINs include city parks, lakes and reservoirs, mountains, schools and museums, and three national parks and the national recreation area in the study area, etc. Locations of PINs are being entered into a GIS so that public land managers and county or municipal planners can identify special places that local residents want to ensure are protected, or corrected if an eyesore.

See "Outside Lines" on page 16

[1]The responses to this experimental research technique were fairly low: 144 cameras (41%), and 87 surveys (60%).

"Outside Lines" continued from page 15

These southeast Utah residents are quite satisfied with their communities as places to live, rating them 5.6, on average, on a 7-point satisfaction scale. In reporting "what was especially good about living in their communities," 29% cited the natural environment, 23% community character, and 23% people and neighborhood qualities. Respondents rated the "importance of the natural environment to their quality of life" *very* important (6.4 on a 7-point scale).

Grand and Wayne Counties, which have popular national parks, rated tourism highest in importance among the counties, 6.0 on the 7-point scale. Area residents, overall, would prefer slightly more tourism (4.5 on a 7-point scale) than present levels.

In rating *changes* that could affect their quality of life, residents wanted *increases* in traditional jobs, mining, and agricultural zoning, but also in attracting tourism, tourism jobs, parks and open space, and levels of tourism and outdoor recreation. Only "the amount of wilderness area in southeastern Utah" was rated as needing to *decrease* to improve quality of life, especially by Emery and San Juan county residents.

Older residents (over 65) were more likely than young to middle-age adults to complete the photo exercise and survey, suggesting that retired persons participated more than others in the quality-of-life study. Some 35% of the follow-up survey respondents reported being retired, and their average length of residence was 35 years. This research produced 1,550 photographs, showing both community and landscape elements that need protection or correction to keep and enhance quality of life for local residents of southeast Utah.

Quality of life & post-materialist values

In a survey of the general public and opinion leaders on the Colorado Plateau, conducted during the summer of 1998[2], we evaluated (1) the effect of several recreation management scenarios on quality of life and (2) residents' feeling of post-materialism. Post-materialism is defined as the feeling that needs such as "belonging," "self expression," and "quality of life" are among the most important personal values (Inglehart 1995). Residents were selected at random in two regions: southeast Utah; and southwest Colorado/northwest New Mexico. Opinion leaders, defined in this study as persons attentive to policy issues and actively involved in community affairs, were a targeted group. They were selected because of their influence and involvement in recreation and resource management issues.

Our study of recreation and quality of life in southeast Utah showed residents to be decidedly outdoors oriented. We found that at least occasionally 69% fish, 78% camp, and 78% view wildlife or nature; fewer reported that they at least occasionally hunt (41%). When we asked questions about the affect of specific management activities we found general agreement that restrictions on use of public lands would reduce the quality of life: half (51%) of the respondents believed that their quality of life would be negatively affected by "limiting access to popular camping areas" or "closing some recreation access roads." However, only 34% believed their quality of life would be negatively affected by "designating certain areas for specific recreation uses;" 29% saw this as positive (the remainder were neutral). Opinion leaders were far less likely to link reduced quality of life with these activities. For example, although 25% of opinion leaders believed their quality of life would be negatively affected by "closing some recreation access roads," 44% believed their quality of life would be positively affected.

Once basic needs have been met, people's priorities turn to such post-materialist values as "belonging, esteem, and intellectual and esthetic satisfaction." Prominence of these values reflects a "subjective sense of security" (Inglehart 1981). More than a feeling of economic well-being, post-materialism is a long-term sense that life's basic needs have been met; people with these values emphasize self-expression, the quality of life, and protection of the environment (Inglehart 1995). Our study provides an understanding of how post-materialist values are expressed by the general public and opinion leaders. This is important to federal managers in a region noted for controversies over public land management.

We found that 24% of southeast Utah respondents expressed post-materialist values. Although this is not a majority, it contrasts with only 8% who expressed materialist values, emphasizing economic and physical security. Sixty-eight percent of the general public sample expressed "mixed" values. This picture was quite different for opinion leaders who were markedly more post-materialist (45%) and less materialist (3%). The significance of this finding is that post-materialist values will likely lead the public toward a need for inclusion in resource decisions and a greater sense of belonging between the community and public lands.

Economic analyses

Information on how spending by tourists affects the southeast Utah regional economy is needed for defining management and policy options that can best provide economic opportunities while sustaining the region's fragile natural ecosystem. To understand the impacts of tourism on the southeast Utah economy, we constructed a detailed inter-industry model of the regional economy to track the changes in economic activity from spending by visitors, as these dollars ripple through different sectors of the economy. Economic input-output (I-O) models are commonly used to predict the total level of regional economic activity that would result from a change in spending (Jackson et al. 1992). The Impact Analysis for Planning (IMPLAN) model, developed by the U.S. Forest Service, was used to construct a regional input-output model of the southeast Utah economy (Minnesota IMPLAN 1998).

A tourist usually buys a wide range of goods and services while visiting an area. Major spending categories include lodging, food, transportation, and recreational equipment. Tourism spending generates considerable economic benefits for local businesses that provide services to them. Average daily travel-related spending estimates used in this study were created by the U.S. Forest Service from the 1991 National Survey of Hunting, Fishing, and Wildlife-Related Recreation (U.S. Department of the Interior 1991).

Approximately three million people visited the southeast Utah region in 1995 (State of Utah 1996). Estimated 1995 spending by visitors amounted to nearly $99 million in terms of total gross output and resulted in 2,006 jobs (table 1). The services and trade sectors of the economy are the most impacted, accounting for a combined total of 76% of total output and 89% of the jobs created by visitor spending. Agriculture, mining, and construction are the least impacted, accounting for a combined total of 3% of total output and less than 2% of the jobs created by visitor spending.

[2]This study covered 15 counties on the Colorado Plateau. In the five-county southeast Utah part of the study there were 447 respondents and a response rate of 53.6%. There were 118 opinion leaders with a response rate of 76.1%.

A 1992 study by the Governor's Office of Planning and Budget projected that the number of visitors to Utah's national parks will grow at a long-term rate of about 3.5% per year (State of Utah 1992). At this rate, visitation to southeast Utah would increase to 4.23 million visitors per year by 2005. Projected spending by visitors in the year 2005 would account for $139.6 million in terms of total gross output and 2,829 jobs (table 2). This increase in tourism would result in over $40 million per year increase in total output and 823 new jobs, as compared to 1995.

Information on how changes in tourism level affects the southeast Utah economy provides one of the pieces needed for defining the optimal allocation of publicly managed resources there. This information needs to be combined with information on sensitivity of the region's natural systems to tourism levels, provided by local resource managers, to find the level of tourism that is best for the local economy and for conserving the area's natural resources.

Table 1. Current output and employment for southeast Utah

Sector	Total Output ($ Millions)	Employment (# Jobs)
Agriculture	0.338	8.98
Mining	1.385	5.74
Construction	1.208	15.10
Manufacturing	4.317	34.06
Transportation	8.751	35.80
Trade	18.005	431.63
F.I.R.E.	5.841	45.65
Services	57.293	1371.19
Government	1.829	57.86
Total	**98.967**	**2006.02**

Source: Minnesota IMPLAN, 1998 (in 1995 dollars)

Table 2. Projected output and employment for southeast Utah

Sector	Total Output ($ Millions)	Employment (# Jobs)
Agriculture	0.476	12.7
Mining	1.953	8.1
Construction	1.704	21.3
Manufacturing	6.089	48.1
Transportation	12.344	50.5
Trade	25.398	608.9
F.I.R.E.	8.239	64.4
Services	80.818	1934.2
Government	2.580	81.6
Total	**139.602**	**2829.7**

Source: Minnesota IMPLAN, 1998 (in 1995 $)

Implications for national parks

The results of these social science studies have important implications for the several units of the national park system in southeastern Utah. First, the decision arena in this region is extraordinarily complex, with sometimes conflicting, sometimes mutually supporting objectives among various players. Interactions in resource and land management issues occur among different levels of government; between government and the private sector, with business and active nongovernment, special interest organizations (NGOs) in the region.

Quality of life for local residents has a balanced focus between their communities and the unique red-rock, canyon country environment of the Colorado Plateau. What the people have built for themselves–their homes, neighborhoods, communities, family and human relations, and church communities–are essential and provide safe, secure environments for their children. They want their children to inherit this valuable social-cultural resource at a level of quality of life comparable to their own. The natural beauty of the region is also essential to residents' quality of life: the mountains, cliffs, canyons, lakes and rivers, the clean air, the rural character, and the close but uncrowded natural environment. Many of their "special places" are, inevitably, on national forests, parks, or other public lands. Post-materialist values are evident in a sizeable segment of the general population and seem to be held by nearly half of the opinion leaders. As residents of this area of the Colorado Plateau find sufficient financial resources to get by on, they focus on belonging to this intriguing region, the aesthetic satisfaction of it, and the quality of their communities and landscape, their quality of life.

Residents of southeast Utah welcome tourism somewhat hesitantly. They would like increases in "traditional industries," but recognize that the tourism and outdoor recreation that the region attracts are doing more for the general economy. However, many in the region see object lessons in tourism, for example, in the sudden, overwhelming popularity of Moab: "Be careful what you ask for because you just might get it." Economic input-output assessment shows that tourism has some real positive potential, although it is not, as projected, transforming for the region. A 10-year increase in revenue of $40 million per year plus 825 new jobs does not seem overwhelming to the region, but the populations of several of these counties is relatively small. Given the probability that the revenue and jobs generation would be concentrated in some locales, the effects could be significant.

Communities in southeast Utah want to see controlled growth in tourism and outdoor recreation: growth that brings visitors into town to eat, shop, and stay overnight, but not take away the local sense of community. Managers can help local governments or regional collaboratives develop strategies for stimulating steady tourist and outdoor recreation visitation growth, while avoiding the boom and bust cycles that can come with high-tech outdoor recreation or with sudden destination fads. Working "outside the lines," in partnership with regional communities and consortia, national park and other public land managers can understand the values of their neighbors; determine where they have shared values; and find ways to de-emphasize differences, while still being responsive to the laws and missions that guide them. PS

References

Inglehart, R. 1981. Post-materialism in an environment of insecurity. American Political Science Review 75:880-900.

Inglehart, R. 1995. Public support of environmental protection. PS: Political Science & Politics 28(1): 57-71.

Jackson, R. S., D. J. Stynes, D. B. Prost, and E. L. Siverts. 1992. Economic impact analysis as a tool in recreation program evaluation. Instruction Report R-92-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Minnesota IMPLAN Group, Inc. 1998. IMPLAN System (1995 data). 1725 Tower Drive West, Suite 140, Stillwater, Minnesota 55082, www.implan.com.

State of Utah, Governor's Office of Planning and Budget. 1992. Rural Utah tourism. Salt Lake City.

State of Utah, Governor's Office of Planning and Budget. 1996. Utah labor market report. Salt Lake City.

U.S. Department of Interior. 1991. National survey of fishing, hunting and wildlife-associated recreation, national report. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C.

Jonathan G. Taylor (jonathan_taylor@usgs.gov), Nina Burkardt, Lynne Caughlan, and Berton Lee Lamb are with the Social and Economic Analysis Section, Midcontinent Ecological Science Center, U.S. Geological Survey, Fort Collins, Colorado.

Figure 1. Ecosystem management calls for collaborative decision making and adaptive management to deal with the problems presented by fragmented landscapes.

Ecosystem management: Political challenges for managers and scientists

By Hanna J. Cortner and Margaret A. Moote

Traditional resource management grew out of the conservation movement at the turn of the 20th century. That movement created professional, scientifically-based resource management disciplines and agencies such as the National Park Service dedicated to reversing the previous century's practices of resource abuse and waste. But over time the laudable conservationist concept of sustained yield became institutionalized as a politics of maximum sustained yield. Policy and agency budgets came to stress commodity production and outputs, whether timber in case of the U.S. Forest Service or visitor services (e.g., roads and parking areas, trails, visitor centers) in terms of the National Park Service. The "use and enjoy" side of the National Park Service's 1916 mandate gradually overshadowed its resource preservation side. While the environmental decade of the 1970s witnessed legislation such as NEPA (National Environmental Policy Act) that provided more public access to agency decision making, strong, competing national interest groups dominated the policy debate. That debate became increasingly polarized, full of acrimony, and absent civility, as exemplified by protracted battles over spotted owls and future plans for Yellowstone and Yosemite. Moreover, managers clung to an outmoded professional ethos that fundamental allocation decisions regarding resources should be entrusted to experts, i.e., themselves. This created a perception of aloof and elitist bureaucrats that further separated managers and the public.

Admittedly, the conservation movement of the 20th century can claim many significant accomplishments. Nevertheless, in the face of changes in social values, technology, demographics, and scientific knowledge, the governance framework that evolved out of that movement does not currently fare well under critical assessment. It is increasingly being recognized as not sufficient for achieving either ecological or democratic sustainability. Thus, ecosystem management, which is organized around the concept of long-term ecological sustainability, is being proposed and applied as an alternative. Our research (*The Politics of Ecosystem Management*, Island Press, 1999) examines the patterns of politics that gave rise to the call for ecosystem management, the criticisms it faces, and the political challenges that successful implementation of such an alternative will necessarily entail.

A paradigm shift?

The principles and ideals of ecosystem management differ so much from traditional resource management that several observers have called ecosystem management a paradigm shift, i.e., a revolution in the ideas, values, assumptions, and methodologies that guide scientific inquiry and management practice. Unlike traditional management, ecosystem management does not begin with enumerating outputs; in ecosystem management objectives are related first and foremost to the condition of the ecosystem. Ecosystem management makes ecological sustainability–long-term maintenance of ecosystem productivity and resilience–a primary goal. Levels of use are adjusted to meet that goal. Protection and restoration of ecosystem structures and processes, particularly biodiversity, is paramount. Ecosystem management further recognizes a critical interdependence between social and ecological vitality and includes humans and human societies in resource management to an unprecedented extent. It breaks new ground by insisting that the social and political basis of natural resource management goals be made explicit and by encouraging their development through an inclusive and collaborative decision-making process (figure 1). Ecosystem management is based on an ecosystem science that integrates many disciplinary approaches. Given the recognized complexity and dynamic nature of ecological and social systems, ecosystem management embraces the concept of adaptive management, which requires constant reassessment and revision as new information becomes available.

While the principles of ecosystem management certainly imply a dramatic shift from the patterns of politics that came to characterize much of natural resource management, it is nonetheless premature to declare ecosystem management the new paradigm. First, ecosystem management faces strong and wide-ranging criticisms from both sides of the political spectrum.

Critics say that it is fuzzy, ambiguous, and untested, politically and legally untenable, full of contradictions, an effort by resource experts to recapture the ground they have lost since extensive public participation was institutionalized in the 1970s, a plot to turn all public land into nature preserves and parks, and a threat to private property rights. Second, while substantial information has been accumulated regarding ecological processes and the political dysfunction of the traditional paradigm, the values, theories, methodologies, and tools of the old paradigm have not yet been fully discarded. Maximum sustained yield and "expert" decision making by resource managers are still the norm in many cases. Agencies remain wedded to traditional public involvement programs that feature one-way communication and focus more on meeting legal thresholds and gaining support for proposed agency plans than on meaningful public deliberation. Utilitarian human-use values and demands continue to trump efforts to preserve park resources and protect biodiversity. Major decision-making entities such as Congress remain committed to the traditional paradigm. The politics of interest still dominates.

Clearly there are a number of major philosophical and institutional hurdles to be addressed and overcome before ecosystem management can be fully accepted and implemented as a new paradigm. Profound changes in the American governance system in its philosophy, institutions, notions of citizenship, politics, and resource management practices will be necessary. These changes range from redefinition of the values defining relationships among humans and nature and between citizens and government, to creation, reform, or even dismantling of traditional resource management institutions. This will entail, at a minimum, reexamining laws and policies, rethinking property rights (both public and private), changing administrative organizations, aligning market operations with the goal of sustainability, and building social capital for more effective public engagement. Changes by all players in all institutions will be necessary. If resource professionals, for example, are unwilling or unable to withstand a radical revision of their own values, management practices, and institutional structures, a paradigm shift seems unlikely. Instead the rhetoric of ecosystem management will be applied without any meaningful shift in management attitudes and practices and lasting results on-the-ground. National Park Service managers will therefore need to reexamine management practices and standard operating procedures to ensure that they promote behaviors that advance the principles of ecosystem management, learn to share power with a variety of community groups and sister agencies, more actively engage citizens in park decision making, and align budget priorities to achieve the ecosystem management goals. Likewise, park scientists will need to embrace changes in the institution of science.

Changes in the institution of science

Changes in scientific inquiry will mean new methods, new research questions, and new roles for park scientists and managers. Innovative ways to provide more avenues for direct public participation in the scientific enterprise will need to be developed. Adaptive management will require greater use of lay people and volunteers to assist with monitoring, analysis, and evaluation. Such a "civic science" will encourage citizens to serve as lay scientists and managers. This will also require science to make a renewed commitment to providing policy-relevant information as society makes the social and ethical decisions that shape sustainability. Park Service scientists and managers, for example, will need to learn new ways of working with the public (including park visitors and nearby communities) in the process of developing and interpreting scientific data and analysis (figure 2). Science, therefore, will be used to inform a more public and fully deliberative decision-making process.

Ecosystem management will also require scientists to address more effectively the split between the social and natural sciences. Because ecosystem management stresses the importance of humans in the ecosystem and socially derived goals and objectives, park science will need to reflect a larger social science role. Park social science will need to focus both on issues internal and external to the parks, determining, for example, how visitors relate to park resources and services, how management decisions affect, and are affected by, social, economic, and political conditions in surrounding communities, and how incentives can be devised and barriers removed for managing across ownership boundaries. Monitoring will include social analysis and evaluation of lessons learned through experimentation with new institutional arrangements and policy tools.

Figure 2. Visitor education programs will have expanded roles in ecosystem management.

Organizational change

The importance of organizational change, especially in how resource agencies relate to one another and the public, is crucial to adoption of an ecosystem approach. Ecosystem management means management across ecological, political, generational, and ownership boundaries. Defining management units ecologically rather than politically will require recognition of the mutual responsibility for ecosystem processes that transcend conventional boundaries and coordination to an unprecedented degree (figure 3, next page). The greater Yellowstone ecosystem is perhaps the most frequently cited example of a complex set of multiple resource problems originating from a system that divides ecological processes into distinct units for management by multiple entities. But in countless other park areas, new institutional arrangements and collaborative processes will also be necessary to manage park problems originating from other jurisdictions. Such problems, for example, range from the urban and commercial development pressures on nearby lands that is affecting Saguaro National Park, Blue Ridge Parkway, and Gettysburg National Military Park, to the air pollution from distant sources that is imperiling Mount Rainier, Grand Canyon, and Big Bend Na-

See "Political" on page 20

"Political" continued from page 19

Figure 3. When management units are defined ecologically rather than by arbitrary political boundaries, greater coordination will be required to deal with the realities and impacts of different ownership objectives.

tional Parks. While working from an ecosystem management perspective may certainly mean more Park Service input into management of lands adjacent to its units, it may also mean less agency control over management and science within park boundaries. Consequently, similar organizational adjustments will be required to enable Park Service personnel to more effectively explore with adjacent communities and interested stakeholders off-park problems arising from proposed changes in park operation, such as road and campground closures, species reintroduction, or the use of fire.

Bureaucratic efforts to protect agency domains, however, have long been recognized as one of the impediments to effective coordination. Turf battles persist among agencies and different levels of government; specialists in one agency lack trust in similar specialists in another. Cultural barriers divide managers and scientists. Even within agencies there may be competition among specialists or different parts of the agency; better external coordination can occur only when there is better internal coordination. Coordination is both a process and a structure of relationships that distributes power, access, and resources.

The recent upsurge in the formation of a number of collaborative, community-based conservation and watershed groups is an encouraging sign. These groups present one means of addressing both environmental concerns for ecological sustainability and democratic concerns for justice and economic equity. Citizens involved in collaborative efforts, however, often cite bureaucratic barriers such as agency inertia, administrative red tape, lack of interagency coordination, jurisdictional conflicts, and "reactionary policies" as impediments to their efforts to work collaboratively with agencies. Moreover, agency personnel at the local level who want to be involved in community processes frequently find that they lack support from administrative superiors. The Park Service has been involved in a number of large-scale, ecosystem efforts at the regional level, e.g., Everglades and Yellowstone, as well as in several community-based efforts. More needs to be done, however, and much more needs to be learned about how to make the agency more effective participants in such collaborative groups. In this regard, allocating time and dollars for developing and fostering relationships with communities outside park boundaries will need to be recognized as just as important as administrative work inside park boundaries.

For change to occur, agency incentives and rewards systems will need to be adjusted to ensure that they encourage and reward behaviors consistent with an ecosystem approach. National Park Service managers will need to ensure that agency culture fosters a spirit of cooperation and a willingness to share power with other agencies, nongovernmental organizations, and private citizens. Social science that focuses on the processes and consequences of organizational change can assist park managers in revamping their units to create a learning organization that operates in an adaptive management mode.

Conclusion

Ecosystem management is not just about science–more science, better science, needed science. It is also about politics and political choices; new patterns of politics will be required. Political choice will determine how ecosystem management evolves in the future–whether it creates new and viable patterns of politics to supplant traditional modes and how it progresses toward the goal of long-term ecological sustainability. Neither Park Service managers nor scientists can thus afford to ignore the political nature of ecosystem management. The political challenges of ecosystem management must be recognized and confronted if ecosystem management is to move beyond theory and the noteworthy, but limited, applications made to date. In meeting these political challenges park science–including social science disciplines working in concert with other scientific disciplines, park managers, and the public–has a significant role to play. PS

Citizens often cite bureaucratic barriers such as agency inertia, administrative red tape, lack of interagency coordination, jurisdictional conflicts, and "reactionary policies" as impediments to their efforts to work collaboratively with agencies.

Hanna J. Cortner is Professor in the School of Renewable Natural Resources, University of Arizona, Tucson, AZ 85721 (520-621-3501; hcortner@ag.arizona.edu), where she teaches and does research in the area of natural resources policy and administration. Margaret Ann Moote is Senior Research Specialist in the environmental conflict resolution program at the Udall Center for Studies in Public Policy at the University of Arizona (520-621-7189; moote@u.arizona.edu).

Yosemite National Park, Steve Thompson

Figure 1. Sign of the times—warm weather and rains combined to melt the alpine snowpack in Yosemite National Park in early 1997, resulting in widespread damage to park facilities, park closures, and reductions in local, regional, and state tourism spending.

Economic analysis of national park issues:

An assessment of the impacts of the 1997 floods in Yosemite National Park

By Chris Neher and John Duffield

For anyone who has visited small towns such as West Yellowstone, Montana, or Mariposa, California, one thing quickly becomes evident. Communities that are adjacent to large national park units have economies that are highly dependent on travel spending by park visitors. This degree of dependence can vary dramatically from park to park depending on such factors as location and annual visitation to the nearby park and the size and complexity of the local economy. The highest level of economic dependence is found in small tourism-oriented communities in relatively rural areas. It is not surprising, therefore, that when either natural events or shifts in park policy lead to substantial changes in visitation to these parks, local residents can become quite concerned. The issue of how declines in park visitation will impact the local economy is of more than just academic concern for these tourism dependent communities. Because of the close ties between some park units and local economic activity, it is important for park managers to have an understanding of the tools and methods used to explore this type of economic interdependence.

The National Park Service (NPS) has long had an in-house tool (called the Money Generation Model or MGM) to estimate the economic impacts of visitation changes. A recent review of this model identified limitations in the parameters used by the model, including multipliers, expenditure estimates, and assumptions concerning measures of visitation changes (Duffield et al 1997a). This article provides a brief overview of an NPS-sponsored 1997 study (Duffield et al 1997b) that utilized tools other than the MGM to analyze the impacts of the 1997 flood in Yosemite National Park on economic activity in surrounding communities and counties.

Between January 1 and 3, 1997, Yosemite National Park was struck by the largest flood in the park in over 40 years (figure 1). Heavy rains combined with a large snowpack led to high water that immersed much of Yosemite Valley and washed out roads and utilities in the park and downstream along Highway 140 to El Portal. The flood caused significant damage to the park infrastructure, buildings, roads, employee housing and visitor services. The park was fully closed in January and only partially open in February and March. By late January 1997 (just one month after the onset of the flood) the park was able to provide a preliminary damage assessment and outlined a $178 million estimate of the costs to fully restore roads, trails, utilities, buildings, and grounds (NPS 1997). Damages to private property (primarily park concessioner property) were estimated at $7 million (Yosemite Concession Services Corporation 1997).

Because of the substantial economic impacts of the flood, visitor closure, and proposed recovery actions, the National Park Service chose to conduct an economic assessment of the flood. This assessment identified, described, evaluated, and estimated the economic impacts of the flood, park closures, and the reconstruction spending on the local, regional, and state economies. Economic impacts associated with the flood were expected to fall into two general classes: (1) negative impacts on local economic activity and on the visiting public due to park closures and travel restrictions, and (2) positive impacts on local economic activity due to reconstruction spending within the park.

Our study used two very different but complementary economic perspectives to examine these impacts: regional economic modeling and models of demand for outdoor recreation. Regional economic modeling was used to identify the relationship between changes in expenditures (in this case expenditures by visitors to Yosemite, on food, lodging, and other retail items) and overall activity in the local economies. The usual measures of expenditure impact are changes in personal income, em-

See "Economic" on page 22

"Economic" continued from page 21

ployment, output, and tax revenues. Regional economic modeling describes the impacts of local expenditure changes on individuals and business. Our study used the basic input-output models and data sets provided by the impact analysis planning (IMPLAN) software (Minnesota IMPLAN Group, 1996).

The impacts of park closure or travel restrictions on people unable to visit Yosemite, or the Yosemite area, are not measured within the regional economic framework, but rather using models of demand for outdoor recreation. Regional economic models are based only on market transactions (the buying and selling of goods or services). The impacts associated with consuming services, such as entry into Yosemite National Park, that are not priced in the market (or are only marginally priced) cannot be fully measured within the regional economic framework. Visitation to Yosemite is only minimally priced (until March 1997 at only $5 per car, and $20 per car today) and does not reflect the full value of the service derived. When individuals will pay upwards of $100 per day for golf green fees or $50-$100 per day to fish rivers in areas such as Montana or Idaho, one can be sure that the market price to visit Yosemite is not $5 or even $20. Recreation demand models such as travel cost models or contingent valuation models can be used to estimate the value associated with these nominally priced services. (An overview of these types of models is provided in Ward and Duffield 1992, and Braden and Kolstad 1991).

Our analysis of the regional economic impacts associated with reduced visitation to Yosemite National Park required two primary data: (1) the estimated reduction in visitor days due to the flood impacts, and (2) the estimated expenditures per day for these types of visitors. Information on park visitors and their expenditures was collected in 1990-91 by James Gramann (1992a, 1992b). Estimates of visitor expenditures per day were developed based on Gramann and other sources. Yosemite National Park visitation statistics were obtained through NPS staff at the park and at Lakewood, Colorado.

Estimates of visitation reductions

In undertaking this analysis, there was some uncertainty in projecting the timing and scale of both the recovery activities and future visitation to the park. Similarly, it was difficult to project exactly how visitation levels would respond to interrelated factors including reductions in lodging and camping units, ongoing road construction, and changes in visitor fees associated with the Fee Demonstration Program.

Based on the combined effect of the reductions in lodging, campsites, and road capacity, we estimated that the flood effects would result in between 204,000 and 630,000 fewer recreational trips to the park in 1997, depending on the set of assumptions concerning when facilities would be repaired and available for use. We further estimated that in 1998, 122,000 fewer recreational visits would be made to Yosemite National Park due to flood impacts.

Regional economic models and findings

Using IMPLAN, regional economic models were developed for the state of California and four counties surrounding the park: Mariposa, Merced, Tuolumne, and Madera. In the most heavily impacted county, Mariposa County, we estimated that 1997 personal income would be reduced by $1,159 per capita ($18 million for the entire county). Additionally, Mariposa County was estimated to lose 956 jobs and $1.67 million in county occupancy and sales tax revenues. The personal income loss amounts to a 6.6% decline in this measure of economic activity. The remaining three counties we studied all showed much lower income losses (the estimated per capita personal income losses for Madera, Tuolumne, and Merced Counties were $27, $50, and $7 respectively). This result is consistent with our finding that among the four counties Mariposa County has, by far, the highest percentage of its output and employment tied to tourism-related economic sectors.

The spending associated with the 1997 emergency action and reconstruction activities in the four-county area to some extent offset the decline in visitor spending. However, even assuming that 20% of direct reconstruction dollars went to businesses in the four counties, losses from visitation reductions still lead to large net personal income losses in 1997. Considering net losses associated with reduced visitor expenditures and gains from reconstruction spending within the counties, we estimated that net aggregate 1997 personal income in the four-county area would be reduced by $24.23 million and that 1,301 jobs would be lost. It is important to note that these estimated losses are annual averages. While employment may have been down significantly during the January-March shutdown period, it may have largely recovered later in the year.

Recreation demand model and findings

Our recreation demand analysis focused on losses suffered by visitors who *would have* visited Yosemite except for the flood-related closures (estimated to be between 204,000 and 650,000 in 1997). Based on estimates of visitor benefits derived from previously published studies, the value per recreational visitor trip was estimated to be between $124 and $358 in 1997 dollars (Walsh 1990, Clawson 1959, and Duffield 1992). The 1997 visitor losses were estimated to be within the rather wide range of $26 million to $233 million. These loss estimates are an upper bound since they do not take account of substitute activities a visitor may have chosen to pursue instead of visiting Yosemite.

We estimated that net aggregate 1997 personal income in the four-county area [surrounding the park] would be reduced by $24.23 million and that 1,301 jobs would be lost (annual averages).

While those would-be visitors who were prevented from visiting the park due to the flood suffered economic losses, in the longer-term (post-recovery), it is likely that the total benefits visitors derive annually from the park will be *increased* by the change associated with the recovery activities. It is expected that Yosemite Valley will be more aesthetically pleasing and better organized due to a reduction and

reorganization of structures. In addition, the shift of some lodging, camping and administration activities outside of Yosemite Valley should reduce congestion as noted in the General Management Plan (NPS 1980).

Estimates in retrospect

From the perspective of two years after our initial report, we know that the actual decline in Yosemite National Park visitation between 1996 and 1997 was 375,000 visitors. This estimate falls well within our estimated range of visitation losses. At the time of our 1997 analysis there was a great deal of uncertainty regarding the speed of infrastructure reconstruction within the park and the response of visitors to the flood damage and constraints imposed by reconstruction activities. Our 1997 report assumed that all park lodging constraints would be removed by July, 1998, and the park would be back to full visitation levels that month. Conversations in January, 1999, with Mike Osborne (the fee coordinator for Yosemite) indicated that the park still has not fully recovered from the flood. The park currently has 200 fewer lodging units and 350 fewer campsites than before the flood. Additionally, road closures and traffic delays continue to cause difficulties for park visitors. Actual visitation to Yosemite in 1998 was about 389,000 below visitation for 1996. It is clear that negative impacts of the 1997 flood in Yosemite are still affecting visitation levels to the park. A complicating factor is that beginning in 1997 fees were increased in Yosemite. However, preliminary analysis of other similar parks such as Yellowstone indicate that any price response to fee changes to date has been negligible (Duffield et al. 1999).

While our 1997 report relied on previously published data and value estimates, in 1998, an NPS-sponsored visitor survey in the park asked questions on visitor willingness to pay for their trip to Yosemite National Park. From these survey question responses we estimated that the median willingness to pay for a trip to Yosemite in 1998 was $196. This estimate is near the midpoint of the range of estimates used in our 1997 study.

Conclusions

The results of our study of the economic impacts of the 1997 Yosemite floods underscored the strong linkages between visitation to the park and employment and income in the counties and communities surrounding the park. Those counties and communities closest to and with the strongest economic ties to tourism and tourist spending were the most heavily impacted by visitor reductions. However, a tentative conclusion of our study is that *on aggregate* the net losses to potential visitors from the Yosemite flood and travel restrictions substantially exceeded the losses suffered by employees and business owners in the adjacent counties. The most heavily impacted specific *individuals*, however, were undoubtedly among the local business owners and their employees rather than visitor populations. The per trip loss for the average visitor was on the order of $200 but the per capita losses in Mariposa County, the most heavily impacted county, (allocated over the entire county population) was approximately $1,200. This latter estimate would be much higher if computed for the most affected subpopulations–business owners and employees in tourism-related sectors. PS

Those counties and communities closest to and with the strongest economic ties to tourism and tourist spending were the most heavily impacted by visitor reductions.

References

Braden, J., and C. Kalstad. 1991. Measuring the Demand for Environmental Quality. New York: New Holland.

Clawson, M. 1959. Methods of Measuring the Demand for and Value of Outdoor Recreation. Resources for the Future Reprint No. 10 (Februory). Washington, D.C.

Duffield, J., C. Neher, J. Bayer, and J. Carey. 1997. Economic Assessment of the Highwater 97a Incident Yosemite National Park. Report for the National Park Service. Denver, CO.

Duffield, J., D. Patterson, and C. Neher. 1999. Evaluation of the National Park Service Fee Demonstration Program: 1998 Visitor Surveys. Report for the National Park Service. Moscow, ID.

Gramann, J. H. 1992a. Visitors, Alternative Futures, and Recreational Displacement at Yosemite National Park. Department of Recreation, Park, and Tourism Sciences, Department of Rural Sociology, Texas Agriculture Experiment Station, Texas A&M University, January 1992.

Gramann, J. H. 1992b. Expenditures by Auto Travelers Visiting Yosemite National Park. Department of Recreation, Park, and Tourism Sciences, Department of Rural Sociology, Texas Agriculture Experiment Station, Texas A&M University, January 1992.

Minnesota IMPLAN Group. 1996. IMPLAN Pro Software and Data.

National Park Service, United States Department of the Interior. 1997. Yosemite Flood Recovery 1997. Yosemite National Park, California, January 1997. 23 pp.

National Park Service, United States Department of the Interior. 1980. Yosemite National Park/ California: General Management Plan, Visitor Use/Park Operations/Development. September, 1980.

Walsh, R. 1980. An Economic Evaluation of the General Management Plan for Yosemite National Park. Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO.

Ward, K., and J. Duffield. 1992. Natural Resource Damages: Law and Economics. John Wiley & Sons, New York.

Yosemite Concession Services Corporation. 1997. Damage Assessment Report. Yosemite National Park, California. January, 1997.

Dr. John Duffield is an Adjunct Research Professor of Economics at The University of Montana, Missoula, Montana and is president of Bioeconomics, Inc. a private economic consulting firm. He can be contacted at Bioeconomics, Inc., 315 South Fourth East, Missoula, MT 59801; (406)721-2265 or e-mail: bioecon@montana.com.

Chris Neher is an economist working for Bioeconomics, Inc., a Montana economic consulting firm. He can be contacted at Bioeconomics, Inc., 315 South Fourth East, Missoula, MT 59801; (406)721-2265 or e-mail: bioecon@montana.com

Public participation:

Relevance and application in the National Park Service

By Seth Tuler and Thomas Webler

Government agencies are under increased pressure to conduct policy planning and decision-making activities in more transparent and inclusive ways. The clear trend is toward broader and more frequent public involvement and collaboration. For example, the U.S. Fish and Wildlife Service organizes deliberation among stakeholders for endangered species recovery planning (Clark et al. 1994, Clark and Wallace 1998). The Army Corps of Engineers has experimented with a variety of collaborative problem solving and public participation techniques (Creighton et al. 1998). The U.S. Forest Service continues implementation of a variety of approaches to public participation, including "collaborative learning" and adaptive management planning (Gericke et al. 1992, Sarvis 1994, Shindler and Creek 1997). At its nuclear weapons production sites where cleanup is the major issue, the Department of Energy has set up site-specific advisory boards (Bradbury and Branch 1999). Throughout many parts of the federal government, and within state governments as well, involvement of stakeholders and citizens is becoming a priority issue.

To "conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same" (NPS Organic Act, 1916, 16 U.S.C. sec. 1), the National Park Service must accommodate a multiplicity of values and interests among those who would use, enjoy, and protect park resources in much the same way as other agencies must accommodate diverse values and interests in their decision making. In fact, enabling legislation for new parks, such as Boston Harbor Islands National Recreation Area and Death Valley National Park require involvement of major stakeholders in park management decisions. Park and resource management planning as well as the National Environmental Policy Act (NEPA) process are other areas where parks are increasingly incorporating participatory activities. Voyageurs National Park has used extensive public involvement activities to develop a new general management plan. Opportunities for public involvement include, for example, public hearings, advisory committees, and working groups.

Responding to these new demands presents important challenges, including how to run processes that: (1) make use of the best science available; (2) are widely seen as fair and legitimate by all involved; and (3) use financial and staff resources in a responsible manner. In this article we review the reasons why public participation should play a growing role in National Park Service activities as we enter the next century. We also describe how recent social science research can provide lessons to guide managers' efforts to design and implement public participation.

Rationales for participation

In the past decade, social science research has made a great deal of progress on two questions:

(1) *why* public participation should occur. For example, people still disagree about whether lay people should be involved in agency decisions at all.

2) *how* to best design and implement a participation process. For example, there is uncertainty about how to best involve, meaningfully, diverse lay people and scientists in an efficient, effective decision-making process.

In 1990, Daniel Fiorino provided a wonderful approach to answering the "why" question when he outlined three kinds of reasons for involving the public in decision making: instrumental, substantive, and normative.

Instrumental reasons for public participation

These reasons are associated with achieving program goals. For example, a park may promote participation by recreation interest groups in management planning because it helps ensure that resource use guidelines are followed. In some instances self-enforcement may be the only option available to parks. Instrumental reasons for public participation are that it helps achieve mandate and goals, reduces legal challenges, enhances legitimacy and trust, reduces costs, and reduces conflict.

Participation can enhance legitimacy and build trust (Renn 1998, Tuler and Webler forthcoming). They can help an agency or organization achieve programmatic goals when people are more likely to defer to decisions that are viewed as being legitimate and when the decision maker is trusted. Recent social science research has revealed that important attributes leading to trust are how much an organization is seen as caring and committed to the people affected by it (Kasperson et al. 1992; Peters et al. 1997).

Finally, public involvement can reduce costs and conflict associated with a decision. Although participation can be costly in terms of staff effort and time, it is not as costly as the legal challenges and delays that can come about from inadequate involvement. Parties who feel included in the decision making may be less likely to see legal action as necessary. Conflict reduction is another benefit. Some groups or individuals opt to intervene through external political means such as protests, backdoor politics, or public confrontation. Experience has shown that these strategies can be disabled by offering these parties a meaningful role in the process (Bleiker and Bleiker 1995). If they refuse to participate, the group can loose its public legitimacy. For instance, many believed that northern New England avoided a spotted owl-type controversy because of the extensive, inclusive process undertaken by the Northern Forest Lands Council (McGrory-Klyza and Trombulak 1994).

Substantive reasons for public participation

These reasons are associated with making better decisions. For example, when Rocky Mountain National Park wanted to improve the scenic experiences of visitors, social science researchers handed out returnable cameras to visitors, asking them to photograph positive and negative scenes. This provided direct access to visitor pref-

erences (Taylor 1998). Substantive reasons for public participation included more knowledge, new ways to define the problem, new ways to envision solutions, and solutions that are more acceptable.

While technical experts can generate sound alternatives, they can also miss important information or suggest options that are not acceptable to the public. The following illustrations from transportation planning and public health protection illustrate how public participation can improve the quality of decision making:

- In Holland, when faced with a number of unacceptable alternatives, citizens brainstormed a solution that experts missed–using the breakdown lane–to solve a temporary traffic problem (Pestman 1998).
- On Cape Cod, Massachusetts, conservationists and fishermen are collaborating to design gill-net breakaway devices that meet the needs of fishermen while also ending incidental takings of endangered right whales (Wiley 1998).
- In western Nevada, Department of Energy scientists ignored a key pathway of exposure to Shoshone Indians from nuclear weapons testing fallout because they failed to recognize that the Shoshone eat wild hare, including the hares' thyroid gland, which increases the exposure to radioactive iodine (Frohmberg 1999).

Normative reasons for public participation

These reasons are associated with concepts of right and wrong. In a democratic society, we assume that citizens should have some say in decisions that affect them (Cvetkovich and Earle 1994, Rosenbaum 1978, Wellman and Tipple 1990). Some social science researchers have linked this to the idea of informed consent–that government has the responsibility to obtain the consent of the governed (National Research Council 1996, Shrader-Frechette 1993, Bleiker and Bleiker 1995). Normative reasons are extremely important to members of the public, while agency staff may be more focused on instrumental or substantive reasons. Normative reasons for public participation are respectful of the individual, give people a chance to be heard, and involve citizens in governance.

Applying social science research to public participation

Now we turn to the "how" question: how should public involvement be done? Recently, this has been the subject of some interesting social science research. Foremost is the publication of a report by the National Research Council called *Understanding Risk: Informing Decisions in a Democratic Society* (1996). While the report is about *risk* decision making, it is widely applicable to a range of issues, including park management.

The committee that wrote the report stressed the need to distinguish between two fundamentally different ways of making sense about the world. They called these *analysis* and *deliberation.* Analysis includes science, but also systematic investigation and reasoning by citizens or stakeholders. Deliberation includes political debates about preferences, but also the talk that goes on among scientists as they evaluate each other's work or design studies. Both citizens and experts need to participate in analysis and deliberation (Webler and Tuler 1998). It is important to understand that the report does not make and less legitimate the importance of science and technical analysis in policy making. Rather, it sees analysis and deliberation as equally important and mutually supportive ways of building understandings.

Many of the activities conducted by the National Park Service, such as developing resource management plans, are appropriate for an analytic-deliberative process. In a recent article in *Bioscience,* Dietz and Stern (1998) argued that broadly based deliberative processes to guide and interpret scientific analysis are appropriate for situations characterized by:

- *Multidimensionality.* For example, park management plans can have many effects on local communities, park resources, and visitors' experiences. The benefits and costs of different decisions are not equally shared by all.
- *Scientific uncertainty.* For example, there are many uncertainties associated with ecosystem functioning, wildlife population dynamics, and visitor behaviors and preferences. Parks must address such uncertainties and find ways to cope with them.
- *Value conflict and uncertainty.* For example, people differ in the importance they attach to the outcomes of decisions. Some people wanted Olympic National Park to maintain exotic populations of mountain goats, while others were more concerned with the impacts of the goats on native wildflowers.
- *Mistrust.* For example, local communities may not trust a park if they perceive it to have been established through an illegitimate taking of private lands.
- *Urgency.* For example, it is often not feasible to wait for additional scientific certainty or resolution of value conflicts.

The challenge, of course, is to find the right combination of analysis and deliberation at each step of a decision-making process. Conducting competent science is clearly a key part of a successful process, but so is getting the relevant science. Even the best analysis may be useless if it does not relate to what people care about. Getting the participation right means doing the outreach correctly, so that the appropriate parties are involved. Getting the right participation means finding the appropriate way to involve stakeholders and citizens in the process. The National Park Service and individual park units will not be served well by dedicating all resources and staff to public participation. Rather, we suggest that NPS managers should consult with a wide range of affected parties. Together they can best decide when and how to conduct a participatory process. Certainly, caution must be exercised to avoid implementing an elaborate process when a more simplified (and less costly) one will suffice, and vice versa.

Lessons from prior research

The *Understanding Risk* report offers some initial guidance for matching policy problems with process designs through a diagnostic activity. Just as a medical doctor diagnoses a patient's condition, staffers can diagnose a policy environment and propose an appropriate policy making instrument. As with medicine, "cookbook" clarity is impossible (National Research Council 1996, see also Earle and Cvetkovich 1991, Webler 1997). On the other hand, we do not need to reinvent the wheel every time.

During the past 10 years social science researchers have learned much about how to do public participation better. Lessons can be learned from prior experiences, including those of other federal agencies such

See "Participation" on page 26

"Participation" continued from page 25

as the Environmental Protection Agency, U.S. Forest Service, Army Corps of Engineers, Centers for Disease Control and Prevention, and Department of Energy. These experiences can help NPS and park managers make judgments about the appropriate amounts of analysis and deliberation throughout a process. Like any judgment, a number of needs must be balanced. Among them are: How to gather and use the best information? How to ensure broad and meaningful participation? How to make a decision with available–but limited–resources? And how to reduce the uncertainties inherent to a tolerable level?

For example, a key lesson from prior research is that everyone measures success differently, both in regard to process *and* outcomes–and not everyone may agree with each other (Carnes et al. 1998, Landre and Knuth 1993, Lauber and Knuth 1997, Moore 1996, Shindler and Neburka 1997, Tuler and Webler 1999). Thus, conveners of a process should identify the ways that different participants define success. While "success" can be defined in many ways, in the context of federal and state agency efforts the definition should at least in part be related to the need to show that resources (e.g., funding, staff time) are being used effectively and that the greatest amount is being done for the least amount of effort.

Other lessons have to do with the opportunities for participation and the forms of interaction that are created among the participants. For example, to effectively ensure that participation is meaningful for all, convening organizations must do more than focus simply on balanced representation and opportunities for participation. They must also *support* participation and the *balancing* of influence, so that prejudice, preferential treatment, or imbalance in resources necessary to participate effectively are eliminated (Kasperson 1986, Renn 1992, Renn et al. 1995). The best processes ensure proactive outreach to those who may be affected by a decision (Bleiker and Bleiker 1995, Tuler and Webler forthcoming). Conveners of a process should conduct a preliminary investigation into their expectations and find a way to involve at least the most outspoken of these parties in the design of the process. This can require that agencies learn who they need to talk with about a decision (e.g., Force and Williams 1989). Agencies are often judged for their responsiveness and accountability on the basis of how well potentially affected parties are kept informed of activities and decisions. Lastly, participants care about the quality of their discussions and interactions, including being treated respectfully and being heard or listened to (Becker et al. 1995, Bradbury and Branch 1999, Hartley 1998, Tuler forthcoming, Tuler and Webler 1999). Because of their pivotal role, facilitators should ask that participants agree to basic ground rules about how questions are asked and information presented.

Conclusion

Social science research offers a tremendous resource to NPS managers as they engage in participatory planning and decision-making activities. Both planners and participants will benefit by developing greater familiarity with the participation techniques and resources that are available. Public participation consultants offer courses and training in these areas. Some offer "coaching" to help planners work through problems that arise. In addition, there is a wealth of case studies describing innovative and exemplary participation processes. Familiarity with that literature will enhance the ability of NPS managers to think creatively about how to design processes. They should adapt what is known to the specific needs in the National Park Service. For example, the National Park Service could benefit from developing its own diagnostic guidelines for matching process features with problem types.

At the same time, the National Park Service may face constraints that others have not, and careful attention will need to be given to which lessons are relevant. The Park Service has a narrow mission as defined by the Organic Act to conserve resources and provide for their enjoyment. Thus, for example, the lesson that a process should be inclusive of all concerns may not always be possible. Public participants may want to include issues that are outside of this mission.

Yet, the National Park Service cannot hide behind its narrow mission. The political culture is evolving toward greater public accountability and participation in governance. As the National Park Service responds to this change, it can find much usable knowledge from social science research. PS

References

Bleiker, A., and H. Bleiker. 1995. Public Participation Handbook for Officials and Other Professionals Serving the Public. Ninth Edition. Institute for Participatory Management and Planning, Monterey, California.

Bradbury, J., and K. Branch. 1999. An evaluation of the effectiveness of local site-specific advisory boards for U.S. Department of Energy environmental restoration programs. Report PNNL-12139. Pacific Northwest National Laboratory, Washington, D.C.

Carnes, S. A., M. Schweitzer, E. B. Peelle, A. K. Wolfe, and J. F. Munro. 1998. Measuring the success of public participation on environmental restoration and waste management activities in the U.S. Department of Energy. Technology in Society 20(4):385-406.

Clark T. W., and R. L. Wallace. 1998. Understanding the human factor in endangered species recovery: an introduction to human social process. Endangered Species UPDATE 15(1):2-9.

Clark, T. W., R. P. Reading, and A. L. Clarke. 1994. Endangered Species Recovery: Finding the Lessons, Improving the Process. Island Press, Washington D.C.

Creighton, J. L., J. Delli Priscali, C. M. Dunning, and D. B. Ayres. 1998. Public involvement and dispute resolution: a reader covering the second decade of experience at the Institute for Water Resources. IWR Report 98-R-5. U.S. Army Corps of Engineers, Alexandria, Virginia.

Cvetkovich, G., and T. C. Earle. 1994. The construction of justice: a case study of public participation in land management. Journal of Social Issues 50(3):161-78.

Dietz, T., and P. C. Stern. 1998. Science, values, and biodiversity. Bioscience June: 441-44.

Earle, T., and G. Cvetkovich. 1991. Platitudes and comparisons: a critique of current (wrong) directions in risk communication. Pages 449-54 in C. Zervos, editors. Risk Analysis: Prospects and opportunities. Plenum Press, New York.

Fiorina, D. 1990. Public participation and environmental risk: a survey of institutional mechanisms. Science, Technology, and Human Values 152:226-43.

Force, J. E., and K. L. Williams. 1989. A profile of National Forest planning participants. Journal of Forestry 87(1):33-38.

Frahmberg, E., R. Gable, V. Sanchez, and D. Quigley 1999. The assessment of radiation exposures to Native American communities from nuclear weapons testing in Nevada. Risk Analysis.

Gericke, K. L., J. Sullivon, and J. D. Wellman. 1992. Public participation in National Forest planning. Journal of Forestry 90(2):35-38.

Hartley, T. 1998. Participant competencies in deliberative discourse: cases of collaborative decision making in the U.S. EPA Superfund Program. Paper presented at the International Symposium on Society and Resource Management, University of Missouri, Columbia, Missouri, 28-31 May.

See "Participation" on page 47

Social impact assessment:

Understanding how outside development alters the park experience

By Rabel J. Burdge

Attempts at modernization in both first and third world countries have altered the physical environment and created untold financial problems, disrupting the lives of countless millions of the world's population. When the developments were few and the numbers of people small, concern was less and the impacts on life-sustaining ecosystems fewer. However, accelerated growth has brought the earth's resources and its people closer to sustainable limits. As a result, community leaders, government agencies, legislators, and even the average citizen want to know the consequences and impacts of developmental change prior to project approval and the permit to go ahead.

By *Social Impact Assessment* (SIA), I mean the systematic analysis *in advance* of the likely impacts a development event (or project) will have on the day-to-day life (environment) of persons and communities. We do social impact assessment to help individuals, communities, as well as government agencies and private sector organizations understand and be able to anticipate the possible social consequences on human populations and communities of proposed project development or policy changes. Social impact assessment allows people to understand *in advance* the consequences of a proposed action or policy change. Like a biological, physical, or economic impact, a social impact has to be pointed out and measured. It may impact big numbers of people as would restricting auto traffic in Yosemite or fewer numbers, as for example, the closing of a hospital in a rural community. It may be required by law, as in the case of the National Environmental Policy Act (NEPA), which is triggered when federal funds, land, and legislation are involved. It may simply be seen as prudent, as for example, evaluating the positive and negative benefits of promoting tourism to Chaco Culture National Historical Park in New Mexico.

What started social impact assessment?

President Richard Nixon signed the National Environmental Policy Act on December 31, 1969. Under that law, proponents of development projects and policies are required to file an environmental impact statement (EIS) detailing the impacts of the proposal, as well as project alternatives, on the physical, cultural and human environments. The NEPA legislation also requires mitigation measures for impacts and a monitoring program to ensure that mitigation is actually working (NEPA, 1969). Henry "Scoop" Jackson, the late senator from the state of Washington, was responsible for including the *triggering mechanism* in the NEPA legislation, which required an Environmental Impact Assessment (EIA) if federal land, laws, or monies were involved. The inclusion of the triggering mechanism was a unique legislative requirement and ensured that EIS statements would be written. Subsequently, the courts have ruled that if a biological or physical environmental change leads to an alteration in human communities an SIA must be completed as part of the environmental impact assessment process (IOCGPSIA 1994).

NEPA legislation and the trans-Alaska pipeline permit

In February 1970, the Bureau of Land Management of the U.S. Department of the Interior submitted a six-page EIS to accompany the application for the trans-Alaska pipeline permit. Two days later the Wilderness Society, the Friends of the Earth, and the Environmental Defense Fund filed suit contending that the EIS was inadequate because it did not consider the implications to the permafrost of pumping hot oil through a pipe on the ground. In addition, no provision was made for a disruption of the annual migration of several caribou herds due to the pipeline and the road to be built beside it. Although not specifically mentioned in the litigation, some observers wondered where all those construction workers and their families would be housed who came north to work on the pipeline (Dixon 1978). Three years later the permit to build the pipeline was issued and most of the potential environmental problems had been addressed to the satisfaction of the courts, the plaintiffs, and the Alyeska Pipeline Company (a collection of U.S. and Canadian oil companies that owned leases on Prudhoe Bay). Anticipatory planning had worked and all sides agreed that the NEPA process had allowed project proponents to deal with issues that might otherwise have been overlooked.

After the permit to build the Trans-Alaska pipeline was approved, one of the Inuit Chiefs commented "...now that we have dealt with the problem of the permafrost and the caribou and what to do with hot oil, what about changes in the customs and ways of my people?... (Dixon 1978)." Would the traditional cultures and way of life be changed by such a massive construction project? What about the influx of construction workers who spoke different dialectics (of English) and brought with them a distinctive lifestyle? Obviously, with a total population of 350,000 (in 1973) the Alaska could provide only a fraction of the estimated 42,000 persons that would work on the pipeline during peak construction. Because of these and other related events the impacts of development on the human populations began to be included with biophysical and economic assessments (Dixon 1978). Social impact assessment differs from other types of social science analysis in that it is *anticipatory*. The goal is to measure the consequences of the project or policy change before the event actually takes place.

See "Assessment" on page 28

"Assessment" continued from page 27

A case study in scoping for SIA: What would be the social impacts on Biscayne and Everglades National Parks if Homestead Air Base were converted to a commercial airport?

In 1996, the Metropolitan Dade County Commission (Florida) approved a plan to lease a large portion of the Homestead Air Force Base for 70 years for development by the Homestead Air Force Base Developers, Inc., to build and operate a commercial airport (figure 1). However, the project has been delayed pending additional federal and state assessments of the impact of the proposed aviation facility on nearby, environmentally sensitive Biscayne Bay and the Everglades. A Supplemental Environmental Impact Assessment (SEIS) for the Reuse of the Homestead Air Force Base (HAFB) in south Florida was to be prepared by the U.S. Air Force and the Federal Aviation Administration (FAA). As a cooperating agency in preparing the scoping document for the SEIS, the National Park Service was asked to identify and recommend the scope of work related to social impacts of concern to the National Park Service.

As part of the EIA-SIA scoping process, Gary E. Machlis, Visiting NPS Chief Social Scientist, Paul George of Miami-Dade Community College, and I were asked to do the SIA scoping as part of the agency response to a need for an SEIS (Machlis et al. 1998). We were asked to consider three alternatives, but our efforts focused on what was called "full capacity" or "maximum possible usage" condition for the former Air Force Base. This alternative is based on the Dade County Airport Master Plan, the FAA Airport Layout Plan, and estimates by consultants and interested parties. It assumes the potential (not existence) of an additional runway, and further alters the mix of flight operations. Estimates of flight operations are based on maximum capacity for one-runway peak flight operations in 2014, approximately 240,000 per year. Another runway could expand that number up to 380,000 per year.

The SIA guidelines (IOCGPSIA 1994) call for analysis of "primary, secondary, and cumulative social impacts." *Primary impacts* are directly caused by the proposed action. *Secondary impacts* are those that indirectly result from the proposed action. *Cumulative impacts* are those that are a consequence of the proposed action in combination with other local and regional changes that might be ongoing as a result of the conversion to a full-scale commercial airport.

We examined social impact variables under the general categories of (1) population characteristics, (2) community and institutional change, (3) political and social resources, (4) individual and family changes, and (5) community infrastructure resources (Burdge 1999). These variables provided guidelines for our scoping work along with variables of concern that reflect the special purposes and uses of Biscayne National Park, Big Cypress National Preserve, and Everglades National Park as part of the national park system (NPS 1979 and 1983), and their role in the South Florida Ecosystem Restoration Project (Harwell 1997).

Potential *primary social impacts* include but were not limited to:

1. significant increase in passenger landings (e.g., number of passengers, particularly non-local tourists) as part of commercial aviation flight operations,
2. significant increase and change in noise levels, timing, distribution, and quality (particularly in Biscayne and Everglades), as part of the increased and altered mix of flight operations leading to changes in the visual environment related to haze, and night-sky light,
3. significant increase in both density and spread of urbanized development, as part of the build-out of the commercial facilities and residential areas, and accompanying commercial expansion beyond the current urban development boundary (UDB) near Biscayne, and
4. significant changes in community identity and industrial focus as a result of the shift from a military/retirement- to commercial-based air transport economy within the primary zone of influence.

Possible *secondary social impacts* include:

1. an increase in visitor numbers (as well as a change in visitor types) to Biscayne and Everglades, resulting from increased passenger landings and urbanized growth and development,
2. a significant change in the visitor experience and park preservation values as a result of the deterioration of natural quiet or natural sounds due to increased noise levels, haze, and night-sky lighting,
3. a significant change in infrastructure needs (roads, sewers, schools, etc.) in the primary region of influence (ROI), beyond the UDB, and particularly near Biscayne,

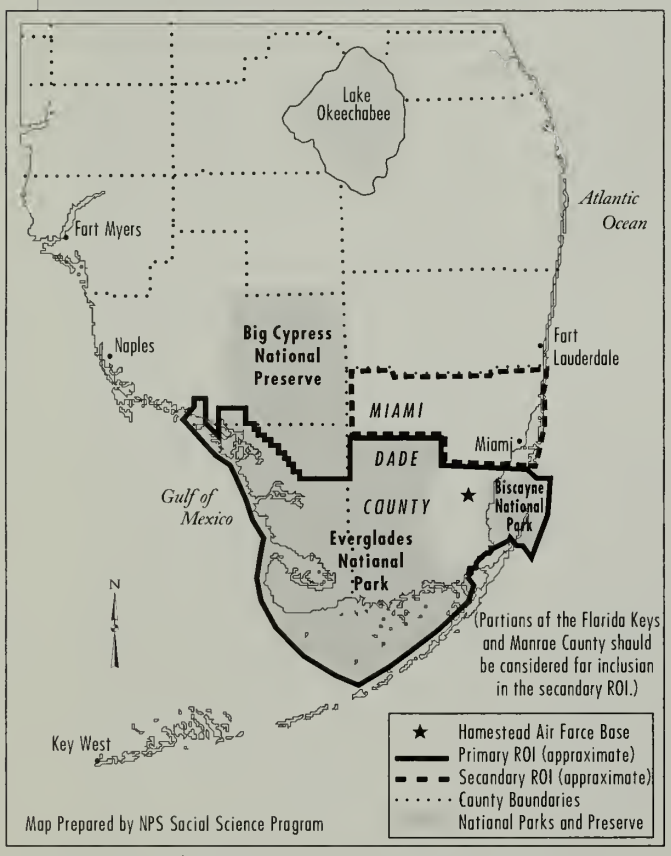


Figure 1. Location of Homestead Air Force Base, Biscayne and Everglades National Parks, and Big Cypress National Preserve, Florida.

4. an increase in visitors to Biscayne and Everglades due to an increase in population in the primary ROI, particularly near Biscayne, and
5. a change in community cohesion and local culture, due to changes in community identity, industrial and commercial focus, and park preservation values.

Examples of *cumulative social impacts* include:

1. a significant increase in park management activities (particularly at Biscayne), including resource protection, environmental monitoring, visitor protection, and maintenance, due to changed visitation and urbanized development,
2. an increase in park infrastructure needs (particularly at Biscayne), due to increased and changed visitation patterns,
3. a significant change in recreational uses, visitor types, and visitor distribution (particularly at Biscayne), due to increased noise levels,
4. an increase in complexity and intensity of required park-regional-local governmental cooperation, due to population influx leading to urban development, and
5. a reduction in park preservation values gained by visitors and the general public, due to deterioration of natural quiet or natural sounds, visual impacts, and urbanized development.

In March 1998, we forwarded to the Director of the National Park Service suggested social impact variables to be addressed in an SEIS. We also pointed out that many of the social impacts of concern to the Park Service are also potentially related to the South Florida Ecosystem Restoration Project (Harwell 1997). The director combined our analysis with that from the ecosystem team and forwarded the recommendations to the U.S. Air Force and the Federal Aviation Administration for inclusion in the scoping document for the supplemental environmental and social impact assessment.

Assessing social impacts of development outside park boundaries

Social impact assessment is a tool to help park managers understand how development outside park boundaries changes management procedures inside. Remember, SIAs are completed *before* the development event. If a supplemental SIA were to be done, the two superintendents could develop management plans based on good population projections in both the primary and secondary ROI and knowledge about the type of urbanized development (particularly near Biscayne and affecting Biscayne Bay). The SIA would address how increased noise and air emissions due to expanded flight operations and urbanized development affect both the park experience and preservation values and detail the requirements for a buffer zone between the current urban development boundary and Biscayne.

The two superintendents would also know about the occupational mix of a commercial sector based on air transport and the infrastructure needs (water, roads, sewer, schools, etc.) that would be required for urbanized development and population growth. The assessment would address how a reduction in park preservation values might alter the local and regional tourism industry. These and other changes would be known in advance of the permit to expand the air base.

Epilogue

On December 18, 1998, the Third District Court of Appeals in Florida ruled that the construction of a commercial airport on the old Homestead Air Force base could not proceed until a full environmental and social impact assessment study of the impact of completion and operation of a commercial airport on nearby Everglades and Biscayne National Parks. The Appeals Court said Miami-Dade County had rushed through development plans at the expense of its obligation under state law to prepare management plans to protect natural resources. In their ruling, the court cited the problems of noise, lack of quiet, urban congestion, alteration of the visual environment, and increased visitor use as suggested by the three NPS social scientists in their portion of scoping for a supplemental EIA-SIA. A draft EIA-SIA should be available for comment by Park Service personnel by early 2000. **PS**

References

Burdge, R. J. 1999. A Community Guide To Social Impact Assessment: Revised Edition. Social Ecology Press, Middleton, Wisconsin.

Burdge, R. J. 1998. A Conceptual Approach To Social Impact Assessment: Revised Edition. Social Ecology Press, Wisconsin.

Dixon, M. 1978. What Happened to Fairbanks: The Effects of the Trans-Alaska Oil Pipeline on the Community of Fairbanks, Alaska. Westview Press, Boulder, Colorado.

Harwell, M. A. 1997. Ecosystem management of south Florida: developing a shared vision of ecological and societal sustainability. BioScience 47(8):499-512.

IOCGPSIA (Interorganizational Committee on Guidelines and Principles for Social Impact Assessment). 1994. Guidelines and principles for social impact assessment. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-16,29p. Reprinted in *Impact Assessment*. 1994. 12:2, pp. 107-152 and *Environmental Impact Assessment Review*. 1995. 15:1, 11-43; and Burdge, 1998, cited above, pp. 93-124.

Machlis, G. E. et al. 1998. The SIA Scoping Document: Finding New Uses for Old Military Bases. Pages 67-78 in R. J. Burdge. 1998. A Conceptual Approach to Social Impact Assessment: Revised Edition, cited above.

NEPA, The National Environmental Policy Act of 1969. Public Law 91-190: 852-859.42, U.S.C., and as Amended (P. L. 94-83) 42 U.S.C. 4321-4347.

National Park Service. January 1983. General Management Plan, Development Concept Plan, Wilderness Study and Environmental Assessment. Biscayne National Park, Florida.

National Park Service. May 1979. Final Environmental Statement. Master Plan. Everglades National Park, Florida.

USAF Department of the Air Force. August 1997. DRAFT Homestead Air Force Base FEIS Review. Air Force Center for Environmental Excellence, Conservation, and Planning Directorate, Environmental Analysis Division. Internal Working Draft.

Rabel J. Burdge is a Professor of Sociology and Environmental Studies at Western Washington University, Bellingham. He can be reached at burdge@cc.wwu.edu.

The national park system public use statistics

By Tom Wade

The National Park Service has been reporting recreation visits to its park system units since its creation in 1916. During those eight decades, the annual visitation has increased from 358,000 to 286.7 million in 1998. Many factors influence visitation to the 378 units including national and international economic conditions, local and national weather, and the ever-changing demographics of the population. So how did 1998 visitation compare to previous years?

The national park system received 286.7 million recreation visits in 1998. This was a 4.2% increase in public use or 11.5 million more visits than in 1997. The 1998 increase was directly influenced by major changes in the method of counting public use at six units in the Washington, D.C., area. These changes caused a higher annual percentage change for the park system than would have normally occurred.

The units in Washington, D.C., obtain their visitor counts by sampling the attendance at their units and not by trying to count every visitor. The physical layout of the monuments and memorials make counting every visitor an impossible task. Before 1998, staff counted visitors by making just one pass through the area, not by counting visitors for the entire 15-minute sample period. The correction for the proper sample period resulted in a 33% increase in reported visitation.

Without this administratively induced increase, the National Park Service would have received 274.7 million recreation visits (0.2% decrease). Because of the changes in counting procedures, the national visitation should be viewed as an adjustment and not as an actual increase in visitation. Visitation trends will have more value when examined on an individual park basis.

The national park system received 16.0 million more recreation visits from 1994 through 1998 (using the adjusted national total for 1998). This was a 6.1% increase over the five-year period or an average of 1.2% per year. When the last 10 years were examined, the rate of increase remained the same at 1.2% per year (256.1 million adjusted recreation visits were recorded during 1989).

Since January 1998, parks experienced an increase in visitation in 22 months when compared to the same month in the previous year. Except for September 1997, and December 1998, the park system had more recreation visits in every month than it received in the previous year. This increase occurred despite the influences of variable weather in the United States (affecting at least 50 units across the nation) and the troubled global economic condition, especially in Asia.

Recreation visits are skewed

Visitation to the national parks is highly skewed as the 10 most visited units (3% of the system) receive over 30% of the nation's visits and the 25 most visited units (7% of the system) receive 50% of the nation's visits. The full range of visitation to individual units extend from Blue Ridge Parkway's 19.0 million recreation visits to Aniakchak National Monument and Preserve's 209 recreation visits (table 1).

Recreation visits by region

The national park system is administratively divided into seven regions. This allows the agency to respond quickly to changing conditions within a limited geographic area. The change in recreation visits from 1997-98 ranged from +10 million in the National Capital Region to -847,000 in the Pacific West Region (table 2). Following is an overview of some factors that influenced the changes in the different regions.

Alaska–experienced its first year of decreasing visitation since 1989. The ongoing construction of a parking lot affected Kenai Fjords National Park (-43,000 visits) while a decline of 110,000 visits to Sitka National Historical Park was the result of an administrative change in the method of counting public use. Of course, the annual decrease for this region was only 23,000, which is less than half of the average daily visitation at the most visited unit of the national park system (Blue Ridge Parkway's average daily visitation is 52,000).

Intermountain–had its fourth year in a row with decreased visitation, as 66% of the units reported fewer visits in 1998 than in 1997. Grand Canyon National Park attributed its decrease of 552,000 recreational visits to inclement spring weather and the variable global economic situation.

Midwest–had 67% of the units report an increase in visitation, as it had beautiful weather in 1998 when compared with the El Niño weather-related problems in 1997. Indiana Dunes National Lakeshore (+625,000) is typical of this region as it had increased visitation in 11 of the 12 months.

National Capital–had the six major units in downtown Washington, D.C., report a combined 12.0 million more visits than they reported in 1997. The increase was the result of changes to the individual unit's counting procedures and should not be viewed as 12.0 million more people. All previous years, including 1997, were significantly under-reported. If the six units had received only

Table 1.
Most and least visited units of the national park system during 1998

Ten Most Visited Units		Ten Least Visited Units	
19,026,498	Blue Ridge Pkwy	4,451	Yukon-Charley Rivers NPres
14,046,590	Golden Gate NRA	3,740	Bering Land Bridge NPres
9,989,395	Great Smoky Mountains NP	3,616	Eugene O'Neill NHS
8,788,055	Lake Mead NRA	3,293	Alibates Flint Quarries NM
7,124,022	Gateway NRA	3,034	Thomas Stone NHS
6,584,802	George Washington Memorial Pkwy	2,960	Cape Krusenstern NM
5,810,094	Natchez Trace Pkwy	2,100	Noatak NPres
5,200,633	Statue of Liberty NM	1,282	Nicodemus NHS
5,019,175	Delaware Water Gap NRA	462	Rio Grande WSR
4,804,185	Cape Cod NS	209	Aniakchak NM &Pres

Table 2.
National park system regional visitation statistics

Region	1998	Difference from 1997	% Change
Alaska	1,991,864	-22,986	-1.1
Intermountain	43,634,110	-631,333	-1.4
Midwest	22,140,343	1,208,121	5.8
National Capital	41,158,219	10,910,012	32.9
Northeast	54,629,311	1,186,428	2.2
Pacific West	57,737,486	-847,825	-1.4
Southeast	65,447,782	419,363	0.6

Table 3.
Visitation to national park system units by population center

Population Center	1998	Difference from 1997	% Change
Urban	89,963,908	11,589,831	14.8
Suburban	24,362,630	-537,763	-2.2
Outlying	51,152,721	-191,263	-0.4
Rural	90,809,767	30,365	0.0
Remote	3,629,097	90,905	2.6
Mixed	26,820,992	520,705	2.0

as many visits in 1998 as they reported in 1997, the region would have decreased by 5.8%.

Northeast–had its entire increase in four units: Castle Clinton National Monument (+281,000), Delaware Water Gap National Recreation Area (+267,000), Statue of Liberty National Monument (+462,000), and Gateway National Recreation Area (+316,000). The region would have decreased by 0.3% without the increase in the four units.

Pacific West–experienced the largest decrease of all regions, reflecting the double influences of variable weather and the troubled global economy. Muir Woods National Monument (-686,000) had the largest decrease in visitation in the national park system but the decrease was the result of changes to its method of counting public use, not actually 686,000 less people.

Southeast–region and the nation was, as always, dominated by Blue Ridge Parkway (19,026,000), which accounts for 29% of the region's and 6.6% of the nation's recreation visits. Excluding Blue Ridge Parkway, the rest of the region decreased by 0.5%. Canaveral National Seashore was severely affected by the summer wildfires (-665,000), while Gulf Islands National Seashore (-403,000) also had weather-related problems. Meanwhile, Timucuan Ecological and Historic Reserve (+512,000 or +422%) opened up some new areas. This region received more recreation visits than the combined visitation to the three least visited regions (Alaska, Midwest, and National Capital).

Recreation visits by population center

A major factor influencing visitation at all units of the national park system is their proximity to population centers (table 3). The more people who live within a day's drive of a unit and the ease with which people can get to a unit certainly affect the number of visits that a unit would receive. Following is a partial explanation as to what influenced visitation at the various geographical categories.

Urban–(located within the central city). The units in downtown Washington, D.C., that had counting procedure changes belong to this category. Because of these administrative changes and the inclusion of two new units in 1997 (Franklin Delano Roosevelt Memorial and Korean War Veterans Memorial), this category has increased 29% or 21 million recreation visits over the last two years.

Suburban–(located outside the central city but still within an area of greater than one million people). Of the nine units with more than one million visits, six reported a decrease in visitation. The combined visitation to the suburban and urban categories is 40% of the entire national park system.

Outlying–(located in an area of less than one million people). This category has a disproportionate number of units receiving more than one million recreation visits (26%) resulting in a per unit average of over one million recreation visits.

Rural–(accessible by paved highway, scheduled air or marine transportation service). One hundred sixty-seven units, or almost half the national park system, are assigned to this category. As the largest and most visited group of units, its growth remains slow but constant, increasing by 4% over the last 10 years.

Remote–(requires special travel arrangements to reach). The 25 units that comprise remote units have the lowest average annual recreation visits (145,000) of any population center category. Despite the extraordinary measures that must be taken in order to visits these units, this category has grown by 86% over the last 10 years. Almost all the Alaskan units are in this category.

Mixed–(a mixture of urban, suburban, outlying, and remote areas). Blue Ridge Parkway dominates this category as it does in every category it is associated with. This is especially true of mixed units since there are only two other units designated as mixed (Chesapeake and Ohio Canal National Historical Park and Natchez Trace Parkway). This category has deceased by 7% over the last 10 years.

Recreation visits in the future

The national park system has recorded approximately 11.2 billion visits (8.4 billion recreation visits and 2.8 billion non-recreation visits) from 1916-98. This means that the park system has received over 190 visits every second for the last 82 years. Assuming the current rate of increase, it should receive its 12 billionth visit some time in 2000. As the pressure increases to both maintain park resources and simultaneously provide the high quality of service that the public deserves, the sheer volume of visits to the national park system will be a major factor in the decision-making process. The need to control the number of people entering parks and provide for their safety will be an important aspect of future managerial decisions. PS

Tom Wade is with the NPS Public Use Statistics Office in Lakewood, Colorado. He can be reached at 303-987-6900. The office is part of the Concessions Program Center and employs two computer specialists to update the public use statistics monthly, produce the NPS Statistical Abstract annually, and maintain a related website www.nature.nps.gov/stats.

Visitor opinions and park resources

By Margaret Littlejohn

How many park resource managers have used visitor opinions in making a management decision about park resources? Visitor opinions about park resources and the quality of their national park visits vary, as do the visitors themselves. Visitors sometimes share verbal feedback or write letters to National Park Service (NPS) employees. Often, these comments are not scientifically collected, sometimes not compiled, and therefore have little impact on improving park operations. Many park managers, recognizing the importance of obtaining more scientific and collective feedback on how well visitors are being served, request visitor studies.

Resource managers are beginning to realize that through visitor studies, visitor opinions about resource management issues can be scientifically gathered. Managers often choose to query visitors about issues such as crowding, the importance of park qualities (such as air quality, recreational activities, solitude, and wilderness), resource issues that interest visitors, and the impacts of other visitors and their activities on people's visits.

One NPS research program that conducts visitor studies is the Visitor Services Project (VSP), based at the University of Idaho Cooperative Park Studies Unit. The VSP develops different tools that provide the National Park Service with valuable visitor feedback. One of these tools, the in-depth visitor studies at individual park units, began in 1982. Up to 10 in-depth visitor studies have been conducted each year since 1988. Since then, over 85 VSP in-depth visitor studies have been conducted, with an average response rate of 79%.

VSP in-depth visitor study questionnaires are customized to allow park managers to ask visitors questions about the most important issues facing the park. The questionnaires gather standardized demographic information, and customized information about trip planning, opinions about park visits, park issues, and feedback on individual and overall service quality. This direct and collective feedback from visitors is valuable information for park managers, who can use it to make operational changes or better plan for the future, ultimately benefiting the visitors.

Recent VSP in-depth visitor studies reveal some interesting information about visitors' views on natural and cultural resources and use of those resources in the parks. Some comments show visitors' increasing awareness and concern for park resources. Several examples follow.

A visitor's comment:

"This park is a magnificent treasure, which merits bold and even controversial measures to safeguard it for future use as a natural haven, protecting the environment and enriching the people who experience it."

Crowding

A number of VSP visitor studies have addressed visitor opinions about crowding in parks. During a 1998 VSP visitor study, Cumberland Island National Seashore (Georgia) visitors were asked to give their opinion about the current limit of 300 people per day allowed on the island. As shown in figure 1, most visitors (82%) felt that the current limit is "about right."

Resource management objectives

Visitors have occasionally been asked whether they support particular resource management objectives in parks. At Fort Bowie National Historic Site (Arizona) in 1996, visitors were asked if they supported the following objective: "The current National Park Service objective is to manage Fort Bowie National Historic Site in its remote setting with minimal improvements." Most visitors (88%) said they supported that objective, while 5% did not support that objective and 7% were not sure. When asked if they felt the Park Service has achieved that objective, 92% said "yes," 4% said "no," and 4% were "not sure."

Impact of modern conveniences on historic setting

Park managers may be interested in finding out if visitors perceive certain resource-related issues as problematic. For example, during the 1997 Lincoln Boyhood National Memorial (Indiana) visitor study, visitors were asked, "Do you feel that automobile and train traffic within the park impacts the historic setting of the Living History Farm?" Many visitors (63%) said that automobile and train traffic did not impact the historic setting. Twenty-two percent were not sure and 14% said automobile and train traffic did impact the historic setting.

Appropriateness of activities

Park managers may want to gauge visitors' knowledge of the appropriateness of certain activities in a park setting. In the 1995 visitor study questionnaire at Bandelier National Monument (New Mexico), visitors were asked to rate how appropriate certain activities were in the monument. The activities visitors were asked to rate included: walking or sitting on ruin walls, collecting artifacts (such as potsherds), walking off trail among the ruins, exploring ruins in caves, feeding animals, and collecting plants (picking flowers, collecting pine cones, etc.). Visitors used a 4-point scale to rate the appropriateness as follows: 1=always, 2=usually, 3=sometimes, 4=never. Figures 2 and 3 show examples of the responses. More visitor groups feel that collecting artifacts in the park is never appropriate (91%) than walking off trail in the ruins (65%).

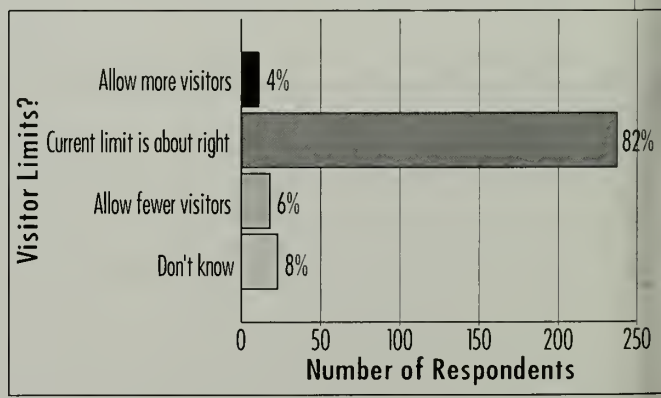


Figure 1. Visitor opinions about current visitation use limit, Cumberland Island National Seashore, 1998. (n=289 visitor groups.)

Importance of park features or qualities

How important are selected park features or qualities to visitors at the parks they visit? At Grand Teton National Park (Wyoming) in the 1997 visitor study, visitors were asked to rate the importance of native plants and animals using a scale from 1 (not important) to 5 (extremely important). Most visitor (87%) rated native plants and animals as "extremely important" or "very important."

Visitor Services Project visitor studies were conducted at Great Smoky Mountains National Park (Tennessee and North Carolina) during July and October 1996. Visitors were asked to rate the importance of the following park features and qualities to their visit to the park: native plants and animals, clean air, scenic views, recreational activities (such as hiking, camping, fishing, etc.), solitude, and historic buildings. In the summer study, visitors gave the highest "extremely important" or "very important" ratings to scenic views (95%), clean air (90%), and native plants and animals (80%), as shown in figure 4. In the fall survey, the same three features or qualities received the highest importance ratings from visitors: scenic views (95%), clean air (87%), and native plants and animals (74%). In both of the studies, the two features that received the highest "not important" ratings were recreational activities and historic buildings.

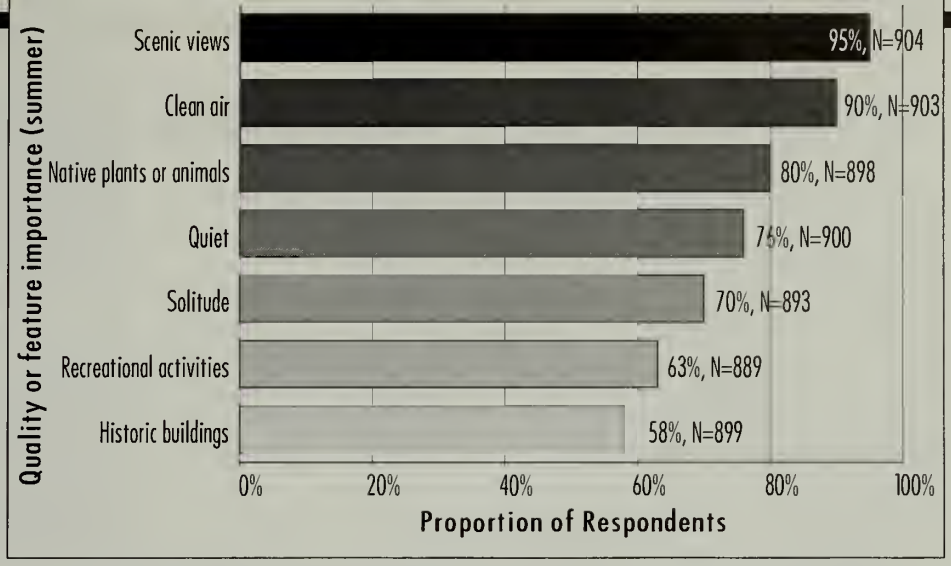
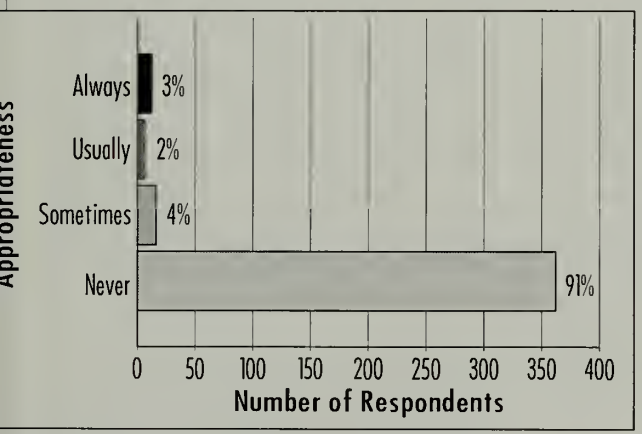


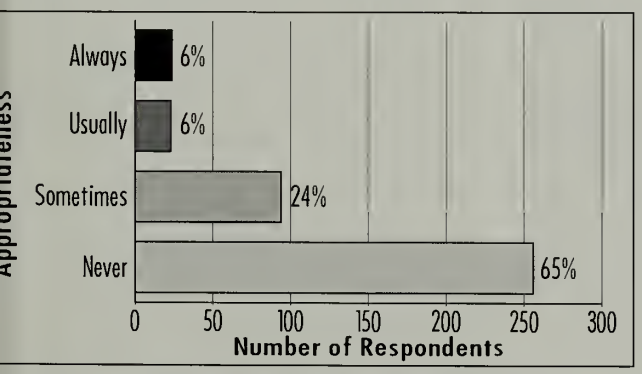
Figure 4. Combined proportions of "extremely important" or "very important" ratings of park qualities or features at Great Smoky Mountains, summer, 1996.

Other visitors' impacts

Sometimes, visitors' enjoyment of park resources is impacted by other visitors and their activities. During 1997, Voyageurs National Park's (Minnesota) visitor study showed that visitors were disturbed by other visitors using personal watercraft. Noisy people, loud music, or motorboats were also cited as ways visitor groups disturbed others.



gure 2. Appropriateness of collecting artifacts in the manument, ndelier National Manument, 1995. (n=396 visitor groups.)



gure 3. Appropriateness of walking off trail in the ruins, Bandelier ıtional Manument, 1995. (n=397 visitor groups.)

Resource subjects of interest

Resource issues are often discussed in interpretive programs with the recognition that informed visitors are less likely to damage resources. Having visitors identify the resource subjects that they are most interested in learning about results in more informed visitors and more wisely spent park funds. In the spring 1996 Chiricahua National Monument (Arizona) visitor study, visitors were asked to identify subjects they were most interested in learning about from the following list: threatened and endangered species, animal protection, air quality, wilderness, historic resources, role of fire, or any other subject the visitor wanted. The most common answers were wilderness (67%), historic resources (61%), and threatened and endangered species (46%). Air quality (23%) was the least requested subject.

Using visitor opinions

These examples show a few types of resource management information that park managers can learn from visitors. While visitors cannot be expected to make management decisions regarding park resources, they can provide information that is useful for park managers to incorporate into their decisions regarding resources. Some visitor responses may point out the need for better visitor education on resource management issues, while others support management objectives of protecting park resources. In designing survey questionnaires, it is important to recognize that visitors do not always come to parks with preconceived expectations–many visitors are not subject experts and may not be well informed about specific subjects. Ultimately, resource management decisions need to be made by well-informed managers who incorporate visitor opinions into their decisions. PS

Margaret Littlejohn is Visitor Services Project Coordinator, National Park Service, based at the Cooperative Park Studies Unit, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID 83844-1133. She can be contacted by e-mail at littlej@uidaho.edu.

Protecting park resources using interpretation

James H. Gramann

Figure 1. An NPS interpreter greets hikers at the Shiloh National Military Park trailhead to deliver one of three test messages designed to reduce damaging behavior during hikes.

Park staff use two general approaches to protect natural and cultural re sources from purposeful or unwitting damage by visitors. Under a "direct approach," a park's staff manages visitor behavior overtly through surveillance, by enforcing regulations, and by physically channeling visitors away from sensitive areas. "Indirect approaches" use information and interpretation to promote voluntary conformance with rules. This article reviews the theoretical basis for indirect management, presents research evaluating its effectiveness, and discusses gaps in current social science knowledge related to indirect management as a resource-protection tool.

Theoretical basis

Several experiments have tested the effectiveness of interpretation and information in reducing rule violations and damaging behavior in outdoor settings. The results of many of these are consistent with predictions of prosocial behavior theory (Gramann et al. 1995). "Prosocial behavior" is defined as voluntary behavior done to help others, without the incentive of material rewards for helping or the threat of probable punishment for not helping. In many cases, obeying protective rules in parks is prosocial behavior. This is because no tangible reward for rule obedience exists, and the likelihood of being caught and punished for disobedience is often small.

Two propositions form the core of prosocial behavior theory (Schwartz 1977). First, other things being equal, prosocial actions should be more likely when people are *aware of the consequences* of their helping (or not helping) for others or for the environment. Second, persons should be more likely to behave prosocially when they *feel personally responsible and qualified to help.* The first of these conditions is called "awareness of consequences" and the second "ascription of responsibility."

Applying prosocial behavior theory to resource protection requires an understanding of the reasons for damaging actions. Gramann and Vander Stoep (1987) described several motives for these actions and how they could be addressed using interpretation and education within the framework of prosocial behavior theory.

One reason visitors violate protective rules is that they are unaware that certain regulations exist. Obviously, interpretation and information–if it reaches the relevant audience–can play a major role in making people more aware of protective regulations in parks.

However, sometimes visitors violate rules, even if they are aware of them. One reason for this is that they may not realize the negative consequences of their actions for other users or for the environment. Many impacts on resources are cumulative, becoming evident only after many damaging actions occur over long periods. Because visitors' time in parks is short, people may not connect their behavior with damaging effects. However, they might refrain from harmful actions if this cause-effect relationship were explained in an "awareness-of-consequences" message. Interpretation is one way to make people aware of the consequences of their behavior for a park's resources.

Sometimes, visitors are aware of a rule and its reasons, but obeying it in a particular circumstance may seem unreasonable or even impossible. This leads to "responsibility-denial," a situation in which people deny having a reasonable obligation or the skills to comply with rules. For example, prohibitions against dumping waste from recreational vehicles may be ignored if sanitary dump stations are full or if the fee for use seems excessive. Responsibility-denial can be countered by publicizing reasonable alternatives to prohibited actions or by making people feel qualified to help in certain situations. The latter dynamic underlies many adopt-a-site programs, including litter cleanup campaigns and archeological site-protection efforts. In a prosocial-behavior framework, these programs increase people's ascription of responsibility to protect natural and cultural resources.

Of course, people sometimes damage resources willfully and vindictively. Although such malicious behavior may be relatively uncommon in many parks, a single instance can produce significant and costly damage. Willful violators are fully aware that their actions are wrong, but they persist because they are pursuing goals that are in fundamental conflict with resource protection. Willful vandalism almost always requires direct and forced compliance with regulations. However, research shows that providing interpretation and information about rules, and enlisting visitors in resource protection, can be very effective as indirect approaches to changing many other types of harmful behaviors.

Research

The effectiveness of interpretation and education in resource protection was demonstrated in several experiments conducted in national parks and other recreation areas during the 1980s and early 1990s (Gramann et al. 1995). Unfortunately, little research evaluating indirect management has been done since, leaving key questions unanswered. These are discussed at the end of this article.

The following study describes an evaluation of interpretation's effectiveness in reducing cultural resource damage at Shiloh National Military Park (figure 1), a Civil War battlefield in Tennessee (Vander Stoep and Gramann 1987). Other demonstrations of indirect management's effectiveness have been done in national forests (Martin 1992,

Roggenbuck and Berrier 1982) and at reservoirs operated by the Army Corps of Engineers (Oliver et al. 1985). Therefore, the utility of indirect management as a resource protection tool seems to generalize across a variety of outdoor settings.

Cultural resources at Shiloh consist mainly of monuments, statues, and cannons. Although some resource damage in the park is caused by weathering and aging, visitors also contribute to the deterioration of cultural resources. At the time of the study, much of the destructive behavior was linked by NPS staff to organized youth groups who hiked through the park. Damaging behavior ranged from graffiti and defacement (a relatively rare problem) to more common actions, such as climbing or sitting on statues (figure 2). To combat the problem, three experimental treatments and a control condition were tested over 12 fall weekends. The behavior of hikers at four different locations in the park was monitored using time-lapse photography.

In treatment 1, the awareness-of-consequences (AC) treatment, hikers were met by a uniformed interpreter as they arrived at the trailhead that was the starting point for most of the hikes. They were welcomed to the park and told about specific behaviors, such as touching or rubbing bronze statuary and striking and climbing on monuments that caused damage over a period of time. They were asked to help protect the park's resources by setting an example for others, and then allowed to proceed. This treatment was in effect on three randomly assigned weekends and was intended to promote awareness of protective rules and the reasons for them.

Treatment 2 was the awareness-of-consequences plus resource protection treatment (AC + RP). Hikers received the same AC message as those in the first treatment, and were then asked to participate in a "Heritage Guardian" program. This involved returning a form on which hikers recorded any damage to cultural resources they observed during their visit (fresh scratches, breaks, marks, and missing pieces) and listed conditions they felt encouraged others to behave destructively. Groups were told they were distinctively qualified to help the National Park Service because they hiked in areas seldom reached by other visitors. Participation was voluntary, but no groups declined to take part. This treatment was designed to reduce responsibility-denial by promoting ascription of responsibility.

In Treatment 3, the AC + RP + I treatment, incentives were added to the first two messages. Two incentives were awarded for returning a completed Heritage Guardian form to the park. The first was a 24-inch streamer similar to those scouts attach to troop banners. The streamer was blue, printed in gold, and marked with the words "Shiloh NMP Honor Award/ Heritage Guardians." The second incentive was a certificate signed by the park superintendent. This treatment was also in effect on three randomly assigned weekends. Although not based on prosocial behavior theory, it was thought that incentives might be an effective external motivator for young people who had not yet developed internal codes of appropriate behavior.

Figure 2. Hikers climb on a large headquarters manument at Shilah. Besides damaging the manument, this behavior exposes youth to risk of injury if they fall or are pushed.

Finally, on three other weekends, a control condition was in effect. Groups were welcomed to the park and then allowed to proceed on their hikes. This control served as a baseline against which the effectiveness of the other three treatments was measured.

The amount of damaging behavior on each weekend was scored by two judges who independently reviewed each roll of film. The judges were "blind" to the treatments, i.e., unaware of the experimental conditions in effect on any weekend. Scoring was done by analyzing the film frame-by-frame using a stop-action projector. For ease in identification on camera, all persons included in the treatments and control condition were given bright orange stickers to wear that read "I'm a 25th Anniversary Trail Hiker."

Results

All treatments significantly reduced damaging actions when compared to the control condition (figure 3, following page). This was especially true for climbing and hitting, the most harmful activity. Table 1 shows that the three treatments were equally effective in this case, reducing hitting and climbing by about 88% compared to the baseline condition. The treatments were least effective in reducing touching or rubbing of monuments. This may have been because the Heritage Guardian program required hikers to examine monuments to identify scratches and other damage. This would appear as touching and rubbing on film.

Statistical analysis showed that the treatments did not differ significantly *from each other* in their effectiveness in reducing the most damaging behaviors. The simplest and least costly measure–a simple awareness-of-consequences message–was as effective as the Heritage Guardian program and the incentives.

Table 1.
Percent change in damaging behavior vs. control (combined sites)

	Experimental Treatment		
Behavior	AC	AC+RP	AC+RP+I
All behaviors	-77.7*	-73.6*	-58.7*
Sitting on base	-70.8*	-78.2*	-52.2
Touching	-65.4*	-24.4	+4.6
Climbing, hitting	-87.9*	-87.6*	-87.1*

**difference from control condition significant at p = 0.05*

See "Interpretation" on page 36

"Interpretation" continued from page 35

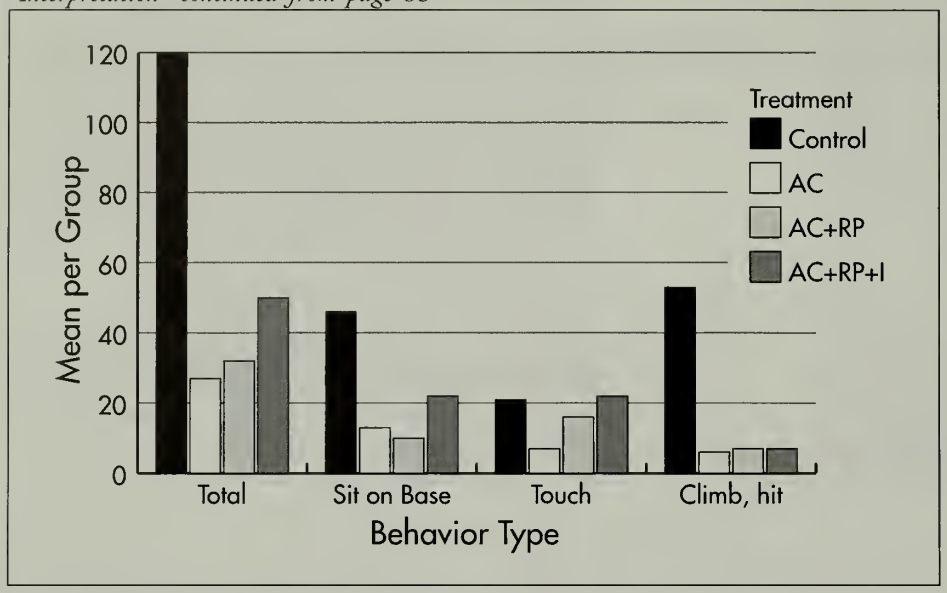


Figure 3. Change in damaging behavior by treatment (combined sites).

Applications to other situations

In other experimental research utilizing control groups, interpretation (either in verbal or printed form) has been used to significantly reduce littering in a highly developed Corps of Engineers campground (Oliver et al. 1984), camping at overused national forest wilderness sites (Roggenbuck and Berrier 1982), wildlife feeding at Crater Lake National Park (Schwarzkopf 1984), off-trail hiking at Mount Rainier National Park (Johnson and Swearingen 1992), and pumice removal at Mount St. Helens National Volcanic Monument (Martin 1992). In none of these circumstances was the targeted behavior completely eliminated; however, the situation was dramatically improved compared to baseline conditions in which no actions were taken.

The Shiloh messages did not threaten punishment for rule violations, but other field experiments support the effectiveness of these types of "sanction" messages. This is especially true if visitors feel punishment for violations is serious and likely (Gramann et al. 1995, Johnson and Swearingen 1992). Unfortunately, this condition is often hard to satisfy in many areas of the national park system.

An interesting question raised by indirect management research in rural parks is how well such techniques would work in urban areas. At more remote parks, many visitors seem predisposed toward resource protection. In communicating rules, interpreters are often working *with*, rather than *against*, visitors' basic values. But in urban parks, visitor populations are more diverse, and many users may not share as strongly in the underlying value of resource protection. In these areas, a combination of indirect and direct management approaches would seem to be the most effective approach, but no research in urban park settings has been published on this topic. Nevertheless, despite these gaps in the knowledge base, in many situations common to the national park system, social science research shows that interpretation can be an effective resource-protection tool. PS

The simplest and least costly measure–a simple awareness-of-consequences message–was as effective as the Heritage Guardian program and the incentives.

The messages at Shiloh were delivered verbally by a uniformed interpreter with excellent social skills. This probably contributed to the their effectiveness. Even so, other studies suggest that written messages in brochures and signs that state *and* explain rules can be effective in changing visitor behavior (Christensen et al. 1992). However, limited research indicates that written messages are not as effective as verbal messages in doing this (Gramann et al. 1992).

Literature Cited

Christensen, H. H., D. Johnson, and M. Brookes, editors. 1992. Vandalism: research, prevention, and social policy. General Technical Report PNW-GTR-293. USDA Forest Service, Portland, Oregon.

Gramann, J. H., R. Bonifield, and Y. Kim. 1995. Effect of personality and situational factors on intentions to obey rules in outdoor recreation areas. Journal of Leisure Research 27:326-43.

Gramann, J. H., H. Christensen, and G. Vander Stoep. 1992. Indirect management to protect cultural and natural resources: research, ethics, and social policy. Pages 251-64 in H. Christensen, D. Johnson, and M. Brookes, editors. Vandalism: research, prevention, and social policy. General Technical Report PNW-GTR-293. USDA Forest Service, Portland, Oregon.

Gramann, J. H. and G. Vander Stoep. 1987. Prosocial behavior theory and natural resource protection: a conceptual synthesis. Journal of Environmental Management 24:247-57.

Johnson, D. R. and T. Swearingen. 1992. The effectiveness of selected trailside sign texts in deterring off-trail hiking at Paradise Meadows, Mount Rainier National Park. Pages 103-119 in H. Christensen, D. Johnson, and M. Brookes, editors. Vandalism: research, prevention, and social policy. General Technical Report PNW-GTR-293. USDA Forest Service, Portland, Oregon.

Martin, D. S. 1992. The effect of three signs and a brochure on visitors' removal of pumice at Mount St. Helens. Pages 121-31 in H. Christensen, D. Johnson, and M. Brookes, editors. Vandalism: research, prevention, and social policy. General Technical Report PNW-GTR-293. USDA Forest Service, Portland, Oregon.

Oliver, S. S., J. Roggenbuck, and A. Watson. 1985. Education to reduce impacts in forest campgrounds. Journal of Forestry 83:234-36.

Roggenbuck, J. W., and D. Berrier. 1982. A comparison of the effectiveness of two communication strategies in dispersing wilderness campers. Journal of Leisure Research 14:77-89.

Schwartz, S. H. 1977. Normative influences on altruism. In L. Berkowitz, editor. Advances in Experimental Social Psychology 10:221-79.

Schworzkopf, S. K. 1984. Feeding of golden-mantled ground squirrels by park visitors at Crater Lake National Park. Research Paper, CPSU/OSU 84-89. NPS Cooperative Park Studies Unit, Oregon State University, Corvallis, Oregon.

Vander Stoep, G. A., and J. Gramann. 1987. The effect of verbal appeals and incentives on depreciative behavior among youthful park visitors. Journal of Leisure Research 19:69-83.

James Gramann is a professor at Texas A&M University. He teaches and does research on the social dimensions of protected-area management. He can be reached at the Department of Recreation, Park and Tourism Sciences, Texas A&M University, College Station, TX 7 7843-2261; 409-845-4920; Fax 409-845-0446; e-mail: jgramann@rpts.tamu.edu.

The NPS Visitor Survey Card:
First year survey and implications for park management

By Terry R. Bergerson

In 1993, Congress passed the Government Performance and Results Act (GPRA), which directs federal agencies to join the *"performance management revolution."* For the past several years, the National Park Service has been working to implement GPRA, to make it "fit" the agency and mission and to make it useful. As mandated by GPRA, the Park Service has developed national park systemwide standards for a broad range of key performance measures including both annual and long-range goals. One of these goals involves the annual measurement of visitor satisfaction in units of the national park system.

In 1997, the National Park Service assigned the Social Science Program the task of developing a standard GPRA survey that could be used annually by all park units to measure visitor satisfaction. The survey was given the name Visitor Survey Card (VSC)–a GPRA-based, customer evaluation system for the National Park Service modeled after "the best in business." The project is being conducted by the University of Idaho Cooperative Park Studies Unit (UI CPSU), under the direction of Dr. Gary Machlis, NPS Visiting Chief Social Scientist. Terry Bergerson coordinated the project.

The overall objectives of the project were to develop a visitor service evaluation system that:

1. is efficient and cost-effective to implement,
2. is appropriate for use in all units of the national park system,
3. allows for comparison at various NPS organizational levels,
4. is timely for managers,
5. is scientifically sound, and
6. provides useful information to managers–for meeting GPRA reporting requirements and improving visitor services.

The VSC is similar to mail-back customer satisfaction surveys successfully used in major U.S. corporations (figure 1).

The card addresses 12 indicators of visitor satisfaction, allowing visitors to rate the quality of park facilities, visitor services, and recreational opportunities. Visitors rate the services using a 5-point scale ("very good," "good," "average," "poor," and "very poor"). For GPRA reporting purposes, the card includes an overall quality question used as the primary measure of visitor satisfaction.

Methods

The VSC studies are based on a systematic survey of park visitors. Four-hundred survey cards are distributed to a random sample of visitors in each park during a 30-day study period. Visitors at selected locations that are representative of the general visitor population are sampled. For each survey, park staffs select an interval sampling plan based on the previous year's visitation. Park staff are trained to carefully hand out survey cards according to an approved set of survey instructions and guidelines.

Survey administration

After a 45-day collection period, all returned survey cards are electronically scanned, and the data coded and analyzed. A standard VSC data report is generated and delivered to each park approximately three months after the completion of their survey. At the end of the year, reports at the cluster, region, and systemwide levels are generated and delivered to the National Park Service.

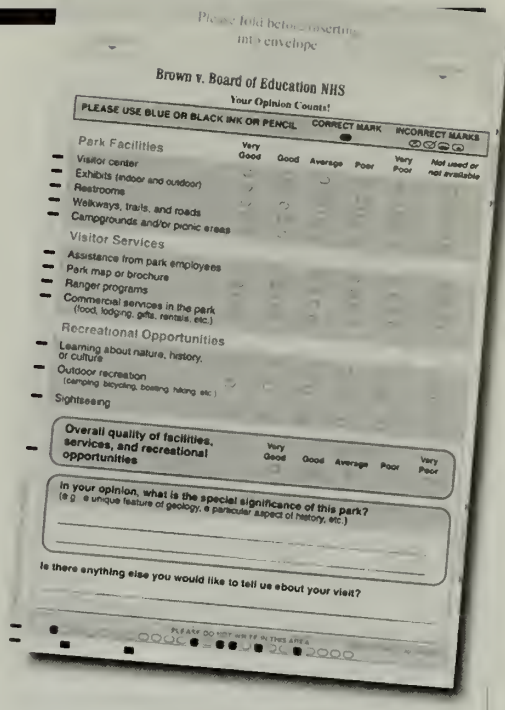


Figure 1. 1999 Visitor Survey Card.

Results

A 1998 VSC survey was completed in 281 national park sites. The average response rate for these park surveys was 24%.

Each park report contains three categories of data–park facilities, visitor services, and recreational opportunities. Within these categories are graphs for each indicator evaluated by park visitors (table 1). Responses for indicators within

Table 1.
Visitor Response Categories and Indicators

Service Categories	Service Indicators
Park Facilities	Visitor center
	Exhibits (indoor and outdoor)
	Restrooms
	Walkways, trails, and roads
	Campgrounds or picnic areas
Visitor Services	Assistance from park employees
	Park map or brochure
	Ranger programs
	Commercial services in the park
Recreational Opportunities	Learning about nature, history, or culture
	Outdoor recreation
	Sight-seeing

See "Survey Card" on page 38

"Survey Card" continued from page 37

each service category are averaged into a combined graph for the category.

For GPRA-reporting purposes, each report contains a rating of the park's overall quality of facilities, services, and recreational opportunities. A visitor is "satisfied" if their response is either "very good" or "good." Based on evaluations by park visitors, there is strong evidence of excellent customer service in the national park system. Of the 281 parks that completed a 1998 VSC survey, 275 (98%) successfully met the annual systemwide goal of 77% visitor satisfaction.

In addition, survey results are summarized at the cluster level. Table 2 shows the percentage of park visitors satisfied overall with appropriate facilities, services, and recreational opportunities for 12 clusters in the national park system. Some regions include a single cluster or do not have a cluster designation. These areas are not included in table 2. Overall satisfaction scores for these clusters ranged from 90%-96%.

Survey results are also summarized at the region level. Table 3 shows the percentage of park visitors satisfied overall with appropriate facilities, services, and recreational opportunities for each of the seven NPS regions. Regional overall satisfaction scores ranged from 93%-96%.

Finally, survey results are summarized at the systemwide level. Visitor responses for each of the 12 service indicators (table 1) are combined and averaged at the systemwide level. Table 4 shows the percent of visitors satisfied with these service indicators. Direct employee services such as assistance from park employees and ranger programs received high visitor satisfaction ratings. Commercial services in the park received the lowest visitor satisfaction rating of the 12 service indicators.

Visitor responses for indicators within each service category (table 1) are also combined and averaged at the systemwide level. Table 5 shows the systemwide percentages of visitors satisfied with park facilities, visitor services, and recreational opportunities. Recreational opportunities received the highest visitor satisfaction ratings of the three service categories.

Twenty-two thousand nine-hundred thirteen (22,913) respondents in 281 units of the national park system rated the overall quality of facilities, services, and recreational opportunities at the park they visited. Ninety-five percent of these respondents were "satisfied" with the overall quality of services provided. This high level of visitor satisfaction is strong evidence of the agency's willingness to serve the public.

Survey response rate and nonresponse bias

The project's research and development effort included an investigation to determine a typical survey response rate for similar mail-back customer service cards. Of the firms contacted, typical response rates for similar mail-back customer service cards without financial incentive ranged from 10%-30%. A review of the customer satisfaction literature confirmed this range to be reasonable (Varva 1997, Hayes 1997). The 24% average response rate for the 1998 VSC project is comparable to the best in private-sector customer service evaluations and acceptable for general performance measurement.

Although nonresponse bias is a potential problem in the VSC project, a number of steps were taken to deal with it. Nonresponse bias is a function of many factors within a survey–not just the final response rate (Dillman 1978). These include the *survey instrument*, *survey methodology*, and the final *response rate*. The VSC project carefully addressed each of these factors to reduce the potential for nonresponse bias in survey results. In addition, a test was conducted to identify nonresponse bias within the VSC survey results.

To test for nonresponse bias, the University of Idaho CPSU compared survey results from three VSC studies with the results from three 1998 VSP studies. These VSP studies contained the same

Table 2.
Percent of visitors satisfied, by cluster, in 1998

Cluster	% Visitors Satisfied
Allegheny	96
Appalachian	96
Chesapeake	96
Gulf Coast	96
Atlantic Coast	95
Colorado Plateau	95
Columbia Cascades	95
Rocky Mountain	95
Southwest	95
New England	94
Pacific Great Basin	93
Pacific Island	90

(n=281 parks, 22,913 respondents)

Table 3.
Percent of visitors satisfied, by region, in 1998

Region	% Visitors Satisfied
Midwest	96
Southeast	96
Intermountain	95
Northeast	95
Alaska	94
National Capital	93
Pacific West	93

(n=281 parks, 22,913 respondents

Table 4.
Systemwide percent of visitors satisfied, by service indicator, in 1998

Systemwide Service Indicators	Percent Visitors Satisfied
Assistance from park employees	96
Sight-seeing	95
Learning about nature, history, or culture	93
Park map	93
Ranger programs	93
Visitor center	93
Exhibits	91
Outdoor recreation	91
Walkways, trails, and roads	91
Campgrounds or picnic areas	83
Restrooms	81
Commercial services in the park	74

(n=281 parks, 22,913 respondents)

Table 5.
Systemwide percent of visitors satisfied by service category, in 1998

Systemwide Service Indicators	Percent Visitors Satisfied
Recreational Opportunities	93
Visitor Services	91
Park Facilities	89

(n=281 parks, 22,913 respondents)

Table 6.
Comparison of overall satisfaction within 1998 VSP and VSC survey results

1998 Units	Visitor Services Project		Visitor Survey Card Project	
	% Satisfied	N Size	% Satisfied	N Size
Acadia NP	96	996	95	86
Chattahoochee River NRA	80	658	85	107
Jean Lafitte NP & Preserve	95	528	95	79
Average	***90***		***92***	

overall satisfaction question included on the visitor survey card for GPRA measurement of visitor satisfaction. The average response rate for these three VSP studies was 76%. These VSP studies were conducted at the same park, season, and survey locations as the VSC studies. Table 6 shows the percentage of visitors satisfied overall from these three parks for both the VSP and VSC studies. This comparison identifies similar results for the two types of studies. The comparison suggests that nonresponse bias is not a significant factor within the 1998 VSC results.

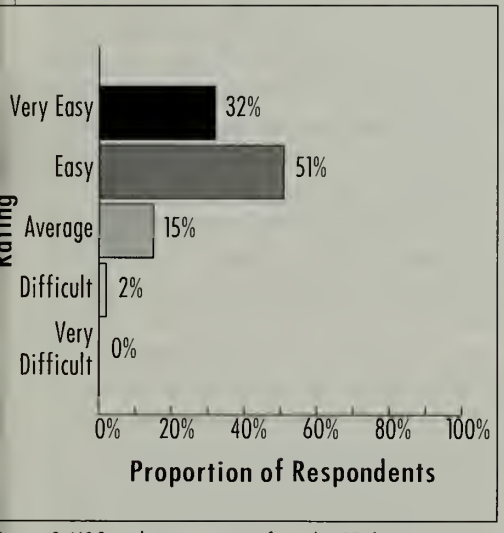


Figure 2. VSC evaluation: ease of use (n=156).

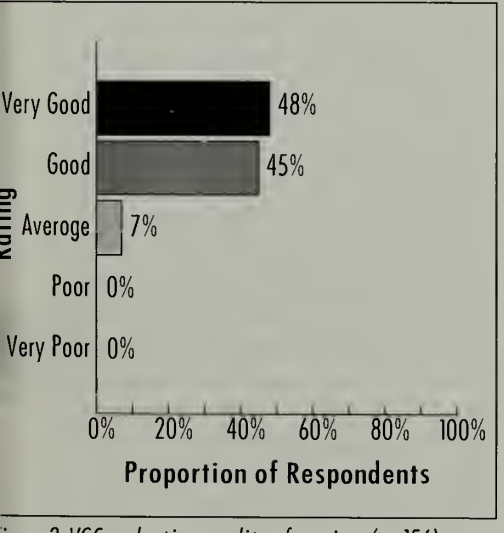


Figure 3. VSC evaluation: quality of services (n=156).

Feedback from the NPS

In an effort to improve the VSC survey, each park staff had an opportunity to evaluate the 1998 survey and reporting process. An evaluation card was provided for each participating park unit. Fifty-six percent of the parks completing a VSC survey returned an evaluation card. Figures 2 and 3 show the results of this evaluation.

The evaluation results suggest that park staffs found the VSC instructions and guidelines easy to use (figure 2). The results also suggest that park staffs were satisfied with the quality of services provided by the VSC staff (figure 3).

Using the VSC survey results

As part of the GPRA process, the National Park Service has developed a hierarchy of mission statements and goals to guide the performance management process. This planning framework provides the structure for measuring park performance across the system. At the park level, long-term and annual goals are tools for performance evaluation. The long-term and annual goals for visitor satisfaction state the desired future condition of the visitor's experience at units within the national park system.

In 1999, the annual goal for visitor satisfaction will be increased to establish a reasonable systemwide standard. In future years, the annual and long-term goals will be used as a tool to increase the level of visitor service in all units of the national park system.

Conclusion

The 1998 VSC survey results provide the National Park Service with useful information for managers, staffs, and the public on customer satisfaction. The results also allow the agency to monitor performance on customer service standards in accordance with the National Performance Review. In addition, survey results provide the Park Service with the ability to transfer the usable knowledge gained from the evaluations into improved customer service at the local, regional, and systemwide levels.

While the National Park Service is providing excellent customer service, there are still opportunities for improvement. The survey results show that visitors rate certain service indicators lower than others. Although the majority of parks have high customer service ratings, an effort is needed to bring all units of the system to this high level of visitor service. Finally, there is the long-term challenge of maintaining a consistently high level of visitor service in all units from year to year.

In future years, additional benefits will be realized as VSC survey results accumulate from year to year. Baseline data at the individual park, cluster, region, and systemwide levels can be compared with each new year's survey results. In addition, annual and long-term goal performance will continue to be monitored at all parks across the system. And perhaps most importantly, continuous measurement of customer service performance will become a part of the agency culture. **PS**

References

Dillman, D. A. 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley & Sons, Inc., New York.

Hayes, B. E. 1997. Measuring Customer Satisfaction. ASQ Quality Press, Milwaukee, Wisconsin.

Machlis, G. E. 1996. Usable knowledge: a plan for furthering social science and the national parks. National Park Service, Washington, D.C.

Varva, T. G. 1997. Improving Your Measurement of Customer Satisfaction. ASQ Quality Press, Milwoukee, Wisconsin.

Terry Bergerson is the Visitor Survey Card Project Coordinator. He is a Research Support Scientist with the University of Idaho Cooperative Park Studies Unit in Moscow, Idaho, and can be reached at 208-885-4806; e-mail: tberger@uidaho.edu.

National Park Service managers' views of the Recreation Fee Demonstration Program

By A. E. Luloff, Cristina Pratt, Richard S. Krannich, Donald R. Field, and Brian W. Eisenhauer

As part of the Recreation Fee Demonstration Program, the National Park Service (NPS) and the three other federal land management agencies (U.S. Fish and Wildlife Service, U.S. Forest Service, and Bureau of Land Management) are required to evaluate the impact of this new program on park visitors and park operations. The Park Service is the only agency that has initiated a detailed study of how management personnel at individual park units evaluate the effects of the program on their units, and how these individual units are responding to the program. A study team represented by social scientists from The Pennsylvania State University, University of Wisconsin-Madison, and Utah State University was commissioned to conduct a three-year survey of managers' perceptions of impacts from the Recreation Fee Demonstration Program on park operations.

This article reports on the methodologies utilized and findings from the FY1997 evaluation, which had three purposes. These were to assess NPS management personnel reactions to the implementation and operation of the Recreation Fee Demonstration Program on their park units; assess management perceptions of the program's efficiency, including costs of management, revenues, and impact on visitation; and assess how funds generated from the Recreation Fee Demonstration Program were used within individual participating units.

Methodology

In May 1998, questionnaires were mailed to all national park system units participating in the Recreation Fee Demonstration Program. Follow-up letters and phone calls were made until a 100% response rate from participating parks was achieved. While 100 individual projects had been authorized in the NPS Recreation Fee Demonstration Program, in some cases two or more park units participated jointly in the program. Therefore, a total of 109 surveys were returned for analysis.

Findings

Key findings include the following highlights from park managers' opinions and perceptions of the Recreation Fee Demonstration Program's effects on park visitation and management. First, most managers perceived no overall effect on visitation patterns. Seventy-five percent of the managers felt that the Recreation Fee Demonstration Program had not affected visitation patterns, such as the number of visitors coming to their park by season of the year, or on weekends versus weekdays. Fifteen percent believed the fee increase caused a shift in visitation patterns, and 10 percent did not have an opinion.

Second, community and visitor reaction to the Recreation Fee Demonstration Program was perceived to be favorable. Managers believed the local business community, local area citizens, and local park users were most likely to shift their views about the Recreation Fee Demonstration Program, with 11%-15% of managers indicating that these constituencies' views had shifted from initially negative to positive. However, for these three local area constituencies, managers were most likely to indicate consistently positive (24%-29%) or consistently neutral (25%-37%) opinions. According to managers, visitors supported the fee program under two conditions: (1) if the funds collected remained in the unit where they were generated, and (2) if these funds were used to improve facilities and visitor services. Ninety-four percent of the parks were engaged in public information and communication activities to explain the Recreation Fee Demonstration Program to park visitors and the general public.

Third, the fee program was perceived to have a positive effect on park base budgets. Sixty percent of the managers had a positive view of the Recreation Fee Demonstration Program's contribution towards their park's base budget situation. These managers indicated that the program allowed for greater flexibility in budget allocations. Thirty-four percent indicated that the program had no effect on their base budget, attributing this to the program's newness. Six percent indicated somewhat negative effects on base budgets, citing start-up costs and program operating expenses.

Fourth, managers were beginning to perceive a positive effect of the fees on the quality of visitor services. Forty-three percent of the managers indicated that the Recreation Fee Demonstration Program improved the quality of visitor information services at their parks. These managers believed there was general improvement in funding availability and spending flexibility, which they attributed to the program. Twenty-eight percent indicated improvements in visitor facilities. Twenty-nine percent said visitor center operations had improved.

Fifth, it was found that initial delays in the transfer of fee revenue to parks were a source of some concern, though in most cases these problems appeared to be reduced by the end of the program's first year of operation. Sixty-three percent of the managers said they did not receive funds in time to spend them during FY1997, a key problem in implementing the Recreation Fee Demonstration Program. Of this group, 25% attributed allocation delays to park-level management, 25% attributed delays to regional-level management, and the remaining 50% attributed these fiscal problems to national-level management. Nevertheless, 60% of participating units reported receiving their FY1997 funds in sufficient time to allocate them effectively for use in FY1998.

Finally, the study found that fee program funds were used for priority projects as determined by park staff. At the beginning of the Recreation Fee Demonstration Program, park managers were required to identify proposed projects for which to use additional fee revenues. Eighty percent indicated desires to expend funds on priority, maintenance, infrastructure, and resource management projects.

Two areas of park operations in 1997 stood out in terms of receiving funding emphasis from the Recreation Fee Demonstration Program: infrastructure and information services (figure 1). In addition, 67% of the units utilized some funds to support the operation of the Recreation Fee Demonstration Program, and 25% of these parks reported that the projects funded had been identified in their general management plan.

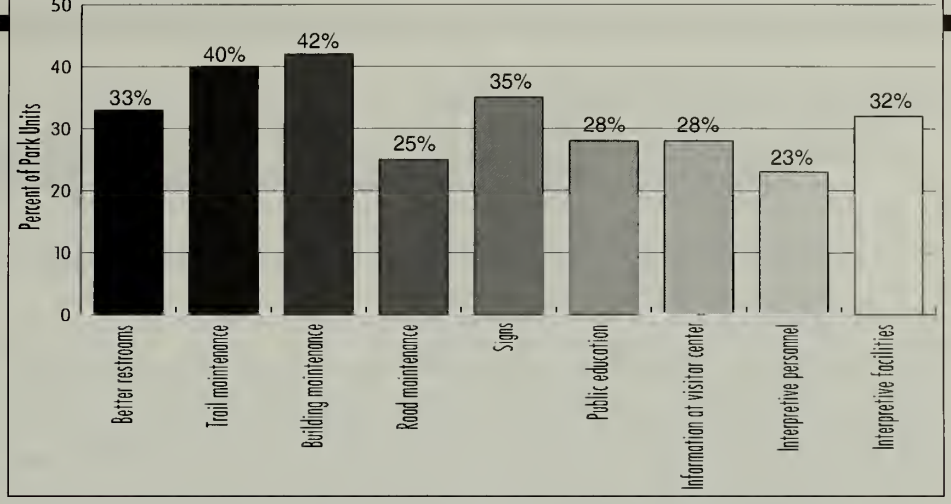


Figure 1. Managers' responses indicating various uses of FY97 Fee Demonstration Program revenues.

Utility of findings

There are several benefits of this study for park management. First, it meets an important need for sharing information about the Recreation Fee Demonstration Program with the public. Such information can help the individual units, as well as the National Park Service, maintain an active dialogue with the public about their responses to the Recreation Fee Demonstration Program. It helps foster an environment based on public awareness about the program and the many positive effects it is having on park services, facilities, and programs. Further, it is apparent that there is generally widespread support for and acceptance of this program by the public, as evidenced by managers' reports of only minor adverse effects on visitation patterns. Such information should prove invaluable in making the case to the Congress for continuation of the program.

At the same time, by engaging in an evaluation process from the outset of the program, this study provides insights into aspects of the National Park Service's Recreation Fee Demonstration Program that require attention and fine-tuning. Our study revealed concerns with fiscal problems and allocation delays, particularly with those viewed as originating at the national level. These issues suggest the need for some restructuring and streamlining of procedures to help insure more timely fund allocations and more efficient program administration procedures.

At the unit level, this study allows park managers to share information or results with their staff on how the program has been perceived by other units in the Recreation Fee Demonstration Program. As a result, it can act as a barometer on how any given unit is doing relative to other participating units. Similarly, the study provides managers with a window into how different units are allocating their fee-related resources and the kinds of problems being encountered in these units.

Next steps

Our project is responsible for examining changes over time in the perceptions of managers toward the Recreation Fee Demonstration Program and its operation. To accomplish this task, we have completed a second study of participating units (in October 1998) and have compared the results of this study with those reported here. We have provided senior park management with the results of this comparison for their report to Congress. Finally, we are completing the design of the final survey (to be conducted in October 1999), which will be used to compare manager perceptions of program operation over a two-year period. The results from this analysis will be available in late spring 2000. **PS**

Related Literature

Field, D. R., R. S. Kronnich, A. E. Lulaff, and C. Pratt. 1998. National Park Service Managers' Views Toward the Recreational Fee Demonstration Program—1997. Executive Summary submitted to the National Park Service. University of Wiscansin, Department of Forest Ecology and Manogement.

Kronnich, R. S., B. W. Eisenhauer, D. R. Field, C. Pratt, and A. E. Lulaff. 1999. Implications of the National Park Service Recreational Fee Demanstration Program for park operations and management: perceptions of NPS managers. Journal of Park and Recreation Administration 17(3):35-52.

Lulaff, A. E., R. S. Krannich, B. W. Eisenhauer, D. R. Field, C. Pratt, D. Marcauiller, and D. Adams. 1998. Assessment of the National Park Service Fee Demanstration Program. First Annual Report submitted to National Park Service; submitted to University of Idaho. Pennsylvania State University, Institute for Policy and Evaluation Research.

Lulaff, A. E., C. Pratt, R. S. Krannich, D. R. Field, and G. L. Theadori. 1999. Management assessment of the National Park Service Recreational Fee Demanstration Program in FY1998: a comparison with results from FY1997, executive summary no. 2. Pennsylvania State University, Institute for Policy and Evaluation Research.

Lundgren, A. L., and D. W. Lime. 1997. Overview of a 1997 National Park Service monitoring study to obtain visitor reactions to the Recreational Fee Demanstration Program. Final report submitted to National Park Service Midwest Region, National Fee Program, and Social Science Program. University of Minnesota, Department of Forest Resources, Cooperative Park Studies Unit, St. Paul, Minnesota.

Lundgren, A. L., D. W. Lime, C. A. Warzecha, and J. L. Thampson. 1997. Monitoring 1997 park visitor reactions to the National Park Service Recreational Fee Demonstration Program. Research Summary. University of Minnesota, Department of Forest Resources, Cooperative Park Studies Unit, St. Paul, Minnesota.

A. E. Luloff is Professor of Rural Sociology with the Department of Agricultural Economics and Rural Sociology at The Pennsylvania State University; 111 Armsby Building; University Park, PA 16802; 814-863-8643; fax: 814-865-3746; e-mail: ael3@psu.edu. Cristina Pratt is a Research Associate in the Department of Forest Ecology and Management, University of Wisconsin-Madison; Richard S. Krannich is Professor of Rural Sociology and Forest Resources, Utah State University; Donald R. Field is Professor of Forest Ecology and Management in the Department of Forest Ecology and Management, University of Wisconsin-Madison; and Brian W. Eisenhauer is a graduate student in the Department of Sociology at Utah State University.

Social Science Needs Assessment:

A survey of NPS urban park managers

By Ronald A. Harris and Alfredo B. Lorenzo

A needs assessment is a process for gauging the current situation in an organization (or a community), reaching value-based judgments, and prioritizing the status of needs (Carter and Beaulieu 1992). The Social Science Needs Assessment (SSNA) is a survey instrument developed by the Urban Recreation Research Center (URRC) for assessing the social science needs of urban park managers in the National Park Service. The Urban Recreation Research Center was established on October 1, 1998, at Southern University and A&M College, Baton Rouge, and is part of the NPS Social Science Program.

Survey approach

The survey is a commonly utilized approach to assess need. Visiting every urban park to interview the superintendents would be very costly. Instead, all NPS urban park managers were surveyed to minimize data collection costs. The Social Science Needs Assessment is a 108-item survey designed to assess the social science needs of NPS urban park managers. The Social Science Needs Assessment asked managers to rate their current need for (1) research tasks, (2) technical assistance activities, (3) training opportunities, and (4) delivery methods. Many of the research items on the survey came from *Usable Knowledge* (Machlis 1996).

The first 107 items in the instrument are scaled from 2 to -1. Respondents were asked to rate the importance to their park of the items that were described by circling the most appropriate number. The rating scale is 2 for *very important* (VI), 1 for *important* (I), 0 for *don't know\no opinion* (DK), and -1 for *not important* (NI). Ratings indicate the manager's "intensity" of need. When a manager marks an item "very important," we infer that he or she really needs this social science item. The responses were rank-ordered by average weight, using the mean for each item. The calculation includes all responses to the survey items: positive, negative, and zero values. Discussion of these results follows.

These results are limited to NPS urban park managers with sites that are either inside or within 100 miles of metropolitan statistical areas or else consolidated metropolitan statistical areas. The national park system had 377 total sites when the survey was distributed on December 10, 1998, and completed by February 9, 1999. One-hundred sixty (42%) park sites were classified as urban parks (n=120) or parks adjacent to urban areas (n=40). The response rate to the survey is 83% (133 of 160). This high response rate supports our statistical inferences about NPS urban park managers. We suspect that superintendents often delegated responsibility for completing the survey to key informed staff members, which remains valid. The few missing responses to the survey make the results reliable.

Survey results

The survey results are presented in sections: (1) research tasks, (2) technical assistance activities, (3) training opportunities, (4) delivery methods, and (5) comments. Using figures, we discuss the top ten rated items for each part of the survey, with mean ratings.

Research tasks

The NPS urban park managers were asked to rate 49 research tasks on their importance. The top ten rated research tasks are shown in figure 1. The top four items, which follow, have a mean rating, on a scale from –1 to +2, of higher than 1.5–trending towards "very important."

1. Assess interpretive programs, media, and public contact activities in urban parks.
2. Develop strategies for integrating visitor and community-based perspectives into decision making.
3. Analyze visitor expectations and evaluate experiences.
4. Identify critical visitor impacts on natural and cultural resources in urban parks.

For example, item 18 (second item in figure 1) on the survey has a mean response rating of 1.59. Therefore, this item

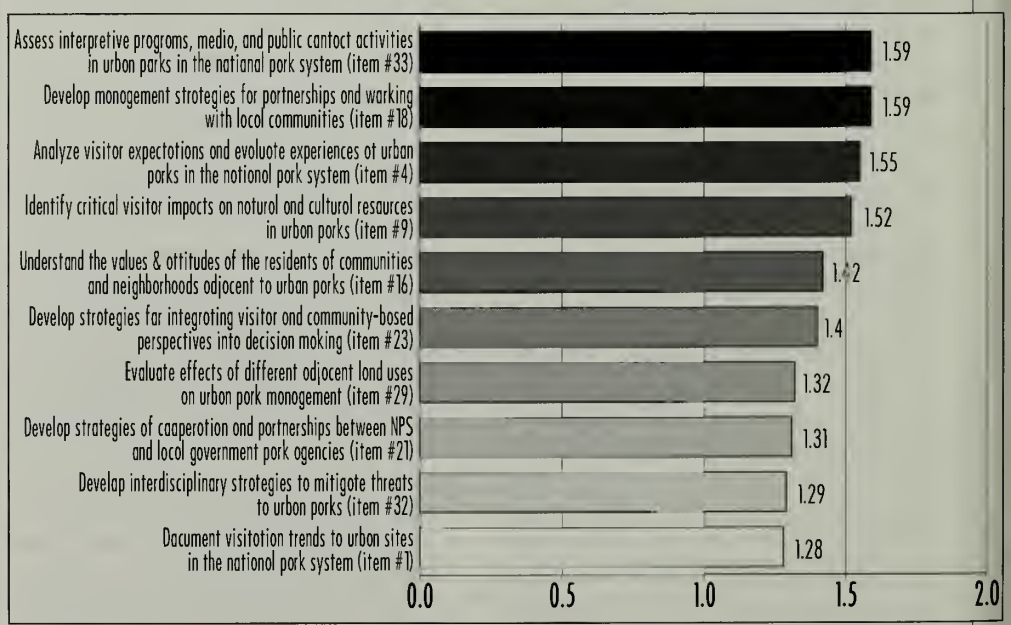


Figure 1. Ten most important research tasks rated by NPS urban park managers.

ranges between "important" and "very important," according to managers surveyed.

The mean rating for items 18 and 33 (first item in figure 1) reveals a need for research on interactions between and among urban parks and relevant local publics. For example, working with partnerships and local communities, concern with media and public contacts, are shown. The response to items 4 and 9 (third and fourth items in figure 1, respectively) indicate the need for research on visitation. For example, visitor expectations and resource impacts need to be better understood for urban parks.

The managers of urban parks have provided useful information by rating the importance of what they need and do not need among the research task items offered. The managers indicate the importance of partnerships and working with communities toward effective delivery of park programs. There is an overwhelming need to conduct research on analyzing visitor expectations and evaluating their experiences at urban parks.

Technical assistance activities

The respondents were asked to rate a list of 24 technical assistance activities under four main subject areas: (1) social science research methods, (2) information technology, (2) management consultation, and (4) program evaluation. Manager ratings should prove useful for developing technical assistance programs tailored to urban park needs in the national park system. The top ten rated items are shown in figure 2. The four top items that follow have a mean rating greater than 0.9. This suggests that these items are "important" technical assistance needs.

1. Improving visitor relations, e.g., customer service
2. Impact analysis, e.g., measuring outcomes
3. Assistance with conducting visitor surveys
4. Assistance with interpreting survey results

The survey results indicate interest by managers of urban parks in the national park system for technical assistance. The highest-ranking technical assistance needs range from improving visitor relations (i.e., customer service) and measuring outcomes to interpreting survey results.

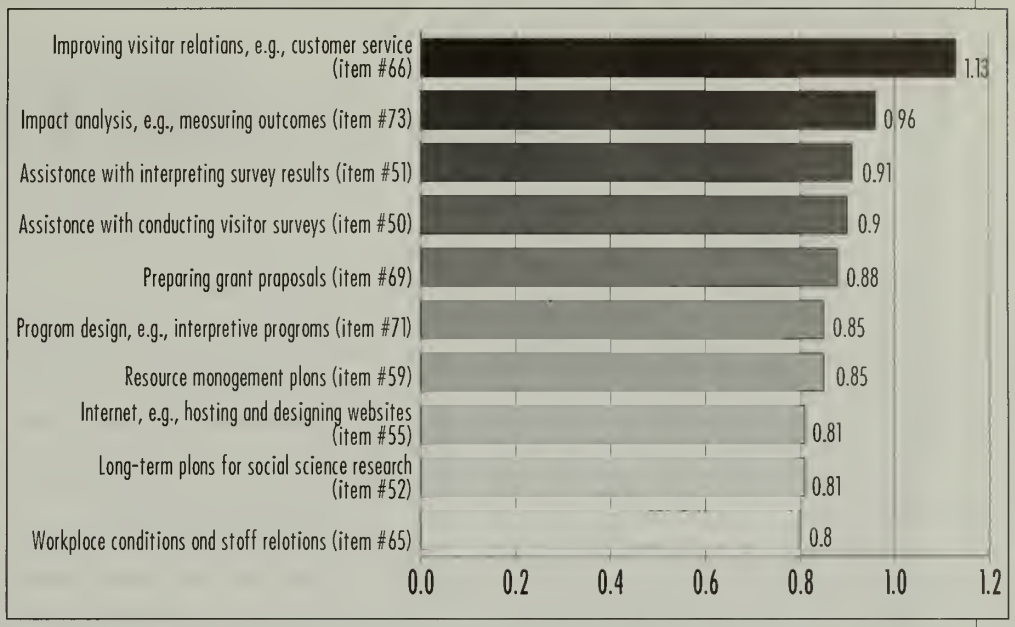


Figure 2. Top ten needs for technical assistance activities rated by NPS urban park managers.

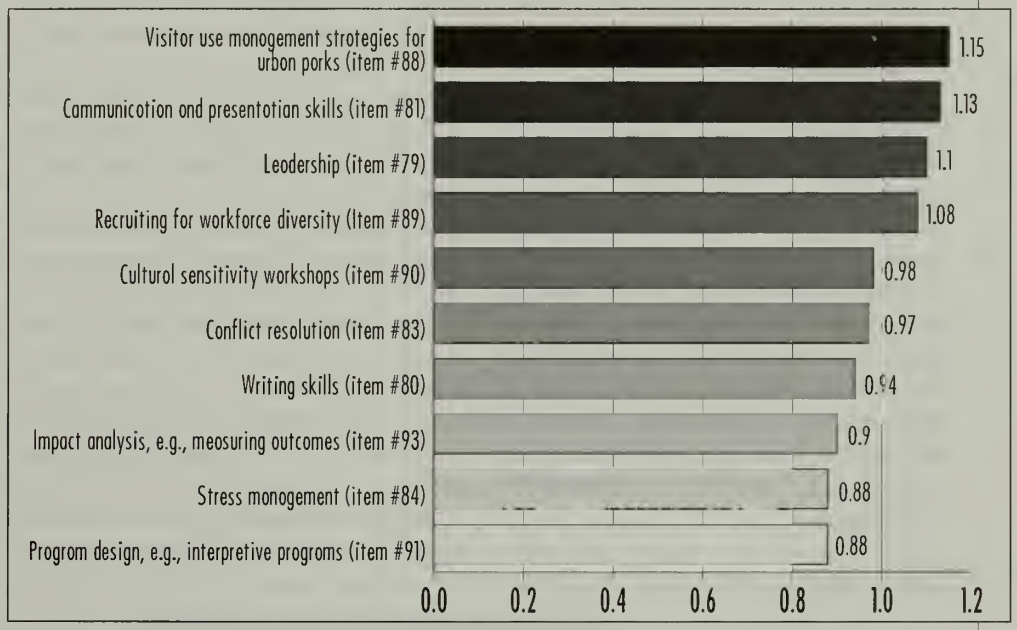


Figure 3. Top ten needs for training opportunities rated by NPS urban park managers.

Training opportunities

The respondents were asked to rate a list of 19 training opportunities in three areas: (1) information technology, (2) short courses in management, and (3) program evaluation. The manager ratings should prove useful for developing specific programs designed to target the training needs of urban parks. The top ten rated training opportunities are shown in figure 3. The four top items, which follow, have a mean rating greater than 1, which suggests they are "important" needs.

1. Visitor use management strategies for urban parks
2. Communication and presentation skills
3. Leadership
4. Recruiting for workforce diversity

The respondents expressed interest in receiving training in all topics, excepting the Internet. The survey results indicate need by NPS urban park managers for

See "Needs" on page 44

"Needs" continued from page 43

training opportunities in several areas. Ratings can be used to develop and implement training programs and continuing education opportunities for areas managers deem important.

Delivery methods

The survey respondents were asked to rate 12 delivery methods, ranking their usefulness. The ratings should prove useful for developing programs that will best deliver research findings, technical assistance, and training opportunities to urban parks. The top ten rated delivery methods are shown in figure 4. The top four items, which follow, have a mean rating of 1 or more, indicating that they are "important."

1. Internet
2. Fact sheets
3. Reference handbooks
4. Workshops

Prioritizing preferred delivery methods should help to facilitate a cost-effective transfer of information and technical assistance to urban parks in the national park system. The survey results indicate strong preferences among the respondents for delivery methods. These delivery methods should receive priority for training opportunities, technical assistance activities, and dissemination of research information.

Conclusion

This needs assessment is an important first step by the Urban Recreation Research Center to support the National Park Service and its Social Science Program. Understanding the needs of managers of urban parks in the national park system is vitally important to meeting the NPS legislative mandate to conduct scientific research in social sciences. The survey results will help the URRC prioritize the needs of urban parks to develop its research agenda, provide specific technical assistance and training programs, and improve delivery of usable knowledge, while minimizing costs.

The survey results indicate that the majority of respondents need social science research, technical assistance, and training opportunities. We find overwhelming need for research on visitor expectations and an evaluation of experiences. Just 3% of NPS urban park managers rated this item of need "not important." Urban park managers with the National Park Service agree on the importance of developing partnerships and working with their communities for more effective delivery of park programs. These results reveal managers' needs for technical assistance, such as improving visitor relations and interpreting survey results. Respondents expressed an interest in getting training for every topic, except the Internet. Prioritizing delivery methods should facilitate cost-effective transfer of information and technical assistance to urban parks in the national park system. There are strong preferences among managers for the delivery methods: Internet, fact sheets, workshops, reference handbooks, and "how-to" information brochures.

The managers' comments indicate need for economic research, impact analysis, and opinion surveys. They also cite the need for technical assistance on management issues. The need for further research on resource impacts from visitation was echoed by many key informants during the interviews that we conducted at the site visits to urban parks. This social science needs assessment of NPS urban park managers provides the Urban Recreation Research Center and the NPS Social Science Program with usable knowledge to develop and deliver research, technical assistance, and training programs. The results prioritize the current needs of NPS urban park managers for social science.

At this juncture, the Urban Recreation Research Center has developed a comprehensive strategic plan based on the survey results. In the next few years, while many of the initial research, technical assistance, and training programs are completed, the Center will resurvey NPS urban park managers to see if any distinguishable changes in the values, priorities, and needs of NPS urban park managers occurred and whether changes can be attributed to URRC programs. PS

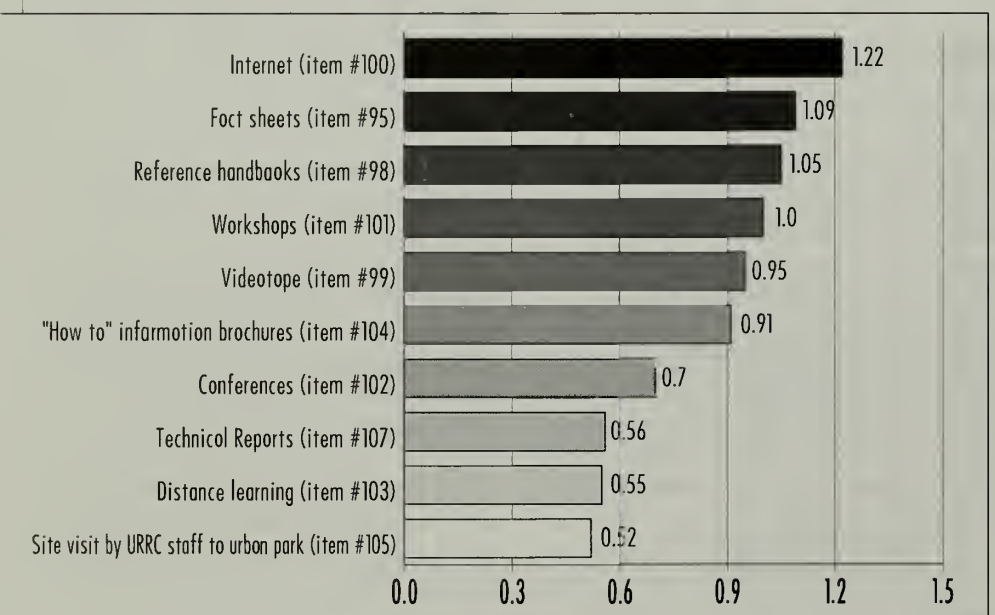


Figure 4. Top ten delivery methods rated by NPS urban park managers.

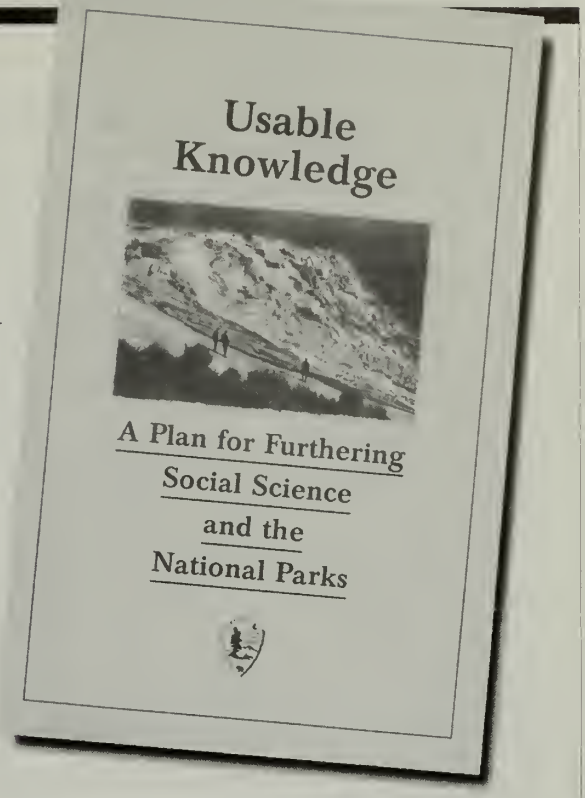
Literature Cited

Carter, K. A., and L. J. Beaulieu. 1992. Conducting a Community Needs Assessment: Primary Data Collection Techniques. University of Florida, Gainesville.

Machlis, G. E. 1996. Usable knowledge: a plan for furthering social science and the national parks. National Park Service, Washington, D.C.

Ronald A. Harris is Assistant Professor, Department of Public Administration, School of Public Policy and Urban Affairs, Southern University and A&M College, Baton Rouge. He can be reached by telephone 225-771-3104 and e-mail: ruow@yahoo.com. Alfredo B. Lorenzo is Associate Professor, Urban Forestry Program, Southern University and A&M College, Baton Rouge. He can be reached by telephone 225-771-3866 and e-mail: ablorenz@subr.edu.

Usable Knowledge:
A progress report on the NPS Social Science Program



By Gary E. Machlis

Understanding the relationship between people and parks is critical for protecting resources and providing for public enjoyment. Hence, social science research is critical to the mission of the National Park Service, and it is an important function of the agency.

In 1996, the National Park Service (NPS) approved a plan for an expanded program of social science. *Usable Knowledge: A Plan for Furthering Social Science and the National Parks* was the work of many individuals and groups: NPS managers and university scientists participating in several workshops across the country, a social science committee established by the National Park System Advisory Board, the Associate Director for Natural Resource Stewardship and Science, the newly appointed Visiting Chief Social Scientist, a review committee of park superintendents, and the NPS National Leadership Council. The plan outlined a specific and ambitious set of tasks to be accomplished in FY1996-99.

This article briefly reviews the progress made in achieving the objectives set forth in *Usable Knowledge*.

An overview of the plan

Usable Knowledge defined the scope of the program and its role within the National Park Service. The program's scope includes economics, geography, psychology, political science, and sociology, as well as interdisciplinary research. (Archeology, anthropology, and ethnography programs are active within the Park Service, and located in the Cultural Resource Stewardship and Partnerships directorate.) The objectives of the program are to "conduct and promote state-of-the-art social science related to the mission of the National Park Service, and deliver usable knowledge to NPS managers and the public."

The plan inventoried current social science infrastructure and activities, and made several key recommendations for improving social science in the national parks. These recommendations included integrating the social science program into the Natural Resources Stewardship and Science directorate, implementing key recommendations of the 1992 National Research Council's report on science in the parks, establishing a small social science program office within the Washington Office (WASO), expanding the cadre of social scientists working with the National Park Service through research competitions and other initiatives, and restructuring university partnerships to systematically include social science research.

The recommendations were followed by a detailed action plan that included specific tasks, an annual schedule, and a targeted budget for FY1996-99. Tasks were organized around three strategic areas: creating the WASO social science office, implementing new and critical initiatives, and improving existing programs. These are discussed below. (It is important to note that numerous other programs, activities, and cooperative partnerships are ongoing–the University of Minnesota's active social science partnership with the Midwest Region is an example–and that many social scientists are engaged in individual projects with units of the national park system.)

NPS Social Science Program

A small Washington, D.C., office was established. The position of Visiting Chief Social Scientist was created, to be filled by a university or government social scientist for a multiyear term. Responsibilities of the position include managing the overall program, conducting research, working with other agencies and the scientific community, and serving as a social science advisor to the NPS leadership.

An NPS social science specialist position was created to assist in managing the program. A university scientist works with the staff through a cooperative agreement. A graduate student internship was established, and students from four universities have spent a semester in Washington, D.C., working with the National Park Service.

The WASO office has implemented several activities to serve NPS park managers. A website (www.nps.gov/socialscience/intro.htm) was created and is on-line, to provide current information and assistance to managers and scientists. The Office of Management and Budget (OMB) survey approval process–required for all federally funded surveys of the public–has been streamlined. For basic visitor surveys, a new "expedited" process has reduced the time required from five months to two weeks, and now saves money. To provide NPS managers with "state-of-the-art" social science, *a Social Science Research Review Series* has been inaugurated. Each issue reviews the scientific literature on a specific topic of interest to the National Park Service. The first issue (Winter 1999) dealt with the effect of noise on visitor experiences; the second issue explored minority use of parks (Spring-Summer 1999); the third covered employee safety (Fall 1999). Additional issues will address carrying capacity and public involvement.

The Washington Office provides technical assistance to parks, clusters, and regions as requested; a common example

See "Knowledge" on page 46

"Knowledge" continued from page 45

is conducting peer reviews of draft research reports or research proposals submitted to park staffs. The office has been commissioned to prepare social science plans for parks and program centers. Research plans have been completed for the Harpers Ferry Center, the South Florida parks and preserve, and the Risk Management Division. The program has also provided assistance on selected international projects–including water conservation activities with South Africa, visitor surveys in Slovakia, and social science planning in Costa Rica and Poland.

Critical initiatives

A key recommendation of *Usable Knowledge* was to expand the cadre of social scientists working with the Park Service, and develop several competitive research programs. An agenda of research on national needs was developed (with input from park superintendents), to support research projects critical to the entire national park system, and unlikely to be funded by any one region, cluster or park. The program distributes to the scientific community a periodic request for proposals, and interested researchers submit detailed study plans to a review panel that includes social scientists and NPS managers, and which selects the winning study teams. The research covers a wide range of important topics, including:

- improving the Money Generation Model (used by many park managers to estimate the economic impacts of parks),
- evaluating the impact of the Fee Demonstration Program upon park operations, visitors and local communities,
- developing carrying capacity management methods supportable by science,
- conducting a national public survey (focusing on citizens that do not use the parks), and
- learning from special "events" that can teach the National Park Service valuable insights on park management–such as the 1995-96 government shutdown's impact on park gateway communities, or the socioeconomic impacts of the 1997 Yosemite flood.

To encourage and develop the next generation of scientists working in the national park system, a scholarship program was developed. While managed by the social science office, and including the social sciences in each year's competition, the Canon National Parks Science Scholars Program is broadly aimed at the biological, physical, social, and cultural sciences. The program is underwritten by Canon USA, Inc. Partners include the National Park Foundation (NPF), the National Park Service, and the American Association for the Advancement of Science (AAAS). Canon USA has contributed over $2.5 million dollars to fund Ph.D. dissertations on topics selected by park superintendents, and announced to the nation's universities each fall. Eight Canon Scholars were selected in 1999, and the first class of new scientists will graduate in 2000.

Over 40% of the visits to the national park system take place in urban parks, and many parks once remote are increasingly surrounded by metropolitan regions. To provide NPS managers of urban parks with needed social science research, technical assistance, and education, an Urban Recreation Research Center (URRC) was established through a competition among nine historically black colleges and universities. Southern University–Baton Rouge was selected, and has begun its activities with a needs assessment of NPS managers, to ensure that its future research projects meet NPS needs. An added, important benefit of the URRC is to increase the opportunity for minority students to gain experience with the National Park Service, and the URRC has a job fair, diversity training, and other activities planned and underway.

The OMB survey approval process has been streamlined.

Improving existing programs

The Visitor Services Project (VSP) has, since 1982, conducted visitor studies at selected units of the national park system. An advisory committee of NPS managers receives nominations from the parks and regions, and selects up to 10 parks for a VSP study each year. Over 110 parks have undertaken a VSP study since the project began. These in-depth visitor studies are used by parks to assist in park planning, operations, resource management, and working with local communities. An annual report, *Serving the Visitor*, is produced, and widely distributed.

Beginning in 1998, the Visitor Services Project was assigned the task of conducting visitor surveys needed to report performance toward Government and Performance Act (GPRA) goals. A short visitor survey card was developed, tested, and used in over 280 parks in 1998, and customized reports prepared for each park, cluster, and region. Based on the first year experience, the survey card was improved, and is currently being used in parks throughout the country.

A key component of *Usable Knowledge* was restructuring partnerships between the National Park Service and universities, so that the agency could effectively employ university social science to meet park needs. This objective is included in the development of the Cooperative Ecosystem Studies Units (CESU) concept. Each CESU includes a host university, partner universities and institutions, and several federal agencies. They are interdisciplinary in scope (including the social sciences), and will provide research, technical assistance, and education to park managers. The first round of the CESU network includes six federal agencies, 23 universities, and additional partners, and became operational in FY1999. Additional CESUs will be established this year.

Not yet achieved

Not all of the tasks listed in the 1996 social science plan have been achieved. The plan called for several inter- and intra-agency working groups to more effectively coordinate social science activity; these have not succeeded. The social science website was initially conceived as including social science databases that could be used by managers and scientists; this has not yet happened. The plan called for regular meetings between managers and social scientists; social science sessions at last year's George Wright Society meeting were fruitful examples of the value of such interchanges, but they remain *ad hoc*.

The plan called for developing a sabbatical program for social scientists interested in working in units of the national park system, providing technical assistance, conducting their own and park-

sponsored research, and offering training to park employees. The limited program has been replaced with a broader Sabbatical in the Parks Program now being developed. It will act as a "matchmaker," bringing together available university faculty in all sciences with interested park staffs–providing usable knowledge at low cost and high value.

Next steps

Beyond the 1996 plan, there is much more to do to fully deliver social science to NPS managers and the public. The plan focused on developing a national program, and this has largely been accomplished. An important strategic step is to now increase the social science capabilities of the National Park Service at the regional, cluster, and park level. Only a few parks have social scientists on staff or duty-stationed on-site. Only a few regions have efficient access to social science expertise through the U.S. Geological Survey or cooperative agreements with universities. Funding for park-specific social science research is largely not available, and must be increased, if park managers are to have the necessary information required for science-based decision making. Several social science disciplines–economics and geography in particular–are vital to the National Park Service, yet not well represented among available researchers.

Usable Knowledge represented both a practical definition of applied social science for park managers, and a detailed "road map" for the first several years of the new NPS Social Science Program. In this and following years, new directions and ways of serving park managers, the scientific community, the public, and the parks need to be explored and tested. Yet the basic rationale for NPS social science–that understanding the relationship between people and parks is critical to effective park management–remains a scientific and management constant critical to the National Park Service. PS

Gary E. Machlis is Visiting Chief Social Scientist, National Park Service Social Science Program, and Sociology Project Leader for the University of Idaho Cooperative Park Studies Unit. He can reached by e-mail at gmachlis@uidaho.edu.

"Particip

Henry Cole and Associates. 1996. Learning from success: health agency efforts to improve community involvement in communities affected by hazardous waste sites. Report prepared for the U.S. Department of Health and Human Services and the Agency for Toxic Substances and Disease Registry. Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

Kaspersan, R. E., D. Golding, and S. Tuler 1992. Siting hazardous facilities and communicating risks under conditions of high sociol distrust. Journal of Sacial Issues 48(4):161-87.

Kasperson, R. E. 1986. Six propositions for public participation and their relevance for risk communication. Risk Analysis 6(3):275-81.

Landre, B., and B. Knuth. 1993. Success of citizen advisory committees in consensus-based water resources planning in the Great Lakes Basin. Society and Natural Resources 6:229-57.

Lauber, B. and B. Knuth. 1997. Fairness in moose management decision-making: the citizens' perspective. Wildlife Society Bulletin 25(4):776-87.

Lynn, F. M. 1987. Citizen involvement in hazardous waste sites: two North Carolina success stories. Environmental Impact Assessment Review 7:347-66.

McGrory-Klyza, C., and S. Trombulak, editors. 1994. The Future of the Northern Forests. Middlebury College Press, Middlebury, Vermont.

Moore, S. A. 1996. Defining 'successful' environmental dispute resolution: case studies from public land planning in the United States and Australia. Environmental Impact Assessment Review 16:151-69.

National Research Council. 1996. Understanding Risk: Informing Decisions in a Democratic Society. National Academy Press, Washington D.C.

Pestman, P. K. 1998. Dutch Infrastructure Policies, Public Participation, and the Environment in the 1990s: The Politics of Interfering Logics. Pages 185-202 in F. H. J. M. Coenen, D. Huitema, and L. O'Toole, editors. Participation and the Quality of Environmental Decision-making. Kluwer Academic Press, Dordrecht, Netherlands.

Peters, R. G., V. T. Covello, and D. B McCollum. 1997. The determinants of trust and credibility in environmental risk communication: an empirical study. Risk Analysis 17(1):43-54.

Renn, O. 1998. The role of risk communication and public dialogue for improving risk management. Risk, Decision, and Policy 3(1):5-30.

Renn, O., T. Webler, H. Rokel, P. Dienel, and B. Johnson. 1993. Public participation in decision-making: a three-step procedure. Policy Sciences 26:189-214.

Renn, O., T. Webler, and P. Wiedemann, editors. 1995. Fairness and Competence in Public Participation: Evaluating Models for Environmental Discourse. Kluwer Academic Press, Dordrecht, Netherlands.

Renn, O. 1992. Risk communication: towards a rational discourse with the public. Journal of Hazardous Materials 29:465-519.

ublic Participation and
Pages 43-54 in Stuart Langtan,
ipation in America. Lexingtan
Baaks, Lexington, Massachusetts.

Sarvis, W. 1994. The Mount Rogers National Forest Recreation Area and the rise of public involvement in Forest Service planning. Environmental History Review (Summer):40-65.

Shrader-Frechette, K. 1993. Consent and nuclear waste dispasal. Public Affairs Quarterly 74:363-77.

Shindler, B., and K. A. Creek. 1997. Monitaring and evaluating citizen and agency interactions: framework developed for adaptive management. Report submitted to the USDA Forest Service, Cooperative Agreement #PNW 94-0584. Oregon State University, Department of Forest Resources, Portland.

Shindler, B., and J. Neburka. 1997. Public participation in forest planning: eight attributes of success. Journal of Forestry 95(1):17-19.

Taylor, J. 1998. Personal communication.

Tuler, S., and T. Webler. 1999. Voices from the forest: what participants expect of a public participation process. Society and Natural Resources 12:437-53.

Tuler, S. forthcoming. Forms of talk in policy discourse: distinguishing between adversarial and collaborative discourse. Journal of Risk Research.

Webler, T. 1997. Organizing public participation: a review of three handbooks. Human Ecology Review 3(1):245-54.

Webler, T., and S. Tuler, editors. 1998. Forum: perspectives on the U.S. National Research Council's "Understanding Risk" report. Human Ecology Review 5(1):35-66.

Webler, T. 1995. 'Right' discourse in public participation: an evaluative yardstick. Pages 35-86 in O. Renn, T. Webler, and P. Wiedemann, editors. Fairness and Competence in Public Participation: Evaluating Models for Environmental Discourse. Kluwer Academic Press, Dordrecht, Netherlands.

Wellman, J. D., and T. J. Tipple. 1990. Public forestry and direct democracy. The Environmental Professional 12:77-86.

Wiley, D. 1998. Saving wholes and fishermen: a collaborative process to redesign fishing gear to protect endangered species and threatened lifestyles. Paper presented at the International Symposium on Society and Resource Management, University of Missouri, Columbia, Missouri, 28-31 May.

Seth Tuler and Thomas Webler are with the Social and Environmental Research Institute in Leverett, MA 01054. Dr. Webler is also Core Faculty of the Doctoral Program in Environmental Studies at the Antioch New England Graduate School, 40 Avon Street, Keene, NH 03431. Correspondence should be directed to: Seth Tuler; P.O. Box 253, Leverett, MA 01054; 413-548-9968; e-mail: SPTuler@crocker.com.

Meetings of Interest*

May 16-18

The Third Conference on Research and Resource Management in the Southwestern Deserts will convene in May in Tucson, Arizona, to discuss *Creative Coopertaion in Resource Management.* Sponsored by five federal bureaus (including the National Park Service), two state agencies, and a cooperating association, the sessions will focus on creative collaboration in land use, research, and resource management. Specific topics include: ecological research and management; conservation collaboration in the upper Gulf of California region; physical science; species recovery and conservation; cultural resources; conservation and monitoring of southwestern herpetofauna; and Sonoran Desert conservation plan partnerships. A poster session is also planned. For more information about registration contact Lee Benson at lee_benson@nps.gov; program information is available from Bill Halvorson at halvor@srnr.arizone.edu. Further details about the conference are available at www.srnr.arizona.edu/nbs/meetings.html.

October 16-20

The Natural Areas Association is planning its 27th annual conference, *Managing the Mosaic: Connecting People and Natural Diversity in the 21st Century,* to be held in St. Louis, Missouri. Celebrating the bicentennial of the Lewis and Clark Expedition, the banquet address will explore the historical and future implications of their trip, while plenary and concurrent sessions will focus on different aspects of biodiversity and how humans fit into the new century of management. Session topics planned include: insects in natural communities; economic values of natural diversity; monitoring; ecoregional planning; conserving caves, streams, and urban lands; partnerships; and many others. Further information is available from the Natural Areas website at www.natareas.org ("conferences" link) or from conference coordinator Kate Leary (573-751-4115, x183; learyk@mail.conservation.state.mo.us).

October 18-22

The Eleventh International Conference of the Society for Human Ecology will meet in Jackson, Wyoming, to discuss *Democracy and Sustainability: Adaptive Planning and Management.* The meeting will build on discussions about adaptive planning and management decisions, introduced at the tenth conference, by focusing on the interrelationship between democratic institutions and ecosystem sustainability. The conference will bring together researchers from around the world whose concerns are the enrichment of human well-being and the concomitant protection of environmental quality. These scholars are working on issues such as: (1) the relationships between human activities and environmental change; (2) the effects of environmental changes on human health and well-being; (3) the dynamics of human adaptation to societal, technological, and environmental change; and (4) methods by which environmental planning and decision making can be improved. Jonathan Taylor, whose article appears in this issue on page 14, is the program contact (jonathan_taylor@usgs.gov). Forms for submitting abstracts are available on-line at www.societyforhumanecology.org/conference.htm.

* Readers with access to the NPS NR Intranet can view a comprehensive listing of upcoming conferences and meetings at www1.nrintra.nps.gov/ (click "conferences, meetings, and training").

BULK RATE
POSTAGE & FEES PAID
U.S. Department of the Interior
Permit No. G-83

PARK SCIENCE
Integrating Research and Resource Management
National Park Service
Natural Resource Information Division
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287

PARKSCIENCE

INTEGRATING RESEARCH AND RESOURCE MANAGEMENT

WOLF HANDLING ON
ISLE ROYALE

***ECOLOGICAL SCALE* REVIEWED**

PROTECTING RESOURCES
AND VISITOR OPPORTUNITIES

A CONVERSATION WITH POINT REYES
SUPERINTENDENT
DON NEUBACHER

VOLUME 20 • NUMBER 2 • FALL / WINTER 2000

UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE

RESTYLING
IN THE CENTURY OF THE ENVIRONMENT

Nearly six years have elapsed since the last face-lift given to *Park Science.* The current changes coincide with the new millennium, or what participants to Discovery 2000 last September in St. Louis began referring to as the "century of the environment." The purpose of the changes, however, is based on a practical matter rather than a symbolic one: to compel the interest of new readers, both within and outside the National Park Service, and to stimulate greater appreciation for science-based park management.

Park Science *through the years: 1981 (top), 1991 (middle), and 1995.*

About to begin its 21st year, *Park Science* has a devoted audience. Yet we have often wondered who is not reading it and what we could do to induce them to become readers. We even asked a question to this effect in a reader survey five years ago, and we got a few varied responses. Among them were to include more social science articles, feature the recommendations of superintendents, upgrade the science being reported, print both technical and nontechnical articles, provide more information on potential grant sources, help build synergy between maintenance and resource management operations, provide real-world management solutions, and publish on the Web. In many cases we have acted upon these ideas. One suggestion, however, has not been addressed until now: to make this publication more competitive with the many newsletters and bulletins that vie for the attention of readers.

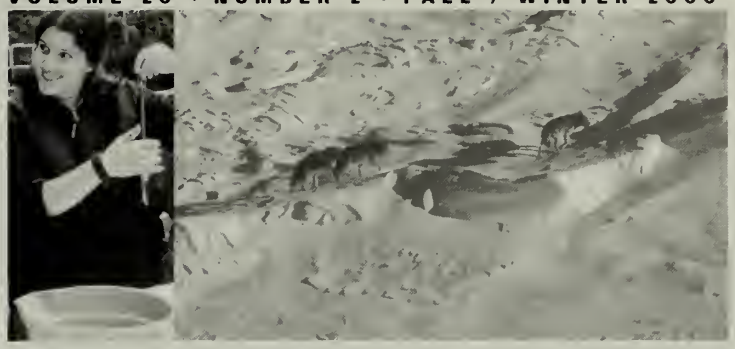
With impetus from the *Park Science* editorial board and design concepts provided by Glenda Heronema of the Denver Service Center, we introduce a new look for *Park Science* this issue that is more attractive and magazine-like, and thus more friendly and inviting. Gone is the institutional newsletter appearance, replaced by more fully developed pages and the use of color as an enticement to new recruits and devoted readers alike. We sincerely hope the new design will garner attention from those otherwise inclined to pass it by, while retaining the interest of those who have always found it informative. We believe the new look will broaden our reach, increase our ability to nurture science-based park management, and build public awareness and understanding of our resource preservation mission. Please let us know what you think.

Does this signal a change in our message? Essentially, no. *Park Science* will continue to report recent and ongoing research and its application in park management. However, as we begin this century of the environment, we want to be more inclusive of all park operations and plan to modify the Highlights department along these lines. Specifically, we want to feature brief articles that describe what all NPS operations in parks are doing to preserve natural resources and how they are applying science to improve their own operations. For example, we want to share the contributions of maintenance and visitor and resource protection divisions to the accomplishment of natural resource management projects. Likewise, interpretive programs that involve the public and school children in our natural resource management programs through hands-on participation are of interest. We want to feature the views of park superintendents on the role of science in resolving management problems. And, of course, we intend to continue publishing research results that have implications for natural resource management along with reports of the many activities of park natural resource programs across the nation.

As always, we invite you to participate in *Park Science* by submitting your stories and helping us achieve this goal.

Jeff Selleck
Editor

PARKSCIENCE
VOLUME 20 • NUMBER 2 • FALL / WINTER 2000



Departments

Cover Story

Features

ON THE COVER
Wolves travel the icy shoreline of Siskiwit Bay at Isle Royale National Park, Michigan. After having successfully studied wolves and moose on this wilderness island for 30 years without handling, biologists began a live-trapping program in 1988 that provided important genetic information to managers. Last year the park investigated the possibility of returning to a hands-off monitoring approach. PHOTO BY ROLF O. PETERSON

ECOLOGICAL SCALE Theory and Applications

By D. L. Peterson and V. Thomas Parker, editors

A book review by Allan F. O'Connell, Jr.

Much of how we care for and manage our natural world this century will revolve around how ecological scale is interpreted. The question of scale—the range of specificity applied in natural resource studies and management—is fundamental and critical for ecologists. Yet application of scale concepts is a complex and contentious area of ecology that is often difficult for resource managers to implement in planning and conservation efforts. Given the enormous amount of material currently available and the difficulty scientists and resource managers face in simply finding all available literature on a particular topic, "Ecological Scale—Theory and Applications" represents an important compilation of information under one cover. For a topic described as "important, poorly understood, and controversial" (another review of this book), this publication should be a mainstay for scientists and resource managers everywhere in need of a thorough and first-rate reference on ecology.

"This publication should be a mainstay for scientists and resource managers everywhere in need of a thorough and first-rate reference on ecology."

Part of the "Complexity in Ecological Systems" series, Ecological Scale is divided into four sections: (1) integration of process, pattern, and scale; (2) interpretation of multiple scales in ecosystems; (3) ecological inference and application—moving across multiple scales; and (4) incorporating scale concepts in ecological application. The entire volume is 608 pages, with 33 different contributors (some authors participated in more than one chapter) and 72 pages of references. The book is truly interdisciplinary, and the editors have clarified and illuminated the importance of scale in a variety of ecosystem components: animals (including an entire chapter on large mobile organisms), plants, water, food webs, and soils. Additional highlights include scale-oriented reviews of ecological theory, ecosystem management, relationships to policy and decision making, experimental design, and measuring environmental change.

A previous book review in *Park Science* stated "many books on conservation topics have poorly integrated chapters, are hard to read, are often dull, and end up serving primarily as references for a narrow, technical audience" (see volume 18(1):10–12). Some of these assertions may apply to Ecological Scale; browsing the chapters reveals a good deal of complexity in consideration of the many tables, figures, and citations. I had some trouble maintaining focus and interest in some chapters but attribute this to my own particular interests. Nonetheless, given the diversity of topics covered, I found the volume to contain a wealth of important information on how ecologists and resource managers view ecosystems and their various components. Additionally, the book delves into the application of the concepts of measurement, analysis, and inference in both theoretical and applied ecology, essential information for park resource managers.

Ecological Scale—Theory and Applications

1998, Columbia University Press
608 pages

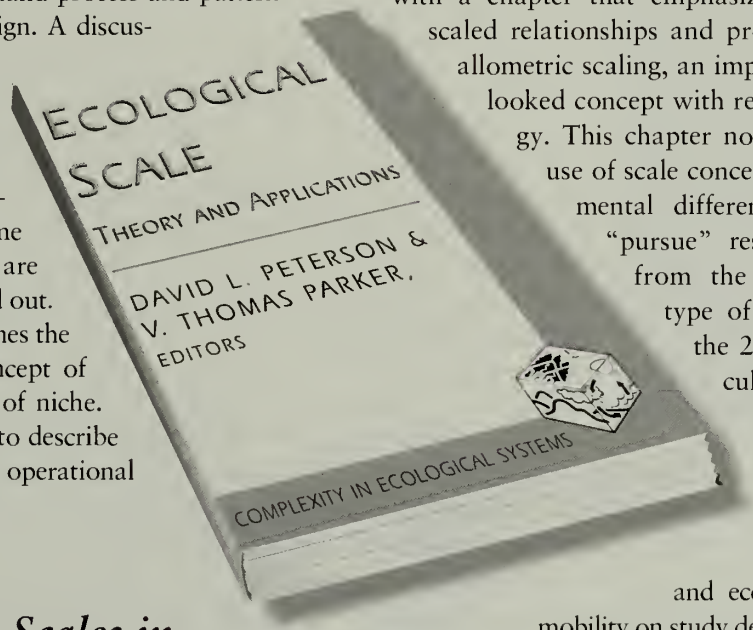
Cloth
ISBN 0-1231-10502-9
$63.00

Paper
ISBN 0-231-10503-7
$35.00

With some humorous, but thought-provoking chapter titles that include "Homage to St. Michael or why are there so many books on scale," the importance of scale in biological systems quickly becomes evident. With the interest of the resource manager in mind, I have attempted to summarize each of the four sections, point out some highlights, and offer a few parting comments.

Section I—
Integration of Process, Pattern, and Scale

The book begins with the aforementioned "Homage to St. Michael..." chapter that discusses the semantics and implications of the terms "scale" and "level" in ecology. This section provides a detailed review of techniques used for detecting spatial patterns including a concise definition of fractals and the need to understand process and pattern as they relate to experimental design. A discussion ensues using landscapes as a backdrop and concluding that the integration and organization of scaled relationships within complex systems will clarify our understanding of the natural world. Some things are scale dependent, others are not, and the differences are pointed out. The last chapter of section I examines the ambiguity that surrounds the concept of habitat and the evolving concept of niche. The Habitat-Based Model is used to describe these relationships and the model's operational framework is presented.



Section II—
Interpreting Multiple Scales in Ecological Systems

A paleoecological perspective compares hypothesis testing versus the description of microscopic plant pollen (fossil) that is the primary source of information about environmental change. The question "How can techniques be used for management applications?" is examined. The discussion then focuses on soils and their resulting spatial and temporal relationships. Criticism is levied on the views ecologists have long held for soil, and the major misperceptions of the soil environment are addressed. The physical environment and biological structure of lakes and riverine systems are reviewed along with the importance of human influences on these systems. The next chapter considers how to examine scale issues in the context of plant community dynamics and the usefulness of hierarchy theory and predictive model development. A well-crafted chapter on animal population dynamics completes the variety of single-system components that are examined, and will likely stimulate integrated work on animal populations in the context of dispersal and landscape structure. The last two chapters focus on food webs (i.e., species richness, trophic or nutritional levels) and landscapes, two topics representative of integrating the components previously discussed.

Section III—
Moving Across Scales: Ecological Inference and Applications

Based on the variety of topics, this section has little continuity, much like the following review. Nevertheless, the topics are important and offer insights into the study and management of large organisms and the use of applied scaling theory to conduct research. The section begins with a chapter that emphasizes the importance of scaled relationships and provides an overview of allometric scaling, an important and often overlooked concept with respect to scale in biology. This chapter notes that the increasing use of scale concepts represents a fundamental difference in how scientists "pursue" research, a move away from the purely observational type of research pervasive in the 20th century. The difficulty with remote sensing and the use of large data sets is complicated by the differences in the meaning of scale to geographers and ecologists. The impact of mobility on study design and interpretation with respect to how animals interact with the environment is directly related to scale. The break point for what is considered a large organism was not defined, but one gets the impression that extrapolation could be made to any size organism. The importance of trees, in particular tree branches, in determining patterns of vegetative change is offered as the scale from which to focus ecological research. The authors give a variety of reasons in support of this approach as opposed to either the leaf- or the entire tree-focused approach. The next three chapters are key for scientists and resource managers alike, given the importance of ecosystem disturbance, study design, and data analysis in conducting and interpreting research. While the discussion surrounding these three topics is overwhelming, the topics themselves are of critical importance if we are to critically examine and understand our resources. Although some topics like time series and autocorrelation are more suited for the scientist, the resource manager striving to keep abreast of the intricacies of the science in their parks would do well to review these chapters.

See "Book Review" in right column on page 7

news&views

Alcatraz Bird Census

Dear Editor,

The article entitled "Alcatraz bird census ... or the ABC program" in the spring 2000 issue of *Park Science* [20(1):6] contains several inaccuracies. Ranger Brett Woods did found the Alcatraz Bird Census (ABC) in the early 1990s. However, after his brief stint on the island ended, I took over ABC program management. The program hardly "languished" as the article stated. Instead, it ran successfully until I left the island in 1997.

I worked on Alcatraz from 1991 to 1997. Among my myriad duties, I served as Natural Resources Coordinator for the island. I recruited, trained, and supervised the volunteers that conducted the ABC until I left for Everglades National Park in 1997. During my tenure as "Birdman of Alcatraz," the ABC did quite well. There was no apparent need for changing the census procedures or database management. I was therefore disturbed to note that the article suggested that the ABC stagnated or stopped after Woods' departure.

Wilfredo Reyes
Park Ranger
Everglades National Park

Golden Gate NRA regrets the article's tone. However, the decision to standardize methods for recording bird frequency and occurrence data on Alcatraz along with regular reporting has improved the value of the information. For example, the area search protocol[1], now used on Alcatraz and at other areas in the park, distinguishes birds on land from those on water, information that was useful to park management in a recent environmental impact statement. The technique has other benefits, including its widespread usage. Database management evolved to reflect the needs of the protocol, and the software was changed to meet the NPS standard.

[1]Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. USDA Forest Service, Publication PSW-GTR-144, Albany, CA.

Axtell and Vequist take on new challenges

Last spring, Mike Soukup, the Associate Director for Natural Resource Stewardship and Science, announced the selection of Craig Axtell as Chief of the new Biological Resource Management Division. Headquartered in Fort Collins, the new division will help carry out the thrusts of the Natural Resource Challenge to protect native and endangered species and their habitats and to aggressively control nonnative species. The division was funded and established in FY2000.

In taking the new position, Axtell left his job with Rocky Mountain National Park where he served as Chief of the Division of Resource Management and Research. His career with the National Park Service spans 25 years and also includes positions as Park Planner and Economist with the Denver Service Center and Resource Management Specialist at Everglades and Isle Royale National Parks. He graduated from Colorado State University with a B.S. in forest science and an M.S. in natural resources management.

Since coming on board in May, Axtell has been busy setting up Exotic Plant Management Teams to address the problem of invasive plants in parks. Four teams are currently operational and have begun exotic plant eradication efforts at parks in the National Capital Region, Chihuahuan Desert and shortgrass prairie, Hawaiian Islands, and Florida. Other functions of the new division are national coordination of threatened and endangered species management, integrated pest management, technical assistance with animal trapping and wildlife veterinary operations in parks, and advice to parks on other complex biological resource issues.

Also making a switch in jobs is Gary Vequist, who was recently selected as the Associate Regional Director for Natural Resource Stewardship and Science in the 13-state Midwest Region. Duty stationed in Omaha, Nebraska, Vequist formerly served as Chief, Resource Management and Visitor Protection, at Carlsbad Caverns National Park in New Mexico. He replaces Ron Hiebert, who transferred to the Colorado Plateau Cooperative Ecosystem Studies Unit at Northern Arizona University in Flagstaff, Arizona, last December.

Before his assignment at Carlsbad, Vequist held positions as the Alaska Regional Resource Manager for seven years and supervisory resource manager at Glacier Bay National Park, Alaska, for eight years, in addition to numerous other seasonal park positions. He earned a B.S. in zoology from Washington State University and an M.S. in environmental quality engineering from the University of Alaska. He brings to his position broad experience working with species inventorying and monitoring, fire and cave management, visitor protection programs, and scientific research.

Ecosystem valuation website launched

Are you looking for ways to increase the relevance of your park's resource preservation goals and projects in the eyes of park visitors, neighbors, and other constituents? While justifying such programs and actions strictly on economics would be folly, economics should not be ignored and can help managers evaluate which preservation projects to undertake and how to justify their expense. Resource managers may find the website "Ecosystem Valuation" helpful in understanding how economists value the beneficial ways that ecosystems affect people. Written and developed by Dennis King (University of Maryland) and Marisa Mazzotta (Univeristy of Rhode Island), the site is designed for non-economists who need answers about the benefits of ecosystem conservation, preservation, or restoration. It provides a clear, nontechnical explanation of ecosystem valuation concepts, methods, and applications.

The website contains: a discussion of the purposes and context for ecosystem valuation (The Big Picture); a non-technical overview of the economic theory of benefit estimation (Essentials of Ecosystem Valuation); descriptions of specific valuation methods, including both dollar-based measures and nonmonetary measures (Dollar-Based Ecosystem Valuation Methods, and Ecosystem Benefit Indicators); case study illustrations of each method; practical considerations related to the methods, including when each method is most appropriate, and the links to sources of related information (Links); and opportunities to provide feedback and share your experiences as you develop and use estimates of ecosystem benefits (Feedback).

The URL for Ecosystem Valuation is www.ecosystemvaluation.org/. The site is funded by the USDA Natural Resources Conservation Service and the National Oceanic and Atmospheric Administration.

"Book Review" continued from page 5

Section IV—
Incorporating Scale Concepts in Ecological Applications

This section describes how managers and scientists can effectively apply concepts of scale to natural resource management. Flow chart (i.e., word) models, tables, and diagrams effectively support the text and illuminate how we use scale to measure environmental change and how scale affects research, management, and most importantly policy. Discussion of policy issues include air pollution and salmon in the Pacific Northwest, fire, and global climate change, each demonstrating a perspective that all resource managers should consider.

> "Highlights include scale-oriented reviews of ecological theory, ecosystem management, relationships to policy and decision making, experimental design, and measuring environmental change."

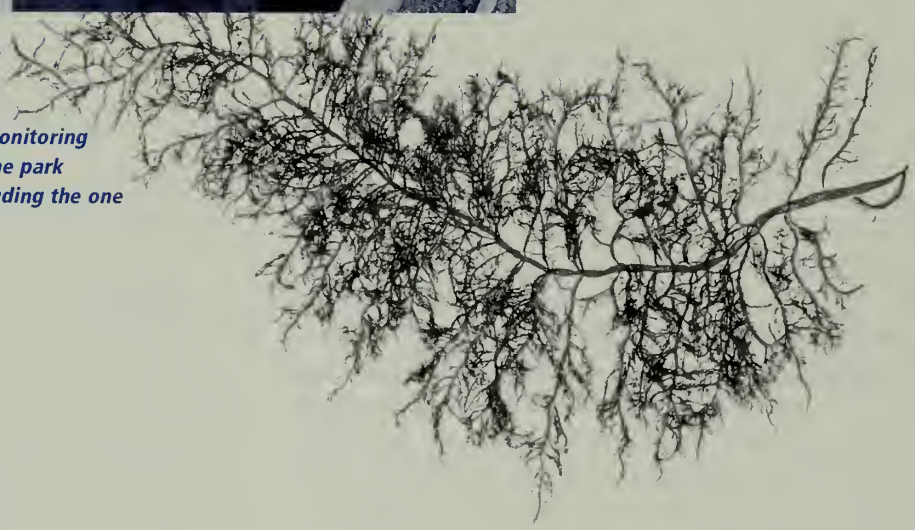
Conclusion

Covering the complexity of the scale topic, this volume represents an important compilation of information on a topic that is often misunderstood, and one for which little attention is paid (although, thankfully, this seems to be on the decline). Although technical, this book provides full exposure to the scale issue in ecology and is an important reference for researchers and resource managers who are working to understand and preserve ecological function in parks. The authors and editors have combined to provide a needed examination of a very important topic. In summary, why purchase all those books on scale when just one will do? The mountain of information alone stuffed into this one book should prompt all parks to get a copy and have it on hand as a quick and ready reference.

About the Author

Allan F. O'Connell, Jr., is a Research Wildlife Biologist and Leader of Cooperative Park Studies with the USGS Patuxent Wildlife Research Center on the campus of the University of Maine. He can be reached at allan_oconnell@umit.maine.edu or 207-581-2873.

HIGHLIGHTS



Students weigh and sample juvenile fish (above, left and right) at Sitka National Historical Park, Alaska, as part of a Nature Watch Program to encourage hands-on experience in scientific monitoring and nature discovery. One student improved the park herbarium, adding 18 species of seaweed, including the one at the right, as voucher specimens.

Students gather data at Sitka

Sitka National Historical Park is located at the mouth of Indian River, which flows through a temperate rainforest in southeastern Alaska. In September 1999, the park started a Nature Watch Program to give middle school and high school students hands-on experience in scientific monitoring and the discovery of nature. Local students and those attending boarding school from remote villages are documenting the state of local watersheds through stream surveys, biological inventories, water chemistry analysis, measuring stream flows, recording types of streambed materials, identifying juvenile fish, and mapping river channels. Students collect these data with help from park biologist Jennifer Williams, park rangers, and volunteers from Alaska Department of Fish and Game (ADF&G), U.S. Forest Service, and the Sitka Tribe of Alaska.

One of the program activities, fish surveys, was conducted throughout the year and provided the students with a valuable hands-on experience in fish identification and handling, data collection, and project organization. The goal of these surveys was to determine the species present and their age class. First, the students learned to distinguish between juvenile coho salmon and Dolly Varden, then they separated the species into designated buckets. If a fish species was unknown to the student, the ADF&G or NPS biologist helped make the identification. Next, three students weighed and measured the juvenile fish and recorded the information. The information will be used to determine how long the fry develop in the stream before migrating to sea.

The program, which ran through last winter, created a new source of data for park managers. The students' fish sampling efforts have resulted in documenting the presence of cutthroat trout, a species previously unknown to raise its young in Indian River. Sampling of junile fish is also helping the park delineate prime rearing locations

for salmon, trout, and char. The information collected will be used to better understand and protect park resources.

Sasha Stortz, a 10th grader, found the park's resources interesting enough to volunteer time throughout the summer. Working on a voucher collection project, Sasha has pressed and added 18 new species of seaweed to the park's current herbarium of 50 species. Later in summer she assisted with production of Web page photo galleries specific to the natural resources at Sitka National Historical Park.

Sitka National Historical Park's Nature Watch Program has brought the park closer to the community, raised awareness of park resources, allowed students to discover more about nature, and offered creative opportunities for individual students. The park will continue to enhance the program through future proposals and community outreach.

Gauging Hoover's fishing hole

Floods and stream flow form the basis of a partnership between Herbert Hoover National Historic Site (Iowa) and the Iowa District of the U.S. Geological Survey (USGS). After flooding in 1993, the USGS assessed flood recurrence on a tributary of the west branch of the Wapsinonoc Creek within the park. The USGS has continued its relationship with Herbert Hoover National Historic Site since that time by installing a National Streamflow Network stage gauge in the park.

The National Streamflow Network of the USGS consists of more than 7,000 gages across the nation. These gauges contribute the data necessary to address water quality and quantity issues. Data appear on the Web at www.usgs.gov.

Herbert Hoover National Historic Site uses the gauge as part of a water monitoring program. Flooding poses a threat to historic resources in the park with a high probability that a 25-year recurrence flood would cause damage to structures. Understanding the behavior of the creek may lead to better prediction and mitigation of damaging floods.

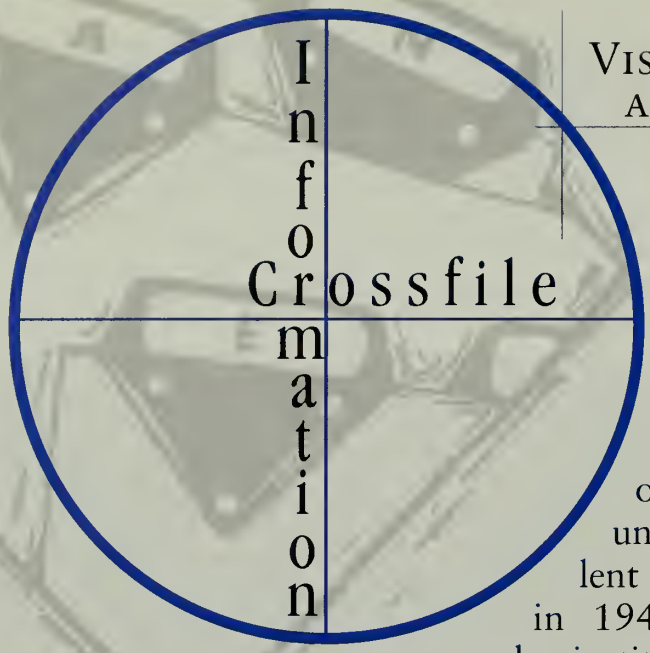
The park also uses the gauge as a demonstration of natural resource management. Interpretive signs and a digital readout of real-time data accompany the gauge housing in a high traffic area of the park. Visitors can read measurements of water temperature, air temperature, rainfall, and stream flow.

Park staff use the stream to help visitors understand that human development has changed water resources in the last two centuries. Wapsinonoc Creek, and its tributary in the park, were very different streams when President Hoover fished them as a boy. Riparian wetlands stabilized stream flow, but development encroached on these wetlands at the turn of the century. Field tiling and additions of impermeable surfaces within the watershed increased the rate and quantity of runoff from storm events. These changes have resulted in flash flooding and bank erosion on the creek.

The stream gauge provides an opportunity to use resource management issues in the park to deliver a broad message about watershed protection and land use. The gauge will provide data for management decisions concerning land use and cultural landscape within the park. Additionally, it will provide the National Park Service with hard science for its leadership role as a public land and watershed steward. PS

Articles wanted

Do you have a story you want to see published in Highlights or another department of *Park Science*? All you need to do is show how a park operation such as resource management, interpretation, visitor and resource protection, or facility management is contributing to the preservation of natural resources in a unit of the national park system through the application of science. Send your submission to the editor (see back cover for contact information) along with a photograph to illustrate your main point. More complete guidelines for submitting all types of articles for publication are available on the *Park Science* website (www.nature.nps.gov/parksci).



Visitors, ungulate management, and interpretation

Management of ungulates in the national park system has varied throughout the history of the parks. From 1900–30 attempts were made to increase numbers of ungulates and enhance viewing opportunities. Concern about the overabundance of ungulates was prevalent from 1930–40 and in 1941 through 1968 parks instituted control programs to limit ungulate numbers. Since 1970, when activist citizen groups emerged, public involvement in environmental decisions increased drastically. Because they want to view animals and preferably at close range, visitors have an interest in the management and welfare of wildlife in parks.

However, surveys revealed that the American public has a poor understanding of ecological concepts and therefore as difficulty in the comprehension of resource management in parks. Examples are the opposition of the public to removal of the mountain goat from Olympic National Park (see photos) where this species is considered alien and the discontinued removal of exotic burros from the Grand Canyon.

R. G. Wright, writing in the Wildlife Society Bulletin (1998. A review of the relationships between visitors and ungulates in national parks. No. 26(3):471–76), suggests that interpretive programs in parks could play a more important role in educating the public about sound park-specific management of ungulates. Park interpretive programs could be strengthened if they regularly included (1) explanations of the effects of land-use adjacent to a park on the park and its wildlife, particularly migratory species; (2) explanations of the environmental, cultural, or ecological function of resource management; and (3) briefings on and explanations of impending management such as control of alien species or culling of overabundant animals.

Meeting the public's desire to see wildlife in parks without creating disturbance of the animals and without inviting well-meaning but inappropriate reversal of management is challenging and calls for innovative techniques. Because of budget limitations and fears of visitor dissatisfaction, some parks seem reluctant, for example, to have visitors leave their vehicles and use public transportation to reduce disturbances of wildlife but increase viewing. (An exception is Denali National Park, which tightly controls private vehicle use on a 130-km road; most visitors use public transportation.) Wright suggests that increasing public understanding of wildlife management in parks may be the only alternative of meeting the objectives of protecting wildlife in parks and retaining the support of the public. Visitors must be made to understand that parks were established as sanctuaries where animals can live in nature but are not to be placed on display, and that management of a park must be toward that end.

Wilderness management survey

A variety of programs designed to foster personal development or treatment of various ailments offer wilderness experience to paying clients. The programs are held in designated units of the National Wilderness Preservation System and on other public or private lands that offer naturalness and solitude. The excursions have social benefits for the clients but may pose a threat to the very wilderness that inspired them.

Preventing adverse effects by wilderness programs is already a grave concern in many areas, but information about such effects was not available until four investigators began a study and collected data about the attitudes, policies, and concerns of wilderness area managers (Gager, D., J. C. Hendee, M. Kinziger, and E. Krumpe. 1998. What managers are saying—and doing—about wilderness experience programs. Journal of Forestry 96[8]:33–37). The researchers sent eight-page questionnaires about policies, attitudes, concerns, and preferred solutions of problems to the supervising administrators of 151 units in the National Wilderness Preservation System: 78 national forests, 49 units in the National Park System, 6 BLM state jurisdictions, and 18 national wildlife refuges. They excluded islands and areas smaller than 5,000 acres where overnight use by wilderness experience programs was unlikely. They received responses about 144 (95%) units.

Two-thirds of the mangers felt that the use of wilderness in their areas of responsibility was increasing. More than a third thought use was growing 25 percent per year or more. All the agencies required permits for use by wilderness programs. Almost a third (29%) of the managers felt that their agency policy was not sufficiently restrictive; most (67%) thought theirs was just right; some (4%) thought theirs was too restrictive. Managers in the USDA Forest Service and the National Park Service tended to think their agency policies were not sufficiently restrictive. Bureau of Land Management and U.S. Fish and Wildlife Service managers thought their policies were just right. As many as 31 percent of the managers suggested that their current policies were too ambiguous or incomplete or that they did not know enough about the number or types of wilderness programs using their areas. Another third reported that their policies either were under revision to be made more restrictive or wished their policies would be revised.

The gravest reported problems created by wilderness experience programs were establishment of new trails and sites, overuse in already saturated areas, site impacts, large group size, lack of wilderness stewardship skills and knowledge, and conflicts with other recreation users. Managers favor programs that promoted understanding and caring for the wilderness resource over programs that emphasized challenge, adventure, and personal growth. Almost a third of the managers think the programs conflicts with other users. Managers want higher standards and better compliance with regulations, certification of program leaders, and liability insurance. Managers recognize the benefits of the program to the participants but do not think that the programs are wilderness dependent.

The survey revealed that communication and coordination among agency managers and wilderness experience program leaders are needed to avoid misperceptions and differences, and minimize the adverse effects by the programs, namely, to secure the benefits of wilderness for present and future generations.

Selecting Biological Indicators for Resource Monitoring

Heavy visitor use in parks can cause unacceptable deterioration of resources such as soil compaction, soil loss, vegetation loss, disruption of normal nutrient cycles, changes in hydrologic cycles, and changes in animal populations. To identify biological indicators that measure visitor effect and response of resources to management, Arches National Park developed a Visitor Experience and Resource Protection (VERP) plan that prescribes five steps (Belnap, J. 1998. Choosing indicators of natural resource condition: A case study in Arches National Park, Utah, USA. Environmental Management 22[4]:635–42). (1) Identified are vegetation types that visitors use most. Compared are samples of vegetation and soil in affected and unaffected sites. (2) Variables that differ significantly between the compared sites are used as potential indicators. (3) Site-specific criteria for indicators are developed with information from previous studies and local experience, and potential indicators are evaluated with the criteria. (4) The selected indicators are further examined for ecological relevance. (5) Final indicators are selected and field-tested, and monitoring sites are designated.

Indicators for monitoring annually in Arches National Park were a soil crust index, soil compaction, and the number of used social trails and soil aggregate stability. Indicators for monitoring every five years were vegetation cover and frequency, ground cover, soil chemistry, and plant tissue chemistry. For monitoring, Arches National Park was divided into zones that reflect various types and

levels of visitor use. In these zones, sites that were affected most by visitors were monitored under the assumption that these sites would best indicate compliance in the rest of the zone. Monitoring sites were changed with changes in visitor use.

The approach to indicator selection in Arches National Park was time- and cost-effective. The identified indicators were better than genetic indicators for different habitat types, geographical locations, or use levels. The process was effective for defining acceptable resource conditions for different levels and types of recreation and for providing management with clear, quantified directions. Weaknesses of a plan like VERP are (1) the need for lead time (2 years or longer) to survey habitats, develop a list of potential indicators, determine ecological relevance, and field-test the indicators; (2) staff expertise for the assessments; and (3) time and money, constraints of which may necessitate that measured variables are limited to those that are clearly visible, inexpensive, and easy to measure. The tiered approach of measuring some variables annually and other variables less frequently may be an acceptable response to time and money constraints.

Global warming favors invasive species

Elements of global change include change in atmospheric composition, greenhouse-gas-driven climate change, increasing nitrogen deposition, and changing patterns of land use that fragment habitats and alter disturbance regimes (Dukes, J. S., and H. A. Mooney. 1999. Does global change increase the success of biological invaders? Tree 14[4]:135–39). These elements can affect species distribution and resource dynamics in terrestrial and aquatic ecosystems. They can favor groups of species that share certain physiological or life history traits. New evidence suggests that many nonnative invasive species are favored by conditions from recent global change. An increase in the abundance of such species may alter basic ecosystem properties. For example, many invasive nonnative plants such as cheatgrass, kudzu, and Japanese honeysuckle are favored by elevated levels of CO_2. The stimulated plant growth from elevated levels of CO_2 may increase fuel loading and under the right conditions increase the frequency and severity of fires. Information from experimental studies suggests that rising CO_2 levels may slow the process of succession in grasslands and thereby increase the dominance of nonnative species in many ecosystems. Most plants increase their water-use efficiency if grown in CO_2-enriched environments. If under such circumstances the rate at which plants transpire decreases, the soil beneath plants dries out more slowly and where plant growth is limited by water, species that can take advantage of the extra moisture may eventually prevail. The abundance of a native species, Hayfield tarweed, in California seems to have increased from such circumstance. But so did seemingly the invasive yellow starthistle. The effects of elevated CO_2 levels are however not readily predictable because they may depend on other factors such as local resource availability, photosynthetic pathways of species, and competition by other species.

Global warming from greenhouse gases is expected to be most intense in winter at high northern latitudes. Changes in global temperatures are also expected to change precipitation regimes. Again, experiments revealed that under some circumstances a short-term increase in water availability can affect the long-term establishment of nonnative species even after treatments are discontinued. Long-term observations revealed that an increase in annual precipitation in arid and semiarid regions of western North America could increase the dominance of invasive nonnative grasses. On the other hand, global warming may decrease or shift the range of some nonnative species.

Observations suggest that climate change will affect interactions among native and nonnative animal species. For example, higher temperatures will favor the Argentine ant to the detriment of native ant species and will decrease habitat for cold, cool, and even some warm-water species. Warm-water nonnative organisms that may expand their ranges are the cane toad, largemouth bass, green sunfish, and bluegill. Generalists that unlike specialists do not depend on specific conditions will adjust better to changing environmental conditions. Invasive species are usually generalists.

Nitrogenous compounds that are released into the atmosphere by fossil fuel combustion, fertilization of agricultural fields, and other human activities return to the surface in precipitation and dry deposition and fertilize a large and growing portion of the terrestrial biosphere. Such nitrogen deposition disadvantages slow-growing native plants that are adapted to nutrient-poor soils but favors faster-growing plants such as grasses. The increase of nitrogen deposition has already altered the species composition of heathlands and chalk grasslands in the Netherlands. Nitrogen deposition may also have already allowed the invasion of California coastal prairie by introduced annual grasses.

Research is required to better predict the effects of global climate change on plants and animals. Experiments must be designed that simultaneously reveal the effects of global change on specific nonnative species and answer general questions about invasion biology.

Meetings of Interest*

March 16–20, 2001 The Wildlife Management Institute is sponsoring its 66th North American Wildlife and Natural Resources Conference this spring in Washington, D.C. The conference will explore improvements in the management of species of concern, the role of hunting in wildlife management, and the relationship of large-scale environmental factors (e.g., global climate change, human population growth and sprawl, and acid precipitation) on the ecological well-being of the continent. Other conference tracks will look at issues related to the conservation of the Chesapeake Bay watershed and wildlife habitat conservation on private lands. Further information is available at www.jwdc.com/wmi/.

April 16–20 The George Wright Society Biennial Conference on Research and Resource Management in Parks and on Public Lands will convene in Denver, Colorado, and explore the theme "Crossing boundaries in park management: On the ground, in the mind, among disciplines." One of the great lessons of the last 20 years has been that parks and park-like places can no longer be managed strictly from within. Undeniably, managers must focus outwardly and routinely engage local communities, partners, and the public in dialogue about park management. Thus, the conference will focus on effective land management in the context of crossing boundaries related to jurisdiction, in our minds, and those that keep us too narrowly focused in our own areas of expertise. David Lowenthal, eminent geographer, biographer, and expert on the perception and meaning of history, will keynote the conference opening session. Environmental philosopher and award-winning nature writer, Kathleen Dean Moore, will also address participants during the week. Further information is available at www.georgewright.org or by calling 906-487-9722.

April 24–26 The Department of Defense is hosting the International Military Noise Conference in Baltimore, Maryland, to address concerns about the continued growth of noise pollution. Participants will include military personnel, environmental officials, and industry and citizen stakeholders with a vested interest in the effects of two types of military noise: environmental and occupational noise. The gathering will provide a forum for the exchange of information on military noise; the associated effects on humans and wildlife; and current, future, and emerging technologies. Further information is available at www.apimeetings.com/.

May 27–June 1 The Society of Wetlands Scientists extends a welcome to everyone who is involved in wetland science, research, protection, management, education, and policy to attend its 22nd Annual Meeting in Chicago, Illinois. Now in the planning stages, the conference will center on wetlands in an urban setting, which provide critical functions in the landscape and provide a key link between large centers of human population and natural resources. Further information is available at www.sws.org/chicago/.

*Readers with access the NPS NR Intranet can view a comprehensive listing of upcoming conferences and meetings at www1.nrintra.nps.gov/ (click "conferences, meetings, and training").

How long do we keep handling wolves in the Isle Royale wilderness?

By Jack G. Oelfke and R. Gerry Wright

Sometime during winter 1948/49, what is now Isle Royale National Park's most famous inhabitant, the gray wolf *(Canis lupus),* entered the Michigan island, crossing the ice-covered Lake Superior from mainland Ontario or Minnesota. Upon their arrival, they discovered what must have been to them, quite simply, *paradise*: an island with plenty of food *(Alces alces,* the moose) and no human harassment. No roads, no hunting, and no serious competition for the ample prey base present. The wolves made quick work of their only true competitor, the coyote, by eliminating it from the island within a few years. More importantly, they asserted an influence over a moose population whose numbers had fluctuated considerably since its arrival to the island ecosystem in the early 1900s, including at least one massive population crash in the 1930s.

Ten years later another significant lake crossing occurred—the arrival of the first researchers into the park to begin a focused study of the wolf population. In 1958 Dr. Durward Allen and his associates began what has become the longest-running wildlife study in the world, the wolf and moose research and monitoring study in the park. By winter 2000 this study had reached its 42nd year, including the last 30 years of investigation under Dr. Rolf Peterson of Michigan Technological University. The research brought to the world a look at wolves and moose in an ecosystem largely free of the ills and influences of modern society. In doing so, these efforts made the wolf famous, the icon of Isle Royale itself. The park, and the stature of the gray wolf in America, has forever changed as a result of these two journeys.

Despite the years of intensive study, the wolves were never handled or touched by humans.

Background

The popular media began its role in creating a near mythical status for the island's wolves as early as 1963 in *National Geographic* (Allen and Mech 1963). A part of the mystique that surrounded the wolves of Isle Royale was that despite the years of intensive study, the wolves were never handled or touched by humans. Even prior to the park's wilderness designation in 1976, park management directed that no handling of wolves would occur through the research efforts. Adequate documentation of the status and trends of the wolf population could be gathered through aerial surveys in the winter (see the cover photograph), and for the first 30 years of the study, that was enough intrusion in their world. The policies and philosophy of designated wilderness, which direct that the minimum requirement or tools be used when completing any action within wilderness (including approved research), influenced this decision, but so did the desire to perpetuate the aura of the untouched wolf population.

By 1980 the island's wolf population stood at 50, an incredible density of one wolf per four square miles. This density was not sustainable, and when the wolf population crashed to 14

Figure 1. Three biologists carry a sedated wolf to an examination site at Isle Royale National Park. Looking for answers to a wolf population crash due, in part, to disease, biologists began live-trapping and handling wolves in the park in 1988. PHOTO BY ROLF O. PETERSON


ONTARIO
17
Thunder Bay
Isle Royale National Park
17
CANADA
Grand Portage NM
UNITED STATES
Grand Portage
Copper Harbor
MINN
61
LAKE SUPERIOR
Sault Saint Marie
53
41
Houghton
26
2
Duluth
28
28
75
2
Superior
MICHIGAN
35
45
2
WISCONSIN

animals by 1982, no one was terribly surprised or worried. By 1988, however, when the wolf population remained in the low teens despite an apparently ample food base, it was clear that something was awry in the population. Park management sought advice from both within the National Park Service and the external research community, and a peer-reviewed proposal in 1988 recommended the need to handle wolves on the island to assess the persistent wolf population decline and the high mortality rate. The practice of handling wolves continued following a meeting of specialists that reviewed the first-year findings. During that period, no end-date for how long the handling was to continue was discussed; rather, most experts involved believed that answers to the questions of the wolf decline would be gained quickly and resolve the issue. Ultimately, disease as a major factor in the island's wolf decline was implicated in the persistent decline (Peterson et al. 1998).

A peer-reviewed proposal in 1988 recommended the need to handle wolves to assess the persistent population decline and high mortality rate.

Handling the island's wolves also led to greater insights of issues related to wild canid populations. Genetics testing of these wolves led to the understanding that virtually every island wolf had descended from the single maternal founder, and that the population was thus highly inbred (Wayne et al. 1991; Lehman et al. 1991; Peterson et al. 1998). As such, we now recognize that the wolves of Isle Royale provide an unprecedented opportunity to determine the significance of genetic losses for long-term viability in small, isolated populations, one of the major tenets of conservation biology.

Wolf handling continued throughout the 1990s (figures 1, previous page, and 2). The population remained low until a significant upturn started in 1994, and by 1999 the population was near the long-term average since the study had begun (25 animals). Handling continued primarily to assess the health of the population and to obtain genetic information from individual wolves.

Values associated with the wolf research program

The National Park Service recognizes several positive outcomes of the long-term wolf research program. Park management has made several substantive decisions based on the research findings and needs, including (1) a complete park closure to visitor use from November 1 to April 14 each year, largely to facilitate the research program and prevent harassment of the wildlife through winter recreational activity; (2) probition of overnight camping in approximately 50% of the park to protect wolf denning sites and to keep visitors from coming into close contact with wolf pups, thus preventing habituation to humans; and (3) a prohibition of mammalian pets on the island to reduce the potential for disease introductions.

Other recognized values of the research program have included the wide dissemination of natural history information on the wolf and moose populations of the park, particularly as it has described these populations in an environment free of human harassment and interference. An adoring global public now awaits the annual updates of these populations.

Finally, 30 years of population data provided a compelling argument that significant change had occurred, and when wolf numbers dropped so low in the late 1980s more intensive investigation was warranted. This database enabled park management and the research community to assess the need for intensive handling of the wolf population.

Wilderness values in the park

The remote location and difficulty in accessing the island has protected Isle Royale from excessive development and recreational use. Many of the recognized values of wilderness—opportunities for solitude, unconfined recreation, a landscape largely devoid of the human imprint—are found at Isle Royale. Recreational activities commonly associated with wilderness, including backpacking, kayaking, and canoeing, represent the largest user groups of the park.

Isle Royale represents a wilderness landscape unique in North America. It is a landscape with no adjacent terrestrial land boundaries (figure 3) and thus avoids the conflicts of neighboring land management practices, political

Figure 2. Biologists draw blood from a female wolf before outfitting her with a radio collar and returning her to the wild. From 12 years of handling like this biologists have learned that the wolves of Isle Royale are descended from the same founding female and are highly inbred.

PHOTOS THIS PAGE BY ROLF O. PETERSON

considerations, or the immigration/emigration of wildlife, which often heightens the need for management of the wildlife resources. This isolation is a critically important distinction for this park and its wildlife populations. It allows a hands-off approach to wildlife management to be employed, wherein manipulation or intervention—even to the point of strictly nonintrusive research and observation—are minimized to the greatest extent possible, and justified because of a concern for wilderness values. It also allows for consideration of keeping wildlife populations completely untouched by humans, as a baseline of *wilderness* wildlife management at one end of the wildlife management spectrum.

Could the wolf research program return to a hands-off monitoring approach?

Assessing the issue

With the wolf population resurgence on Isle Royale has come the need to ask if we need to continue to handle wolves. For 30 years the park obtained the necessary research information it needed without handling wolves; given wilderness concerns and concerns for the health of those wolves that are live-trapped, could the research program return to a hands-off monitoring approach? Or does the research information now being collected as a result of wolf handling, particularly genetics information, outweigh the live-trapping risks and potential conflicts with wilderness values?

To resolve this dilemma, the park and principal investigator agreed to convene an independent scientific panel to assess the issue and recommend a course of action to the National Park Service. This panel could provide an objective and scientifically valid opinion on the merits of continued handling. The scientific review followed the suggestions outlined by Meffe and others (1998). The panel convened in April 1999, and consisted of three experts (two from the USGS Biological Resources Division, one from the Aldo Leopold Wilderness Research Institute), with participation from NPS employees and the project's principal investigator, Dr. Rolf Peterson. Panel members were selected based on expertise in wolf research and wildlife management and familiarity with wilderness and wildlife management in the national park system.

The expert review panel was asked to review pertinent information on the Isle Royale wolf population and the wilderness values associated with the park and provide a recommendation to park management on the following issues:

"Given the past and current wolf population status in the park, anticipated future research needs, and the wilderness designation of the park, is it necessary to continue to livetrap and handle wolves on the Island? Or can the research and monitoring program return to a non-handling monitoring approach? Have we answered the important questions through the handling of wolves over the past 10 years?"

Results and summary

The panel reviewed the relevant issue information and identified the advantages of handling and not handling wolves as a means to determine a recommendation. That information, with a recommendation, was submitted to park management in a summary report (Oelfke 1999).

Although there are numerous advantages of handling wolves in terms of the quality and quantity of information that can be obtained, the most important advantage identified was that handling permitted the ongoing assessment of genetic change within a small population. This assessment is considered to have broad regional or global application and significance for isolated populations. The key advantage to not handling wolves, aside from the obvious removal of possible trapping injury or mortality to the wolves, was the value of minimizing human influence on the population. The return to a policy of not handling wolves would maintain the park as a baseline of wilderness wildlife management.

Five possible strategies were considered by the expert panel for wolf handling in the park, ranging from no handling to increasing the amount of handling to enhance the research program. As discussion of the strategies continued a consensus was reached that the value of tracking the loss of genetic diversity of this population warranted the continued handling of the population; it then became a matter of selecting a strategy that best addressed the wilderness concerns and research information needs.

Figure 3 (above). With no adjacent terrestrial neighbor, Isle Royale National Park requires management that considers its pronounced wilderness value, including the appropriateness of handling wildlife for research purposes. In the near future, genetics information from wolves may be obtained from their droppings, potentially making further handling of the species unnecessary. PHOTO BY ROLF O. PETERSON

Recommendation

The expert panel recommended:

1. Continue handling wolves for the next five years (2000–2004). Up to four wolves per year should be handled, not to exceed two collared wolves per pack, and no more than 12 wolves total over the five-year period (this is close to the capture rate from 1988–93, but allows more flexibility each year). These numbers reflect the desire to maximize handling opportunities during live-trapping efforts, given the logistical difficulties of trapping operations in the park, while still handling only the minimum number of animals necessary for information purposes.

2. Over the five years, aggressively look for data gathering techniques that would not require handling, by challenging the National Park Service and the scientific community to develop and study these new techniques.

3. If, within the five years, new techniques are found for acquiring genetic data without handling the wolves (e.g., such as scat and hair analyses), convene a panel to evaluate whether disease and population counting benefits are worth the continued handling of wolves.

4. If no new techniques are found within the five years, convene a panel to reevaluate the handling issue.

5. If a sudden population crash occurs, explore different strategies that may be needed to respond to the situation.

The park's response

The use of an expert review panel provided the two parties closest to the issue—the Park Service and the principal investigator—an opportunity to step away from the debate and obtain guidance relevant to the issue. Although, ultimately, the final decision on whether to continue wolf-handling practices rests with park management, the independent scientific review provided an unbiased recommendation for consideration.

Park management has largely adopted the panel's recommendations, with the exception of being unwilling to permit the live-capture of more than two wolves per year, reflecting a very conservative attitude intended to minimize possible injury to individual animals (Barnard 1999). The key information needs critical to the research program will remain obtainable.

The park is also aggressively seeking funding for research that will test whether wolf hair and fecal material can be used for tracking the genetic information needs of this population. Recent projects involving similar techniques for grizzly bears and lynx hold promise that these techniques may apply to wolves, ultimately diminishing the need to handle wolves.

For the near term at least, wolf handling will remain an important element of the wolf research program. Meanwhile, the challenge of balancing the wilderness values of a wild wolf population at Isle Royale with the agency and research needs will continue to provide a fascinating case history for review.

References

Allen, D. L., and L. D. Mech. 1963. Wolves versus moose on Isle Royale. National Geographic. February 1963:200–19.

Barnard, D. A.1999. Internal memorandum to Chief, Branch of Natural Resources, Isle Royale National Park, Wolf handling. August 4, 1999. Isle Royale National Park, Houghton, MI.

Lehman, N., A. Eisenhawer, K. Hansen, L. D. Mech, R. O. Peterson, P. J. P. Gogan, and R. K. Wayne. 1991. Introgression of coyote mitochondrial DNA into sympatric North American gray wolf populations. Evolution 45(1):104–19.

Meffe, G. K., P. D. Boersma, D. D. Murphy, B. D. Noon, H. R. Pulliam, M. E. Soule, and D. M. Waller. 1998. Independent scientific review in natural resource management. Conservation Biology 12:268–70

Oelfke, J. G. 1999. Internal memorandum to Superintendent, Isle Royale National Park: Report on review of wolf handling, April 26, 1999. Isle Royale National Park, Houghton, MI.

Peterson, R. O., N. J. Thomas, J. M. Thurber, J. A. Vucetich, and T. A. Waite. 1998. Population limitation and the wolves of Isle Royale. Journal of Mammology 79:828–41.

Wayne, R. K., D. A. Gilbert, N. Lehman, K. Hansen, A. Eisenhawer, D. Girman, R. O. Peterson, L. D. Mech, P. J. P. Gogan, U. S. Seal, and R. J. Krumenaker. 1991. Conservation genetics of the endangered Isle Royale gray wolf. Conservation Biology 5:41–51.

About the Authors

Jack Oelfke is Branch Chief for Natural Resources, Isle Royale National Park, 800 East Lakeshore Drive, Houghton, MI 49931; 906-487-9080; jack_oelfke@nps.gov.

Dr. R. Gerry Wright is Unit Scientist, USGS Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, ID 83844-1136; 208-885-7990; gwright@uidaho.edu.

A CONVERSATION WITH
POINT REYES SUPERINTENDENT DON NEUBACHER

By the editor

Popular with staff, passionate about natural resource management, and savvy about science, Don Neubacher is a park superintendent for the century. With an undergraduate degree in environmental planning and management, he set out on a National Park Service career that took him initially to Glacier Bay National Park, Alaska—then a national monument—then to Point Reyes National Seashore, California, as a seasonal employee. Following his pursuit of a Master's degree in resource management and a teaching stint at Humboldt State University, Neubacher became the Chief of Visitor Services at Point Reyes. Later, his planning skills were put to the test during a four-year assignment with the Denver Service Center working on the general management plan for the Presidio. After serving as Deputy Manager of the Presidio, he became the Superintendent of Point Reyes in 1995. Regional Director John Reynolds describes him as a "leader in everything that has do with resource management and science in parks." Winner of the 1998 regional superintendent of the year award, Don is co-chair of the Natural Resource Challenge implementation committee. The affable superintendent sat down with the editor recently for a conversation about the use of science in park management, the Natural Resource Challenge, and the future of resource preservation at Point Reyes.

Q. In his book *Preserving Nature,* Richard Sellars detailed an appalling historical lack of park management based on science and ecological awareness within the National Park Service. Are we making any progress?
A. I honestly believe a change is occurring. A lot of the newer superintendents are coming from a broader selection pool. I and a couple others in the Pacific West Region come from a resource management background, and that is somewhat atypical. I think more and more of this is occurring, and it brings a different perspective. Over time—if we continue this—we can start managing a little bit differently.

Q. How?
A. Our decision making is a lot more complex than before. More people are knowledgeable about park resources and park values, so that you have to make decisions these days that are based on science or some background that gives you a footing to make decisions correctly. In the past we made decisions primarily towards visitor services, tourism, and on the politics of the moment. I think we're heading towards ecosystem management decisions based on science. The complexity of our society today dictates that. But the second thing is that the Park Service has evolved. Before, most of our money went into visitor services and maintenance, activities that really weren't perpetuating the natural integrity of Point Reyes. Now, because we have a professional resource program, many superintendents talk about ecosystem management, ecological principles, and making sure the ecosystem is intact over time. That's changing now, although it's not easy to accomplish internally.

Q. Give me an example of scientifically informed resource management at Point Reyes.
A. We just restored native Tule elk to the park's wilderness area. When we started the process we were blown out of the water at our first public meeting—I mean, there was very little support. The community wanted us to back up and get good information. So we collected three years of data, and when we came forward with a new plan based on good science, good population dynamics, and good information, we quickly went through the public process. The elk are restored to a wilderness area now and with a lot of public support. There is a major difference if you have good information that can actually back up what you're trying to accomplish.

Q. What specific information was helpful?
A. The public wanted information on population dynamics, disease, and future population control, if necessary. Our experts overcame some of the concern about elk moving out of the park by sharing their research on elk home ranges, which showed that the animals were fairly sedentary. So far, so good. They're staying where we thought they would. We spent about $300,000 trying to get the information so that we could overcome those obstacles.

Q. Point Reyes is a good example of a park that exists in a complex landscape of multiple jurisdictions, in-holdings, infrastructure, and bordering communities. How do you grapple with that?
A. Clearly, management of Point Reyes cannot be done in isolation. We have two national marine sanctuaries offshore, the State Department of Fish and Game, the Marin

Open Space District, and the water districts; we're even adjacent to Golden Gate National Recreation Area. Altogether, we manage about 90,000 acres in Marin County, which is a fairly progressive and very environmentally aware community. The problem with Marin, however, is that it's adjacent to the San Francisco Bay Area, which has 7,000,000 people and is projected to grow to 9,000,000 by 2030.

Q. What are the implications for Point Reyes?
A. When you look at this regional system, you see major problems ahead. Currently, a big corridor called Highway 101 is being developed all the way up to Santa Rosa. If you look 30 or 40 years down the road you see that we are getting cut off, that there's severe habitat fragmentation. There is not good statewide planning in California or even good county planning. I think in the future, having good science is the only way we're going to be able to move forward in a systematic and strategic way to save the park's integrity over time.

Q. In October 1995, you had a serious fire in the park. What was the park's experience with this?
A. The Vision fire occurred up on Inverness Ridge by Mount Vision. For us, it was a massive fire, about 13,000 acres. It started just outside the park by an illegal campfire on state parkland. Because of the urban interface with this park, the damage to adjacent housing in the wildland-urban interface was really phenomenal—$50,000,000 worth of damage. The interesting part about the fire is that while it was a human disaster, there was very little damage to the natural system. For example, we have a Bishop pine forest, which is a fire-prone pine. The fire removed a lot of the adults that were about 30 or 40 years old, but now they're replenishing. In my mind, the fire helped make the system healthy, and that's pretty much what the science has shown us. We have been completing extensive research since the fire occurred.

Q. Were there any negative resource impacts?
A. A subspecies of beaver called the Point Reyes mountain beaver is experiencing a very slow recovery time. That's about the only thing that still lingers as a negative event. As a matter of fact, nesting success among birds was higher. Monitoring after the fire has shown that most natural systems, even some of the endangered plant species, have responded positively to the fire.

Q. Didn't the fire suppression effort cause concern for the welfare of certain resources?
A. Yeah. We had bulldozer lines and some watershed issues that needed attention. We brought in the Burned Area Emergency Rehab Team to respond to the work that the firefighters had done. We got funding over a two- or three-year period to do the rehab. They also helped us work with the public. Because they were so professional, so good, and knew exactly what they were doing, the team helped build confidence in the community about the National Park Service's ability to respond to fire and rehab after fire.

Q. How did that event affect fire management in the park generally?
A. It focused the attention of the public on the potential good of fire in terms of hazardous fuel reduction. And it also made them realize that you can survive a fire, too. Today that has really paid off because we are updating our fire management plan. We burn maybe 500 to 1,000 acres per year. Before the Vision fire, I don't think we would have gotten any public support for prescribed fire. Now we get tremendous public support. And we learned a tremendous amount, too, in terms of regeneration.

Q. Your elephant seal population is increasing. Why is this a concern?
A. Elephant seals are a great conservation success story. They were driven to the brink of extinction and were restricted to one island off Mexico. Over time, they've recolonized the California coast. We got our first pup, I believe, in 1980. We now have a population that's growing and is currently between 1,500 and 2,000. They haul out during the wintertime, pup their young, and molt. We have tremendous habitat for them, dunes and open beach, and a productive system offshore. So there are good food sources nearby. We're not sure, but the population could grow to 10,000 seals. We have two sites that they use a lot—the headlands of Point Reyes and Drakes Beach—but they're starting to colonize Point Reyes Beach. And the question is: How willing is the public to give up their beaches to elephant seals?

Q. Has it gotten to that point yet?
A. No, but it's just around the corner.

Q. How are you preparing for the inevitable confrontation?
A. We're trying to build support through our educational outreach and elephant seal docent programs, but there are definitely some management problems ahead. It takes time to grow public acceptance that elephant seals deserve to have this beach. Dr. Sarah Allen, the park's Science Advisor, has done a phenomenal job of collecting information on the elephant seal populations, monitoring them, and observing their population dynamics. We can share this information with the public and build a constituency for the seals over time, till people are willing to give up a beach space.

Q. Your resource management staff has grown during your tenure. Is it adequate now?
A. When I came on board, there wasn't a Division of Resource Management; it was a component of the Ranger Division. There were only two full-time resource managers and maybe a seasonal. Since then we've gone up to almost 20 FTEs [or full-time equivalents] and they're doing superb work. We've created a Resource Management Division and a Division of Science and Research. We've hired a wildlife biologist and a plant ecologist. We have active vegetation management and habitat restoration programs. Sarah is doing good work with outside institutions. We probably have, right now, 60–70 research projects being conducted by outside insti-

tutions. We also have significant cultural resources, so we've created a Cultural Resource Division. They're just in the beginning stages. So we're in pretty good shape.

Q. How did you fund the increases?
A. You have to get on the regional priority list, which gets combined at the Washington level in the budget proposal. We argued very strongly that Point Reyes had significant resources. We've got 23 federally listed species in the park and we needed a professional staff to do the job well. We've gotten a couple base increases for the resource program. We also received some outside private funding and reallocated park funds.

Q. How did you foster interdivisional support for building up resource management?
A. After the Vision fire we spent time going through a strategic planning process. We set some overall park goals, vision statements, and everything else. It probably took us a year to get through that process. But it brought all of the divisions around to our primary mission, which is preservation of these resources, the nation's heritage, for eternity. Are some staff feeling that the resource divisions are getting most of the funds these days? Yeah, for sure. However, they were the smallest division for so long; they're just finally catching up. You know, it takes a lot of work on the superintendent's part to make sure that all divisions are feeling good about these overall goals and feel part of the team and get rewards, too, when there is additional funding.

Q. Do other divisions get involved in resource management?
A. Yes. During the Tule elk project, we had a major effort with helicopters to capture the elk and relocate them (see photo this page). We invited the administrative staff to certain events because they were doing the contracting. Obviously, law enforcement was very good at keeping areas closed when we were moving elk. Maintenance blindfolded the elk and assisted in the processing. It takes a lot of muscle to lift the animals into the processing area so we could do the blood testing. So maintenance literally wrestled with these elk as we processed them, and they did a great job. All divisions participated, including me. I was out there helping to hold down the elk and moving them into the horse trailer so we could take them to the relocation site.

Q. Was interpretation involved in the elk project?
A. Yeah, they were on site and did great public information officer work. We needed a strategic effort to get information out to the public. They've done everything from publications to integrating information into their programs, displays, and exhibits on site. They've also helped us build a strategy to inform the public on other critical resource management issues—elephant seals, wilderness issues, and coho salmon—and have done a wonderful job.

Q. Describe your relationship with Sarah Allen, your Science Advisor, and Bill Shook, your Chief of Resource Management.
A. First, I want to say that we have a superb management team overall, and Sarah and Bill are core members of that team. I use the advice of Sarah and Bill almost on a daily basis, and that's why I don't like the idea of centralizing this expertise. They need to be on site near the resources so that superintendents have this expertise available to them on a daily basis.

Q. Most people believe that, certainly.
A. We've got to have those people standing next to superintendents to make sure we at least have good information and make the right decision at the right time. You still have to have political will to do the right thing, but overall, if you don't have information, don't know the options, and are not doing good compliance, then you're potentially making some big mistakes long term.

Q. Your region has established several science advisor positions in the past few years. I think you recognize how technical assistance needs to be easily accessible.
A. As a superintendent, I don't see how we could live without individuals like Dave Graber at Sequoia—I mean, he's phenomenal in terms of his knowledge of the Sierras. And Gary Davis at Channel Islands is recognized internationally for his work on marine systems. Sarah is well known because of her expertise in the Gulf of the Farallones on bird distribution and elephant seals, and all the productivity that occurs out there. I'm just hoping that the Park Service will continue to build a cadre of these great minds that can give us really good information and lead the nation in terms of how we should accomplish research not only in the parks but also in the regional context. Because we need partners and I think this approach is very complementary to BRD, [the Biological Resources Division of the U.S. Geological Survey]. We all need to work together to get the science we need to properly manage these important national resources.

Q. Who are some of your primary research partners?
A. We have a BRD field station at Point Reyes and Gary Fellers is integral to the park management team, too. He's internationally recognized for his work on amphibians, including red-legged frogs. Judd Howell at the Western Ecological Research Center at Sacramento State University provides us other expertise. We also work with Stanford and have great connections with the University of California Bodega Marine Lab and Tiburon Marine

Lab operated by San Francisco State. Sarah has brought all this expertise together.

Q. How so?
A. Sarah knows the options and she speaks the right language with the universities. She probably has five graduate students working for her now. This year alone, because of her expertise in bringing talent to the area, we have probably leveraged a half-million dollars of research that we're not even paying for. We just give them access to the resource and assistance to get the work done. Having Sarah to get these people in and do good research has been phenomenal in terms of getting stuff done.

Q. It sounds like you're describing a function of the learning center network, which is in development across the country. Tell us about that.
A. There are two major concepts behind the learning center. One is that you get researchers on site and give them the essentials: a laboratory, a classroom, office space, and access to your park information. You facilitate their work with great benefit to the park. We probably have a backlog of $20,000,000 worth of research and resource management needs. If we can get them in, help them do the research, and leverage a half-million dollars a year or whatever, we're starting to lower that backlog. The second concept is that students or our staff would work side by side with researchers and there would be a learning component. You would get these school kids hooked and, over time, build the next generation of scientists. There are five prototype learning centers now: Point Reyes, Cape Cod, Great Smoky Mountains, Rocky Mountain, and Kenai Fjords in southern Alaska. We're hoping to have money to add five to ten per year over the course of the Natural Resource Challenge, which goes to 2005. If we get 32 centers across the country funded and working together it's a great vision for moving natural resource stewardship forward.

Q. Does it involve housing?
A. Yeah. One of the biggest problems we have in Marin County is that housing is way too expensive. If you want a grad student that's just barely surviving to do research in your park, you've got to provide housing.

Q. When will your facility be ready?
A. We're taking a former historic complex and rehabilitating the buildings; you know, wiring them for GIS and Internet access, creating office space and a comfortable living situation. Over the last three years, we have had to upgrade the sewage treatment facilities. We still need about $80,000 to finish up the classroom. But we've got public and private support. We're pretty close. We hope to inaugurate it in fiscal year 2001.

Q. Your park is one of 13 units in the Golden Gate Biosphere Reserve. What significance does this designation hold for your operation?
A. All of us know that parks will never survive as islands, that our resources are integrated into regional ecosystems and, for air and water, broader systems. The biosphere reserve designation gives us a higher status internationally and it encourages us to work cooperatively with the other entities that are part of the biosphere. We meet on a regular basis and look at joint programs like controlling exotic species or coho salmon restoration. We're also trying to look at the offshore systems. California right now has major problems with overfishing and degradation of coastal and offshore resources in general. So, we're trying to work with the Gulf of the Farallones National Marine Sanctuary, which is part of the biosphere, too. The biosphere helps us focus on a larger context and create partnerships; it's really good for that purpose.

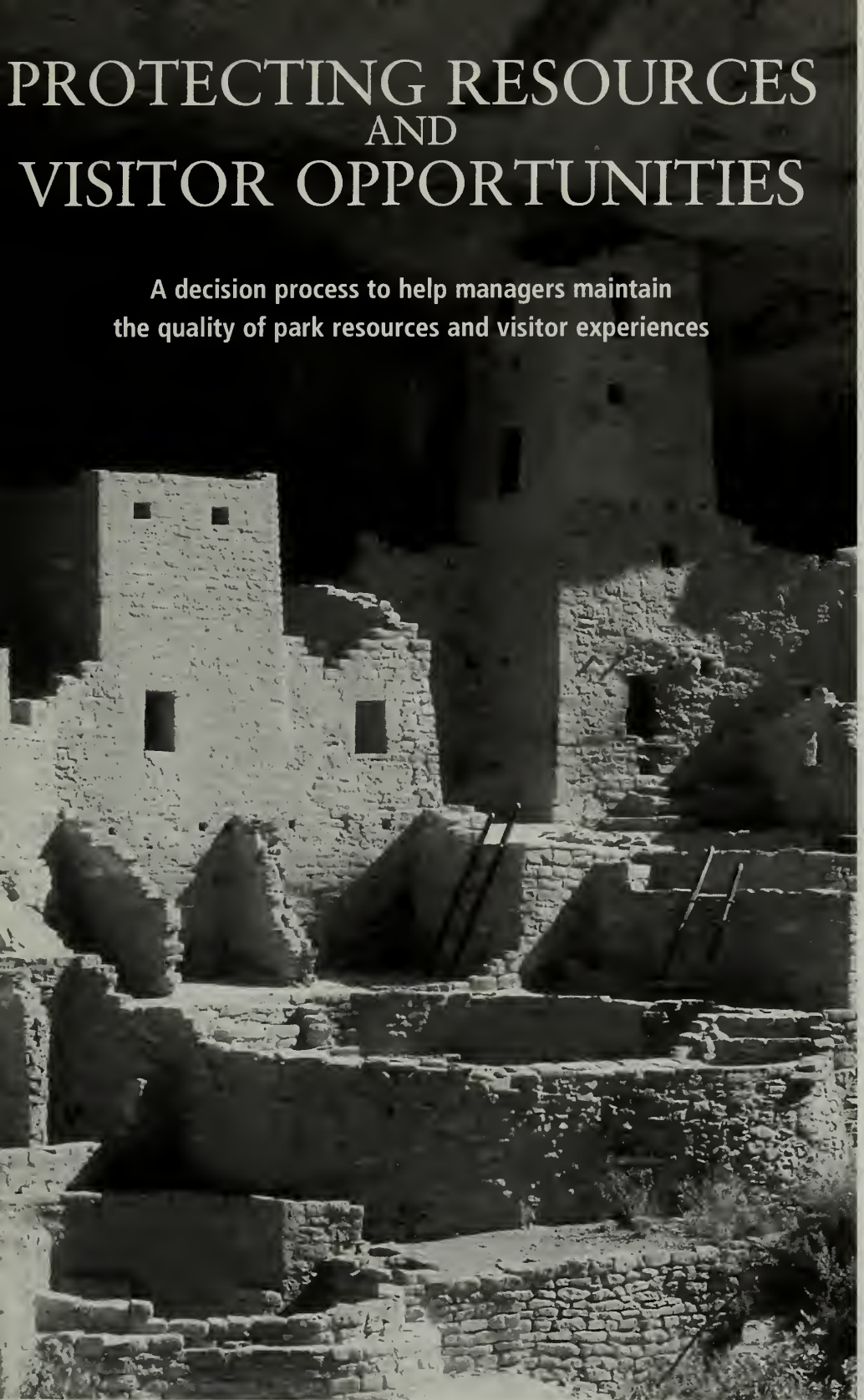
Q. What does the restoration of coho entail?
A. A number of streams drain into Tomales Bay and we've got a major effort going to restore them. We had a lot more fish at one time, but this land was all ranched heavily. There are a lot of dams and stock ponds that we hope will all be removed. Our system is still pretty intact even though there are dams outside the park that won't ever allow the populations to get back to historical numbers.

Q. You're a central figure in the implementation of the Natural Resource Challenge. How's this going?
A. It's interesting that this coincided with the millennium. We started the Challenge in 2000 and it goes to 2005. The real test was whether we could actually generate some funding, and we got approximately $15 million to launch the Challenge in fiscal year 2000. In FY 2001, we had about $18½ million in the President's budget and received about $16 million in funding. The Department has been very supportive and Deny Galvin, Mike Soukup, Bruce Sheaffer, Abby Miller, the Director, and others have done a great job of getting broad-based support. But we could lose it at any moment if we don't keep the momentum heading in the right direction. We have to make sure that we're accountable for the money being spent well. I'm very optimistic. I think that $100 million in funding and new staff could actually change the culture of the Park Service toward more resource stewardship.

Q. What do you hope to accomplish regarding resource preservation while at Point Reyes?
A. I'm fully committed to ensuring that the Natural Resource Challenge is implemented. I think it's ours to lose, and we need to make sure that across the nation there is continued support for this initiative. I really want to accomplish that. The other thing I'd like to do is ensure that parks have the right staffs to make the right decisions. Often superintendents get so focused on their own area they forget it's okay if somebody else gets money. I'm hoping that five or ten years from now we can say that we systematically enabled these parks to become environmental leaders. PS

PROTECTING RESOURCES AND VISITOR OPPORTUNITIES

A decision process to help managers maintain the quality of park resources and visitor experiences



Conducted at Mesa Verde (shown here), Yellowstone, and Arches National Parks, the study helped park managers understand and apply a broadly applicable, yet focused, decision-making process that identifies and remedies unacceptable impacts to resource conditions and visitor experiences in parks. The field tests at these parks allowed researchers to understand the challenges managers face and the skills they employ during problem solving. PHOTOS BY JEFF SELLECK

By
Theresa L. Wang,
Dorothy H. Anderson, and
David W. Lime

Introduction

The National Park Service has a mandate to protect natural and cultural resources while providing quality visitor experiences. This has never been an easy task, yet today the task is made more challenging because of increasing visitation, deferred maintenance, shrinking budgets, cumulative resource impacts, and expanded public participation. Managers frequently deal with such problems as trail deterioration, litter, wildlife displacement or habitat loss, unacceptable levels of crowding at attraction sites, and noncompliant visitor behavior. When managers face such visitor use problems, they are often uncertain about what decision-making process to use to address these impacts, or even what their problem-solving options are.

An important goal of technological innovation in the field of recreation resource management has been to help managers preserve the ecological and cultural integrity of recreation settings while providing the recreation opportunities that visitors desire. Important recreation resource management innovations developed thus far include:

- The Recreation Opportunity Spectrum Planning System (ROS) (Brown et al. 1978; Driver and Brown 1978; Clark and Stankey 1979)
- The Limits of Acceptable Change System for Wilderness Planning (LAC) (Stankey et al. 1985)
- Managing Wilderness Recreation Use: Common problems and potential solutions (A problem-solving handbook) (Cole et al. 1987)
- Visitor Impact Management Planning Framework (VIM) (Graefe et al. 1990)
- Benefits-based Management (BBM) (Driver 1994)
- Visitor Experience and Resource Protection Planning Process (VERP) (Hof et al. 1994)

For the most part, these innovations represent comprehensive planning and management frameworks. Taken together, they suggest a generalized planning process that includes articulating acceptable resource and experiential conditions, establishing management zones, selecting indicators and standards, monitoring resource and experiential conditions, identifying discrepancies between *actual* and *acceptable* conditions, and, finally, taking steps to bring actual conditions in line with what is acceptable. This "final" stage in the planning process is the one in which managers devise action plans to address specific impacts to resource conditions and visitor experiences. It is also the stage at which decision making often flounders. Thus, managers need a decision process that:

- Assists in specifying the scope, severity, and cause of the problem
- Facilitates the identification of a range of possible solutions
- Encourages an in-depth assessment of alternatives
- Strengthens the political credibility of the decision process
- Provides a resource for resolving conflicts between stakeholder groups
- Enables managers to fulfill the NPS mandate of use and preservation

The purpose of this study was to develop a decision process to address unacceptable impacts to resource conditions and visitor experiences in recreation areas.

Developing a decision process by managers for managers

The study incorporated a qualitative approach that engaged manager-participants in a series of hands-on, group decision-making sessions. The qualitative approach allowed participants to actively contribute to the development of the decision process and enabled researchers to deal with problem-solving obstacles as they emerged. Since there is no one "right" way to design a decision-making process, researchers attempted to identify and implement those features that managers agreed upon with regard to process content and flow. A modified focus group or nominal group process and participant observation were employed as the principal data collection methods. Decision-making sessions were also tape-recorded.

Thirty-two people participated in the study. Participants were divided into three groups and group size ranged from 10–12 people. Field tests were conducted at Arches, Yellowstone, and Mesa Verde National Parks from January through April, 1997. Each field test lasted 2–3 days. Participants were drawn from Arches, Canyonlands, Grand Tetons, Mesa Verde, Theodore Roosevelt, and Yellowstone National Parks; the Bureau of Land Management's Moab District in Utah and Farmington District in New Mexico; and a local "Friends" group. Participants met together regularly to discuss and make park management decisions. Participants also worked in an area for which several unacceptable impacts to resources and visitor experiences had been identified. Further, participants were able to articulate acceptable conditions, or indicators and standards, for the unacceptable impacts they had identified.

During the field tests, managers engaged in a decision process with real-life implications and were encouraged to follow whatever decision-making steps and strategies made sense to them. Three decision-making worksheets and a decision-making handbook were available as problem-solving resources. However, managers were free to use the supporting materials at their own discretion. A half-hour *debriefing session* immediately followed each decision-making session. The debriefing session was necessary to elicit manager perceptions about the decision process. During the debriefing sessions, managers frequently identified the decision-making obstacles they had encountered and suggested how to restructure the decision process and supporting materials to eliminate these pitfalls.

Developing the decision process

The field tests allowed researchers to understand the challenges managers face and the skills they employ during problem solving. The field-testing process identified five steps that are essential to solving visitor use problems. This five-step process, together with a companion handbook and worksheets, comprises a decision process to maintain the quality of park resources and visitor experiences. The five decision-making steps are outlined in table 1. The steps include: problem awareness, problem specification, strategy and tactic selection, plan implementation, and monitoring. Although these steps were perceived to be critical to overall success, managers still struggled with the best way to accomplish each task. Of the five problem-solving steps, two steps received the most attention during the field tests: *problem specification* and *strategy and tac-*

tic selection. Many improvements were made to the decision process and supporting resources to guide managers through these two critical steps.

Table 1.
Steps in the decision process to maintain the quality of park resources and visitor experiences

Step 1 *Problem Awareness*	Recognize that unacceptable impacts exist and must be addressed
Step 2 *Problem Specification*	Identify impact Describe acceptable impact levels Describe existing impact levels Determine if existing impact is unacceptable Identify root cause of impact
Step 3 *Strategy and Tactic Selection*	Select appropriate strategy Identify potential tactics Evaluate and select appropriate tactics
Step 4 *Plan Implementation*	Develop implementation plan for selected management tactics Identify specific management actions Identify person responsible for carrying out management actions Implement actions
Step 5 *Monitoring*	Monitor Effectiveness of actions If problem arises, return to problem specification stage

Problem specification

During problem specification, managers focused on an area for which they had identified one or more problems and specified acceptable resource and experiential conditions for that area. Then they determined whether there was a discrepancy between *existing* and *acceptable* conditions. Specifying acceptable conditions is equivalent to identifying the "line" that resource conditions and visitor experiences cannot cross. For example, managers may specify that during peak hours 80% of the visitors should encounter no more than 10 people (singly or in groups) on a specific quarter-mile stretch of trail. If more than 10 people are encountered more than 20% of the time along that stretch of trail during peak hours, then conditions are not within acceptable limits and managers must take action.

At Arches, managers had previously completed the VERP planning process (see *Park Science* 14(1):11–13 and 15(3):9,13). Therefore, during problem specification they referred to previously defined indicators and standards of acceptable conditions. For example, in attempting to address the problem of overcrowding at the Devil's Garden parking area, the following discussion ensued (Arches, researcher field notes, p. 4):

Participant E: [What is the] associated indicator and standard?

Participant D: 150 cars is the [estimated] acceptable limit.... The social standard is 20 persons at one time (PAOT) on a section of trail to Landscape Arch and 10 PAOT to Double "O" [Arch]. Beyond Double "O" it's 5 parties/hour.

Participant A: How many parking spaces [are presently available]?

Participant D: 35 marked spots.

Participant E: A parking lot with 150 slots is desirable.

Participant D: Currently on busy weekends we have 235–250 cars parked there. We want to be in standard 90% of the time, but [we are] only in standard 76% of the time.

Managers at Arches had a good understanding of the conditions they were trying to achieve at various areas within the park. Their extensive use of VERP standards suggests that having gone through the VERP process helped them in identifying acceptable conditions and determining whether existing conditions were within acceptable limits.

At Yellowstone and Mesa Verde, managers determined acceptable conditions based primarily on manager perceptions. Although managers at Yellowstone had previously completed a VERP planning process to address winter use in the park, the problems they addressed during the field test fell outside the scope of earlier planning efforts. This approach lacked the rigor of specifying indicators and standards, but it drew upon considerable manager experience with an area over time. A lack of visitor and resource data hindered decision making, but the decision process helped to pinpoint the specific information managers needed. In fact, one manager at Yellowstone commented, "This process will trigger monitoring."

In general, managers felt that the problem specification portion of the process was helpful in their decision making. Although managers recognized the value of defining the problem, they tended to struggle with problem specification. In some cases managers glossed over this portion of the process in their haste to engage in brainstorming and tactic selection. At other times they defined the problem too broadly, failed to clearly specify the timing or location of the problem, or neglected to conduct an in-depth analysis of all the possible causes of the problem. One of the researchers analyzed *why* managers struggle with problem specification: "Once people start asking

'why,' the 'problem' begins to change. This is probably good, but maybe this 'backing up' ought to be recorded if for no other reason than to keep track of the path they followed to move from problem Z to problem A" (Mesa Verde, researcher field notes, p. 2).

Field test results suggest that problem specification is more complicated than it appears, and that what actually constitutes the "problem" may be a moving target—with definitions changing as the analysis proceeds. Based upon field test results, the decision process and supporting materials were modified to ensure that managers do not jump ahead to considering solutions before they have articulated the scope, severity, and cause of the specific problem they are addressing.

Strategy and Tactic Selection

The brainstorming portion of the process requires managers to identify strategies and tactics that are appropriate to the specific problem being addressed. Managers felt the decision process and supporting materials helped them to generate a range of possible solutions and think "outside of the box."

Field test results revealed a number of factors that either facilitate or inhibit brainstorming. Managers found brainstorming to be more effective when they jumped around, discussing tactics in a free-flowing manner. When managers considered tactics methodically, as if going through a lengthy checklist from top to bottom, the process felt overly tedious. During brainstorming, discussions frequently incorporated dialogue about specific management actions that could be developed for a tactic and the advantages and disadvantages of a potential tactic. One researcher felt such discussion "was generally good and may enhance products" in the next stage of the process. Facilitators play an important role during brainstorming by ensuring that some tactics are not discussed in too great of depth while other tactics are ignored.

Field test results also revealed an interesting brainstorming dilemma. To avoid getting bogged down, the process requires managers to focus on a *specific* problem at a *specific* location. However, this site-specific focus can inhibit brainstorming by limiting the consideration of tactics that would be most effective if conducted on a *park-wide* basis. Consider the following interaction between managers at Arches (Arches, researcher field notes, p. 10–11):

> The decision process ... [was] modified to ensure that managers do not jump ahead to considering solutions before they have articulated the scope, severity, and cause of the specific problem....

Participant H: [I don't] see visitor education at Windows [as mandatory]. It must be park-wide but [I don't] know how it would be done with the hundreds of thousands of visitors.

Participant D: [We could] revisit queuing [and] reservations because indirectly [these approaches] would [address the problem] at Windows if we did [employ them] park-wide.

Participant C: Interesting comment. We should [record] that reservations, queuing, and visitor education are "maybe's;" they're "yes's" if done park-wide.

If managers had ruled out visitor education, queuing, and reservations as potential tactics simply because it seemed like too much work for a single location, and if managers failed to consider park-wide options, the potential effectiveness of these tactics at addressing site-specific problems might have gone unnoticed.

Tactic selection requires managers to assess the relative merits of various tactics. At Arches, one manager asked, "How do you answer the question 'Is this the best way to fix the problem?'" Managers used a wide variety of criteria to select tactics for implementation including park purpose, cost to visitors, manager expertise, legal compliance, off-site impacts, and economic feasibility, just to name a few. Although the decision process includes supporting materials to assist managers with tactic evaluation, improving this part of the decision process is an important direction for future research. Based on field test results, the decision process and supporting materials were modified to facilitate manager consideration of a variety of strategies and tactics. Modifications were also made to facilitate documenting the results of discussion and recording the reasons why specific tactics were selected. When managers consider a wide variety of options and document the reasons behind a chosen course of action, the political credibility of the decision process is strengthened.

Conclusion

This article outlines a decision process to maintain the quality of park resources and visitor experiences and highlights the contributions managers at Arches, Yellowstone, and Mesa Verde made to the development of the decision process. Technological innovation in the field of recreation resource management benefits from extensive manager involvement in the development process. By working closely with managers researchers were able to (1) better understand the process managers use to solve visitor use

problems and (2) develop a decision process and supporting materials that managers find useful and user-friendly. To increase the quality of recreation resource management decision making, and to ensure that improvements in decision making can be replicated across the national park system, managers need decision-making frameworks, tools, and processes. This research project developed a decision process, handbook, and worksheets to help managers solve visitor use problems.

The decision process and handbook build upon previous research by Cole, Petersen, and Lucas (1987); Cole (1989); and Graefe, Kuss, and Vaske (1990). This effort's most important contribution, however, may be in developing a process in which managers use worksheets to specify their most critical problems and to identify alternative management tactics to address these problems. The decision process can be used by managers who have implemented comprehensive planning frameworks, such as LAC, VIM, and VERP; however, it will also improve visitor use problem solving among managers who have not implemented these comprehensive planning processes.

When managers consider a wide variety of options and document the reasons behind a chosen course of action, the political credibility of the decision process is strengthened.

The decision process to maintain the quality of park resources and visitor experiences, and the companion handbook and worksheets, are available from the University of Minnesota, Cooperative Park Studies Unit (1530 N. Cleveland Ave., St. Paul, MN 55108) and the Denver Service Center (c/o Marilyn Hof, National Park Service, 12795 W. Alameda Parkway, Lakewood, CO 80225-0287). PS

References

Anderson, D. H., D. W. Lime, and T. L. Wang. 1998. Maintaining the quality of park resources and visitor experiences: A handbook for managers. Tourism Center publication number TC-777. University of Minnesota Extension Service, St. Paul, MN.

Brown, P. J., B. L. Driver, and C. McConnell. 1978. The opportunity spectrum concept and behavioral information in outdoor recreation resource supply inventories: Background and application. Pages 73–84 in G. H. Lund et al., technical coordinators. Integrated inventories of renewable natural resources: Proceedings of the workshop. USDA Forest Service General Technical Report RM-55. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Clark, R. N. and G. H. Stankey. 1979. The recreation opportunity spectrum: A framework for planning, management, and research. USDA Forest Service General Technical Report PNW-98. Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Cole, D. N., M. E. Petersen, and R. C. Lucas. 1987. Managing wilderness recreation use: Common problems and potential solutions. USDA Forest Service Intermountain Research Station, GTR INT-259. Ogden, UT.

Cole, D. N. 1989. Low-impact recreational practices for wilderness and backcountry. USDA Forest Service Intermountain Research Station, GTR-INT 265. Ogden, UT.

Driver, B. L. and P. J. Brown. 1978. The opportunity spectrum concept and behavioral information in outdoor recreation resource supply inventories: A rationale. Pages 24–31 in G. H. Lund et al., technical coordinators. Proceedings of integrated inventories of renewable natural resources. USDA Forest Service General Technical Report RN-55. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Graefe, A. R., F. R. Kuss, and J. J. Vaske. 1990. Visitor impact management: The planning framework. Vol. 2. National Parks and Conservation Association, Washington, D.C.

Hof, M., J. Hammett, M. Rees, J. Belnap, N. Poe, D. W. Lime, and R. E. Manning. 1994. Getting a handle on visitor carrying capacity—A pilot project at Arches National Park. Park Science 14(1):11–13.

National Park Service. 1997a. VERP—The Visitor Experience and Resource Protection (VERP) framework: A handbook for planners and managers. NPS D-1215. National Park Service, Denver Service Center, Lakewood, CO.

National Park Service. 1997b. VERP—A summary of the Visitor Experience and Resource Protection framework. NPS D-1214. National Park Service, Denver Service Center, Lakewood, CO.

Stankey, G. H., D. N. Cole, R. C. Lucas, M. E. Peterson, and S. S. Frissell. 1985. The limits of acceptable change (LAC) system for wilderness planning. USDA Forest Service General Technical Report INT-176. Intermountain Forest and Range Experiment Station, Ogden, UT.

About the Authors

Theresa L. Wang is an Assistant Professor of Recreation, Parks, and Tourism Resources in the Division of Forestry at West Virginia University. Her address, phone, and e-mail are: Division of Forestry, P.O. Box 6125, West Virginia University, Morgantown, WV 26506; (304) 293-2941, x2416; twang3@wvu.edu.

Dorothy H. Anderson is a Professor of Recreation Resource Management in the Department of Forest Resources at the University of Minnesota. Her address, phone, and e-mail are: 1530 N. Cleveland Ave., Department of Forest Resources, 115 Green Hall, St. Paul, MN 55108; (612) 624-2721; danderso@forestry.umn.edu.

David W. Lime is Senior Research Associate and Unit Leader of the Cooperative Park Studies Unit in the Department of Forest Resources at the University of Minnesota. His address, phone, and email are: 1530 N. Cleveland Ave., Department of Forest Resources, 115 Green Hall, St. Paul, MN 55108; (612) 624-2250; dlime@forestry.umn.edu.

LATE JURASSIC (MORRISON FORMATION) CONTINENTAL TRACE FOSSILS FROM

CURECANTI

NATIONAL RECREATION AREA, COLORADO

By Anthony R. Fiorillo and Richard L. Harris

Curecanti National Recreation Area encompasses the eastern portion of the Black Canyon of the Gunnison and shares a common boundary with the Black Canyon of the Gunnison National Park in west-central Colorado. The park contains three dams comprising the Wayne N. Aspinall Unit of the Upper Colorado River Storage Project. The largest reservoir created by the dams, Blue Mesa Lake, serves as a major recreational resource for fishermen and boating enthusiasts.

Geologically, the park is recognized for having exposures of rocks that date to over 1.7 billion years in age, making these rocks among the oldest in western North America. In addition to these well recognized resources, Curecanti National Recreation Area also contains fossil resources that have significant scientific and educational value. The most important of these fossil finds is in the Upper Jurassic Morrison Formation in the park (fig. 1).

Perhaps most significant of these fossil finds is the discovery of a quarry, which has been discussed elsewhere (Fiorillo et al. 1996; Fiorillo and May 1996), containing the remains of at least two dinosaurs. Excavation of this fossil site continued for three years, and the preparation of the fossil material continues. Continued surveying of the paleontological potential within this park has shown that the Morrison Formation is rich in other fossil resources as well. We briefly report here the occurrence of various fossil traces of invertebrates also from the Morrison Formation, described in more detail elsewhere (Fiorillo 1999), and describe the management, education, and exhibit uses of these important newly discovered resources. These additional sites, along with the previously described dinosaur quarry, emphasize the point that significant management issues may include resources not traditionally recognized within individual parks (see *Park Science* 16[4]:14–15). Further, like the great diversity in the types of remains found in the fossil record, there is also diversity in management techniques that can be employed to document these occurrences. Finally, park visitors are interested in learning about natural resources, including park paleontology. In a telephone conversation on 6 November 2000 with the second author, Gary Machlis, the NPS Visiting Chief Social Scientist, agreed with this assertion. He noted that there are many examples from surveys of park visitors conducted under the Visitor Services Project that show that information about park resources, including natural resources, is an important and highly sought after service provided by the National Park Service.

Perhaps most spectacular of these fossil traces are the remains of ancient termite nests.

BACKGROUND

The Morrison Formation of the western United States has produced the vast majority of the Jurassic dinosaurs from North America; hence, most of the paleontological work on this fossil unit has focused on fossil vertebrates, particularly dinosaurs. This important fossil unit, composed largely of ancient stream, floodplain, and lake deposits, is found at the surface or in the subsurface from Montana to New Mexico and from Oklahoma to Utah. The youngest part of the Morrison Formation is the Brushy Basin Member, which is the source of most of the vertebrate remains from this formation. Underlying the Brushy Basin Member is the Salt Wash Member of the Morrison Formation. The age of this formation has traditionally been considered to be Late Jurassic. Historically climatic interpretations for Morrison Formation deposition range from wet to dry, and most specialists have invoked a strong seasonality during Morrison times.

A new dinosaur locality was discovered in the Morrison Formation during recent paleontological fieldwork at Curecanti National Recreation Area and Black Canyon of the Gunnison National Park (Fiorillo et al. 1996; Fiorillo and May 1996). Continued survey of these parks has pro-

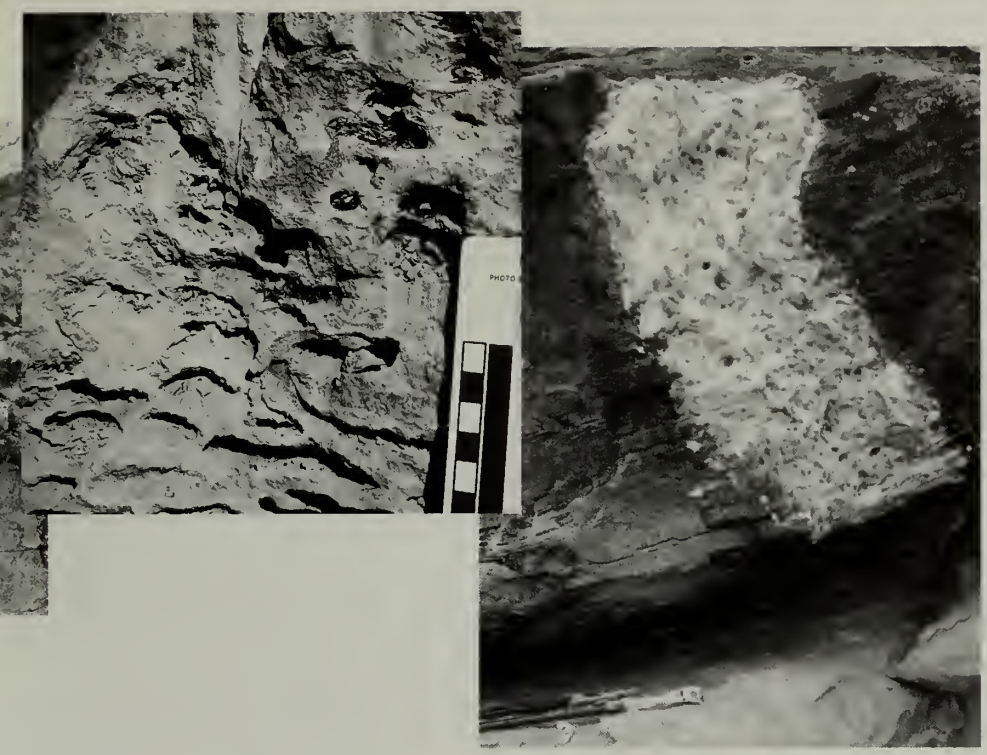


Figure 1 (clockwise from far left). Exposures of the fossil-rich Morrison Formation are evident in this view of the West Elk Arm of Blue Mesa Lake in Curecanti National Recreation Area. These shoreline exposures are very low, and therefore old, in the layering sequence of the Morrison Formation section.

Figure 2. Placed for scale, the handle of a rock hammer runs alongside a Jurassic termite nest from a Morrison Formation exposure in Curecanti National Recreation Area. Notice the pattern of chambers in the nest.

Figure 3. Modern Spinifex termite nest from Western Australia. Notice the similarity in pattern of chambers in this nest compared to the fossil nest in figure 2.

Figure 4. Impractical to move because of its size and weight, the recently discovered Jurassic termite nest was left in situ where paleontologists coated the fossil (shown in figure 2) with latex. The resulting "peel" is used as a mold to cast the fossil in plaster for educational and scientific needs. The paintbrush at the bottom provides scale.

vided new insights into the trace fossils within the fluvial, or stream channel and floodplain, portions of the Morrison Formation, and the overall Jurassic paleoecosystem within these parks. Trace fossils are typically defined as fossilized equivalents of the structures produced in rocks, sediments, and grains by the life processes of organisms, with the study of these features referred to as ichnology (Bromley 1996). The most common trace fossils include burrows and footprints.

LOCAL SETTING

Several types of invertebrate trace fossils have now been identified in the upper part of the Morrison Formation of Curecanti National Recreation Area. These trace fossils record important information regarding the paleohydrologic and paleoecologic setting of this fossil unit in this park. Hundreds of traces occur in fluvial sandstone and mudstone deposits. The traces include crayfish burrows, termite nests, homopteran (an insect order that includes cicadas and aphids) burrows, bee cells, and earthworm burrows (Fiorillo 1999; Fiorillo and Hasiotis 1996). Also present are various sizes of rhizoliths, or plant root traces (Fiorillo and Hasiotis 1996). The invertebrate trace fossils predominantly occur in sandstones, whereas the plant root traces can occur in either the mudstones or the sandstones. Stratigraphically, these fossil traces appear to be confined to the lower part of the Brushy Basin Member or the upper part of the Salt Wash Member of the Morrison Formation. Perhaps most spectacular of these fossil traces are the remains of ancient termite nests (figs. 2 and 3).

The distribution and shape of these traces are related to paleoenvironmental conditions such as variations in water table and soil moisture levels that these burrowing organisms experienced during the Late Jurassic. For example, the length of the crayfish burrows delineates the depth of the water table level. The traces in Curecanti National Recreation Area with the greatest vertical component are the termite nests, which occur within the confines of large fossil root traces. The restriction of this ichnofossil to within a few meters of the Salt Wash/Brushy Basin contact suggests a time of greater aridity during the highly seasonal climate than in other portions of the Morrison Formation in the park.

MANAGEMENT ISSUES

The occurrence and distribution of these trace fossils has scientific importance, as well as public education potential. These fossils are largely located along the shores of the Blue Mesa Reservoir in Curecanti National Recreation Area, in large sandstone blocks that weigh in excess of 1,000 pounds each. Given the logistical difficulty in moving such large blocks, or alternatively, attempting to utilize diamond-bladed rock saws to cut the fossils of interest out of the sandstone, it was deemed most appropriate to follow a third alternative. This third alternative was to produce latex peels of select fossil features. These peels would then be used as molds for making plaster casts that can be used for educational and exhibit needs.

One example of such a process for making a peel of a termite nest is illustrated in figure 4. This particular termite nest shown in this figure has been subsequently cast in plaster, painted, and used as part of a highly successful exhibit entitled "Six Legs Over Texas: the infestation continues" at the Dallas Museum of Natural History.

See "Curecanti" in right column on page 35

AN IMPORTANCE-PERFORMANCE EVALUATION OF SELECTED PROGRAMS IN THE NATIONAL CENTER FOR RECREATION AND CONSERVATION

By Michael A. Schuett, Steven J. Hollenhorst, Steven A. Whisman, and Robert M.Campellone

In 1998, the National Center for Recreation and Conservation (NCRC) of the National Park Service, with West Virginia University, conducted a study to assess satisfaction of NCRC cooperators, in compliance with the Government Performance and Results Act (GPRA). The NCRC surveyed its cooperators in the following programs: (1) Rivers Trails and Conservation Assistance (RTCA), (2) National Heritage Areas (NHA), (3) Federal Lands-to-Parks (FLP), and (4) Wild and Scenic Rivers (WSR) programs. The RTCA program helps communities plan greenways, conserve rivers, and develop new trails through voluntary partnerships that emphasize local ownership and involvement. The NHA program advises community leaders in 18 National Heritage Areas on partnership strategies for conserving cultural and natural resources. The FLP program helps state and local agencies acquire, at no cost, surplus federal land and facilities for parks and recreation. The WSR program is responsible for the management of four wild and scenic "partnership" rivers. This program is responsible ensuring resource protection and partnership goals are met.

The items of highest importance among RTCA cooperators received the highest satisfaction scores.

Purpose and study design

The purpose of the study was to assess the level of satisfaction among "cooperators" who had received a "substantial" level of assistance or services from the four NCRC programs during the 1998 federal fiscal year. Survey recipients were "primary contacts" for each project and primary cooperator organization that received assistance or services from the respective NCRC programs. Each program established criteria unique to their particular set of services to define substantial levels of assistance.

An Importance-Performance (I-P) technique was used. The assistance activities of each NCRC program were segmented into specific elements for which the importance and satisfaction ratings among served cooperators were elicited. The basic assumption underlying the I-P technique is that overall program satisfaction is an aggregate of the satisfaction level for each program element relative to its importance. By acquiring meaningful feedback on the importance and performance of each program element, the NCRC could better target its efforts in meeting long-term performance goals.

Each NCRC program developed a list of elements, and given the unique purposes of each program, it was clear that a different list was required for each program. While many elements were applicable to all four program questionnaires (e.g., assistance with developing a vision, mission, goals, and action plans), other items applied specifically to only one or two programs. The elements were arrayed in a question set for which respondents were asked to assess in terms of the importance of each to their project, and their level of satisfaction with the delivery of each item. A five-point Likert scale was used to rate the level of importance (1 = Very Unimportant, 5 = Very Important) and satisfaction (1 = Very Dissatisfied, 5 = Very Satisfied).

The I-P approach identifies priorities for each element of each of the evaluated programs contingent upon the element's position in a four-quadrant matrix. The "Keep Up the Good Work" quadrant includes program elements cooperators rated as highly important to their particular project, and also rated highly in terms of their satisfaction with the program's delivery of those elements. The "Concentrate Here" quadrant contains elements of high importance to cooperators but on which the program's performance was low. Program elements of low importance to cooperators but were well delivered fall into the "Possible Overkill" quadrant. Finally, the "Low Priority" quadrant contains items that were of low importance but

for which cooperator satisfaction levels were comparatively low.

The study represents a census survey of all program cooperators, thus a questionnaire was mailed to each. Databases were obtained from each program group that included the names, mailing addresses, and various types of program information. The program populations included 162 RTCA cooperators, 11 NHA cooperators, 4 WSR cooperators, and 87 FLP cooperators. Population sizes, responses, and actual response rates for each program are shown in table 1. The first mailing was sent in November of 1998. In order to attain the target response rate, follow-up reminders and a second mailing were sent out on a schedule prescribed by Dillman. The cutoff date for returned questionnaires was April 15, 1999. Response rates, which ranged from 80% for FLP to 100% for WSR, are considered excellent by all estimations and criteria (Dillman 1978). Table 2 on page 32 lists the assistance activities of each NCRC program that were evaluated; the number for each activity corresponds to the numbered data plotted in figures 1–4.

Table 1.

National Center for Recreation and Conservation GPRA Survey: Population Size, Responses, and Response Rates.

Program	Population Size	Responses	Response Rate
RTCA	162	143	88%
FLP	87	70	80%
NHA	11	9	82%
WSR	4	4	100%

Findings

Rivers, Trails, and Conservation Assistance Program

In general, a strong positive relationship (r=0.74) was observed between importance and satisfaction scores for RTCA program elements (figure 1). In other words, the items of highest importance among RTCA cooperators received the highest satisfaction scores. From a service delivery perspective, this indicates a visceral understanding among RTCA personnel about which program elements are most important to cooperators, and thus they have developed their capacity for excellence in these areas. Conversely, the program performed least well on elements of least importance, indicating program efficiency by not wasting resources on elements unimportant to cooperators.

Generally, elements of highest importance and satisfaction tended to relate to organizational development and capacity building, while less important and less well delivered items related to information and evaluation of resources. Program elements in the Keep Up the Good Work quadrant of the I-P matrix included: developing a vision, mission, and goals; ensuring support and involvement from relevant interest groups; assuring support from the community; facilitating meetings; providing information about the experience of other groups; guidance in developing publications and graphic materials; and fulfilling commitments made to the project.

Three items were rated highly important, but did not receive high satisfaction ratings. Items in this Concentrate Here quadrant included: developing the capacity of the organization; providing information on trail development; and helping to secure possible funding sources.

Five items relating to provision of information were rated in the Low Priority or Possible Overkill quadrants. This suggests that relative to the other program services offered by RTCA, providing information (items 7, 9, 10, 11, 12) was seen as neither a high priority nor particularly well delivered. It appears that RTCA cooperators may look to other sources of information while appreciating the one-on-one assistance RTCA can provide them in developing the direction and capacity of their organizations. Other items that fall into these quadrants include site evaluation (6) and overcoming problems and crises (16). The fact that only one item—provision of information on interpretation and education—fell into the Possible Overkill quadrant again suggests that the agency has done a good job at not devoting a disproportionate of resources on low priority items.

Federal Lands-to-Parks

A moderately strong positive correlation (r=0.57) was found between importance and satisfaction scores for FLP services (figure 2, page 33). While the program is doing a

Figure 1. Rivers, Trails, and Conservation Assistance Program

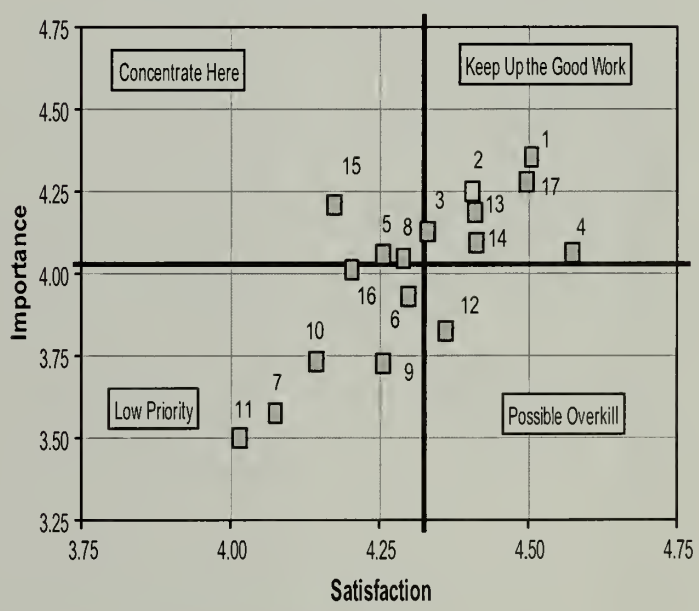
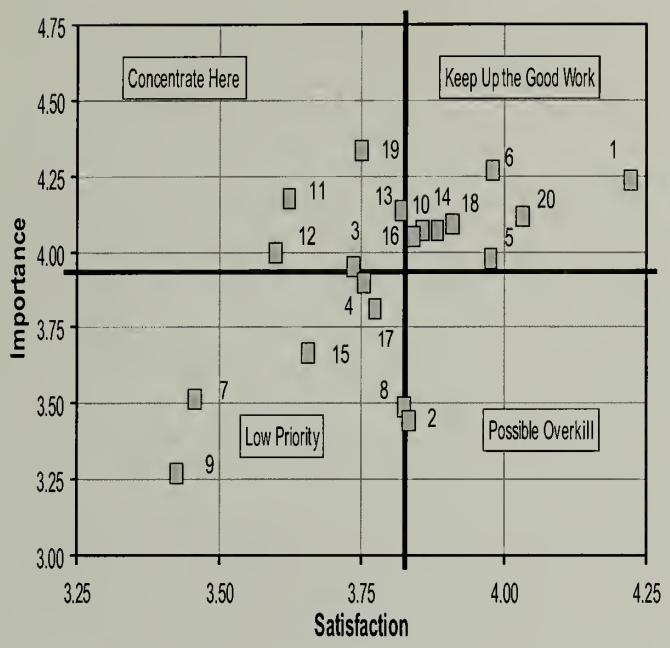


Table 2.
Importance-Performance Quadrants for Four Programs in the National Center for Recreation and Conservation

	Rivers, Trails, and Conservation Assistance	Federal Lands-to-Parks	National Heritage Areas	Wild and Scenic Rivers
Keep Up the Good Work	4 Assistance with facilitation of meetings 1 Assistance with developing a vision, mission, goals, or action plan 17 Fulfilling the commitments made to the project in a timely manner 13 Providing information about the perspectives and experiences of other organizations with similar projects 14 Guidance on developing publications and graphic materials 2 Ensuring support and involvement from relevant interest groups, officials, and organizations 3 Assuring support from the community	1 Assistance with understanding the procedures, requirements, and general process of the FLP Program 20 Availability and extent of involvement by FLP staff 6 Communicating stewardship requirements, processes, or issues 5 Providing information on points of contact and other related agency programs 18 Overcoming unexpected problems, obstacles, or crises 14 Assistance in developing or reviewing third-party operating or use agreements 10 Assistance in preparing FLP application materials 16 Assistance in promoting and supporting your proposal with other agencies or organizations	6 Administering federal funds made available to your NHA 10 Fulfilling NPS commitments made to the project in a timely manner 1 Providing technical information about heritage area development 5 Involving other organizations and agencies that can assist your NHA 3 Helping your organization develop annual and long-range work plans	16 Overcoming unexpected problems, obstacles, or crises 14 Guidance on developing publications and graphic materials 15 Identifying, suggesting, or helping to secure other possible funding sources 17 Fulfilling the commitments made to the project in a timely manner
Concentrate Here	8 Providing information on trail development 5 Assistance with developing the capacity of your organization to undertake the project 15 Identifying, suggesting, or helping to secure other possible funding sources	13 Assistance with proposed changes in land use for acquired properties 19 Fulfilling the commitments made to the project in a timely manner 3 Identification of and notification about available property 11 Preparing property deeds and transferring property 12 Assistance in modifying or enhancing acquired properties	7 Identifying, suggesting, or helping to secure possible funding sources	5 Assistance with developing the capacity of your organization to undertake the project 6 Identifying or evaluating natural, cultural, historic, and recreational resources that are worthy of protection, restoration, or interpretation 9 Providing information on river conservation 12 Providing information on interpretation and education 7 Providing information on protection strategies for natural resources 10 Providing information on open space protection 11 Providing information on protection strategies for cultural resources 13 Providing information about the perspectives and experiences of other organizations with similar projects
Low Priority	6 Identifying or evaluating natural, cultural, historic, and recreational resources that are worthy of protection, restoration, or interpretation 9 Providing information on river conservation 16 Overcoming unexpected problems, obstacles, or crises 10 Providing information on open space protection 7 Providing information on protection strategies for natural resources 11 Providing information on protection strategies for cultural resources	8 Assistance in developing justification for parks, recreation, or conservation 17 Adding credibility to your project with other agencies or organization 4 Providing information on land acquisition or military base reuse processes 15 Assistance in considering alternative methods or strategies for achieving objectives 7 Identifying or evaluating natural, cultural, historic, and recreational resources on the property that are worthy of protection, restoration, or interpretation 9 Assistance in planning the use of property for public use	12 Providing information about the perspectives and experiences of other organizations with similar projects 2 Fostering nonfinancial growth and development of your organization 11 Overcoming unexpected problems, obstacles, or crises	1 Assistance with developing a vision, mission, goals, or action plan 3 Assuring support from the community 8 Providing information on trail development
Possible Overkill	12 Providing information on interpretation and education	2 Assistance with developing a vision, mission, goals, or action plan	9 Assistance with developing publications and graphic materials 4 Providing information about other federal programs that can assist in NHA protection and development 8 Identifying or evaluating natural, cultural, historic, and recreational resources that are worthy of protection, restoration, or interpretation	4 Assistance with facilitation of meetings 2 Ensuring support and involvement from relevant interest groups, officials, and organizations

Figure 2. Federal Lands to Parks Program



good job of developing excellence in areas of highest importance to their cooperators and de-emphasizing items of low importance, six items fell in either the Concentrate Here or Possible Overkill categories. This suggests that for nearly a third of the program elements, the organization is not dedicating sufficient attention or is supporting the element beyond its importance.

In many ways, the FLP findings are in stark contrast to RTCA, suggesting a far different clientele with different service priorities. Unlike the results for RTCA, FLP cooperators seem most interested in, and were most satisfied with assistance they received regarding the "nuts and bolts" of the project. For example, items in the Keep up the Good Work quadrant included: assistance with understanding procedures, requirements, and general processes; providing information on points of contact and other related agency programs; communicating stewardship requirements, processes, and issues; preparation with application materials; development or reviewing third-party operating or use agreements; promoting or supporting the proposal with other agencies; overcoming unexpected problems and crises; and availability and extent of involvement by FLP staff.

The Concentrate Here quadrant also contained items related to the specifics of project completion: identification of and notification about available property; preparing property deeds and transferring property; modifying or enhancing acquired properties; assistance with proposed changes in land use for the properties; and fulfilling the commitments made to the project in a timely manner. It appears that FLP cooperators expect the program to be both an advocate for the property transfer within the federal government and the source of technical legal help in accomplishing the transfer.

Also in contrast with RTCA was the finding of Low Priority for items relating to developing their organization or building public support for the project: developing justification for park and recreation uses of the property; building credibility for the project with other agencies or organizations; providing information on land acquisition or military base reuse processes; alternative strategies for achieving objectives; site evaluation; and planning for public use of the property.

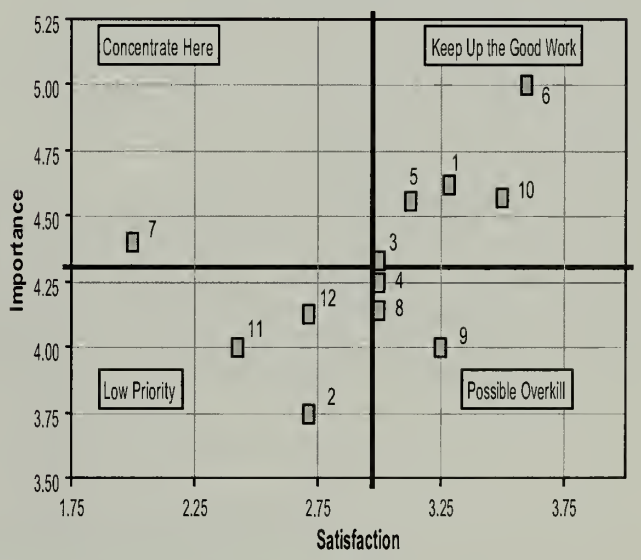
Lastly, assistance with developing the cooperator organization's vision, mission and goals were well delivered, but not viewed as particularly important, and thus fell in the Possible Overkill quadrant. FLP cooperators may have a well-defined and focused mission—acquiring a specific piece of property—and can therefore look to the organization for direct assistance in making the acquisition happen.

National Heritage Areas

In general, relatively high importance ratings among NHA cooperators suggest that the forms of assistance or services provided by the program were consistent with cooperators' priorities (figure 3). Even though the NHA program sustained the lowest mean satisfaction score of the four programs—2.97 across all program elements included in the I-P analysis—their overall results were positive.

Conversely, a moderately strong positive correlation (r=0.52) was found between importance and satisfaction ratings, with only four items falling in the Concentrate Here or Possible Overkill categories. This suggests that the organization is doing a good job at targeting resources to the most important program elements, and is not committing unnecessary resources to items of low importance.

Figure 3. National Heritage Areas Program



Five of the twelve items fell into the Keep Up the Good Work quadrant. In contrast to RTCA and FLP, these items generally relate to managing and sustaining the projects over the long term, and include: providing technical information about heritage area development; helping the organization develop annual and long-range plans; involving other organizations that can be of assistance; administration of federal funds made available to their heritage area; and fulfilling commitments made to the project.

The one item in the Concentrate Here quadrant also relates to long-term program management: securing other sources of funding. The average satisfaction score on this item was 2.0, which was the lowest for any element of all four programs. Like the other cooperators, these respondents placed a high priority on securing additional funding sources, and expressed a high level of dissatisfaction with NHA in this regard.

Three items fell into the Low Priority category: provision of information about other organizations; fostering the nonfinancial growth and development of the organization; and overcoming unexpected problems. Three items fell into the Possible Overkill category: site evaluation of resources; developing publications; and provision of information about other federal programs that may assist their project.

Wild and Scenic Rivers

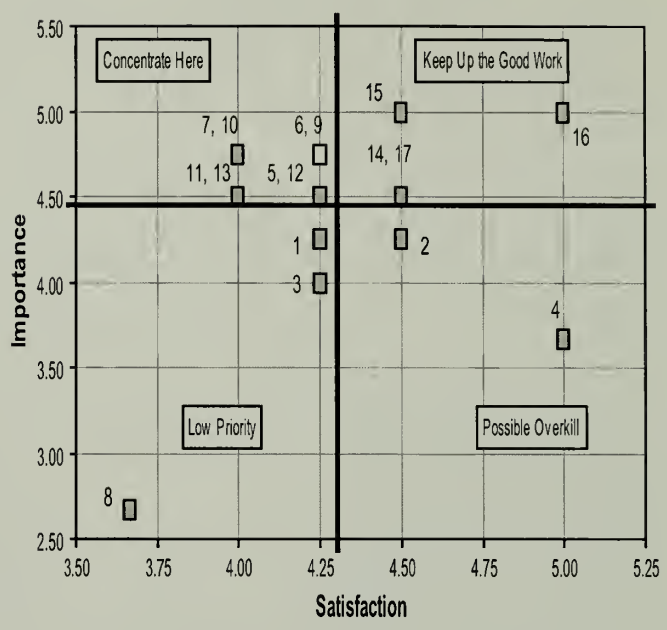
The rivers used in this study represent four "partnership rivers" served by the WSR program. These four rivers are only a small portion of 34 segments and over 2,600 miles of the Wild and Scenic Rivers System administered by the National Park Service. Because of the extremely small population size, the WSR results should be viewed with caution. Nonetheless, as a complete census of the four program participants, the findings are illuminating (figure 4).

A comparatively weak correlation (r=0.27) was observed between importance and satisfaction scores for WSR program elements. This finding could be a result from either low population size or extremely high importance and satisfaction ratings by WSR cooperators. Nonetheless, eight of the seventeen items fell in the Concentrate Here category, suggesting that the organization is not committing sufficient attention to these items.

No meaningful connection was observed among the four items in the Keep up the Good Work quadrant: guidance on developing publications; securing other funding sources; overcoming unexpected problems; and fulfilling commitments made to the project.

However, unlike the other three program groups, WSR cooperators place high importance on resource evaluation and information, but were relatively less satisfied with assistance received in these areas. Items falling into this Concentrate Here quadrant included: developing the capacity of your organization; site evaluation; providing information on protection strategies for natural resources; providing information on river conservation; providing information on open space protection; providing information on protection strategies for cultural resources; providing information on interpretation and education; and providing information on other organizations with similar projects.

Figure 4. Wild and Scenic Rivers Program



Falling into the Low Priority quadrant were: developing vision, mission, goals; building support within the community; and provision of information on trail development. Cooperators placed a low priority on trail development; however, this is a service the WSR program does not emphasize. Two items fell into the Possible Overkill quadrant: assistance with facilitating meetings and enlisting relevant interest groups.

Discussion

With few exceptions, both importance and satisfaction scores suggest a high level of support for and fulfillment of the services delivered. NCRC program staff should be congratulated for having a very good sense of the program elements important to their constituents and delivering on these items.

Of the items common across the four programs, few similarities emerged. For instance, while assistance with developing a vision and mission was viewed as important and well delivered by RTCA participants, it was seen as a low priority or possible overkill by FLP and WSR. This demonstrates the vastly different constituency needs and interests across the four programs, along with the ability of each program group to customize their services to the specific needs of their constituency.

Three of the four programs (RTCA, FLP, and NHA) viewed identification and evaluation of site resources as a low priority. Only WSR placed a relatively high value on its provision. Of the three programs that included assistance with obtaining funding as an item, two (RTCA and NHA) viewed the service as highly important, but were relatively dissatisfied with its delivery. Thus, two general recommendations are given. First, it appears that the NCRC programs should generally de-emphasize site identification and evaluation as a program service. With the exception of the WSR program, this capacity is not highly valued by constituents. Second, NCRC should place a greater focus on assisting constituents with identifying funding strategies and sources for their programs. One way this could be accomplished would be to build expertise on funding sources within the National Center for Recreation and Conservation and field offices. There are several organizations that focus on helping small nonprofits with issues related to fund-raising, grant writing, and financing. Perhaps formal relationships could be developed with these organizations for the purpose of assisting NCRC cooperators with this vexing problem.

Finally, National Park Service programs such as the NCRC are being held more accountable to the public for both the efficacy and efficiency of their operations. The Importance-Performance technique is a useful evaluation tool for disaggregating and evaluating multidimensional organizations comprised of various program delivery elements. Methods of statistical analysis are relatively simple, and are presented visually for straightforward interpretation. As such, the I-P technique has broad applicability to a wide variety of agencies and organizations.

Literature Cited

Dillman, D. A. 1978. Mail and telephone surveys: The total design method. Wiley, New York.

National Park Service. Strategic Plan. 1997. National Park Service, Washington D.C.

About the Authors

Assistant Professor Michael A. Schuett (mschuett@wvu.edu) is a faculty member with the Division of Forestry, College of Agriculture, Forestry and Consumer Sciences at West Virginia University, Morgantown, WV.

Steven A. Whisman (whisman@wvnvm.wvnet.edu) is with the West Virginia Prevention Resource Center, Marshall University Graduate College, South Charleston, WV.

Steven J. Hollenhorst (stevenh@uidaho.edu) is Professor and Head of the Department of Resource Recreation and Tourism, College of Forestry, Wildlife and Range Sciences at the University of Idaho, Moscow, ID.

Robert M. Campellone (rob_campellone@nps.gov) is River Conservation Planner with the Rivers, Trails, and Conservation Assistance Program of the National Park Service, Washington, D.C.

"Curecanti" continued from page 29

Similarly, casts are available to the National Park Service for its educational and exhibit needs. Further these casts provide researchers the opportunity to study accurate reproductions of these fossil features, features that would otherwise be lost due to erosion. The National Park Service has provided the logistical support and framework for the excavation while the Dallas Museum of Natural History has provided the technical expertise for the molding and casting. This partnership has produced a successful model of cooperation between the Park Service and a private institution, and has yielded important scientific, preservation, and educational results from a previously unrecognized resource.

REFERENCES

Bromley, R. G., 1996. Trace fossils: biology, taphonomy and applications. Second edition. Chapman and Hall, London.

Fiorillo, A. R. 1999. Non-marine trace fossils from the Morrison Formation (Jurassic) of Curecanti National Recreation Area, Colorado. Pages 42–46 in V. L. Santucci, and L. McClelland, editors. National Park Service Paleontological Research Volume 4. Technical Report NPS/NRGRD/GRDTR-99/03.

Fiorillo, A. R., and S. T. Hasiotis. 1996. Preliminary report on the continental ichnofossils from the Upper Jurassic Morrison Formation of Curecanti National Recreation Area, Colorado (abstract). Geological Society of America, Rocky Mountain Section, 28(4):7–8.

Fiorillo, A. R., and C. L. May. 1996. Preliminary report on the taphonomy and depositional setting of a new dinosaur locality in the Morrison Formation (Brushy Basin Member) of Curecanti National Recreation Area, Colorado. Pages 555–61 in M. Morales. Editor. The Continental Jurassic. Museum of Northern Arizona Bulletin 60.

Fiorillo, A. R., C. L. May, and R. L. Harris. 1996. Comparison of paleontological resource management in the Rocky Mountain Region by the National Park Service and the U.S. Forest Service. Pages 308–11 in D. Harmon, editor. Making protection work. Proceedings of the Ninth Conference on Research and Resource Management in Parks and on Public Lands. The George Wright Society, Hancock, MI.

Schullery, P. 1997. Searching for Yellowstone. Houghton Mifflin Co., Boston.

ABOUT THE AUTHORS

Anthony Fiorillo is the Curator of Paleontology at the Dallas Museum of Natural History, P.O. Box 150349, Dallas, TX 75315.

Richard Harris is the former Chief of Resource Stewardship and Science at Curecanti National Recreation Area and Black Canyon of the Gunnison National Park. He is currently the NPS Director of the Office of Strategic Planning, 12795 W. Alameda Parkway, P.O. Box 28287, Denver, CO 80225.

PARKSCIENCE
National Park Service
Natural Resource Information Division
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287

PARKSCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT

VOLUME 20 • NUMBER 2 • FALL / WINTER 2000

www.nature.nps.gov/parksci ISSN-0735-9462

PUBLISHED BY U.S. Department of the Interior
National Park Service

DIRECTOR Robert Stanton

ASSOCIATE DIRECTOR, Natural Resource Stewardship & Science Michael Soukup

EDITOR Jeff Selleck

CONTRIBUTORS Information Crossfile • Elizabeth Rockwell
Highlights • Jennifer Gibson, Sherry Middlemis-Brown
News & Views • Rook Cleary

DESIGN Glenda Heronema

EDITORIAL OFFICE National Park Service
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287
E-mail: jeff_selleck@nps.gov
Phone: 303-969-2147
FAX: 303-969-2822

Park Science is a resource management bulletin of the National Park Service that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application in resource management. Published by the Natural Resource Information Division of the Natural Resource Program Center, it appears twice annually, usually in the spring and summer. Additional issues, including thematic issues that explore a topic in depth, are published on occasion. Content receives editorial review for usefulness, basic scientific soundness, clarity, completeness, and policy considerations; materials do not undergo anonymous peer review. Letters that address the scientific content or factual nature of an article are welcome; they may be edited for length, clarity, and tone. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Send articles, comments, address changes, and other information to the editor at the e-mail address above; hard copy materials should be forwarded to the editorial office address. Deadline for submissions is January 15 for the spring issue and April 15 for summer.

Park Science is also published on-line (ISSN-1090-9966). All back issues of the publication, article submission guidelines, and other useful information can be viewed and downloaded from the website www.nature.nps.gov/parksci

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Checks should be made payable to the National Park Service and sent to the editor.

Sample article citation
Oelfke, J. G., and R. G. Wright. 2000. How long do we keep handling wolves in the Isle Royale wilderness? [National Park Service publication] Park Science 20(2):14–18.

Printed on recycled paper

☆ U.S. GOVERNMENT PRINTING OFFICE: 2000 — 673-984 / 450001 Region No, 8

PARK SCIENCE

INTEGRATING RESEARCH AND RESOURCE MANAGEMENT

RECENT COLONIZATION OF MANGROVES AND NESTING FRIGATEBIRDS AT **DRY TORTUGAS**

BACKCOUNTRY WATER QUALITY IN **GRAND TETON**

KNOTWEED CONTROL IN THE NORTHEAST

SONGBIRD MONITORING IN **GOLDEN GATE**

VOLUME 21 • NUMBER 1 • FALL / WINTER 2001

UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE NATIONAL PARK

From the Editor

A MOST VALUABLE RESOURCE

This issue of *Park Science* combines the skills and energies of over 50 people in reporting on research and its application to resource management. Naturally, this variety reflects a multitude of fascinating and critical studies and applications going on in the national parks. Bit by bit this work adds to our understanding of park ecology and improves park management. In this issue, for example, we find two approaches for dealing with the problem of exotic vegetation. In the first, Tom Gardali and his co-authors focus on songbirds as indicators of ecological recovery following the eradication of exotic plant species at Golden Gate National Recreation Area, California. In the other, Kathleen Reeder and Brian Eick describe a partnership with the U.S. Department of Agriculture to first understand and then systematically control two species of knotweed at Johnstown Flood National Memorial, Pennsylvania. Each provides useful insights into the complex process of striving to foster the return of native vegetation and ecological function following exotic plant control.

Two articles provide international perspectives, reminding us that we are part of a broad, international network of scientists and managers endeavoring to conserve parks for people. In particular, John Dennis' report on the meeting of the Man and the Biosphere Program of UNESCO points out how we might improve the participation of the National Park Service in the U.S. portion of this program by learning from examples of several international biosphere reserve models. Also, German forester Thomas Meyer profiles the national parks of Germany in an enjoyable article comparing the history, goals, and resource management issues of the German parks with our own park system. The comparison is fascinating and, along with the MAB report, demonstrates that natural resource management is a global commodity, at times exported and imported by the National Park Service.

I am especially pleased to run a profile, albeit brief, of the recent book, *Yellowstone in the Afterglow,* by Mary Ann Franke of the Yellowstone Center for Resources. The book summarizes the many scientific investigations about the effects of the fires of 1988 on the park and concludes that for the most part the park and its resources are quite durable in response to fire. I certainly was not surprised to hear this but was very happy to read about it in a popular, science-based publication. Thirteen years ago I spent 23 days in Yellowstone as an information officer relating details of the North Fork fire to media and offering hope about the ecological resilience of the ecosystem. By summer's end—fires still burning and emotions hot—this story had worn out its welcome. Nevertheless, renewal would again become the theme of news reports the following spring. Nearly half a career later the information on the lessons learned from the fires is refreshing, relevant, and valuable. Not only does it deepen our understanding of long-term effects of fire on a natural ecosystem, but it also will help us manage future demands for fire information more effectively.

Many other articles appear in these pages, too, echoing individual and group efforts alike to link science and park management. The variety is altogether impressive and enjoyable, and the people behind the science are indeed a most valuable resource in their own right.

Jeff Selleck
Editor

PARKSCIENCE
VOLUME 21 • NUMBER 1 • FALL / WINTER 2001

DEPARTMENTS

ON THE COVER
Once absent at Dry Tortugas National Park, Florida, mangroves and nesting magnificent frigatebirds now thrive in this subtropical marine ecosystem (see cover story on page 20).

COVER STORY

FEATURES

HIGHLIGHTS

Gambusia habitat restored in Big Bend

The Big Bend mosquitofish *(Gambusia gaigei)* is a federally endangered species whose only habitat in the wild is a few warm-water springs at Rio Grande Village in Big Bend National Park (Texas). A remnant of a wetter climate, the tiny, live-bearing fish has endured despite severely limited natural habitat. Furthermore, use of the area for farming before the park was established and subsequent park development worsened the situation. Farmers established roads, constructed ditches for irrigation, and drained the natural spring-fed wetlands to create arable land; the Park Service paved roads, installed a picnic area and freshwater pipeline, and developed a right-of-way for maintenance of an electric power line. By the 1960s, park resource managers were aware of the mosquitofish's tenuous existence and constructed ponds that became the core of their habitat. Beavers helped in the 1980s by building a dam in the runoff channel, but the fish still relied upon the artificial habitat that was vulnerable to leaks, toxic spills, and malfunctioning water pumps.

Recognizing the need for self-sustaining habitat, resource managers applied for funding from the NPS Water Resources Division to restore eight acres of natural, spring-fed wetlands. The project began in 1999 with the removal of an asphalt road and picnic area and recontouring of soils to retain water (fig. 1). The pipeline, power line, and a maintenance facility were also relocated out of the wetland habitat. Aerial photos, detailed topographic mapping, and soil analysis were key to understanding the former extent of the wetlands and in determining suitable upland sites for this infrastructure.

Now in the revegetation phase, the habitat restoration combines plant propagation and transplanting techniques. The park elementary school operates a greenhouse to propogate native plants for restoration projects in the park. For this project, the students are growing primarily salt-tolerant wetland grasses. Transplants also include cottonwoods, willows, baccharis, and cattails. Park Service staff and additional volunteers, including Student Conservation Association aides, Boy Scouts, area students, and local river outfitter employees are carrying out the revegetation (fig. 2). Resource managers watch for and control encroaching nonnative species in the newly disturbed area and have already removed tamarisk, palm trees, buffelgrass, and rabbit's-foot grass. Thorny mesquite thickets in the wetland area, another result of pre-park agricultural practices, are being returned to wetland grasses through active removal and prescribed burning by park fire management staff.

The final phase involves consultation with the Water Resources Division and the U.S. Fish and Wildlife Service's recovery team for Big Bend mosquitofish to consider further enhancements to the habitat. These include considering alternatives to the current practice of pumping water from mosquitofish habitat for domestic uses and mitigating the impact of several farm-era earthen berms that alter drainage in the area. The group will also consider creating an additional pond within the restored wetland.

The park has established two scientific projects to monitor and document restoration results. One uses vegetation and insect monitoring transects as indicators of change in wetland function. The other is a network of soil and surface water monitoring devices (i.e., piezometers) to demonstrate hydrologic change in the system.

Figure 2. Employees transplant native wetland grasses to the restoration site. These and other transplants restore organic matter to the soil and retain moisture. When inundated, the vegetation provides shade and shelter for the mosquitofish, and supports the fish's diet of aquatic insect larvae. With removal of drainage structures and return of wetland soil and plant function, areas of permanent standing water will increase and seasonally wet areas will become more persistent.

Figure 1. The habitat restoration at Big Bend began with the removal of an asphalt road and re-contouring of the land to retain warm-water spring runoff for the endangered Big Bend mosquitofish.

Writer-editor assists Northeast Region natural science program

The Northeast Region's Philadelphia Support Office has engaged the services of a part-time writer-editor to provide natural science publications support for the Chesapeake and Allegheny Cluster parks. This person works closely with the Chesapeake-Allegheny Cluster Chief Scientist John Karish and other persons in the Philadelphia Support Office (PHSO).

General duties are developing, editing, and disseminating information about critical natural resource management issues. The incumbent also publicizes research results pertaining to the physical and social sciences, natural resources, and biology in the Northeast Region's national parks.

The primary goal of the writer-editor is to present new technical information and research results in a style understandable and relevant to general audiences and professionals. In addition to providing material for fact sheets and site bulletins, this person contributes to *Natural Resource Year in Review* and *Park Science*. Editing responsibilities include proofreading publications for the PHSO Technical and Natural Resource Report series. In order to provide natural resource information to as wide an audience as possible, the writer-editor is working with a web-page development

team to incorporate natural science information in the Philadelphia Support Office's website. That website will link to the National Park Service site.

The person who held this position in fiscal year 2001 was Kathleen K. Reeder, who began working with the National Park Service through a cooperative agreement with The Pennsylvania State University in November 2000. Ms. Reeder has expertise in writing expository prose in both the academic and government spheres. Beginning in October 2001, writing and editing duties was assumed by Betsie Blumberg, who has a bachelor's degree in anthropology and master's degrees in anthropology and agronomy. In addition to teaching freshman courses in rhetoric, composition, and technical writing at Penn State, Ms. Blumberg has edited textbooks written by faculty for distance education and workforce education training for the Penn State World Campus, and agricultural extension materials for Penn State's Department of Agricultural Communications.

Strategy for managing the West Nile virus in the Northeast Region

West Nile virus has generated much publicity since it was first identified in New York City in 1999. Although very few humans have died of the infection, apprehension about the number of people at risk—and misunderstanding about the process of transmission itself—have continued to grow. According to Wayne Millington, Integrated Pest Management Coordinator for the Northeast Region, continued education for park employees and managers, including how to identify potential vectors (carriers) and minimize human risk, have been the key to preparing for the 2001 cycle of this disease.

The virus, which can cause encephalitis (an inflammation of the brain) in humans, is spread in the Northeast primarily by members of a mosquito species that prefers to feed on birds. In fact, West Nile virus presents a far greater threat to specific bird populations in the Northeast Region than to humans. Although mortality has occurred in very small numbers of other bird species, the American crow, fish crow, and blue jay seem to be most susceptible. Of these three, the American crow has had the highest mortality rate. For example, in 1999 and 2000, more than 10,000 of them died from the virus. Because of this susceptibility, crows are used by most state and federal agencies as an early indicator for the movement of the virus into an area.

The American crow is highly susceptible to the mosquito-borne West Nile virus and is a management concern for national parks, particularly in the Northeast.
COPYRIGHT DAN SUDIA

The risk that a mosquito carrying the virus will bite a human is extremely low in sparsely populated areas. The threat of infection is greater in cities because the density of the human population makes it more likely that the vector species will find a human rather than a bird to bite. In fact, the few human deaths that have been recorded occurred in areas where people worked or lived under very crowded conditions. For, example, a 70-year-old woman who died of the disease during 2001 lived in a county that has 1,543 people per square mile.

Preparation for the 2001 season in the Northeast Region included regional training meetings for park staff and superintendents. Information about the virus, its vectors, their habitat identification and management, and risk reduction procedures were sent to each park. Every park in the region was also encouraged to communicate with their local and state health departments, and with local or state mosquito control offices, to share information and collaborate in all regional management efforts. Parks that already have experience minimizing the threat of the West Nile virus have assisted those that trained their staff for the first time.

All resource materials compiled by Mr. Millington are available to park visitors, neighbors, and parks outside of the region. Anyone who wishes to have more specific information about the West Nile virus in the Northeast may contact Mr. Millington at (814) 863-8352.

Preserving water resources amid development:

Strategy outlined in Northeast Region report

A newly issued management plan in the National Park Service's Northeast Region may serve as a valuable reference for other parks that share the challenge of preserving the integrity of water resources as urbanization threatens their watersheds. Conducted as a cooperative study by the United States Geological Survey (USGS) and the National Park Service, this plan analyzes the characteristics and susceptibility of water and aquatic life at Cold Harbor and Gaines' Mill, two of eleven geo-

graphically distinct units that are collectively known as the Richmond National Battlefield Park, Virginia.

Although water quality is sufficient now, the Park Service is aware that changes in land use can alter many characteristics of the surface and groundwater, such as flow rate, sediment load, and pollution content. The NPS-USGS team, therefore, began planning how to preserve water resources in August 1999 as development increased near the park's various units, all of which lie outside the city of Richmond. They have conducted a comprehensive analysis of existing information, including all legislation that pertains to the subject areas' water resources and the historical context and condition of the streams. Their research has yielded thorough descriptions of the sites' respective watersheds, geology, hydrology, topography and soils, vegetation, floodplains, riparian areas and wetlands.

Ultimately, the researchers provided evidence that three kinds of information must be obtained in order to assess the impact of development in the future: baseline data about present water quality; inventories of riparian flora and fauna; and inventories of water-dependent flora and fauna. In addition to identifying the methodology needed to establish baseline data, the report recommends efficient, cost-effective strategies for monitoring the water resources and for managing the habitats to protect the flora and fauna dependent on them.

To receive a copy of this management plan, please contact John F. Karish, Chief Scientist, National Park Service, Philadelphia Support Office, Northeast Region, 209B Ferguson Building, University Park, PA 16802-4301. He may also be reached by phone at (814) 865-7974; or via e-mail at john_karish@nps.gov.

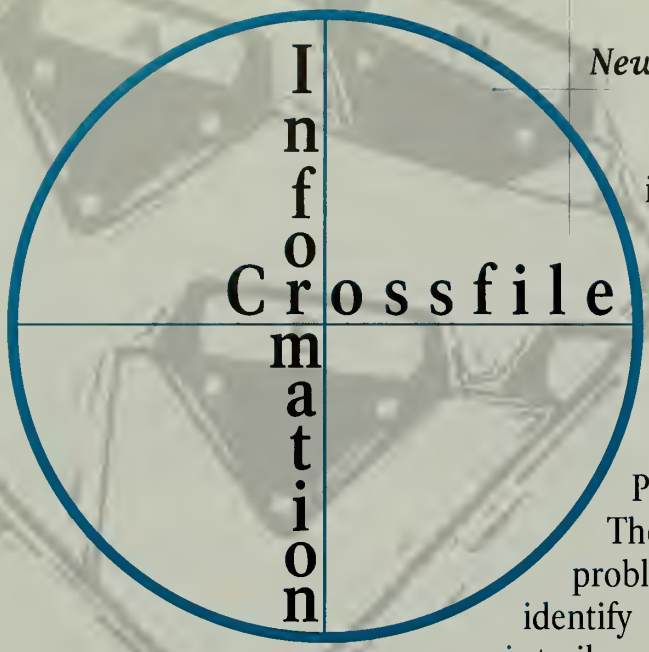
Fisheries enforcement task force on the Potomac

In spring 2000 and 2001, a multiagency task force conducted a fisheries enforcement operation on the Potomac River and adjacent national park system lands administered by the George Washington Memorial Parkway and the Chesapeake and Ohio Canal National Historical Park. The operation took place in the Little Falls-Chain Bridge area that straddles the Washington, D.C.-Maryland-Virginia border (see photo). During the seven days that the task force was active each year, citations were issued for 560 violations. These included the illegal catch of striped bass and shad, use of cast nets, snagging, fishing without a license, and a multitude of *Code-of-Federal Regulations* public use violations associated with alcohol, litter, graffiti, fires, and nighttime closures. Hundreds of pounds of highly prized anadromous striped bass were seized, some of which were donated to a homeless shelter.

The fisheries enforcement task force operated on the Potomac River and lands administered by the George Washington Memorial Parkway and the Chesapeake and Ohio Canal National Historical Park.

The task force was formed as a result of tips to an environmental crimes hotline and complaints about public use violations on NPS-administered lands. This stretch of the Potomac River is very popular for fishing because it is particularly narrow and fish are highly concentrated during the spring spawning runs. With the construction of a fish weir on the nearby Little Falls Dam, species such as striped bass, shad, and perch are now able to use an additional 10 miles of excellent spawning habitat up to the base of Great Falls.

As a result of the task force operation, the National Park Service and other natural resource agencies were able to get a better understanding of visitor use patterns in the area as well as to gather intelligence on commercial fish poaching and other fisheries violations. This information is being used to target educational and enforcement activities to reduce poaching and ensure that critical fish species are able to reach the newly accessible spawning habitat. Before the start of law enforcement efforts, the National Park Service estimated that over 200 striped bass were being poached in the area each day. The Park Service is now working with the Potomac Conservancy and other organizations to reduce poaching through education. The task force members included NPS rangers, U.S. Park Police, U.S. Fish and Wildlife Service, Maryland Department of Natural Resources, Virginia Department of Game and Inland Fisheries, Virginia Marine Resources Commission, Maryland National Capital Park Police, D.C. Harbor Police, and Arlington County Police. PS



New method to assess trail problems

The deterioration of trails from increasing visitation is a problem throughout the United States. Yu-Fai Leung and J. L. Marion developed a method, called the *trail problem-assessment method* (TPAM), to efficiently identify specific portions of trails that require repair (1999. Assessing trail conditions in protected areas: Application of a problem-assessment method in Great Smoky Mountains National Park, USA. Environmental Conservation 26(4):270–79). The method uses multiple indicators to evaluate tread problems. Park managers can use this method to help identify problem areas and take management actions to repair trails.

The authors applied TPAM to survey the condition of 72 backcountry trails (328 mi or 528 km; 35% of all trails) in Great Smoky Mountains National Park. Twenty-three indicators were measured, grouped into three categories to evaluate (1) trail type and use; (2) location, number, and lineal extent of pre-defined tread problems; and (3) design problems (e.g., excessive trail grades) and trail structures (e.g., number and relative effectiveness of constructed water bars and drainage dips for the diversion of water runoff from treads). The indicators were coded and could therefore be rapidly recorded on a simple form. The investigators recorded the distance from the trailhead to features such as water bars, and recorded starting and end distances from the trailhead for highly degraded segments. A recording was made only if a critical indicator condition had been reached. For example, soil erosion was not recorded unless it exceeded a depth of 11.8 in (30 cm) for a lineal distance of 9.8 ft (3 m).

The survey revealed serious deterioration of trails throughout the park, with damage being somewhat worse in the central and eastern portions of the park. Soil erosion of trail treads was the most extensive and possibly the most significant problem (14.9 mi or 24 km of trails had soil erosion exceeding 11.8 in or 30 cm). Rutted treads along with wet soils also contributed to excessive tread width (2.2 mi or 3.6 km in 176 locations or 0.7% of the surveyed trails). Users widen trails by trying to avoid poor or treacherous conditions in the main tread. Wet, muddy soil (752 incidents over an aggregate of 11.3 mi or 18.2 km) was the most frequent type of deterioration, in spite of a drier than average summer. Trails with wet, muddy treads tended to be concentrated where the use by horses was high.

The survey also revealed the effectiveness of trail structures. For example, water bars were rated as more effective than drainage dips for diverting water from the trail treads. Park officials have already used results of the survey in planning the management of trails.

TPAM has some limitations. For example, it cannot be used for determining average tread condition. Identifying which indicator condition constitutes a serious problem and determining the beginning and end of a deteriorating trail segment also are challenges. The authors suggested research be done to compare the precision of TPAM with other methods. A new article by the authors in the Journal of Park and Recreation Administration (fall 2001, volume 19(3):97–117) compares and contrasts TPAM with the point-sampling trail assessment method, providing an illustration of both methods and guidance in selecting between them.

Long-term ecological monitoring of Cape Cod National Seashore

Cape Cod National Seashore is one of 11 national park system units conducting prototype long-term ecological monitoring under the NPS Inventory and Monitoring Program. The seashore represents the Atlantic and Gulf coast biogeographic region, and protocols for monitoring its resources are suitable for monitoring resources elsewhere in the same biogeographic region.

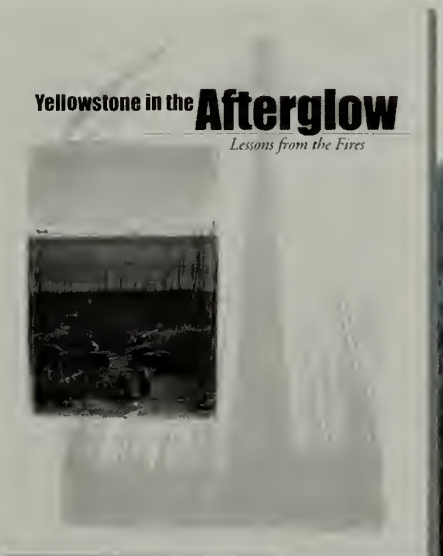
A 59-page technical report (Roman, C. T., and N. E. Barrett. 1999. Conceptual framework for the development of long-term monitoring protocols at Cape Cod National Seashore. Cooperative National Park Studies Unit, USGS Patuxent Wildlife Research Center) presents conceptual models for long-term monitoring of each major ecosystem type on the seashore: estuaries, salt marshes, barrier islands, spits, dunes, ponds, freshwater wetlands, and coastal uplands. The authors explain the complex relations among the natural or anthropogenic agents of change, stresses, and responses in ecosystem structure, function, or processes. The models are provided in the form of matrixes designed to reveal changes in ecosystems due to natural or anthropogenic sources of stress at various temporal and spatial scales.

The importance of Great Smoky Mountains National Park for wood thrush

Large, intact forests are believed to be important population sources for Neotropical landbirds. Great Smoky Mountains National Park, at the border of Tennessee and North Carolina, is one such area, with 508,198 acres (205,665 ha) of contiguous forest in the center of 4.9 million acres (2 million ha) of public land. The park's temperate climate, broad temperature and moisture gradients, and steep, complex topography all contribute to a diversity in bird species unlike any other area in North America. To evaluate the role the park plays in maintaining regional songbird populations, three researchers studied the productivity of the wood thrush (*Hylocichla mustelina* [Simons, T. R., G. L. Farnsworth, and S. A. Shriner. 2000. Evaluating Great Smoky Mountains National Park as a population source for the wood thrush. Conservation Biology 14(4):1133–44]). Great Smoky Mountains National Park is estimated to support a wood thrush breeding population of approximately 10,000 nesting pairs.

The high productivity of wood thrushes in the Great Smoky Mountains (3.31 nestlings per successful nest) indicates that the park provides high-quality nesting habitat. But daily nest survival rates also were below those reported in studies of wood thrushes in other areas, suggesting that the park may support more diverse and abundant predators. The researchers concluded that although Great Smoky Mountains National Park is a substantial population source for wood thrushes on a local scale, its potential to sustain regional or continental wood thrush populations is limited. Their findings indicate that large areas of suitable habitat outside protected areas and other public lands are necessary to sustain continental breeding populations of Neotropical birds.

Lessons from the Yellowstone fires of 1988



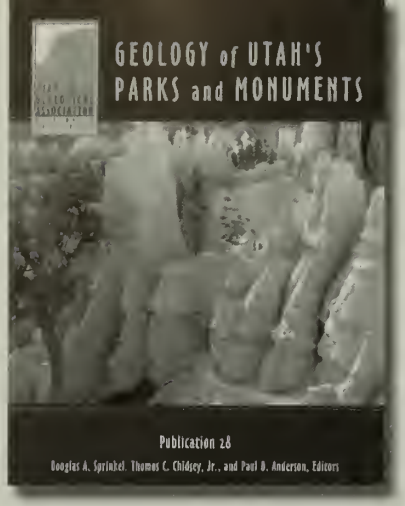
In spring 2001, as the snow melted off the millions of acres of Western forest and grassland that had been hit by the previous summer's record-breaking fire season, land managers began looking for signs of ecological change. They could find some clues about what to expect from the newly released *Yellowstone in the Afterglow: Lessons from the Fires* (Franke, M. F. 2000. National Park Service, Mammoth Hot Springs, Wyoming. YCR-NR-2000-03). Yellowstone National Park produced the 118-page book to summarize the results of several-hundred research projects that have been conducted since 1.4 million acres burned in the greater Yellowstone area in 1988. Many dire predictions were made that summer about the park's future—that wildlife would be reduced, that the forests would have to be replanted, that increased erosion would cause flooding downstream of the park, that visitation would decline. Instead, the research conducted in a variety of disciplines by dozens of scientists from academia and government have largely documented the resilience of the Yellowstone ecosystem in response to large fires.

The moose population on Yellowstone's Northern Range appears to have declined in part because of the loss of old-growth forest, and aspen seedlings are growing in burned areas where aspen had not previously existed, but these are the exceptions. For the most part, the fires of 1988 did not affect the abundance, distribution, or diversity of the park's plant and animal communities. In addition to demonstrating how such conclusions were arrived at, *Yellowstone in the Afterglow* explains the history of the park's controversial fire management policy and how public perceptions of the park and of wildland fire have changed over the years. The book is available in PDF format on the park's website at www.nps.gov/yell/publications/pdfs/fire/afterglow.htm.

New book showcases geology of Utah parks

Utah's parks and monuments contain some of the most spectacular geology and landscapes found anywhere in the world. To celebrate Utah's geologic parks during the millennium year, the Utah Geological Association (UGA) published a guidebook that highlights the geology of the state's parks and monuments (Sprinkel, D. A., T. C. Chidsey, Jr., and P. B. Anderson, editors. 2000. Geology of Utah's Parks and Monuments. UGA Publication 28. 644 pages. ISBN 0-9702571-0-4).

Scientific research into various aspects of the great Yellowstone fires of 1988 is summarized in a recent publication by the park entitled Yellowstone in the Afterglow.



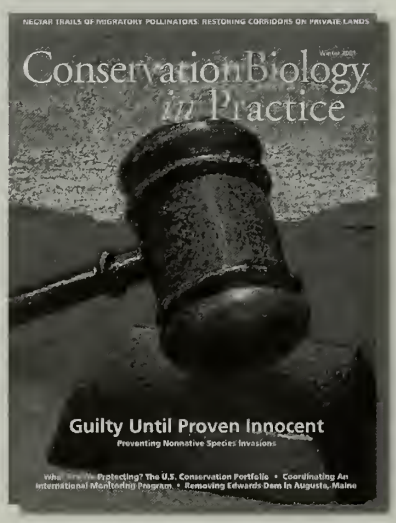
The book is viewed as a model for other states as far as its comprehensiveness, readability, and usefulness in explaining geology. It describes the geology of five national parks (Arches, Bryce Canyon, Canyonlands, Capitol Reef, and Zion), five national monuments in the national park system (Cedar Breaks, Dinosaur, Natural Bridges, Rainbow Bridge, and Timpanogos Cave), and one NPS-administered national recreation area (Glen Canyon), as well as one BLM national monument, one BLM national recreation area, 10 state parks, one geologic area, and one tribal park. In addition, the book has several topical papers, including a survey of paleontological resources in Utah's national parks and monuments.

A companion CD-ROM also is available (Anderson, P. B., and D. A. Sprinkel, editors, Geologic Road, Trail, and Lake Guides to Utah's Parks and Monuments, UGA Publication 29, ISBN 0-9702571-1-2). This compact disc contains road, trail, and lake logs that serve as geologic guides through most of the parks described in the book. The CD-ROM provides general descriptions of each park's geology and detailed descriptions of many geologic features at selected stops. The guides are intended for any park visitor interested in geology, as well as geologists, teachers, and students.

The National Park Service played a major role in the development of the publication and compact disc. Five NPS employees wrote parts of the book, while an NPS employee prepared one section of the compact disc. In addition, the NPS Geologic Resources Division provided financial support in developing the book and helped find and coordinate writing by NPS authors.

New conservation biology journal published

A new journal is now being published that is intended to "bridge the gap between conservation science, practice, and policy." The Society for Conservation Biology launched *Conservation Biology in Practice* in 2000. The journal is designed for conservation practitioners and policy makers who "are short on time but long on information needs." The editors want to "put conservation science into practice and conservation practice into science." Articles in the quarterly magazine cover new conservation biology research, innovative case studies, "hands-on" management tools and techniques, and practical resources for practitioners.



The winter 2001 issue (volume 2[1]) illustrates the topics the journal is covering. Among the features, Jason and Roy Van Driesche discuss preventing nonnative species invasions. J. Michael Scott, Robbyn J. F. Abbitt, and Craig R. Groves provide an overview of the lands being protected in the United States. Sarah DeWeerdt reports on the work of the Declining Amphibian Populations Task Force. And Ron Hiebert (Research Coordinator, Colorado Plateau Cooperative Ecosystem Studies Unit) describes an exotic plant ranking system, an automated web-based tool that can help managers prioritize decisions on the management of exotic plants.

The National Park Service is one of six partners who contributed start-up funds for the journal, help identify editorial material, and promote the journal. Associate Director Mike Soukup is on the editorial advisory board.

More information about *Conservation Biology in Practice*, including subscription information, can be found on the Internet at www.cbinpractice.org, or by contacting the editor, Department of Zoology, Box 351800, University of Washington, Seattle, WA 98195-7075; telephone 206-221-7075.

A guide for managing coral reefs

Coral reef ecosystems are one of the nation's most diverse ecosystems and are very valuable for fisheries, recreation, tourism, scientific research, education, and shoreline protection. Indeed, the value of most coral reef ecosystems is estimated to be in the billions of dollars. They are also fragile and face increasing stresses from many sources.

In 2000, the ecosystem science and conservation working group, an ad hoc committee of the U.S. Coral Reef Task Force, prepared a booklet to assist those involved in planning and managing coral reefs (Coral Reef Protected Areas: A Guide for Management. National Park Service Publication D-1449. 17pp.) Both federal and state agencies helped prepare the guide. The Park Service was a contributor to the booklet and compiled, edited, and published it. The guide is intended for use in developing coral reef management plans and reviewing plans for protected areas. Although the booklet is principally concerned with protected coral reefs under U.S. jurisdiction, it can assist those managing coral reefs elsewhere.

The guide has 13 elements, each of which is covered in one or two pages. References are provided at the end of many of the sections for those seeking additional information. Among the 13 elements are: planning and stakeholder cooperation; marine wilderness areas; enforcement; mapping; monitoring; restoration; and education and outreach.

Copies of the document may be obtained by contacting James Tilmant, NPS Water Resources Division, 1201 Oak Ridge Dr., Fort Collins, CO 80525. The guide is also posted on the Internet in PDF format at http://coralreef.gov/blueprnt.pdf. PS

Meetings of Interest*

January 24, 2002

The Sixth Symposium of Biological Research in the Jemez Mountains, New Mexico, will be held in Santa Fe. The goal of the symposium is to exchange results of ongoing biological research in the Jemez Mountains. For more information contact Stephen M. Fettig, Bandelier National Monument (505-672-3861, ext. 546; stephen_fettig@nps.gov).

March 18-22

The NPS Pacific West and Alaska Regions are sponsoring the West by Northwest 2001 Workshop in Seatle, Washington. Titled "Navigating the Future: Protecting and Sharing the Legacy," the workshop will have three themes: (1) walking the talk of the Organic Act: prohibition on impairment of park resources and values; (2) demonstrating results and accountability: an examination of performance management stratetgies for protection of resources; and (3) rising to the challenge: meeting planning and compliance needs. This training workshop provides NPS staff and partners an opportunity to share information, network, and learn about programs, policies, and standards. For more information, visit www.pwr.nps.gov/prog/natres/wxnw2002/wnwindex.htm.

May 15-17

The National Park Service along with eleven other federal and state agencies and non-profit groups are sponsoring the Fourth Conference on Research and Resource Management in the Southwestern Deserts, to be held in Tucson, Arizona. The theme of the conference, "Meeting Resource Management Information Needs," acknowledges the importance of and increasing need for data to support decision making. Conference sponsors hope to improve the preservation of natural and cultural resources by increasing understanding of current research and resource management challenges, and to achieve more collaboration through discussion of current research and future research needs. Among the invited speakers are Karen Wade, NPS Intermountain Regional Director, who will speak about the Natural Resource Challenge Program, and Nancy Kaufman, U.S. Fish and Wildlife Service Region 2 Director, who will discuss how that bureau is planning to meet its information needs. Additional information on the conference can be found at www.werc.usgs.gov/sdfs/meetings.html.

August 4-9

The Ecological Society of America (ESA) and the Society for Ecological Restoration (SER) will be meeting jointly next summer in Tucson, Arizona. The theme of the meeting is "A Convocation: Understanding and Restoring Ecosystems." The organizers are calling this conference a convocation, because it is the coming together of two organizations, ESA and SER, that share the common purpose of using basic ecological knowledge to solve practical environmental problems. The meeting will include practitioners, managers, regulators, academic scientists, agency researchers, educators, and interested citizens. The organizers also are encouraging ecologists and restorationists in Mexico and Latin America to attend. Esteemed Harvard biologist E. O. Wilson will be giving the keynote address to the conference. For further information on the conference, consult www.esa.org/tucson, or contact the program chair: Paul H. Zedler, Institute for Environmental Studies and Arboretum, University of Wisconsin-Madison (608-265-8018; esa@mail.ies.wisc.edu).

*Readers with access to the NPS Natural Resources Intranet can view a comprehensive listing of upcoming meetings, conferences, and training courses at www1.nrintra.nps.gov/NRMeet/index.cfm.

notes from abroad

PARK MANAGEMENT in Germany

A YOUNG AND GROWING PARK SYSTEM DRAWS INSPIRATION FROM THE U.S. NATIONAL PARK MODEL

Article and photos by Thomas Meyer

Located in central Europe, Germany is about the size of Montana and has a long history of settlement and a high population density[1]. Thus, Germany's landscape is very fragmented and lacks uninhabited natural areas such as old-growth forests. In this setting, Germany has only been able to establish national parks on lands altered by human use; areas suitable for the highest preservation status have been hard to find. Nevertheless 14 national parks exist in my country today (figure 1). They are situated in less populated regions and are generally small compared to parks in North America. However, their objective is similar to U.S. national parks: to allow natural succession, protect natural landscapes, and provide for recreation.

Because of our land use history, the present focus in German parks is on protecting succession so that natural landscapes can develop once again. Our parks are in transition because the primary resource for which they were created is not (entirely) present. Almost 70 years ago Shenandoah National Park (Virginia) became the first "transition park" because its mixed hardwood and evergreen forest had been logged from previous settlement, leaving only small patches of old-growth forest (Engle 1998; Conservation Foundation 1985). As one can imagine, land uses such as agriculture and forestry leave footprints on sometimes fragile ecosystems. Yet, as we all know, resource management is a tool used by park administrations around the world to restore degraded ecosystems. In this respect national parks in Germany and the United States are similar, and, as you will see, an intriguing blend of both similarities and differences in the history and management of the two park systems exists.

1 Two-hundred thirty people per square kilometer or 89 people per square mile compared with 28 per square kilometer or 11 per square mile in the United States.

NATIONAL PARK BY "ACCIDENT"

Germany's first national park was established in the Bavarian Forest in 1970 with the objective of attracting tourists to its remote location. However, the denomination "national park" was merely a public relations strategy to promote a park that was intended purely as a recreational area. Consumptive uses such as timber harvest and hunting were to continue. Thanks only to a few people who were in charge of managing those 13,000 hectares (32,123 acres) was the Bavarian National Park transformed into a "real" national park according to international standards.

The long absence of national parks in Germany can be explained by a different conservation tradition from the United States. Early conservation efforts in Germany focused on species conservation and preservation of natural monuments, leading to the creation of the first nature reserves around 1900. Although some politicians were inspired by the national park idea, their plans failed, in part, because Germany lacked pristine areas and the concept of transition parks had not been established. Additionally, two world wars intervened and diverted attention from the conservation movement.

A second national park was established in the Alps in 1978, followed by three more parks in the Waddensea coastal zone of the North Sea. Thereafter, the potential for additional parks was scant until 1989 when the German Democratic Republic (GDR or East Germany) became more open to the West. With the fall of the Berlin Wall a group of East German conservation leaders went on a study tour of the United States to learn about protected areas and to incorporate new ideas in their latest conservation projects. The former East Germany was less densely settled than its western counterpart and possessed many promising conservation sites. Although several areas suitable for national park designation had been identified in the years of the GDR, their protection as "national parks" was prohibited because the idea was American or capitalist! The conservationists met with NPS officials and visited Shenandoah National Park where they were fascinated to view the results of America's first transition park project. By the time of Germany's reunification in 1990 five parks in the former GDR had been created, setting aside an additional 130,000 hectares (321,230 acres—figure 2, page 14). About 5% of the former East Germany was protected as nature reserve, biosphere reserve, or national park—a great success for nature conservation!

Figure 1. German national parks by state. (Adapted by the NPS Natural Resource Information Division from the original by LANIS-Bund—the German Federal Agency for Nature Conservation, 1999.)

Management Guidelines Needed

In 1973 the International Union for Conservation of Nature and Natural Resources (IUCN) set up criteria for classification of protected areas. The long experience of U.S. parks heavily influenced those standards for national parks around the world. In fact, German park managers aim to meet the IUCN standards since they promote the national park idea better than German law. The IUCN revised its standards in 1992, requiring national parks to fulfill management criteria, such as preservation of ecological integrity and exclusion of any use that might deteriorate it, in at least 75% of an area. This explicit requirement was necessary because forestry, mass tourism, and mining are incompatible with national parks. Nevertheless, natural resource restoration operates with tools commonly associated with forestry, including thinning and replanting. Accordingly, park zoning must distinguish restoration zones from natural areas. Currently only three out of 14 German parks qualify as national parks by IUCN definition.

Natural Landscapes—Step by Step

By far the largest challenge for managers of recently created German parks is addressing the many concerns related to restoring ecological function in cultivated areas. Centuries of forestry, mining, and hunting have left behind a landscape with logging roads, planted forests, introduced species, and unnaturally high deer populations. Restoration work is needed to remove structures like roads, buildings, and bridges and to de-channelize streams. Field trials in the Bavarian Forest have shown that leaving roads intact does not mitigate the human impact. In this case the wilderness ethic nurtured in the United States influenced park managers to undo human impacts where feasible in order to have "wild" landscapes inside park boundaries. The retention of wild landscapes in Germany is a philosophy that parallels, for example, the watershed rehabilitation program in Redwood National Park (California), although removal of logging roads there is mainly to mitigate erosion.

In German national parks meadows and former fields can usually be left completely to natural succession. Only when cultural landforms are crucial to the survival of threatened species are they perpetuated by active management. This policy is comparable to the management of historic landscapes and cultural zones in U.S. parks, even if we do it for different reasons. Due to the small size of German national parks, we try to keep as little area as possible under permanent vegetation management, preferably less than 5%. In contrast, nature reserves, which are smaller in size and permit more active management, are usually better suited for this goal. Furthermore, historic landscapes receive a different protection status

that allows active management to preserve the historic context.

Managers of our young parks generally have two options regarding any resource problem: do something about it or let nature regulate it. The decision to act or not applies to animal populations, plantation forests, roads, and exotic species alike and depends on the philosophy of the park manager, funding, and the feasibility of the proposed remedy. Each park might take a different approach. Surely surprising to the American reader is that national parks in Germany are not within federal, but rather state, authority. Also, states have not officially agreed upon a park management policy. Nevertheless, most park managers are eager to comply with the already mentioned international standards and are advocating wilderness ideas similar to those in the United States. Thus, we are developing an informal management policy that is adapted to our situation in Germany but according to the spirit of John Muir and Aldo Leopold.

Figure 2. (above) The white cliffs of Jasmund National Park attract more than 1.5 million visitors per year.

Figure 3. (right) The natural zone of Hochharz National Park encompasses trees that were killed by a bark beetle infestation (Ips typographus) *20 years ago following windthrow.*

Unique Problems?

In three German parks, where spruce plantations partially cover the park, managers worry about bark beetle infestations and lacking recruitment of native tree species. Trees killed by insects are a normal occurrence in a forest ecosystem and, in general, park managers agree that national parks should protect such processes. Unfortunately, all parks have close neighbors, and since Germany is densely populated, they observe cautiously what happens inside the park boundaries. Private forest owners bordering parks oppose such "large-scale experiments" as they refer to natural processes (figure 3). Local acceptance of parks is crucial and requires managers to respect the fears of park neighbors that insect infestations might spread. In the Bavarian Forest, a buffer zone of at least 500 meters (547 yards) width serves as a barrier where infested trees are removed or stripped of their bark.

Another issue related to plantations is the uniformity of forest stands—often including nonnative tree species (figure 4). How does one deal with this problem? Leaving such stands alone might lead to a natural forest with natural species in a couple hundred years. On the other hand, thinning helps speed up that process by breaking up structures and giving seeds of other species a chance to invade the gaps. This technique adds diversity to almost bare forests. Clear-cuts could also (very fast indeed) help to jump-start a new, natural forest. Except for small acreages, however, this option is not applicable in most parks. Only a decade ago, clear-cuts were banned in Germany by law and today forestry is concentrating on selective harvesting. Reinventing clear-cuts for conservation purposes would surely be a very unfortunate decision.

Wildlife needs regulation in all of Germany because predators like wolves, bears, and bobcats were eradicated centuries ago and are missing in our ecosystems. Without hunting, deer and elk populations would otherwise increase dramatically and have a great impact on vegetation and natural regeneration of our forests. Although hunting for trophies is fairly common in Germany, it is prohibited inside parks. In protected areas elk and deer are regulated by imitating predation, with rangers culling preferably young, weak, and ill animals. Trophies of these "regulated" animals become property of the park.

Figure 4. (left) Müritz National Park, created in 1990, inherited several thousand hectares of pine plantations. Thinning is an option to break up these uniform, unnatural forests.

Figure 5. (below) Former tank shooting range—today the largest forest succession in Hainich National Park.

The situation in Germany's Hainich National Park is somewhat similar to Shenandoah, where farmlands from pre-park days were left alone and a new forest grew up in its place. In Hainich, large areas were cleared in the 1980s to create a Russian-tank shooting range. Today it is the largest forest succession in Germany and has been protected in a national park since 1997 when the military abandoned the area (figure 5). Because only native species revegetate these lands, no further management is needed.

Parks and People

Experience has shown that protected areas in Germany only have a chance to function if created on state property. This is especially true for national parks because they usually exclude or end any detrimental uses that were previously legal. In Germany private landowners living adjacent to parks mostly oppose the parks because they fear restrictions, park expansion, and insect diseases that might escape from within the boundary. Even though visitor spending has a high positive impact on local economies and many jobs can be attributed to the parks, this negative attitude prevails. Studies have shown that the greater the distance between a park and its neighbors, the greater its acceptance. Therefore, the main goal of park interpreters is to address these problems and to educate not only visitors from far away but also park neighbors.

Conclusion

Although the many park management problems described in this article are mostly related to Germany's fragmented and "civilized" landscape, managers in some U.S. national parks are probably dealing with similar issues. Considering that untouched landscapes are decreasing year by year, the ability to find ways to deal with human influence in protected areas will become increasingly important. Perhaps this overview of current park management in Germany will encourage further thinking about resource management in disturbed landscapes and arouse interest in visiting our parks to see what results the "best idea America ever had" has produced abroad. PS

Literature

Conservation Foundation. 1985. National parks for a new generation: visions, realities, prospects. Report. Conservation Foundation, Washington, D.C. 407pp.

Engle, R. L. 1998. Shenandoah National Park: A historical overview. National Park Service. Cultural Resource Management 21(1):7–10.

IUCN. 1994. Richtlinien für Management-Kategorien von Schutzgebieten. IUCN, WCPA, Gland, Switzerland. 23pp.

Knapp, H. D. 1995. Das ostdeutsche Nationalpark-Programm 5 Jahre danach. Nationalpark 87:2–12.

Mitchell, J. G. 1988. Unfinished Redwood. Audubon 90(5):57–77.

Wegener, U. 1995. Tun und Lassen im Nationalpark. Nationalpark 86:22–25.

Wölfel, H. 1994. Waldentwicklung und Schalenwild. Pages 63–75 in Nationalpark Hochharz. Bericht 2. Wissenschaftliche Arbeitstagung. Nationalparkverwaltung Hochharz, Wernigerode.

About the Author

Thomas Meyer is currently working for the State Forest Service of Thuringia, Germany. He graduated with a Master of Science Degree in Forestry from the University of Göttingen, Germany. In his thesis he compared resource management in national parks in Germany and the United States. He also served as an intern with several German parks and Redwood National Park and spent two semesters as an exchange student at the University of California at Berkeley. He can be reached at Wingertstrasse 48, D-61200 Woelfersheim, Germany; ++49-6036-980920; thomas.meyer@lycos.com.

MAB NOTES

SEVILLE +5

A PROGRESS REPORT ON U.S. AND INTERNATIONAL BIOSPHERE RESERVES

By John G. Dennis

Biosphere reserves are internationally recognized terrestrial and coastal or marine areas where management seeks to achieve sustainable use of natural resources while ensuring conservation of the biological diversity of the areas. The first biosphere reserves were designated in 1976 as part of the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and the Biosphere Program (MAB). Biosphere reserves are nominated by national governments for inclusion in the world network of biosphere reserves. Each nation's sites remain under the sovereign jurisdiction of the nominating country. Today, a total of 391 biosphere reserves are recognized in 94 countries. Of these, 47 are in the United States, with 23 involving 30 units of the national park system (table 1, page 18). Although in the past few years some people in the United States have expressed concern that international recognition as a biosphere reserve could cause loss of private property rights, such recognition is sought and obtained voluntarily by the land manager, does not change land ownership status, and does not reduce private property rights. In fact, 13 of the 99 land management units that are part of the 47 biosphere reserves recognized in the United States involve some degree of non-governmental ownership.

In 1994 the United States adopted a strategic plan for the U.S. biosphere reserve program and fully participated when the international biosphere reserve program met in Seville, Spain, in 1995 to develop the Seville Strategy and the Statutory Framework of the World Network of Biosphere Reserves. In 2000, the United States, with a three-person delegation, was one of 46 countries that met in Pamplona, Spain, to learn from each other's experiences in implementing the biosphere reserve concept enunciated in the Seville Strategy (figures 1 and 2).

Figure 1. Participants of the international MAB review meeting in Pamplona, Spain, visited Bardenas Reales, a Spanish biosphere reserve designated in November 2000. Shown are the author (left) and Javier Castroviejo Bolibar, chairman of the Spanish MAB National Committee.

Figure 2. Located in northern Spain near the Pyrenees Mountains, Bardenas Reales Biosphere Reserve sustains high biological diversity through a mosaic of traditional land uses such as grazing and agriculture and natural disturbances that diversify habitat types.

INTERNATIONAL ASSESSMENT AT PAMPLONA

The Seville Strategy contains four broad goals: (1) to use biosphere reserves to conserve natural and cultural diversity; (2) to use biosphere reserves as models of land management and sustainable development; (3) to use biosphere reserves for research, monitoring, education, and training; and (4) to integrate functions within biosphere reserves and strengthen the world network. The Pamplona review, organized into 10 concurrent work groups followed by plenary sessions, assessed the progress of biosphere reserves in integrating the four goals. As the NPS representative for national park-related USMAB (United States Man and Biosphere Program) issues, I participated in the Pamplona review and will discuss the recommendations of the work groups.

RESEARCH AND MONITORING

One work group explored the success of biosphere reserves as sites supporting international research and monitoring programs using examples from Brazil, Indonesia, Canada, Egypt, United States, and Sweden. The group's recommendations encourage the MAB program to harmonize its research initiatives with several international programs; encourage regional networks of biosphere reserves to develop and adopt research and standardized monitoring projects related to conservation and sustainable development, especially at the landscape scale; and encourage biosphere reserves to share results and incorporate the social sciences, local communities, and volunteers into their research and monitoring programs.

SUSTAINABLE CONSERVATION

Presentations from Viet Nam, Czech Republic, and Egypt formed the basis for discussion about the role of biosphere reserves in conserving genetic resources and declining species. Recommendations encourage engaging the scientific community to inventory the potential for, and size constraints of, using biosphere reserves as gene pools of wild and domestic species; involving both local interest groups and national governments and science organizations in ensuring long-term sustainability and local economic viability of the humans involved with the reserves; and designing projects to rehabilitate degraded ecosystems in ways that also have them serve as scientific underpinnings of multilateral environmental initiatives.

Examples from Kenya, Cambodia, Colombia, Argentina, and Sweden provided models for discussions of land management and sustainable development and a conclusion that more work is needed to make biosphere reserves ideal, functioning models for sustainable land, coastal, and marine resource management. Recommendations for carrying out this work include: using social science-based efforts to increase the active partnership of local communities and nongovernmental organizations; developing information systems that incorporate traditional knowledge, enhance information exchange among partners, and generate technical approaches regarding land use and land tenure decisions and conflict resolution in biosphere reserves; applying clearly stated management objectives to integrating biosphere reserves into regional plans and monitoring the success of bios-

phere reserves in contributing to regional-scale sustainable development; and publishing examples of successful integration of biosphere reserves into their broader regions.

Canada, Germany, Niger, China, Uganda, and Argentina provided examples for examining possible roles of biosphere reserves in helping to develop quality economies. Recommendations focus on three broad themes. There is need to highlight the importance of sustainable economic and social development and demonstrate approaches to achieving this development, especially with respect to fostering diverse agricultural activities. Economic activities must be profitable, sustainable, and socially and environmentally responsible. Efforts to develop new economic activities should build on and complement existing regional activities by drawing on special characteristics of the region and its cultural identity and by creating and marketing brand names and symbols that reflect the special character of the region.

TABLE 1.
UNITS OF THE U.S. NATIONAL PARK SYSTEM AND ASSOCIATED BIOSPHERE RESERVES

PARK UNIT	BIOSPHERE RESERVE	YEAR DESIGNATED, EXTENDED
Big Bend National Park (TX)	Big 8end	1976
Channel Islands National Park (CA)	Channel Islands	1976
Denali National Park and Preserve (AK)	Denali	1976
Everglades and Dry Tortugas National Parks (FL)	Everglades & Dry Tortugas	1976
Glacier National Park (MT)	Glacier	1976
Noatak National Preserve (AK) and Gates of the Arctic National Park (AK) (part)	Noatak	1976, 1984
Olympic National Park (WA)	Olympic	1976
Organ Pipe Cactus National Monument (AZ)	Organ Pipe Cactus	1976
Rocky Mountain National Park (CO)	Rocky Mountain	1976
Sequoia and Kings Canyon National Parks (CA)	Sequoia and Kings Canyon	1976
Virgin Islands National Park (VI)	Virgin Islands	1976
Yellowstone National Park (WY, MT, ID)	Yellowstone	1976
Haleakala and Hawaii Volcanoes National Parks (HI)	Hawaiian Islands	1980
Isle Royale National Park (MI)	Isle Royale	1980
8ig Thicket National Preserve (TX)	Big Thicket	1981
Redwood NP (CA)	California Coast Ranges	1983
Congaree Swamp National Monument (SC)	South Atlantic Coastal Plain	1983
Death Valley and Joshua Tree National Parks (CA)	Mojave and Colorado Deserts	1984
Cape Lookout National Seashore (NC) and Cumberland Island National Seashore (GA)	Carolinian-South Atlantic	1986
Glacier 8ay National Park (AK)	Glacier 8ay-Admiralty Island	1986
Golden Gate National Recreation Area and Point Reyes National Seashore (CA)	Central California Coast	1988
Great Smoky Mountains National Park (TN, NC)	Southern Appalachian	1988
Mammoth Cave National Park (KY)	Mammoth Cave Area	1990, 1996

COORDINATION, COOPERATION, AND COMMUNICATION

Presentations from Russian Federation, Estonia, Benin, and United States provided the basis for an exploration of different approaches for managing biosphere reserves that concluded that coordination is the key function in managing biosphere reserves. Recommendations focus on creating specific institutional mechanisms to support coordination, including (as key components) a capacity to encourage participation and consensus, the ability to integrate knowledge into common projects, and the ability to speed the flow of information. Additional recommendations encourage having the international biosphere reserve program develop guidelines for creation, roles, and functions of these institutional mechanisms.

> "Coordination is the key function in managing biosphere reserves."

Discussion of how to coordinate national biosphere reserve networks drew on presentations from China, Canada, France, India, Ukraine, Cuba, and Belarus that emphasized that coordinating structures need dedicated support if they are to achieve their functions of information exchange, project coordination and development, and fund-raising and advocacy. To advance the functioning of biosphere reserves, the work group recommended close coordination between individual biosphere reserve coordinators and their national biosphere coordinating structure; creation of an adequately supported human and financial structure at the time a biosphere reserve is nominated for international recognition; and international cooperation in fund-raising and personnel exchanges as a means of helping foster individual biosphere reserves.

Other participants examined ways for raising visibility and support for the world network of biosphere reserves using case studies from Madagascar, Morocco, Belarus, Argentina, and Brazil. Broad discussions regarding communication, publication of success stories, importance of biosphere reserves for generating income for local human populations, and the coordination role of regional networks led to six recommendations. Key points include needs for guidelines on how to approach potential donors to projects, for awareness-raising mechanisms, and for increasing the involvement of nongovernmental organizations in biosphere reserve activities designed to bring biosphere reserves together.

An examination of the linkage of biosphere reserves to decision making at the national level drew on examples from Cuba, Republic of Korea, Ecuador, Finland, and Germany and concluded that the biosphere reserve concept is not yet well appreciated at this level. Recommendations to improve this linkage urge MAB national committees to demonstrate within the context of their own national situations the added values that biosphere reserves bring in areas of social and sustainable develop-

ment, science, technical assistance, conflict resolution, capacity building, and citizen participation in environmental concerns. The recommendations also urge MAB national committees to participate in developing national strategies for sustainable development, promote biosphere reserves as places in which nations can implement activities as part of international environmental programs, and encourage international exchange activities as a means of raising national awareness of and pride in a nation's own biosphere reserves.

Presentations from Russian Federation, South Africa, Spain, Egypt, Democratic Republic of Congo, and the MAB international office supported an exploration of education, awareness building, and training regarding biosphere reserves that developed themes concerning awareness of economic and social benefits, information exchange regarding education and public awareness, awareness of characteristics of recipient groups, need to use a diversity of methods, and importance of two-way communication. Recommendations evolving from these themes include: connect biosphere reserves using information webs, develop education and awareness programs to use two-way communication involving diverse methods, and encourage biosphere reserves to help develop environmental awareness and opportunities for equitable sharing of benefits through activities that bring together a wide range of participants and information sharing actions.

PERIODIC REVIEWS NEEDED

Article 9 of the Statutory Framework for biosphere reserves encourages countries to review each of their biosphere reserves every 10 years. Presentations of review experiences in United Kingdom, Indonesia, Switzerland, Argentina, Egypt, and Poland showed the practical value of this process in helping nations understand and improve the awareness, support, and function of these dynamic conservation and sustainable use models. Recommendations include using the review to ensure that biosphere reserves fulfill all three key functions of a biosphere reserve: conservation, sustainable development, and support of research, education, and training. Other recommendations pertain to actively involving in the review both local stakeholders and multidisciplinary groups of experts through workshops and field visits; stimulating development and use of new evaluative indicators of success of a biosphere reserve; and sharing the experiences of national reviews internationally to help other nations conduct their own productive reviews.

ASSESSMENT AND OPPORTUNITIES FOR U.S. BIOSPHERE RESERVES

The Seville Strategy, Statutory Framework, and recommendations of the Pamplona review meeting together offer the world a strong, interactive tool for exploring techniques to achieve environmental conservation and sustainable development. The United States Man and Biosphere Program, including the national park system, has a large and well distributed number of sizable, active, and in some places multiorganizational biosphere reserves. The USMAB, again including the national park system, also has clear examples of biosphere reserves that, in terms of the Pamplona review, are failing to contribute research and monitoring, are focal points for people who oppose any program affiliated with the United Nations, are not viewed as models of sustainable development, are lacking in effective coordination, are not supporting quality economies, have not been reviewed, antagonize national decision makers, and are failing to educate stakeholders about the opportunities that biosphere reserves can bring to regions of the United States.

The experiences reported by other nations at Pamplona offer ideas for USMAB. The success of some U.S. biosphere reserves and dysfunction of others suggest a need for USMAB to conduct periodic reviews and to compare the results with those of other countries. Given other countries' experiences, a USMAB review likely would reveal advantages U.S. biosphere reserves could gain by having dedicated biosphere reserve coordinators, active and multiorganizational awareness programs, well developed research and monitoring programs, and demonstration projects designed to explore the characteristics, economic and conservation benefits, and costs of sustainable uses of landscapes and to involve the cooperation of public and private entities. Similarly, such a review likely would identify steps that USMAB would need to take at both national and local levels to make biosphere reserves productive models of conservation and sustainable development. Many of the steps this review likely would reveal would provide mechanisms for implementing actions identified in the USMAB Strategic Plan for the United States Biosphere Reserve Program. As USMAB moves from the State Department to the USDA Forest Service and as it undergoes a new self-evaluation, now is the time for it to apply its Strategic Plan to make the U.S. biosphere reserves effective models of conservation and sustainable development. PS

ABOUT THE AUTHOR

John G. Dennis is a Biologist with the NPS Natural Systems Management Office in Washington, D.C. He is the National Park Service's coordinator for USMAB issues related to units of the national park system and can be reached at 202-208-5193 and john_dennis@nps.gov.

Recent colonization of mangrove and frigatebird populations in the Dry Tortugas

Dry Tortugas National Park is a remote enclave of islands in Gulf of Mexico waters at the end of the Straits of Florida noted for its vintage Spanish-American fort, colorful corals, and teeming tern populations (figure 1). In recent decades researchers have observed ecological change above the water line, notably the establishment of a mangrove forest and nesting of magnificent frigatebirds (Fregata magnificens).

Figure 1. Located 70 miles (114 km) west of Key West, Florida, Dry Tortugas National Park is known for its massive Spanish-American fort, coral reefs, and colonial seabirds. The mangrove forest and seabird surveys were conducted on Bush and Long Keys (background); Fort Jefferson is located on Garden Key (foreground).

Background

Historically, the Tortugas shoals have been valued as an important military outpost and nesting ground for diverse seabirds. The notoriety of these islands was gained from mariners and naturalists alike, most notably John James Audubon, famed artist and ornithologist, who frequented the area in the mid-1800s to observe the rich bird life. The Dry Tortugas was declared a national treasure and bird sanctuary as early as 1908 and incorporated into the national park system in 1935.

The Carnegie Institute maintained a remote marine laboratory on Loggerhead Key at the turn of the last century (i.e., 1900) where many scientific studies of bird and marine life were conducted. In the volumes of historical biological investigations, mangroves and the magnificent frigatebird are of little note. Naturalist John Henry Davis mapped the vegetation of the Dry Tortugas in 1935 and observed the conspicuous absence of mangroves that were ubiquitous in the nearby Marquesas atoll and all other keys of the Straits of Florida. Davis planted thousands of red mangrove *(Rhizophora mangle)* propagules that persisted as seedlings a few years but ultimately failed to take permanent root. In recent years, healthy populations of mangroves and frigatebirds have naturally colonized Long and Bush Keys (figures 2 and 3).

Figure 2. Absent on the Dry Tortugas in 1935, mangroves are now flourishing on Bush and Long Keys.

We conducted a historical and ecological survey of mangrove colonization of the Dry Tortugas to determine forest age, tree growth, and stand structure of these islands. Published accounts and both ground and aerial photography provided a reasonable chronicle of mangrove establishment in shoal sections of Long and Bush Keys, islands adjacent to historic Fort Jefferson and Garden

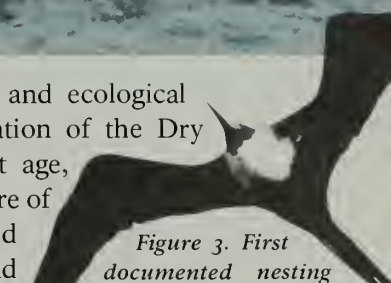


Figure 3. First documented nesting on the Dry Tortugas in 1988, magnificent frigatebirds are now common nesters, their breeding success linked to the surge in mangrove vigor of the past several decades.

Key (figure 4). Presently, robust populations of mangrove trees of all three neotropical species, black mangrove (*Avicennia germinans* (L.) Stearn), white mangrove (*Laguncularia racemosa* (L.) Gaertn.f.), and red mangrove thrive on these keys. In the fall of 1995 and 1997, we measured tree size and density by species in fixed circular plots of mangrove habitat on Bush and Long Keys. We collected surface and soil water samples to characterize the salinity, pH, and nutrient concentrations for each site. Porewaters were extracted at three depths (5, 15, and 25 cm [2, 6, and 10 in]) below the soil surface using a sipper tube and syringe by vacuum suction.

Review of historic seabird surveys

Ornithologists and park staff have provided bird counts on these islands fairly continuously since the early expeditions by Audubon in the 1830s. Frigatebirds have been observed on this site for most of the 20th century either roosting or feeding but only recently confirmed as nesting in the area. We observed nesting frigatebirds perched in the most developed mangrove stands (> 15 m [50 ft] in height) along the extended shoal of Long Key. This colony is thought to have migrated from previous nesting grounds in the Marquesas atoll (32 km or 20 mi to the east) circa 1988–89. The first nestlings at the Tortugas were observed in the spring of 1988 from a total nest count of 9 breeding pairs. By 1993 the nest count had increased to 70 breeding pairs. In recent years, the population has ranged between 50 and 100 breeding pairs.

As we discovered, Bush Key has undergone much shoreline erosion on its north end as evidenced from recent aerial photography compared with historic photos and maps taken from Davis (1942). A brown pelican *(Pelecanus occidentalis)* roost in the remaining mangrove trees on the north end of Bush Key may be hastening the death of these trees along with loss of substrate from beach erosion (figure 5). The red and white mangrove trees along this beach were once established around interior ponds in the center of the island and have grown to 20–25 cm (8–10 in) diameter at breast height (dbh) over the last 50 years. We did not take any plot data at this site because of the degraded condition of the trees and forest. Red mangrove saplings are colonizing the understory and edge of the surviving emergents inside the beach dune, but many are extremely chlorotic (yellowish in appearance due to lack of green chlorophyll) and dying from high concentrations of phosphate and nitrate accumulated from unflushed pelican guano. Early Carnegie Institute studies on these pond systems around 1900 document the presence of sapling-size red and white mangrove recruits. The largest trees might approach 100 years but are no older at this site.

Forest surveys

We established forest plots on the east end of Bush Key in a mixed mangrove stand of all three species: red, white, and black mangrove (see figure 4). The largest canopy trees approached 14 cm (6 in) dbh and 7.5 m (25 ft) in height and are estimated to be about 25 years of age. Internode measurements (i.e., length of stem between leaf scars) of understory red mangrove saplings indicate that they are growing well despite shade conditions and nominal organic soil atop coarse coral debris regularly inundated by saline Gulf water. We found nutrient levels (nitrate and phosphate) in the interstitial water at this site to be comparable to lagoonal concentrations and significantly greater than open Gulf waters. Unlike northern Bush Key where accumulated pelican guano may be detrimental to mangrove health, eastern Bush Key and Long Key are tidally flushed so that the nutrient input of nearby bird colonies is effectively diluted and provides fertile growing conditions for the mangroves.

We also documented tree plots on the north and south ends of Long Key in a fairly large stand of mixed mature mangroves of all three species (see figure 4). The largest and tallest trees, 25 cm (10 in) dbh and 15 m (49 ft) in height, respectively, were central in the stand; however, we did not measure them in order to minimize stress of fledgling frigatebirds. This stand resides in the vicinity of Davis's failed red mangrove plantings of the early '40s. Personal accounts and dated aerial photography confirm a stand age of 50 years or younger. Twin hurricanes in the mid-40's and 60's were among the most intense to hit the Tortugas in the 20th century, scouring island vegetation, shorelines, and park infrastructure. The natural colonization and success of all three mangrove species over the last few decades onto coral wrack under such exposed and harsh saltwater conditions surprisingly compares with the growth and stature of mainland populations of riverine mangroves in brackish waters of Everglades National Park.

The added nutrient input of a resident frigatebird colony into lagoonal waters may be augmenting the growth rate of mangroves as evidenced in accelerated height-growth relations of decade-old saplings. Growth rates, based on internode elongation follow seasonal patterns that allow aging of yearly flushes. Increased elongation patterns follow the 1989 growth year that may be concomitant with nesting history and water quality changes from input of frigatebird guano. Nutrient analyses of collected water samples demonstrated orders of magnitude differences in nitrate and phosphate concentrations in the vicinity of frigatebird and pelican roosts than in adjacent beach and lagoonal waters (figure 6). These results indicate that seabirds that depend on mangroves for nesting and roosting also increase nutrients in surrounding soils and waters that in turn may enhance mangrove photosynthesis and water use efficiency, resulting in enhanced growth.

Figure 4. Historic photos and contemporary aerial images of Bush and Long Keys helped the researchers reconstruct the history of mangrove colonization at Dry Tortugas. Arrows denote the locations of the tree plot survey sites on the east end of Bush Key (bottom left, foreground) and south ends of Long Key (top, background).

Hurricanes

Hurricanes may also have played a critical role in determining the long-term success of mangrove colonization in the Tortugas atoll. Historical accounts of early explorers, lighthouse keepers, and military correspondence refer to the presence of mangroves, bushes, and trees (or the lack thereof) dating to the mid-1700s. Accounts of hurricane impact by island residents and mariners demonstrate the vulnerability of these exposed low-relief islands to violent storms and erosion of emergent vegetation. The relatively small size and open exposure of these islands to sea conditions and hurricane impact may explain the recurrence of mangroves in years after an extended absence of storms. In contrast, the destruction and paucity of mangroves following major hurricanes is pronounced.

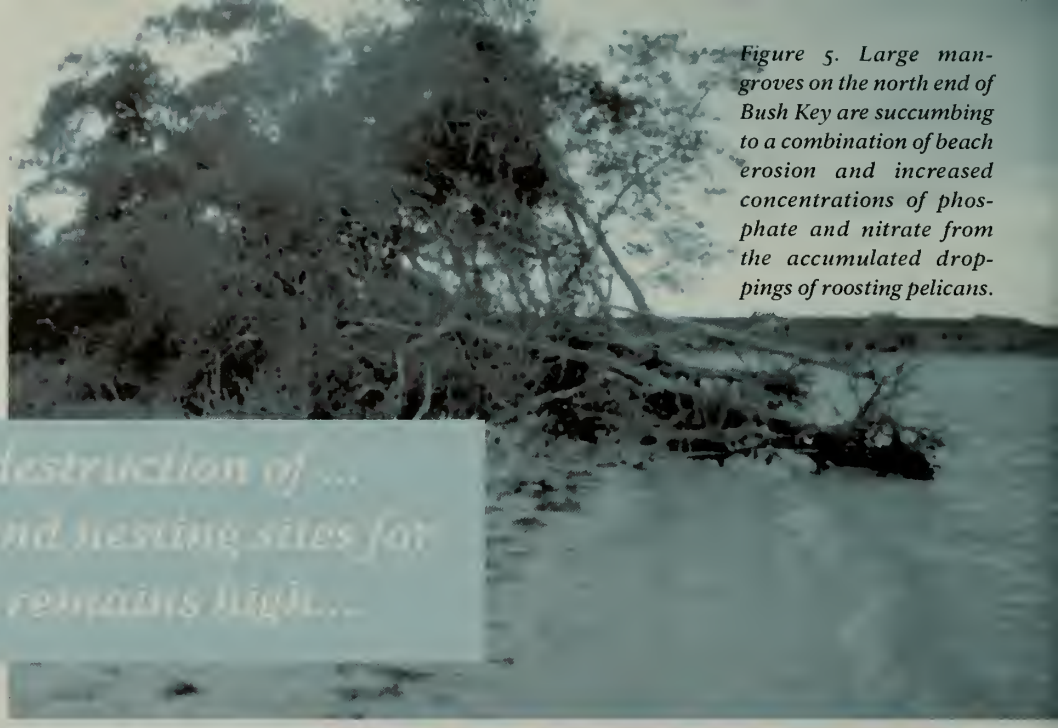


Figure 5. Large mangroves on the north end of Bush Key are succumbing to a combination of beach erosion and increased concentrations of phosphate and nitrate from the accumulated droppings of roosting pelicans.

The current risk of destruction of ... mangrove habitat and nesting sites for colonial waterbirds remains high...

Summary

Our study documents the recent natural colonization of mangroves and nesting frigatebirds at Dry Tortugas National Park. Affected by many factors, the dynamic process illustrates both the fragility and resilience of this subtropical maritime system. The period between major hurricanes, notwithstanding human harvesting of mangroves for fuelwood, may allow mangrove recruits the opportunity and time to develop sufficient size and density to colonize the islands and to attract frigatebirds dependent on mangroves for nesting. The current risk of destruction of the prevailing mangrove habitat and nesting sites for colonial waterbirds remains high because of island exposure and vulnerability to hurricane winds and surge. The probable interaction of breeding bird populations on mangrove community development and decline poses an interesting research question for Dry Tortugas National Park and associated wildlife refuges of the Florida Keys. Finally, the increased nutrient loading potential of island substrates from bird guano appears sufficient to stimulate stem growth of mangroves and may also be affecting other natural and cultural resources not investigated in this study. PS

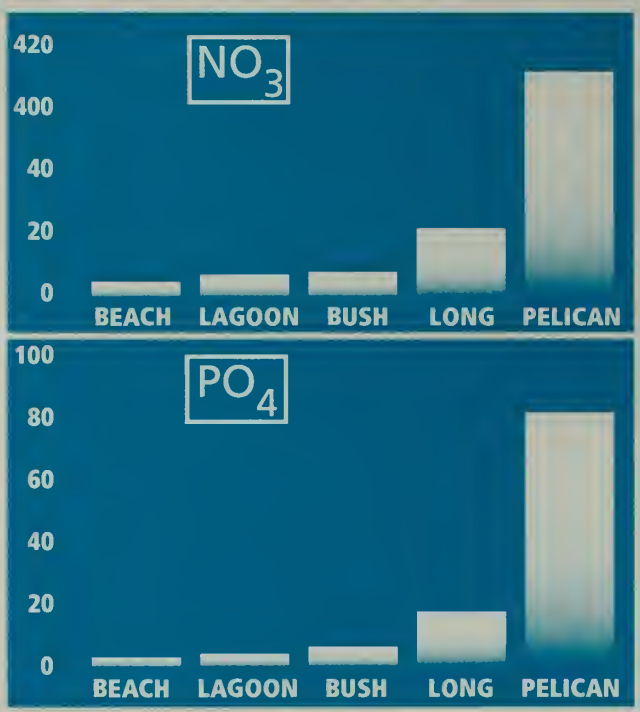


Figure 6. Graph showing relatively high concentrations (micromoles) of phosphate and nitrate at the Long Key and Bush Key study sites, attributed to magnificent frigatebird and brown pelican guano.

About the Authors

Thomas W. Doyle is an ecologist with the Forest Ecology Branch of the National Wetlands Research Center (NWRC), U.S. Geological Survey, Biological Resources Division, 700 Cajundome Blvd., Lafayette, LA 70506. He can be reached at 337-266-8647 or tom_doyle@usgs.gov.

Thomas C. Michot is a wildlife biologist with the Wetlands Ecology Branch of NWRC; 337-266-8664, tommy_michot@usgs.gov.

Also with NWRC, ***Richard H. Day*** is a geographer in the Forest Ecology Branch; 337-266-8557, richard_day@usgs.gov.

Christopher J. Wells is a geographer in the Spatial Analysis Branch, NWRC, and can be reached at 337-266-8651 or chris_wells@usgs.gov.

Backcountry water quality in GRAND TETON NATIONAL PARK

DNA analysis helps identify sources of fecal coliforms

By Niki Tippets, Susan O'Ney, and Dr. Aida M. Farag

Over the past several decades, visitor use of the backcountry areas of Grand Teton National Park (Wyoming) has dramatically increased. The water quality of clear, sparkling mountain streams and lakes is being impacted by concentrated recreational use where, because of the potential for future wilderness designation, no restroom facilities are available. Park officials are concerned about the impacts that these activities have on water quality, and that the consumption of untreated water from these areas may pose a hazard to human health.

Figure 1. Backcountry use of Grand Teton National Park, Wyoming, has dramatically increased in recent years, resulting in water quality degradation of creeks and streams and causing management concern.

BACKGROUND

Fecal coliforms reside in the intestines of warm-blooded animals, including humans, and are excreted in waste materials. The presence of high numbers of these bacteria in surface waters (creeks and streams) may indicate that unsanitary conditions exist that may pose human health concerns. Coliform counts and species of fecal streptococci were identified in water samples collected from the backcountry in Grand Teton National Park in the mid-1970s (McFeters 1975, Stuart et al. 1976). Similar studies in streams of the Sierra Nevada in California in the 1980s (Suk et al. 1987) detected decreased water quality in backcountry areas with extensive human presence when compared to other areas with minimal human presence. Grand Teton National Park personnel (Mark Magnuson, NPS, personal communication) also identified high concentrations of unknown bacteria in the early 1990s. This evidence led resource managers to the belief that the backcountry surface waters of Grand Teton should be evaluated more thoroughly by using recently developed techniques previously unavailable to the earlier investigators. The new techniques analyze DNA to determine the mammalian source of the fecal coliform (Samadpour et al. 1993, Samadpour et al. 1994). With this additional information, natural resource managers would be able to evaluate specific sources contributing to resource degradation (i.e., duck, bear, raccoon, human), and more effectively formulate policies and procedures to address the problem.

In 1996, Grand Teton National Park, the NPS Water Resources Division, and the third author cooperatively designed and initiated a backcountry water quality study in the park. Initial funding for this project was provided by the NPS Water Resources Division with later funding from the NPS Recreational Fee Demonstration Program. Because *Escherichia coli (E. coli)* is prevalent in nature, we used it to identify the source of fecal coliforms. While fecal coliforms are not

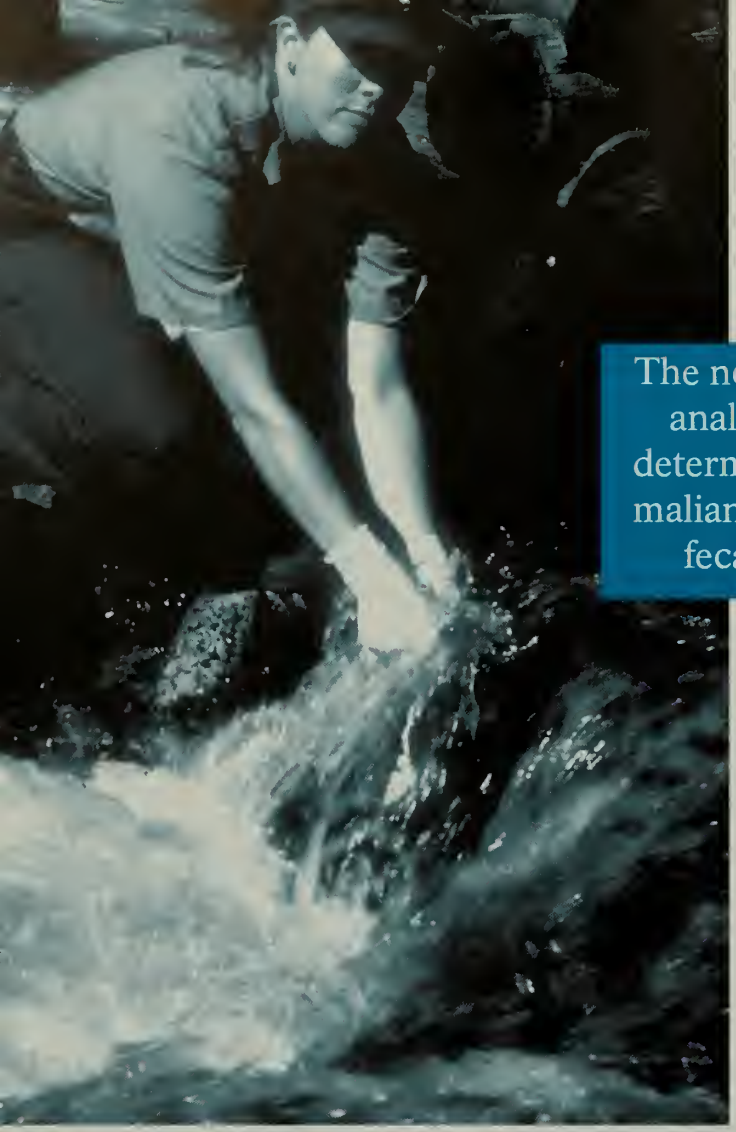


Figure 2. Biological Technician Karin McCoy collects a water sample in Grand Teton National Park as part of a water quality study begun in 1996. The information from the study provides a baseline of park water quality and is helping managers design appropriate solutions to water quality problems.

necessarily pathogenic, they are frequently associated with and may indicate hazardous disease organisms. The Environmental Protection Agency developed water quality standards for levels of *E. coli* in recreational waters based on specific levels of risk of acute gastrointestinal illness. The recommended steady state geometric mean value is 126 *E. coli* per 100 milliliters of water (USEPA 1986). On a few occasions, Grand Teton' s waters exceeded this limit, but on average they were well below this number. Our objectives for the study were to (1) establish baseline conditions of park backcountry surface waters to be used as a tool for measuring future changes, and (2) evaluate the effects that backcountry users may be having on the water quality of selected backcountry streams.

METHODS

We collected water samples following the methods suggested by Suess (1982). In the early years of the study, a local contractor completed the laboratory analyses. In 1999 the public health officer, John Collins, of the NPS Intermountain Region generously donated equipment to the park, allowing us to complete lab work on-site.

The new techniques analyze DNA to determine the mammalian source of the fecal coliform.

We filtered and incubated samples for analyses of fecal coliforms using the membrane filter (MF) procedure described in Standard Methods (APHA 1992). We selected positive fecal coliform colonies and sent them to Dr. Mansour Samadpour, University of Washington, for analysis of the *E.coli* isolates. He performed genetic fingerprinting using ribosomal RNA typing on each *E. coli* isolate. These patterns or DNA types, referred to as ribotypes, were then used to match specific strains of *E. coli* from water samples with ribotypes from known, potential sources. Dr. Samadpour maintains a ribotype database from source samples collected around the country. This facilitates the positive identification of the coliform source, especially human versus nonhuman origins.

THE STUDY

The third author implemented the study under contract during the summers of 1996 and 1997 (Farag 2001) with initial investigations focusing on surface waters of Avalanche, Garnet, and Cascade Canyons. In 1998, the first author assumed management of the project, expanding it into additional backcountry areas. The park has continued to collect data annually. In 2001, the second author took over the study.

In 1996 and '97, we found fecal coliforms in two of the three canyons investigated. Through DNA analysis (or source tracking) we determined that a variety of wildlife contributed fecal coliforms to the waters. In Cascade Canyon, some of the fecal coliforms were of human origin. In 1998, we also found human fecal coliforms in Paintbrush, Cascade, Bradley, and Avalanche Canyons. In 1999, as the study expanded, we found human fecal coliforms in Avalanche, Leigh, Upper and Lower Death, Lower Granite, and Hanging Canyons, at Guide's Wall and Hidden Falls, in Glacier Gulch, at Taggart Lake, and again in Cascade Canyon.

In 2000, we again detected human coliforms in Cascade Canyon, as well as an increase in the number of human coliforms identified in Granite, Death, and Open Canyons. Additional samples were collected near several grazing and boat launch areas within the park to

evaluate the impact of livestock and other activities on surface waters. We found a high number of bovine, bison, and horse coliforms at these additional sites, much as we expected.

IMPLICATIONS

Many of the waters in Grand Teton National Park are identified as Class I areas under the Clean Water Act of 1977 and therefore further water quality degradation is prohibited. The data collected in this study are helping to establish baseline coliform levels for backcountry water quality. They will also help managers determine the effects of increased backcountry use on the quality of park surface waters. This information can be used to guide decision making related to the location of camping zones, limitations on backcountry use, and designing educational programs for park visitors.

In Cascade Canyon, some of the fecal coliforms were of human origin.

Based on study results, resource managers at Grand Teton National Park have recommended that an evaporation-style toilet facility be installed at the base of Cascade Canyon. This site sustains intense use and is visited by an estimated 90,000 people per summer. Park management is currently evaluating the appropriateness, feasibility, and associated costs of this facility and other options, including area use limits. Grand Teton National Park utilizes a resource council to conduct preliminary reviews of proposed projects. The council will determine any additional planning required for compliance with the National Environmental Policy Act. The installation of a toilet facility in Cascade Canyon may be tiered to the development of a backcountry management plan, currently under review. Managers will have to weigh the concerns associated with human waste disposal in the backcountry in order to make their decision. These include human health problems as a consequence of either direct contact or contamination of drinking water, aesthetic concerns of visitors who find improperly disposed of human waste, and the conflict posed by the installation of structures in a wilderness management area. Once management has chosen and implemented a course of action, we will continue monitoring surface waters at Cascade Canyon to assess the effects of the action on water quality. RS

ACKNOWLEDGMENTS

Karin McCoy has supported the study over the last two years by her dedication to sampling and laboratory analysis.

LITERATURE CITED

APHA. 1992. Standard methods for the evaluation of water and wastewater, 18th Edition. American Public Health Association. Washington, D.C.

Farag, A. M., J. N. Goldstein, D. F. Woodward, and M. Samadpour. 2001. Water quality in three creeks in the backcountry of Grand Teton National Park, USA. Journal of Freshwater Ecology 16:135–43.

McFeters, G. A. 1975. Microbial studies of high alpine water supply used for recreation. Final Report to the Department of Interior, National Park Service.

Samadpour, M., J. Liston, J. E. Ongerth, and P. I. Tarr. 1993. Evaluation of DNA probes for detection of Shiga-like-toxin-producing *Escherichia coli* in food and calf fecal samples. Applied and Environmental Microbiology 56:1212–15.

Samadpour, M., J. E. Ongerth, and J. Liston. 1994. Development and evaluation of DNA probes for detection of Shiga-like-toxin-producing *Escherichia coli* in food and calf fecal samples. Applied and Environmental Microbiology 56:1212–15.

Stuart, S. A., G. A., McFeters, J. E. Schillinger, and D. G. Stuart. 1976. Aquatic indicator bacteria in the high alpine zone. Applied and Environmental Microbiology 31:163–167.

Suess, M. J. 1982. Examination of water for pollution control, a reference handbook, vol. 3. Pergamon Press, New York, NY.

Suk, T. J., S. K. Sorenson, and P. D. Dileanis. 1987. The relation between human presence and the occurrence of *Giardia* cysts in streams in Sierra Nevada, California. Journal of Freshwater Ecology 4:71–75.

United States environmental protection agency. 1986. Ambient water quality criteria for bacteria—1986. U.S. Environmental Protection Agency. EPA-440/5-84-002.

ABOUT THE AUTHORS

Niki Tippets is Administrative Support Assistant with Grand Teton National Park, P.O. Box 170, Moose, WY 83012; 307-739-3480; niki_tippets@nps.gov.

Susan O'Ney is a Biological Technician also with Grand Teton National Park; susan_o'ney@nps.gov.

Aida M. Farag is with the U.S. Geological Survey, Columbia Environmental Research Center, Jackson Field Research Station, P.O. Box 1089, Jackson, WY 83001; 307-733-2314 x 11; aida_farag@usgs.gov.

Songbird monitoring in the Golden Gate National Recreation Area:

A MULTIFACETED TOOL FOR GUIDING THE RESTORATION OF REDWOOD CREEK

By
Thomas Gardali, Carolyn Shoulders, Daphne Hatch,
Aaron L. Holmes, Sandra E. Scoggin, and Geoffrey R. Geupel

The goal of many habitat restoration and management projects is to restore ecosystem function. Yet a paucity of basic ecological information exists for land managers to use in designing projects. Armed with such information, managers would have a "head start" toward achieving their goal. Additionally, effective restoration suffers from the difficulty of measuring success and the lack of informational means to make improvements.

Figure 1. Location of the restoration site at Redwood Creek and the reference site at Lagunitas Creek, both in Golden Gate National Recreation Area, California.

Restoration of Redwood Creek, Golden Gate National Recreation Area (GGNRA, fig. 1), is currently under way thanks to funding from the National Park Service Recreational Fee Demonstration Program. One of the first steps is the large-scale removal of GGNRA's highest priority exotic pest plant, cape-ivy *(Delairea odorata)*. Cape-ivy is a fast growing, nonnative vine that blankets native plants (fig. 2), diminishes plant species richness, reduces structural diversity, and may reduce recruitment of light-dependent species such as red alder *(Alnus rubra)* trees in the riparian zone.

As part of GGNRA's broader efforts to monitor songbirds, we have been studying the songbird community in Redwood Creek since 1997. We have found that songbird monitoring is a valuable tool because we can (1) examine the effect of nonnative plants on the bird community, (2) assess the immediate effects of

the restoration activities (i.e., disturbance created by removing of cape-ivy) on the songbird community while (3) simultaneously providing specific information on the habitat requirements of a diverse and healthy songbird community, (4) provide a practical means of measuring the success of the restoration project, and (5) act as an information feedback loop to refine and improve restoration and management (i.e., adaptive management).

To illustrate the utility of songbird monitoring for restoration and management programs we present preliminary results and specific recommendations based on three years of study.

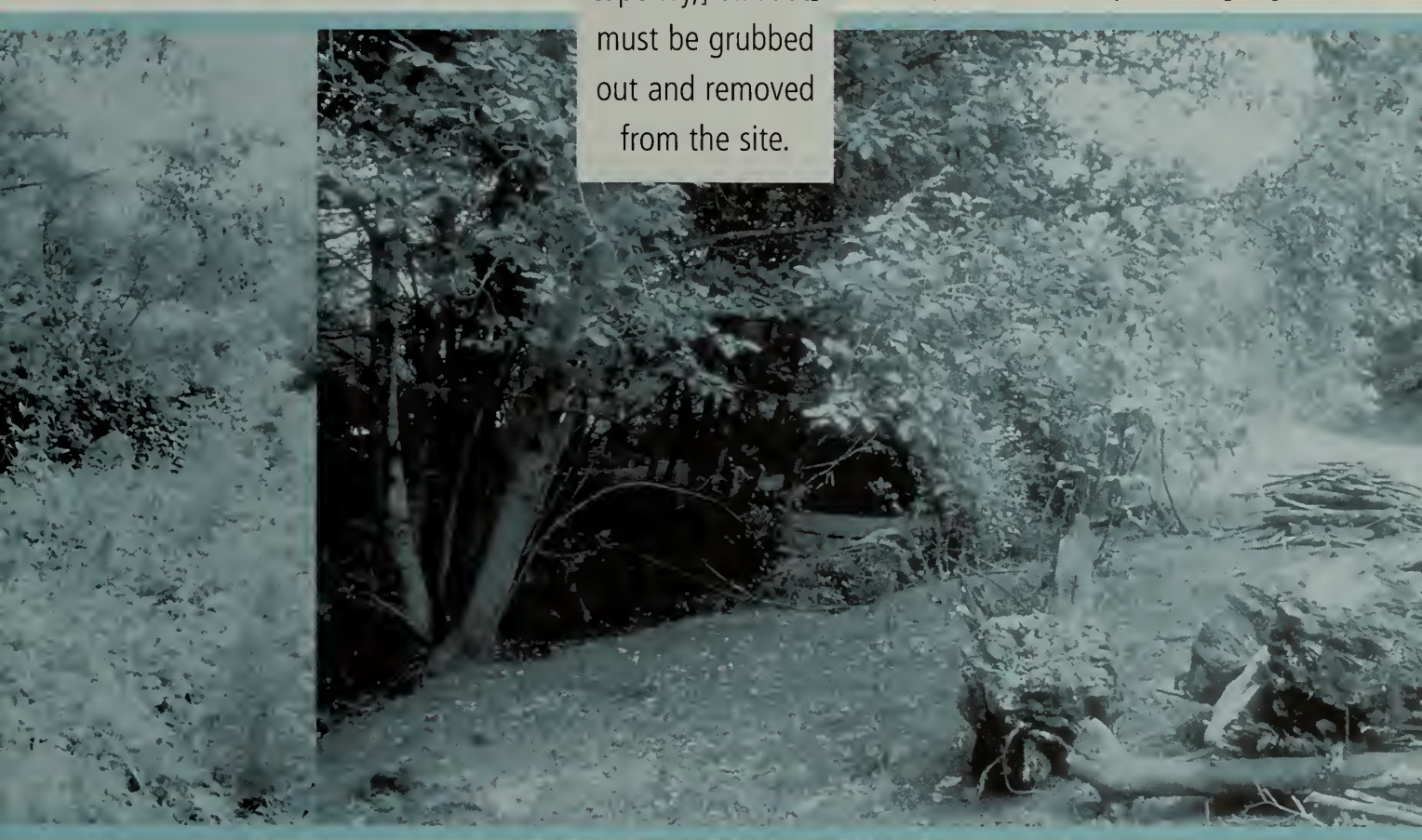
CAPE-IVY REMOVAL AT REDWOOD CREEK

Redwood Creek is a coastal California stream that flows through Muir Woods National Monument into a relatively undeveloped valley and eventually into the Pacific Ocean, Marin County, California. To the millions of casual visitors who travel along Redwood Creek on their way to or from Muir Woods, the riparian corridor of willows (*Salix* spp.) and red alder trees might appear to be well protected and "wild." However, the valley has a history of various land uses including grazing and row crop agriculture and is currently threatened by the highly invasive cape-ivy.

Cape-ivy is notoriously persistent in its growth habit, and within the last 12 years data have shown that cape-ivy alone now makes up approximately 40% of the vegetation cover along the creek. Cape-ivy will resprout from the tiniest piece of root, stem, or even leaf. This eliminates mere cutting as a viable control mechanism. Instead, all roots must be grubbed out and removed from the site. To find the extensive roots on a densely vegetated site, the site must be cleared to expose the ground surface (fig. 3). Therefore, the removal method employed at GGNRA entailed "brushcutting" all herbaceous vegetation on a site, then raking it up. Roots of native species, such as blackberry *(Rubus ursinus)*, thimbleberry *(Rubus parviflorus)*, hedge nettle *(Stachys chamissonis)*, and others were left undisturbed, but roots of cape-ivy were raked up or grubbed out by hand. Since cape-ivy resprouts quickly, roots that first escaped notice typically resprouted with only slight fog drip or light rains, making easy the task of finding and pulling them before the site was naturally revegetated. Initial clearing, cutting and raking required six weeks for an eight-person Marin Conservation Corp crew. However, follow-up removal of cape-ivy resprouts continued almost weekly for the following nine months.

To date, vegetation data from transects on both removal and control areas show cape-ivy removal has been very successful, virtually eliminating the plant. The natural appearance of the site rebounded immediately in the first growing season, with rooted native species growing well. Three years after removal, native plant species have recovered to numbers close

> [To eradicate cape-ivy,] all roots must be grubbed out and removed from the site.



Figures 2 (before, left) and 3 (after, above). Habitat restoration took place along Redwood Creek in Golden Gate National Recreation Area, Marin County, California, where cape-ivy—a persistent invasive plant species—blankets native vegetation. Able to resprout from root, stem, or leaf, cape-ivy must be completely removed, exposing the ground surface, and any remaining vegetation raked up. PHOTOS BY CAROLYN SHOULDERS.

Figure 4. Swainson's thrush was one of three songbird species documented nesting in the native vegetation (lady fern). COPYRIGHT IAN C. TAIT.

to those measured before removal. However, other exotic species, particularly nonnative grasses, as a group, may be establishing at a level of cover similar to that of cape-ivy's before its removal.

Further restoration of Redwood Creek is indicated. Specifically, locally cultivated native plant species will be planted in areas where the nonnative grasses have become established after cape-ivy removal. These plantings will augment the existing riparian vegetation, speed recovery efforts, and have the potential to shade out the nonnative grasses.

Songbirds are excellent indicators of ecosystem health and therefore ideal organisms for guiding and measuring management and restoration.

SONGBIRDS AS INDICATORS

There are many reasons why songbirds are excellent indicators of ecosystem health and therefore ideal organisms for guiding and measuring management and restoration. From a practical standpoint, songbirds are relatively easy and cost-effective to monitor—few other taxa announce their presence in song each spring making detection an easy endeavor. In addition, researchers using songbird monitoring protocols and analyses benefit from the existence of nationally standardized programs and guidelines that aid in repeatability and interpretation of results (e.g., Ralph et al. 1995, Martin et al. 1997, Nur et al. 1999).

From a biological perspective, songbirds serve as sensitive indicators of environmental health because of their high metabolic rate, abundance, and distribution within and across habitats, and relatively high position in the food chain. For example, songbirds are sensitive to changes in food supply, vegetative cover, and predator densities. With songbird studies, we have the advantage of being able to monitor changes at the community (versus single-species) level due to the ease of detection.

For all of these reasons songbirds are nearly ideal study organisms to track the dynamics of natural cycles and anthropomorphic (e.g., restoration and management) changes within an ecosystem and may provide early warning signals of more broad-scale environmental change. Songbird monitoring, however, does not preclude monitoring of other targeted species or measures of ecosystem function. At Redwood Creek, the national recreation area also monitors federally threatened coho salmon and steelhead populations as well as stream flow and changes in channel morphology.

MONITORING TECHNIQUES

The primary field techniques we employed, point counts and nest monitoring, have been extensively used in bird studies (Martin and Geupel 1993, Ralph et al. 1995). Both methods possess a component of vegetation assessment that is done around the census station for point counts and the nest site for nest monitoring.

With the point count method it is possible to study the long-term and annual changes of bird populations, differences in species composition between habitats, and assess breeding status and relative abundance of species. One objective of point count vegetation assessment is to relate the changes in bird composition and abundance to differences in vegetation. These vegetative changes can either be over time or differences between habitats or study sites.

Nest monitoring provides direct information on reproductive success and the local habitat conditions that facilitate maintenance of viable populations, thereby providing specific vegetation information that can be used by land managers. Examination of nests also allows collection of life history data (e.g., clutch size, number of broods, numbers of nesting attempts) that provide important insight into "vulnerability of species to decimation or perturbations" (Martin and Geupel 1993).

RESULTS AND RECOMMENDATIONS

To assess the effects of the disturbance associated with cape-ivy removal, we compared bird species richness, diversity, and relative abundance from data collected before and after removal. We used a nearby creek, Lagunitas Creek, as a reference site. We found that songbird diversity (number of bird species weighted by abundance), richness (number of bird species), and relative abundance increased significantly from the breeding season before ivy removal to the breeding season after removal. Changes in these indexes at our reference site were also positive, although not significantly so. These preliminary findings show that there did not appear to be a negative impact to the songbird community resulting from cape-ivy removal. In fact, we observed three species of songbirds (Swainson's thrush, Wilson's warbler, and song sparrow) nesting in the vegetation that grew post-ivy removal (fig. 4). Additionally, many different species used cape-ivy removal areas for foraging and defended them as part of their nesting territory.

Management and restoration activities cannot avoid some disturbances to plants and animals. Indeed, successful cape-ivy removal requires pulling most of the understory plant species (see previous discussion and figs. 2 and 3). Minimizing these disturbances requires knowledge of the basic life histories of various taxa. For songbirds, the breeding season is a critical period and avoiding planned disturbance events during peak activity is desirable. Using data of the mean range of date of first egg laid and assuming that most songbirds require *at least* one month to raise and fledge young, we showed that the breeding season begins approximately mid-March and extends into mid-August. This range, for a given local area, should be taken into account when planning management activities, with particular attention given to avoiding disturbance during the peak of the breeding season.

In order to guide future restoration efforts for Redwood Creek, we examined structural and floristic vegetation characteristics that may influence bird species diversity, abundance, and nesting success. The following are some of the recommendations we made based on results from bird-habitat analyses (see annual reports Gardali et al. 1999, Holmes et al. 1999, Scoggin et al 2000).

RECOMMENDATIONS

Increase tree species richness (e.g., by planting red alder, willow, and California bay in suitable areas).

Small and total red alder trees showed a positive influence on the nesting success of song sparrows and Swainson's thrushes. Large California bay trees positively influenced the nesting success of Wilson's warblers. Willows were important nest substrates for 12% of all nests sampled (n = 421) and were predominantly used (~50%) by black-headed grosbeaks and warbling vireos. The abundance of warbling vireos, Pacific-slope flycatchers (e.g., fig. 5), Wilson's warblers, and black-headed grosbeaks were positively associated with tree species richness.

> We found that songbird diversity, richness, and abundance increased significantly from the breeding season before ivy removal to the breeding season after removal.

Plant tree species to restore riparian forest structure.

California bay should be planted where the upland (mixed hardwoods) grades into the riparian forest. The mean number of bays around successful Wilson's warbler nests was 2.5 and only 0.37 for unsuccessful nests. Thus, "shrubby" willows should be planted in patches (clumps) in wet areas or areas that flood (or have the potential to flood). Concentrated plantings will create usable habitat quickly while at the same time mimic the natural establishment of vegetation after scouring or soil deposition from a flood (RHJV 2000). To recreate currently occurring red alder densities, the red alders should be planted at varying intervals (from 1–25 m or 3.3–82 ft) but at an average of 6–7 m (6.37 m ± 1.14 m or 20.9 ft ± 3.7 ft; n = 25 nests). This will also allow space for the propagation of understory plant species (see following discussion). Successful song sparrow nests had a mean of 4.5 red alder trees within 11.3 m (37 ft) of the nest while unsuccessful nests had 1.5.

Plant understory species in suitable and appropriate areas to restore riparian forest structure and increase foliage (e.g., California blackberry, willow, sword fern, lady fern, and red elderberry were important nesting substrates for many species).

Bird species diversity was positively associated with a diverse shrub structure. Therefore, understory species should be planted below existing tree canopy where removal of nonnative plant species has occurred and in between new tree plantings. In general, sword fern grows in the upper, dryer areas while lady fern is found more commonly at the stream edges or in the floodplain. California blackberry occurs throughout the watershed as large patches in forest openings and as dense "mats" below tree canopy.

Promote system-wide high structural diversity.

As supported by this study, the presence of early to late successional stages of riparian woodland systems has been identified as a key feature for the successful management of riparian bird communities (RHJV 2000). For example, warbling vireos prefer to establish territories in areas with large trees but have higher nesting success when nest placement is lower in smaller trees. The importance of

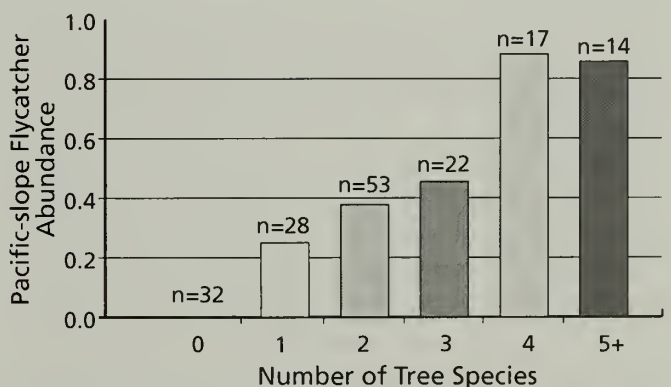


Figure 5. Tree species richness related to mean Pacific-slope flycatcher abundance.

small red alder trees for both song sparrows and Swainson's thrushes suggests improved productivity in early successional habitats.

Manage or create wide riparian corridors that approximate 100 meters.

Abundance of warbling vireos (e.g., fig. 6), Swainson's thrushes, and common yellowthroats were positively correlated with width of the riparian corridor.

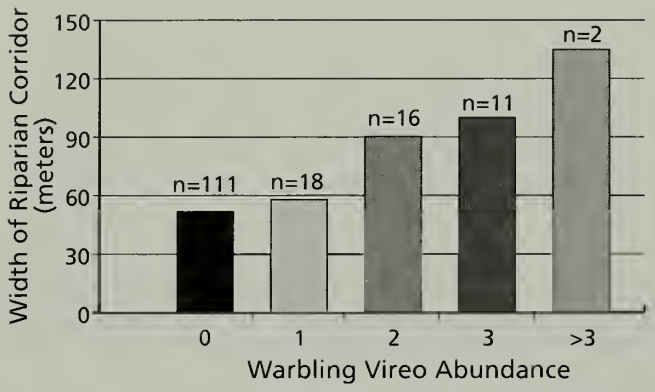


Figure 6. Warbling vireo abundance related to mean riparian corridor width.

Remove nonnative plant species

Nonnative plant species may decrease structural diversity by decreasing plant species richness. Structural diversity is an important habitat characteristic for reproductive success and bird species diversity and abundance. Shrub species diversity and structural complexity had a positive influence on bird species richness and diversity.

Protect and restore adjacent upland habitats.

Upland areas adjacent to riparian corridors may be of critical importance to the maintenance of healthy bird populations. Some species may benefit from a contiguous transition from lowland riparian to upland mixed hardwoods or coastal scrub. For example, we may interpret the positive relationship between Wilson's warbler nest success and California bay as testimony to the importance of adjacent habitats.

CONCLUSIONS

Land managers need many tools to repair and manage ecosystems. Restoration challenges such as cape-ivy removal benefit from the immediate feedback and the long-term planning information that songbird monitoring can supply. Additionally, monitoring can be supplemented with specific research questions to further assess restoration activities as well as investigate other processes that may limit populations of birds and other wildlife. As our preliminary results and recommendations have shown for Redwood Creek, songbird monitoring has the potential to contribute greatly to the informational needs of resource managers.

ACKNOWLEDGMENTS

Funding for this work was provided by the NPS Recreational Fee Demonstration Program, the Marin Audubon Society, and the Golden Gate National Parks Association. Diana Humple and Viola Toniolo provided useful editorial comments. This is Point Reyes Bird Observatory contribution number 970.

LITERATURE CITED

Gardali, T., S. Scoggin, and G. R. Geupel. 1999. Songbird use of Redwood and Lagunitas Creeks: management and restoration recommendations. Unpublished PRBO report to the Golden Gate National Recreation Area.

Holmes, A., D. L. Humple, T. Gardali, and G. R. Geupel. 1999. Songbird habitat associations and response to disturbance in the Point Reyes National Seashore and Golden Gate National Recreation Area. Unpublished PRBO report to the Golden Gate National Recreation Area and the Point Reyes National Seashore.

Martin, T. E., and G. R. Geupel. 1993. Nest monitoring plots: methods for locating nests and monitoring success. Journal of Field Ornithology 64:507–19.

Martin, T. E., C. R. Paine, C. J. Conway, W. M. Hochachaka, P. Allen, and W. Jenkins. 1997. BBIRD field protocols. Unpublished report, Montana Cooperative Wildlife Research Unit, University of Montana, Missoula. <http://pica.wru.umt.edu/bbird/>

Nur, N., S. L. Jones, and G. R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish and Wildlife Service, BTP-R6001-1999, Washington D. C.

Ralph, C. J., J. R. Sauer, and S. Droege 1995. Monitoring bird populations by point counts. USDA Forest Service Publication, PSW-GTR 149, Albany, CA.

RHJV (Riparian Habitat Joint Venture). 2000. Version 1.0. The riparian bird conservation plan: a strategy for reversing the decline of riparian associated birds in California. California Partners in Flight. <http://www.prbo.org/CPIF/Riparian/Riparian.html>

Scoggin, S. E., T. Gardali, and G. R. Geupel. 2000. Assessment of songbird response to cape-ivy removal in the Redwood Creek watershed. Unpublished PRBO report to the Golden Gate National Recreation Area.

ABOUT THE AUTHORS

Thomas Gardali is Terrestrial Program Biologist, Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970, (415) 868-0655, tgardali@prbo.org.

Carolyn Shoulders is Redwood Creek Watershed Coordinator, Golden Gate National Recreation Area, Fort Cronkite, Sausalito, CA 94965, (415) 331-0771, carolyn_shoulders@nps.gov.

Daphne Hatch is Wildlife Specialist, Golden Gate National Recreation Area, Fort Cronkite, Sausalito, CA 94965, (415) 331-0744, daphne_hatch@nps.gov.

Aaron L. Holmes and ***Sandra E. Scoggin*** are Terrestrial Program Biologists, Point Reyes Bird Observatory, aholmes@prbo.org, sscoggin@prbo.org.

Geoffrey R. Geupel is Terrestrial Program Manager, Point Reyes Bird Observatory, ggeupel@prbo.org.

Northeast parks' regional strategy to control KNOTWEED

SUPPORTED BY U.S. DEPARTMENT OF AGRICULTURE

By Kathleen Kodish Reeder and Brian Eick

In October 2000, jointly managed Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial received $100,000 from the U.S. Department of Agriculture's Animal and Plant Health Inspection Service emergency funds to support knotweed control spearheaded by these parks. Natural resources in both parks have been threatened by Japanese knotweed (*Polygonum cuspidatum* Siebold and Zucc.) and giant knotweed (*Polygonum sachalinense* F.W. Schmidt ex Maxim.) (fig. 1). Working with local conservancy groups, The Pennsylvania State University, and federal and local government agencies, the parks are facilitating the development of a coordinated strategy to control both species of this invasive, exotic weed throughout the Conemaugh River watershed.

Figure 1. Identifying effective control measures for giant knotweed became a high priority as the plant began invading major sections of Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site. Left untreated, giant knotweed can grow 8–12 feet in height, blocking views of historic resources and access to trails.

KNOTWEED CHARACTERISTICS

As with many nonnative plants, the introduction of knotweed was based on good intentions. Anecdotal evidence indicates that knotweed was first planted in southwestern Pennsylvania as a soil stabilizer on coal tailings piles and other mining lands in the first half of the 1900s. However, because the plants can spread through their rhizomes (or rhizome fragments) and by seed, they can easily invade disturbed soils, such as riverbanks scoured by flooding, or landscapes altered by construction or mining. Once established, both species of knotweed are extremely persistent.

The most prevalent, and problematic, species in the two parks is giant knotweed, which is rapidly invading the riverbank of the historic lakebed at Johnstown Flood National Memorial. If not controlled, the plant (capable of growing 12 feet high) will have an impact on visitor use by blocking views of historic resources and access to trails. Before treatments were begun, knotweed occupied a combined total of approximately 35 acres in the two parks. If it spreads until the entire riverbank is lined with large, dense stands, giant knotweed will significantly reduce native plant diversity and degrade the quality of wildlife habitat.

DEVELOPING A CONTROL STRATEGY

Realizing in 1995 that controlling the pervasive knotweed would require a comprehensive, long-term strategy, the parks developed a program based on three goals: (1) obtaining an understanding of the plant's reproductive ecology in order to reduce invasions; (2) developing an integrated pest management plan based on proven treatment methods; and (3) promoting regional awareness of knotweed and effective control measures.

To obtain information about the reproductive ecology of both knotweed species, the National Park Service funded a two-year study by Amy Niewinski and Dr. Todd Bowersox at The Pennsylvania State University School of Forest Resources. The research report, issued in 1999, indicated that the giant and Japanese knotweed populations sampled have the potential to produce viable seeds (Niewinski, A. T., T. W. Bowersox and L. H. McCormick. 1999. Reproductive ecology of giant *(Polygonum sachalinensis)* and Japanese *(Polygonum cuspidatum)* knotweed. National Park Service Technical Report NPS/PHSO/NRTR-00/079. University Park, PA. 37 pp.). The seeds, which have no dormancy requirement, remain viable in the seedbed and are capable of establishing new, perennial populations. Non-shaded locations that are free of a well-developed leaf litter provide the best potential for seedling establishment. Conversely, knotweed is unlikely to become established in forested ecosystems with sufficient amounts of shade and abundant leaf litter.

TEST TREATMENT

Unfortunately, information about eradication treatments was inconsistent. The National Park Service, therefore, funded research by Drs. Larry McCormick and Todd Bowersox (McCormick, L. H., and T.W. Bowersox. 1998. Eradication and control of Japanese knotweed at the Staple Bend Unit, Allegheny Portage Railroad National Historic Site. Penn State School of Forest Resources, University Park, PA. 15 pp.) to develop an effective method of eliminating knotweed while allowing the establishment of native plant species. The two-year study, begun in 1996, revealed that two herbicides, glyphosate and imazapyr, are effective in controlling knotweed. However, imazapyr readily treavels to the roots of non-target vegetation. In other words, imazapyr would kill trees adjacent to the treatment areas even if those trees were not directly sprayed. Glyphosate will not kill plants that are not directly sprayed. The parks, therefore, chose to base their integrated pest management plan on using glyphosate.

The herbicides glyphosate and imazapyr are effective in controlling knotweed.

Figures 2, 3, and 4 (top to bottom). These three photos represent the three major stages in treating a targeted area in the Staple Bend Tunnel Unit of Allegheny Portage Railroad National Historic Site. The pre-treatment view (top) features knotweed emerging in spring (May 1998). The post-treatment view (middle) of the same scene, taken a year later, illustrates the effectiveness of the herbicide treatment in preventing the return of knotweed. The third photo in the series shows that by August 1999, native pioneer plant species, mostly pilewort, were able to flourish once the knotweed had been eradicated.

During spring and late summer 1998, the researchers tested the effectiveness of a foliar application of 4% glyphosate with a surfactant in water on a three-acre site that was completely covered by giant knotweed (see fig. 2). By the subsequent spring, there had been a 97% reduction in the number of adult plants. In July, surviving adult plants were treated with an application consisting of 4% glyphosate in water. Monitoring in September 1999 revealed that no adult plants had survived and knotweed seedlings comprised less than 1% of the cover (see fig. 3).

Most encouraging of all, native plant germination in the treatment area was phenomenal. Pilewort *(Erechtites hieracifolia)* and pokeweed *(Phytolacca americana)* quickly formed dense cover (see fig. 4). Seedlings of staghorn sumac (*Rhus typhina* L.), smooth sumac (*Rhus glabra* L.), and black cherry (*Prunus serotina* Ehrh.) were also found. Subsequent monitoring in 2000 revealed that nearly 100% of the groundcover consisted of native pioneer plant species, and surviving knotweed plants still formed less than 1% of the cover. Knowing that knotweed does not thrive under dense plant cover, the parks' managers expect that seed germination and rhizomatous spread from knotweed populations adjacent to the parks will be greatly reduced in areas where the native plant communities have been restored.

Figure 5. This scene features knotweed growing along the south fork of the Little Conemaugh River, approximately one-half mile upstream from the Johnstown Flood National Memorial boundary. The importance of convincing owners of neighboring lands, rights-of-way, and waterways to implement effective knotweed eradication methods is paramount to the success of the comprehensive regional plan to protect the resources of the watershed.

OUTREACH AND FOLLOW-UP

As effective as the described eradication treatment may be, the parks' natural resource staff are aware that their efforts will ultimately fail if others do not use similar control methods on neighboring lands, rights-of-way, and waterways (fig. 5). To encourage this local and regional awareness, the parks have participated in the development of the Kiski-Conemaugh Rivers Conservation Plan, a comprehensive regional plan that addresses the basin's land, water, biological, and cultural resources. Because of the parks' efforts, identification and control of invasive plants, particularly knotweed, have been added to the plan. The parks have, likewise, assisted the Conemaugh Valley Conservancy and the Southern Alleghenies Conservancy in developing control plans.

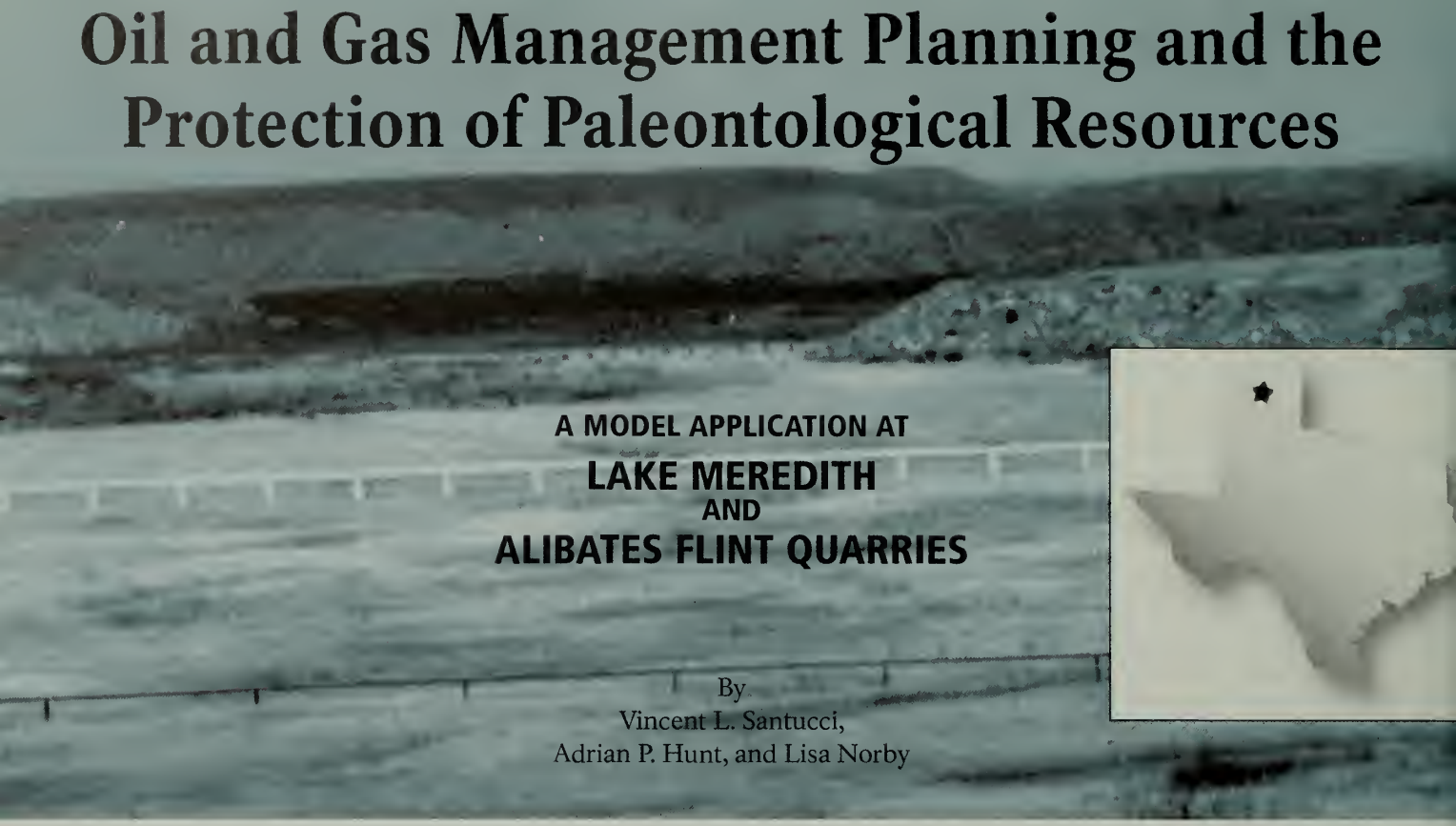
Fortunately, the grant funds awarded by the U.S. Department of Agriculture will enable the National Park Service not only to expand the treatment areas within the two parks, but also to support control efforts by other groups and to develop public outreach and education activities. In 2001, the cost of the initial treatment of knotweed in critical areas of the Allegheny Portage Railroad National Historic Site was approximately $500 per acre. Ultimately, although eradicating all knotweed from the landscape would be cost-prohibitive, the National Park Service hopes that a comprehensive regional management plan will protect the critical resources of the watershed and reduce the spread of knotweed throughout western Pennsylvania.

ABOUT THE AUTHORS

Kathleen Kodish Reeder (kkr1@psu.edu) is Writer-Editor for the Northeast Region, National Park Service; University Park, Pennsylvania.

Brian Eick is currently Natural Resource Management Chief at Appomattox Court House National Historical Park, (brian_eick@nps.gov).

Oil and Gas Management Planning and the Protection of Paleontological Resources



A MODEL APPLICATION AT LAKE MEREDITH AND ALIBATES FLINT QUARRIES

By
Vincent L. Santucci,
Adrian P. Hunt, and Lisa Norby

For the first time the National Park Service has addressed the protection of paleontological resources in a park as part of oil and gas management planning. The milestone came during the development of an Oil and Gas Management Plan / Environmental Impact Statement (EIS) for Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument. Still in draft form, the plan defines a long-term management direction for existing and anticipated oil and gas operations in the parks. Specifically it addresses the issues associated with the development of nonfederal oil and gas rights underlying these northwest Texas parks (fig. 1).

Assessing Risks to Fossils

As part of the plan, the National Park Service developed a *reasonably foreseeable development scenario* (RFD) to project future oil and gas development in the parks and to provide a basis to measure potential environmental impacts. The RFD estimated that over the next 15 to 20 years, in areas of the parks where drilling and production could be permitted, up to 85 new wells could be drilled. Ground-disturbing activities associated with oil and gas development can potentially damage or destroy nonrenewable paleontological (and other) resources.

GROUND-DISTURBING ACTIVITIES ASSOCIATED WITH OIL AND GAS DEVELOPMENT CAN POTENTIALLY DAMAGE OR DESTROY NONRENEWABLE PALEONTOLOGICAL RESOURCES.

Lake Meredith and Alibates Flint Quarries are located between two major structural basins in the Texas Panhandle. Paleontologists have obtained important collections of fossils from Triassic, Miocene, Pliocene, Pleistocene, and Holocene sediments in and around these two units of the national park system. However, the lack of adequate baseline paleontological resource data has limited the staff's ability to determine whether the oil and gas operations have adversely impacted the paleontological resources at the parks.

Figure 1. Oil and gas pipelines traverse the two Texas parks along with rights-of-way granting operator access. The recent park planning identified fossil-rich areas requiring protection from oil and gas activities.

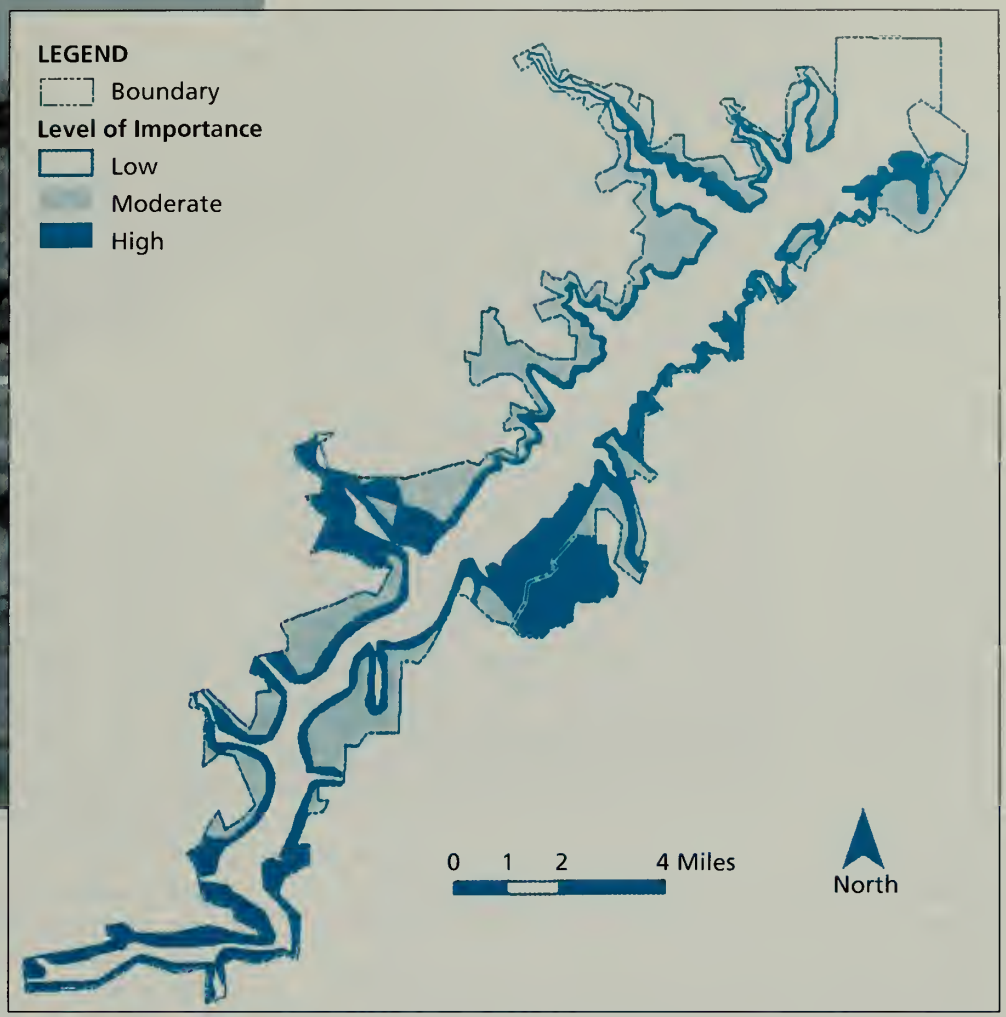


Figure 2 (above). A key tool in the oil and gas management planning process was the development of a paleontological resource sensitivity map, which identifies areas of high, moderate, and low probability for the occurrence of fossils. When preparing a plan of operation for oil and gas development in the parks, an operator must first hire a qualified paleontologist to survey the high-probability fossil areas.

Inventory Needed

Comprising park managers, staff of the Natural Resource Program Center, NPS paleontologists, and others, the oil and gas management planning team identified the need to consider the protection of paleontological resources in the planning process. Therefore, NPS paleontologists undertook a comprehensive paleontological resource inventory of the parks by reviewing literature, searching museum collections, and conducting field surveys. In the process the Park Service developed a "paleontological resource sensitivity map" identifying areas of high, moderate, and low probability for the occurrence of fossils (figure 2). First, NPS staff used geologic maps to determine surface exposures of fossil-bearing strata in the parks. They then correlated the predicted fossil areas with the actual occurrence of fossils in the field to fine-tune the sensitivity map.

During the inventory NPS paleontologists identified over a dozen paleontological localities consisting of diverse fossilized plants, invertebrates, vertebrates, and trace fossils. Significant paleontological resources were linked to the Upper Triassic (late Carnian) Dockum Group, including the remains of ancient amphibians (metoposaurs), reptiles (aetosaurs, phytosaurs, rauisuchians), and a great abundance of petrified wood (Murry 1989). The NPS staff documented six fossil localities from the Miocene-Pliocene Ogallala Group that contain root casts, silicified grasses, insect burrows, mammal bone beds, and a mastodon tooth (Hunt and Santucci in press; Wilson 1988). Additionally, within the national recreation area and national monument five Pleistocene paleontological localities are documented and include a site in which a nearly complete skull of the giant bison *Bison latifrons* (fig. 3, page 38) was collected (Anderson 1977; Dalquest and Schultz 1992; Hunt 2000). Resource management staff have entered the known paleontological resource localities into the parks' geographic information system database and plan to monitor these sites periodically in the future.

Standard Operating Procedures Developed

The oil and gas management plan / EIS identifies standard operating procedures for locating and protecting paleontological resources (Santucci 2000). These procedures outline circumstances when a paleontological survey is necessary and how the survey should be implemented. The procedures also provide guidance when an unanticipated discovery of fossils occurs during approved operations or fossils are damaged within previously identified paleontological localities.

Three alternative actions are identified in the EIS for paleontological resources. Alternative A is the continuation of current management practices in which proposals for oil and gas development are evaluated case by case. Alternatives B and C designate special management areas throughout the parks for protection of the paleontological resources. Additionally, alternatives B and C prescribe the application of the standard operating procedures for locating and protecting paleontological resources. For example, in high-probability fossil areas, the operator of any oil-and-gas-related, ground-disturbing activity, would be required to survey for paleontological resources and describe ways of minimizing fossil disturbance; the survey of medium-priority areas would be recommended.

The EIS is now being finalized; public comments have been received and are being incorporated into the plan. The record of decision is anticipated in early 2002. The National Park Service prefers alternative B.

Conclusion

The Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument Oil and Gas Management Plan and Environmental Impact Statement represents the first time that paleontological resources have been considered in this type of planning in the national park system. The benefits resulting from the consideration of fossil protection in the planning process are many. For example, the planning process focused NPS staff on the need for baseline paleontological resource inventories of the parks. It also prompted the development of new standard operating procedures for locating and protecting fossils, which may be a useful model for other parks addressing similar issues. Also, it has drawn national attention to the significance of fossils in these parks. Finally, it has strengthened the protection of nonrenewable paleontological resources at Lake Meredith and Alibates Flint Quarries.

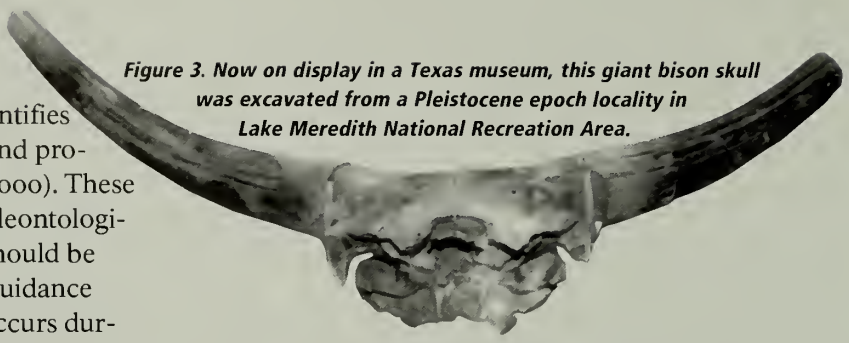


Figure 3. Now on display in a Texas museum, this giant bison skull was excavated from a Pleistocene epoch locality in Lake Meredith National Recreation Area.

Literature Cited

Anderson, B. A. 1977. Overview of bison remains from the Plum Creek area, Lake Meredith Recreation Area, Texas. Southwest Cultural Resources Center, Santa Fe. Unpublished report on file at Lake Meredith National Recreation Area. 10 pp.

Dalquest, W. W., and G. E. Schultz. 1992. Ice age mammals of northwestern Texas. Midwestern State University Press, Wichita Falls. 309 pp.

Hunt, A. P. 2000. Preliminary assessment of the paleontological resources of Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument. Unpublished National Park Service Report. 17 pp.

Hunt, A. P., and V. L. Santucci. In press. Paleontological resources of Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument, West Texas. New Mexico Geological Society Guidebook.

Murry, P. A. 1989. Geology and paleontology of the Dockum Formation (Upper Triassic), West Texas and eastern New Mexico. Pages 102–44 in S. G. Lucas and A. P. Hunt, editors. The Dawn of the Age of Dinosaurs in the American Southwest. New Mexico Museum of Natural History, Albuquerque.

Santucci, V. L. 2000. Standard operating procedures for locating and protecting paleontological resources (appendix F). Lake Meredith National Recreation Area and Alibates Flint Quarries National Monument Oil and Gas Management Plan / Environmental Impact Statement. National Park Service.

Wilson, G. A., 1988. The effects of subsurface dissolution of Permian salt deposition, stratigraphy and structure of the Ogallala Formation (Late Miocene age), northeast Potter County, Texas. Unpublished M.S. Thesis, West Texas State University.

About the Authors

Vincent L. Santucci (vincent_santucci@nps.gov) is the Chief Ranger at Fossil Butte National Monument, Wyoming, and has been involved with paleontological resource management and inventories in the national parks since 1985.

Adrian P. Hunt (adrianh@mesatc.cc.nm.us) is the Museum Curator for the Mesalands Dinosaur Museum in Tucumcari, New Mexico.

Lisa Norby (lisa_norby@nps.gov) is a Petroleum Geologist with the NPS Geologic Resources Division in Denver, Colorado.

Research Permit and Reporting System:

The On-line LAUNCH Is UP

Research activities in the national park system are regulated through a Research Permit and Reporting System. Revamped in January 2001, the on-line permit system streamlines the permit application process.

A product of many park research activities is the collection of plant, animal, geologic, and other specimens that require care and storage per NPS standards. Proper collections management emphasizes the need for park research permit coordinators to work closely with park or regional NPS museum curators.

By Jonathan Bayless and Norm Henderson

The National Park Service reached an important milestone on 16 January 2001 when it became the first bureau in the Department of the Interior to enable researchers to apply on-line for a research and collecting permit. Although few people were aware of this development initially, the launch of the Research Permit and Reporting System (RPRS) at http://science.nature.nps.gov/research began an era of better service to researchers and improved access to research information for all. The first researcher to use the system logged on in the first hour of operation; nine months later over 2,700 research applications had been made. Like Friendship 7—the capsule that carried John Glenn as the first American into orbit—the launch of the new permit system is both a crowning achievement and yet only the first step.

Improvement on old system

The Research Permit and Reporting System provides many improvements on the former system designed to help the National Park Service facilitate research in a consistent, streamlined manner. Moreover, it contributes to making the national park system a better place for science, a goal that has required more than goodwill to achieve. The long and complicated history of permitting research and collecting in the national parks shows only mixed success in attempts to improve the bureau's reputation among researchers (Bayless 1999). Some scientists expressed frustration and anger at what they saw as an unfair and illogical research permitting process. They claimed a lack of consistency was causing them hardship when they dealt with unclear permit requirements. Investigators complained that the application procedures between parks were vastly different for no discernable reason, and that this was causing delay in the implementation of research programs.

Investigators complained that the application procedures between parks were vastly different for no discernable reason....

In 1996, at the request of the National Park Service, the Office of Management and Budget (OMB) reviewed the administration of the special use permit (SUP) for research activities and found that it was being used inappropriately for that purpose. The SUP process was intended for non-recurring special uses, and given that the National Park Service routinely reauthorized research, a specific research permit would be needed. Further, while the SUP form was originally approved as both an information gathering and permitting tool, it was being used strictly as a permit. To complete the form, parks gathered information using a multitude of techniques, all in violation of OMB rules and requirements. With the passage of Public Law 105-391 in 1998, the Service was given a research mandate to "assure that management of units of the National Park Service is enhanced by the availability and utilization of a broad program of the highest quality science and information." The law highlighted the need to overhaul the research and collecting permit process.

Task force

The successful on-line launch was due in large part to the efforts of the NPS permit task force, which developed the new approach (Winfree 1999). The task force consisted of 15 members from parks, support offices, and the Washington Office, including the authors, from a diverse background of scientific and program expertise. Headed by Tim Goddard, Computer Specialist, Natural Resource Information Division, Natural Resource Program Center, the task force identified several needs to implement a simplified yet comprehensive research-permitting program. Specifically, a new permit form, an OMB-approved application, and a comprehensive set of standard requirements would be needed. Their recommendations formed the foundation for the RPRS system.

Through a cooperative agreement between Yellowstone National Park and the Department of Energy, Idaho National

Engineering and Environmental Laboratory, came the next step: development of a conceptual software model of the system. The goal of integrating the model with the Investigator's Annual Report was realized through an interagency agreement with the U.S. Geological Survey (USGS), Biological Resources Division. Under guidance from the Natural Resource Information Division, the USGS Midcontinent Ecological Science Center currently maintains the RPRS software and servers. Dr. John Dennis, Biologist, Natural Systems Office, Washington Office, is responsible for policy support and assistance to park permit coordinators (available via waso_nrss_researchcoll@nps.gov).

New features

The Research Permit and Reporting System replaces the diverse array of earlier park research applications and creates a uniform standard for the national park system. This allows scientists, once they become familiar with the application process in one park, to repeat it easily in any other park. The system also allows the applicant to submit a research and collecting proposal of any content-format providing it has sufficient detail for staff to assess the impacts and benefits of the project, potentially eliminating the need for staff to rewrite proposals. The ability to report progress or research findings is possible through the incorporation of the existing Investigators Annual Report into the new system. Another innovation is the creation of a unique "study number" that links proposals, permits, reports, and citations and allows for tracking and updating.

The Research Permit and Reporting System will eventually be the primary method for researchers and government agencies to access information on past research, research needs, and to exchange information and applications with parks.

Park permit coordinators still evaluate each permit application, communicate with investigators, and coordinate other related matters. However, the process is now centralized and consistent. Park coordinators work with applications, permits, and reports through on-line access to the permit system without having to manage the software and databases that reside on a central server. Upgrades and problem solving are the responsibility of NPS programmers and contractors with the necessary skills and expertise. Two training courses in 2001 have provided 45 park coordinators with hands-on experience and increased knowledge on policy and procedural issues related to the permit system.

The system has had its share of technical problems in its first year. Computer viruses and Internet service interruptions have caused the system to go off-line; fortunately it has been restored in each instance within a day or two. While loss of passwords by park coordinators has caused frustration, it has been the simplest problem to fix. Also, some parks have poor Internet connections, via telephone modems, that can slow access speeds to a crawl. But overall most parks seem to be on-line and enjoying the power of the system.

Future

The Research Permit and Reporting System will eventually be the primary method for researchers and government agencies to access information on past research, research needs, and to exchange information and applications with parks. However, many system improvements will first need to be achieved to realize this potential. At the Third Conference on Partnership Opportunities for Federally Associated Collections held 12–15 November 2000 in Austin, Texas, we attended the "Permit Me" workshop on federal permits. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service discussed their permitting processes for importing and exporting threatened and endangered species, and the taking of migratory birds. Approximately 25 different permits are available on the Internet for these purposes, but only as downloadable forms that must be printed, filled out, and mailed back. The diverse and overlapping nature of many permits was of concern to many workshop attendees. The future challenge for the National Park Service will be to integrate the RPRS with all other government permits in a manner that is clear and understandable to scientists and specifies the correct permit for a particular situation. Indeed, the concept of a standardized Department of the Interior permit has already been discussed.

The launch of the current system is creating new visions for what features and capabilities are desirable in the next round of upgrades. For example, connectivity between databases, e-mail, and on-line systems are goals for improving the system. In addition, many specific policy application issues revealed by this initial launch must also be addressed. If the first release of the Research Permit and Reporting System is analogous to a space capsule orbiting Earth, then the system still has a long way to go before it attempts a lunar landing. Undoubtedly the success of this first step, with the continued cooperation and feedback of park research coordinators, is critical for the realization of all subsequent improvements. PS

Literature cited

Bayless, J. W. 1999. Regulating National Park Service research and collecting: A fifty-year search for a legal, flexible, and standardized approach. Pages 418–22 in D. Harmon, editor. On the frontiers of conservation: Proceedings of the 10th conference on research and resource management in parks and on public lands. George Wright Society, Hancock, MI.

Winfree, R. 1999. Research and collecting permit procedures revised. Page 57 in J. Selleck, editor. Natural Resource Year in Review—1998. National Park Service, Department of the Interior, Lakewood, CO.

About the Author

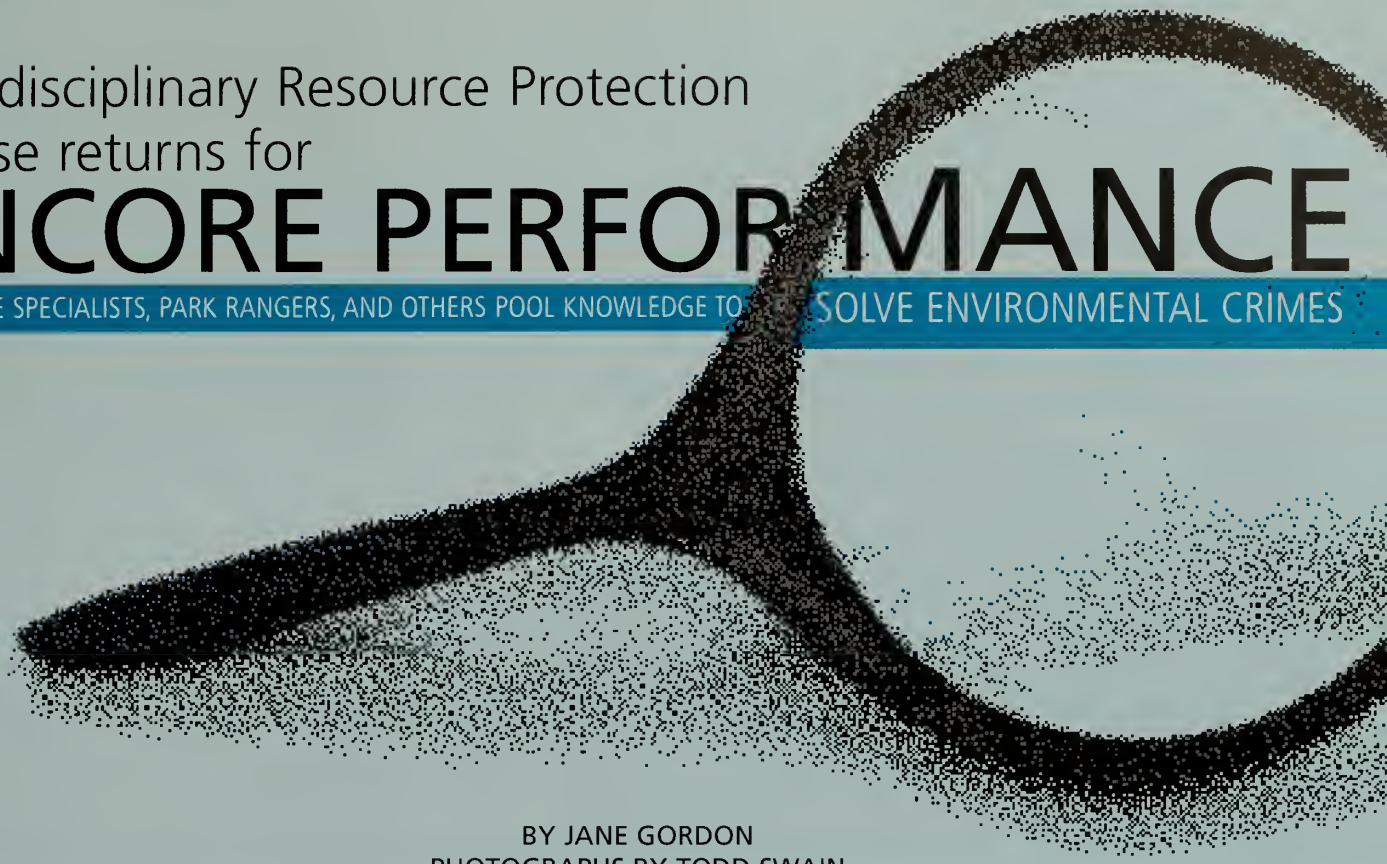
Jonathan Bayless is National Natural Landmark Coordinator, Pacific Great Basin Support Office, 1111 Jackson Street, Oakland, CA 94607; 415-215-3802; jonathan_bayless@nps.gov.

Norm Henderson is Research Coordinator, Glen Canyon National Recreation Area, P.O. Box 1507, Page, AZ 86040-1507; 520-608-6272; norm_henderson@nps.gov.

Interdisciplinary Resource Protection course returns for

ENCORE PERFORMANCE

RESOURCE SPECIALISTS, PARK RANGERS, AND OTHERS POOL KNOWLEDGE TO SOLVE ENVIRONMENTAL CRIMES



BY JANE GORDON
PHOTOGRAPHS BY TODD SWAIN

In October 2000 individuals from a variety of jobs within the National Park Service convened for the second annual Interdisciplinary Resource Protection Training. This innovative class focuses on the way different divisions in the Park Service can work together to investigate and prosecute resource crime. Included among the diverse group of participants were archeologists, botanists, wildlife biologists, law enforcement officers, hazardous materials specialists, and public information officers. At a time when specialization is increasingly common and necessary in the Park Service, this type of training fills a void. It offers Park Service staff the opportunity to come together and profit from the collective skills of the Service as a whole, rather than to work in isolation from one another. Beware, however, lest this description sound too rosy. This 50-hour class is not for the faint-hearted; work is intense with seldom an idle moment.

> Botanists,
> wildlife biologists,
> archeologists,
> law enforcement officers,
> hazardous materials specialists,
> and
> public information officers
> [participated in the course.]

The setting

The course is hosted at Camp San Luis Obispo, a former military base that is transformed into "San Luis Obispo National Historic Site" for the purposes of the training. Upon arrival, participants are briefed about the course: they will spend a day with federal legal experts pursuing case reviews and environmental law, followed by three intensive days of crime investigation scenarios. Groups are expected to function autonomously, electing their own leaders, choosing their own timelines, and pursuing their own investigations. The scenarios stimulate the bulk of learning, and the stage is set for complex and unpredictable investigations. San Luis Obispo National Historic Site has its own set of rules and regulations, military history, evidence of early cultures, wildlife, and recreational opportunities. Actors from a local university drama club people the site in a variety of functions and roles, playing villains, tricksters, salespersons, and jilted lovers. Villages replete with food stands, rock shops, condominiums, and crack houses emerge from the old

Figure 1. The annual interdisciplinary training course combines the skills and creativity of various park positions, including natural resource management, law enforcement, archeology, and public affairs.

Figure 2. In three days of intensive crime investigation scenarios that involve forensics, chemistry, botany, biology, and other disciplines, course participants put together a case to prosecute a natural resource crime in a national park. Part of the process involves documenting evidence and clues of a natural resource crime.

Figure 3. Course participants get an opportunity to fill various roles in the investigation. Here a public information officer relays news about the crime.

army base, while realistic props such as frozen bobcats appear in suspect freezers. Federal attorneys from Los Angeles staff a mock courtroom where participant cases culminate in trial.

During the daylong scenarios participants find that they must expand their concept of what the investigation process may involve. Problem solving and creative thinking are keys to success in this type of work. Participants scour the scenes for physical evidence, explore telephone records, and visit restaurants frequented by looters. They experiment with various materials and technologies, such as dental stone for fine print casting and video cameras for crime scene surveillance. They discover a variety of resources available to them, including a U.S. Fish and Wildlife Service forensics lab, on-call U.S. attorneys, local ornithologists, marine mammal specialists, entomologists, and hazardous waste cleanup specialists.

Practical scenarios

Inasmuch as resource crime runs the gamut from wildlife poaching to hazardous waste disposal to vandalism, the scenarios offer a variety of possible case studies. Each challenges participants to use the full range of their group's skills, including expertise in the natural, cultural, and forensic sciences (figs. 1–3). A daylong scenario might unfold as follows: the group's public information officer receives an anonymous tip about illegal waste dumping along the shore of Camp San Luis Obispo's protected river. Upon walking the riverbank, the group notices an unusually high number of dead fish along the shore. The fisheries and wildlife specialist identifies these fish as native steelhead trout *(Oncorhynchus mykiss)*, a species whose local population is already endangered. Under the guidance of the resource specialist, the group samples water quality, but is frustrated when they are unable to determine the cause of the fish kill.

The group decides to take a closer look along the shore.

A botanist notes an area of disturbed vegetation upstream of the fish kill. While two members collect additional water samples, the team's archeologist finds tire marks 300 yards from the shoreline. A quick check of the simulated historic site's rules and regulations reveals that this area is closed to vehicles. Realizing that the site may be a crime scene, one of the group's law enforcement rangers cordons off the area, protecting crucial evidence. Her efforts pay off when, upon closer inspection, the group discovers footprints and a pile of empty plastic containers nearby.

he team's archeologist finds tire marks 300 yards from the shoreline.

Clues at the scene lead the group to send two of its members to interview people in the local commercial district. Those remaining on-scene scour the area and subsequently make an important discovery that leads the group's hazardous materials specialist to suspect perchloroethylene as the chemical responsible for the fish kill. They send samples of their find to a local lab for identification. Meanwhile, investigation in town turns up new possibilities. Additional group members arrive to follow up on leads and conduct further interviews. An employee at a paint factory points investigators to a subcontractor whose job is to clean out chemical tanks in the area. While locating the subcontractor proves unsuccessful, interviews reveal that his girlfriend works at the local hamburger stand. Angry with her wayward boyfriend, or perhaps simply feeling the call for justice, she shares helpful information with the plain-clothes investigator.

Group members convene to share details. The sum of the clues and evidence is the basis for "probable cause" to search the premises of the suspected subcontractor. With the aid of an on-call assistant U.S. attorney, the group develops and executes a search warrant on his trailer on the south end of the historic site. The search is comprehensive and provides the links that ultimately bring the case to court.

The outcome of the investigation? That is never predictable. But if your interest is sparked, consider attending a future course to discover it for yourself.

Aftermath

After negotiating the three diverse, day-long scenarios, course participants commented that they had used materials and techniques that they never before would have considered using. All agreed, however, that the most valuable resource was the collective skills of the group members. The opportunity to witness colleagues at work is rare for many participants. Many admitted that they were previously unaware of the scope of certain positions outside of their own. With this new familiarity comes a host of new collaborative opportunities available at the park level.

The recognition of each other's talents is complemented by the participants' discovery of their own strengths and specialties. Many were surprised to see how important their skills are to the investigation. One botanist was shocked when her knowledge of local plant species led team members to elect her as group leader for the following day's investigation. As she directed the final day's activities, however, it became clear how well the group had profited from its shared knowledge. Without hesitation, team members collected evidence, conducted interviews, and documented the investigation at her command. And while the team leader handily oversaw the scientific aspects of the investigation, she demonstrated the same ease as she off-handedly referred to such new legal concerns as probable cause and consent searches.

The opportunity to take advantage of this training arises annually, usually in the fall. Course lodging, meals, and tuition are funded by the U.S. Attorney's Office in Los Angeles, which leaves only the cost of transportation and per diem to be borne by individual parks. As advertised, the training will help parks improve in the investigation and prosecution of resource crimes. Equally important, the integration of technically skilled and creative staffs—park rangers, resource specialists, scientists, legal experts, and others—facilitates synergism and teamwork in this important, shared aspect of park preservation.

About the Author

Jane Gordon recently transferred from Park Ranger, Grand Teton National Park, to Law Enforcement Officer, Arapaho-Roosevelt National Forest, Colorado, and can be reached at jhgordon@fs.fed.us.

For information about the training course, contact ***Todd Swain***, Criminal Investigator, Joshua Tree National Park, California at 760-367-5542 or todd_swain.nps.gov.

PARKSCIENCE
National Park Service
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287

PARKSCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT

VOLUME 21 • NUMBER 1 • FALL / WINTER 2001

www.nature.nps.gov/parksci

ISSN-0735-9462

PUBLISHED BY U.S. Department of the Interior
National Park Service

DIRECTOR Fran Mainella

ASSOCIATE DIRECTOR, Natural Resource Stewardship & Science Michael Soukup

EDITOR Jeff Selleck

CONTRIBUTORS Tim Connors · Catherine Denardo · Mary Ann Franke · Einar Olsen · Kathleen Reeder · Michael Rees · Elizabeth Rockwell · Raymond Skiles

DESIGN Glenda Heronema

EDITORIAL OFFICE Jeff Selleck
National Park Service
P.O. Box 25287
Denver, CO 80225-0287
E-mail: jeff_selleck@nps.gov
Phone: 303-969-2147
FAX: 303-987-6704

Park Science is a resource management bulletin of the National Park Service that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application to resource management. Published by the Natural Resource Information Division of the Natural Resource Program Center, it appears twice annually, usually in the spring and summer. Additional issues, including thematic issues that explore a topic in depth, are published on occasion. Content receives editorial review for usefulness, basic scientific soundness, clarity, completeness, and policy considerations; materials do not undergo anonymous peer review. Letters that address the scientific content or factual nature of an article are welcome; they may be edited for length, clarity, and tone. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Send articles, comments, address changes, and other information to the editor at the e-mail address above; hard copy materials should be forwarded to the editorial office address. Deadline for submissions is January 15 for the spring issue and April 15 for summer.

Park Science is also published on-line (ISSN-1090-9966). All back issues of the publication, article submission guidelines, and other useful information can be viewed and downloaded from the website www.nature.nps.gov/parksci.

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Checks should be made payable to the National Park Service and sent to the editor.

Sample article citation
Tippets, N., S. O'Ney, and A. M. Farag. 2001. Backcountry water quality in Grand Teton National Park. [National Park Service publication] Park Science 21(1):25-27.

PARK SCIENCE

TERMITE TREATMENT TESTS AT
STATUE OF LIBERTY

PIKA PERSISTENCE
AT CRATERS OF THE MOON AND LAVA BEDS

ECONOMIC IMPACT ANALYSIS AT
FORT SUMTER

A ROLE FOR FOSSIL INVENTORIES
IN ECOLOGICAL RESTORATION

ATMOSPHERIC NITROGEN DEPOSITION AND
WESTERN PARKS

VOLUME 21 • NUMBER 2 • SPRING 2002

UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE

From the Editor

CULTURAL RESOURCE CONNECTIONS

I am delighted to present an article that focuses on cultural resource preservation as our cover story. Authors Mark Gilberg and Nan-Yao Su report on a relatively new termite treatment that is friendlier to the environment and more effective in the long term than many traditional termiticide applications. The study, a series of field trials in five units of the National Park System, is thorough and documents a viable alternative to deal with subterranean termites, a serious threat to our historic structures and objects. I am hopeful that the article will increase the awareness of this promising technique among cultural and natural resource managers and facility managers alike.

As always, in selecting an article for the cover I look for potentially broad applications of research, timely topics, less common subjects, or material that represents progress for the National Park Service. I also consider a subject's appeal, perhaps to a new or sporadic reader of *Park Science*. This article, which applies research to cultural resource preservation through manipulation of a natural resource, struck me as particularly intriguing.

Another link between cultural and natural resources is described in this issue's Highlights department. Resource and facility managers at Valley Forge National Historical Park have changed their traditional mowing operations that formerly managed 1,400 of the park's acres as lawn. Now, half of that acreage is allowed to grow into meadow, representing the historic landscape of the 18th century (see photo) and giving visitors a better visual approximation of the place George Washington used for the encampment of his troops.

Looking back to fall 1995, our cover article described a cultural-natural resource connection of another kind. The authors reported a technique used at Amistad National Recreation Area, Texas, to date rock art (pictographs) through chemical analysis of the paint. The process also identified natural crusts formed from bio-geo-chemical interactions among the rock substrate and paint that gradually cause the pictographs to appear faded. Through the application of natural sciences, the investigators improved the correspondence of the rock art to the cultures that produced them, enhancing resource interpretation and preservation.

There is opportunity for more of this kind of reporting in *Park Science* that explores relationships between cultural and natural resource management and the cultural and natural sciences. Even as many of us focus daily on preserving natural resources, our efforts contribute to the ecological integrity of a national park and the greatness of the National Park System, ideas that are culturally important. Or we may manage species (e.g., wildlife that symbolize the American wilderness or a particular time period), landforms (e.g., natural landmarks), or other phenomena (e.g., dark night skies) that are simultaneously natural and cultural resources. We may strive to understand the natural setting of a park that was important historically or prehistorically or the effect of natural processes (e.g., shoreline processes) on the preservation of cultural resources. Even cultural resource preservation can have implications for natural resources (e.g., armoring of forts and relocation of lighthouses).

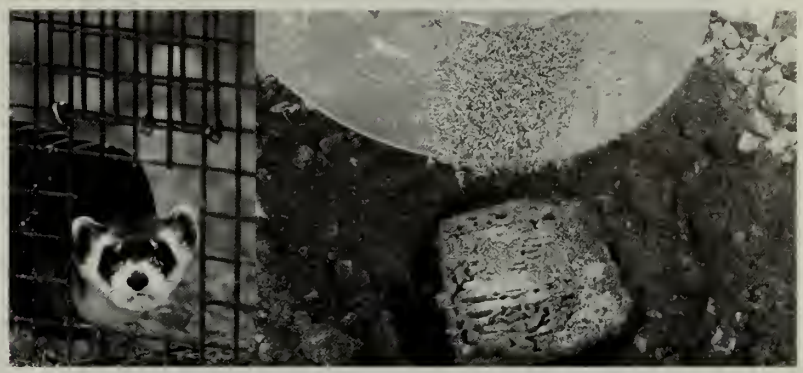
Certainly, connections between cultural and natural resource management in the National Park System are abundant. Writing and reading about them encourages holistic thinking about the resources in our care and the scientific tools at our disposal. I invite you to share additional links among these resources in future issues of *Park Science*.

Jeff Selleck
Editor

PARK SCIENCE
VOLUME 21 • NUMBER 2 • SPRING 2002

DEPARTMENTS

ON THE COVER
International symbol of freedom and justice, the Statue of Liberty is one of five national parks where researchers have tested new technologies to control termites. Results of the field trails are reported in our cover story on page 16.



COVER STORY

FEATURES

news & views

Handling wolves on Isle Royale

"The attention given to [handling wolves on Isle Royale (volume 20(2):14–18)] is commendable and in the spirit of the federal agency whose principles are most similar to my own. It is hoped that the basic 'hands off/management of human visitation only' principle will be adopted by the other public land management agencies.

On the other hand, it is hoped that the National Park Service has or will adopt the principle of public involvement in policy—as have some other public land management agencies. It seems to me deplorable and out of spirit with NPS principles that no public seemed to be involved in this issue on Isle Royale. If this if true ... why is that?"

—Michael J. Riegert
Stetsonville, WI

I first wish to assure Mr. Riegert that the National Park Service (NPS) and Isle Royale National Park value the comments we receive from the public and that we make every effort to routinely invite the public to participate in our planning and decision-making efforts. For example, at Isle Royale we recently completed a general management plan, during which we hosted 10 public meetings and issued six detailed newsletters for the purpose of gathering public input into the planning process. As a result, hundreds of written comments from the public were received and considered. Presently, we are developing a wilderness and backcountry management plan that has provided ample opportunities for public input. A draft plan will soon be made available to the public for review and comment. Not only is public involvement required by the National Environmental Policy Act (NEPA) of 1969, it is simply good business to seek input from interested and knowledgeable citizens.

Wolf handling at Isle Royale began in the late 1980s, after extensive peer review by scientists and the U.S. Fish and Wildlife Service, the agency responsible for administering the Endangered Species Act. Under the NPS Management Policies in place at that time, nondestructive research and monitoring activities were considered a "categorical exclusion." Categorical exclusions are actions that, under normal circumstances, are not considered major federal actions and that have no measurable impacts on the human environment. By definition, categorical exclusions are excluded from further NEPA review and do not require public involvement in the decision-making process. Staff of the National Park Service felt the application of the categorical exclusion was appropriate for this particular monitoring activity because wolf handling techniques and protocols for handling were well established and had the concurrence of the U.S. Fish and Wildlife Service. In 1999, when the scientific review of the existing handling program was being conducted, the same categorical exclusion was applied. The park was not required to include the public in the evaluation, nor had any indication from any of the interested groups that they wanted to be included in the process. The review panel carefully considered all alternatives and felt that the decision made would best serve the wolf population at Isle Royale.

Lest this all sounds too bureaucratic, I also add that, at Isle Royale, there is no topic of more public interest than that of the wolf population and our wolf research program. In reality, the public, while not through a formal public process, is indeed involved in the program on a continual basis simply due to the program's high popularity, visitor curiosity on the topic, and the easy access to the researchers involved in the project.

And as an update, a recommendation made in 1999 to pursue other means of obtaining genetic material from the wolves is now in progress. A research project has been funded to examine wolf scat as a viable source of genetic material. That answer may be available by late 2003.

—Jack Oelfke
Isle Royale National Park

Honors awarded for natural resources work

The National Park Service recently presented six individuals with its 2000 Director's Awards for Natural Resource Stewardship and Science. The honors recognize outstanding achievements in the protection of ecosystem health in parks. This year, a sixth award was initiated, the Director's Award for Professional Excellence in Natural Resources, given in recognition of an NPS employee who fosters creative and innovative resource management practices in support of the mission of the National Park Service. The awards were given during the October 2001 meeting of the Natural Areas Association in Jacksonville, Florida. The people selected for these awards have, among other things, developed innovative vegetation management programs, advanced the use of sustainable practices, restored native ecosystems, and furthered our knowledge of coastal ecosystems.

Tamara S. Naumann, botanist at Dinosaur National Monument, Colorado-Utah, was the first recipient of the Director's Award for Professional Excellence in Natural Resources. Tamara designed and developed a vegetation management program that addresses weed management, restoration of native species and communities, and rare plant research and monitoring. Each of these components has applicability to other parks and agencies across the Colorado Plateau. Each component also has a strong educational aspect ranging from presentations to volunteers, to development of a rare-plant coloring book for youngsters. Tamara's involvement in national and interagency activities, volunteer activities, weed programs, weed management, and rare plant management serves as a model for parks on the Colorado Plateau and elsewhere.

Mike Finley, the immediate past superintendent of Yellowstone National Park, was the recipient of the Director's Award for Superintendent of the Year for Natural Resource Stewardship. Mike was recognized for his instrumental leadership in several complex and controversial areas of resource management, including the restoration of the gray wolf, management of bison, winter use in Yellowstone, and conservation of the Yellowstone cutthroat trout. Mike has shown strong support for scientific research and professional resource management. He has recognized the importance of good information in decision making, insisting that management decisions be science-based.

Chris V. Case, Facility Manager at Pictured Rocks National Lakeshore, Michigan, was presented the Director's Award for Excellence in Natural Resource Stewardship through Maintenance. Chris is a leader in the field of sustainable resource management and in the application of "green" technologies at the park. He has researched, developed, and introduced a comprehensive program encompassing sustainable energy (including solar), park-wide recycling, "biofluids" conversion, and product inventory and standardization. His efforts resulted in the conversion of six hand-operated camp-

Several of the winners assembled in Jacksonville, Florida, in October to receive the awards from Mike Soukup, NPS Associate Director for Natural Resource Stewardship and Science. Pictured from left to right are: Chris Case, Mike Soukup, Samantha Weber, Tamara Naumann, and Charles Roman. Absent are Mike Finley and Tim Tunison.

ground water pumps to 24 solar chlorinated well pump systems; development of a solar power grid system for seasonal employee housing, and conversion of diesel additives and hydraulic fluid to soy-based biofluids in vehicles. He has worked closely with Sandia National Laboratory, U.S. Department of Energy, solar contractors, and the Michigan Soybean Promotion Council in applying these technologies in the park.

The recipient of the Trish Patterson-Student Conservation Association Award for Resource Management in a Small Park was **Samantha E. Weber**, Chief of Natural Resource Science at Cabrillo National Monument, California. Through her hard work and determination, Samantha initiated the Division of Natural Resource Science at Cabrillo and implemented a geographic information system (GIS) program. Lacking professional and support staff for her program, she developed a network of resource managers and scientists in and outside the National Park Service to assist the monument. The natural resource science and GIS programs are now integral parts of the monument's operation. Samantha also has worked closely with scientists who wished to do research in the monument to ensure that their projects meet the monument's information needs.

J. T. "Tim" Tunison, Resource Management Specialist at Hawaii Volcanoes National Park, was presented the Director's Award for Natural Resource Management. Tim led and documented experiments to remove exotic plants in very small areas called special ecological areas (SEAs), and focused on methods that encourage native species to reestablish. He collaborated with scientists to use SEAs as living laboratories, formulating and testing hypotheses about native ecosystems and their vulnerability to exotic plant invasions, and devising practical techniques to restore and protect native systems. As a result, Tim and his resource management crew have effectively restored native ecosystems in the park ravaged by exotic plant infestations—a task some thought was hopeless. His successes have encouraged all the

NPS land managers of the Pacific islands to revisit their techniques for managing exotic species.

Dr. Charles Roman was the recipient of the Director's Award for Natural Resource Research. Dr. Roman is a research scientist in the Biological Resources Division of the U.S. Geological Survey. He has been studying the ecology of coastal ecosystems on behalf of the NPS Northeast Region's coastal parks for more than 15 years. Dr. Roman's research has been essential to the protection of coastal barrier national seashores in four major areas: evaluating effects of hydrologic alterations on freshwater wetland ecosystems; restoring salt marshes and small estuaries; quantifying changes in coastal ecosystem structure, function, and process; and evaluating relationships between sea level rise and salt marsh habitat structure. His innovative work has inspired much research interest in national parks among the scientific community.

Park Science congratulates all of the year's award winners.

Excellence in Geographic Information Systems recognized

The first National Park Service GIS awards for fiscal year 2001 were presented at the National Park Servicewide GIS Spatial Odyssey conference in Primm, Nevada, the week of December 3, 2001. Seven categories of awards were established. Of the seven nominees who won awards, five were from the Northeast Region. The winners were:

GIS Enabler: Mike Hill, Superintendent, Assateague Island National Seashore—for his all-around support of the GIS program at Petersburg National Battlefield (where he formerly served as superintendent). His efforts helped establish the program in this "small" park, resulting in big benefits to it and other national parks in the region.

Heroism: Richard Easterbrook, GIS Specialist, Petersburg National Battlefield—for his work in resource protection at New River Gorge, following two substantial floods in summer 2001. Richard provided GIS products such as maps of soils, hydrology, and archeology to aid an emergency response team in identifying damaged resources and infrastructure.

Community Service: Mark Adams (pictured above, left), GIS Specialist, Cape Cod National Seashore—for his success using GIS to involve disparate parts of the community in park decisions. **Richard Friedman**, GIS specialist with McKinley County, New Mexico—an NPS partner with Chaco Culture National Historical Park—also received this award. His outstanding knowledge of the prehistoric road system in the park, GIS skills, and cooperative attitude have helped predict the location of archeological sites so that they can be studied and protected cooperatively by the park, Navajo, Zuni, and other community partners.

Partnering: Mark Duffy, GIS Specialist, Assateague Island National Seashore—for establishing sustained and productive GIS partnerships with local and county programs. His efforts have helped focus GIS applications on coordinated regional planning to preserve park, county, and watershed resources.

Excellence in Application: Dan Hurlbert, GIS Specialist, Shenandoah National Park—for his extensive and high-quality work on GIS at the park, ranging from applications in fire to interpretation. Additionally, his technical GIS skills have been key in maintaining the park's scenic and rural character by modeling the potential visual impacts of proposed development.

Nontraditional Users: Dan Spotskey, Grand Canyon National Park—for supporting a murder trial through the preparation of maps showing the crime scene in the park. The GIS products were exhibited in court to help the judge and jury understand the complex terrain, its remoteness, and how the suspect—who pleaded guilty to the crime—pushed his wife over a cliff in 1993.

Team Project: Crater Lake National Park's maintenance and GIS programs and the University of Hawaii—for combining GIS and Global Positioning Systems technologies to effect real-time mapping of snowplows in relation to park roads and facilities. This project will have application in all snowy parks by allowing snowplow operators to maneuver their machines in whiteout conditions, minimizing damage to park signs, walls, and other infrastructure in addition to increasing personal safety.

Park Science congratulates the winners. PS

Articles wanted

The editor is always looking for articles to publish in *Park Science* that demonstrate the application of science to park management. If you can show this connection in on-the-ground resource management or by analyzing the implications of research findings for management, please consider writing an article. Additionally, the contributions of park operations such as interpretation, law enforcement, and facility management to preserving park resources are of interest, and the articles about them need not be written by researchers or resource managers. Features, brief highlights, announcements of meetings or conferences, book reviews, and summaries of journal articles are wanted. Complete guidelines for submitting all types of articles are available on the *Park Science* website at www.nature.nps.gov/parksci.

HIGHLIGHTS

Research reveals dinosaurs and other fossil wildlife at Big Bend

Research at Big Bend National Park, Texas, is increasing our knowledge of the environment when dinosaurs lived on the planet. Since 1995, vertebrate paleontologist Dr. Julia Sankey has been visiting Big Bend to find fossils of Late Cretaceous animals such as dinosaurs and mammals (fig. 1). The Cretaceous period ended 65.5 million years ago and was the last geologic period with dinosaurs. Big Bend is the most fossil-rich national park that preserves materials from the last 35 million years of the dinosaurs' existence. The park also contains some of the southernmost fossils from the Late Cretaceous period in North America. Sankey's work is contributing to painting one of the most complete pictures of a Late Cretaceous dinosaur ecosystem anywhere on the planet.

Sankey has focused on collecting fossils from microvertebrate sites. These are accumulations of small teeth and bone that often form in ancient stream channels. To recover the fossils, sediment is collected and washed through fine-mesh screens. With the aid of a microscope, fossil teeth and bone are then sorted out. The teeth can sometimes be identified to the species level and help provide a picture of the ancient ecology of the area.

Thirty-eight different kinds of fossil vertebrates have been discovered in the Talley Mountain area of the park, including dinosaurs, mammals, lizards, and other animals. Fossil teeth from nine plant- and meat-eating dinosaur species have been found (fig. 2). The plant-eating dinosaurs include dome-head (pachycephalosaurid), duck-billed (hadrosaurid), and horned (ceratopsian) dinosaurs. The meat-eating dinosaurs include an older relative of *Tyrannosaurus rex* and small theropods (*Saurornitholestes* sp. and *Richardoestesia* sp., including a new species, *Richardoestesia isosceles*). Many of the dinosaur teeth are small, probably from juveniles or younger individuals. Although no nest sites have yet been found at Big Bend, these teeth provide evidence that dinosaurs nested in the area.

Aside from finding new and different kinds of fossils, this research is helping scientists better understand the environments in Big Bend in the Late Cretaceous period. The environments in the park were different from areas further north. Big Bend was drier and may have had seasonal droughts and subsequent flash floods. Documenting the Late Cretaceous animals in areas like Big Bend, with such different environments, helps scientists better understand the ecology of the time. This may also help us understand why the dinosaurs went extinct at the end of the Cretaceous period.

Figure 1. Working first as a graduate student at Louisiana State University and now with the South Dakota School of Mines and Technology, Dr. Julia Sankey has been studying fossils of Late Cretaceous dinosaurs and mammals in Big Bend National Park since 1995.

Figure 2. Teeth of plant-eating (A, B, and D) and meat-eating dinosaurs (remainder) from Big Bend. Letter A, bottom row, is a new species of small, carnivorous dinosaur that may have been a fish-eater (see Sankey, J. T. 2001. Late Campanian southern dinosaurs, Aguja Formation, Big Bend, Texas. Journal of Paleontology 75(1):208-15).

Black-footed ferrets:
An Endangered Species Act success story (so far)

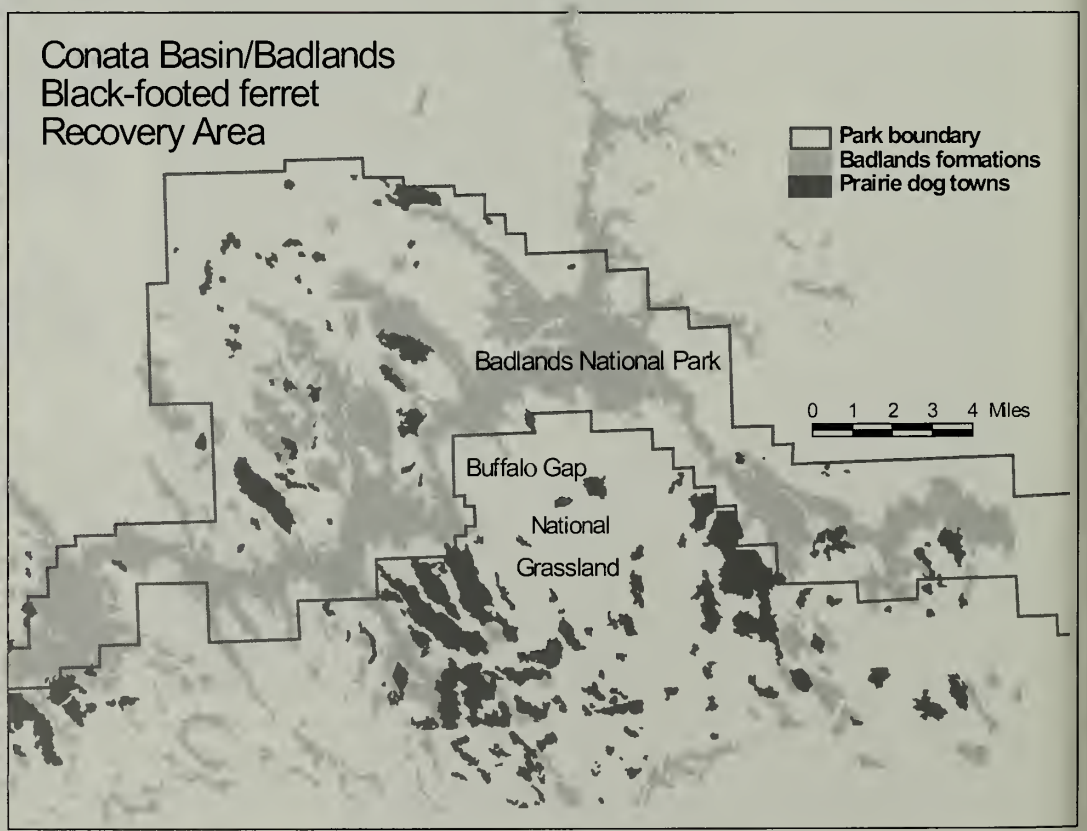
In 1994, parts of Badlands National Park and Buffalo Gap National Grassland (South Dakota) were designated as the Conata Basin/Badlands Recovery Area for the federally endangered black-footed ferret. A major, four-year reintroduction program began, which was described in detail in 1995 in *Park Science* 15(2):1,16–18. Designation as a "nonessential experimental population" allowed biologists flexibility and use of adaptive management techniques critical to bringing back from the edge of extinction this secretive, little-known species.

So where does the program stand nearly eight years down the road? Badlands Chief of Resource Management Brian Kenner and Black-footed Ferret Program Manager Doug Albertson report that the population has reached approximately 250 animals. Most of the ferrets reside on the national grassland because of the extensive black-tailed prairie dog complexes found in the vast prairie there. (Prairie dogs are the sole food source of the ferret.) As many as 55 wild-born litters (averaging approximately 3 kits/litter) have been born there in a single year. Perhaps most significant is that wild-born kits from this recovery area are now being captured and translocated to the Cheyenne River Sioux Reservation, to the east of the park, to help reestablish ferrets in a new area. These wild-born animals have a better survival rate than captive-born individuals, thus jump-starting a population that, because of the reservation's vast prairie dog towns, has the potential to number several hundred.

Disease, particularly sylvatic plague, canine distemper, and tularemia remain serious concerns to ferrets and prairie dogs. However, nonlethal blood sampling of predators in the area does not indicate an immediate threat. Plague, an introduced disease that has decimated prairie dog populations in recovery areas west of South Dakota, presently shows no indication of reaching the Conata Basin/Badlands. Establishment of a large, thriving ferret population farther east on the Cheyenne River Sioux Reservation will afford greater security from any future outbreaks and is therefore a high priority for the interagency ferret recovery team.

While Badlands National Park cannot by itself support a sustainable ferret population, it is a valuable part of the Conata Basin/Badlands population area, and now has a base-funded ferret management program for long-term monitoring of ferrets, prairie dogs, and related habitat parameters. In the future, should a disease outbreak or other factors decimate this ferret population, the park's experienced, professional staff will be able to translocate excess animals from other wild populations (that may themselves originate from the Conata Basin/Badlands population) to again restore the population. Only by having several large populations like the Conata Basin/Badlands will the species be secure for the long term.

Black-footed ferret as it was about to be released in 1994 in Badlands National Park.



Meadows recreate history at Valley Forge

At Valley Forge National Historical Park (Pennsylvania), 1,400 acres was once managed as lawn. When one mowing over the entire park was finished, the maintenance crews would start over again from the beginning, managing 10 passes a season. The lawns always had a "rough" look, but that was before the current Field Management Plan was implemented in 1994. Now, half of the acreage is mowed 15 times a season while the other half is left to grow up into meadow. Not only do the mowed areas look neater, but also the grassy meadows recreate the "sense of place" at historical Valley Forge, which is the reason the management plan was adopted.

In 1777, General Washington and his troops camped at Valley Forge in farmland where wheat, barley, and rye were cultivated. Some of the old 18th century farmhouses still stand. Today, because of the change in management that allows for high grasses waving in the breeze, the landscape resembles the farming community that existed just before the encampment.

The current management program does not reduce maintenance costs, and mowing is still done continuously. But now it is used to enhance historical interpretation. For example, where the boundaries of the 18th century farms are known, a meadow indicates the area of one farm while the adjacent lawn represents the neighboring farm. Thus, visitors get a sense of the size and relationship of the 18th century farms that was not apparent when mowing was more comprehensive.

Mowing also serves practical purposes. Mowed borders 50 feet wide frame the meadows and show visitors that these fields are here by design. Along the roads, the mowed borders allow motorists to see deer approaching. Between the fields and stands of trees, borders 20 feet wide serve as firebreaks. And, to invite visitors to walk in the meadows, there are mowed paths 15 feet across where people can exercise their dogs or jog without being surprised by snakes or being bitten by ticks.

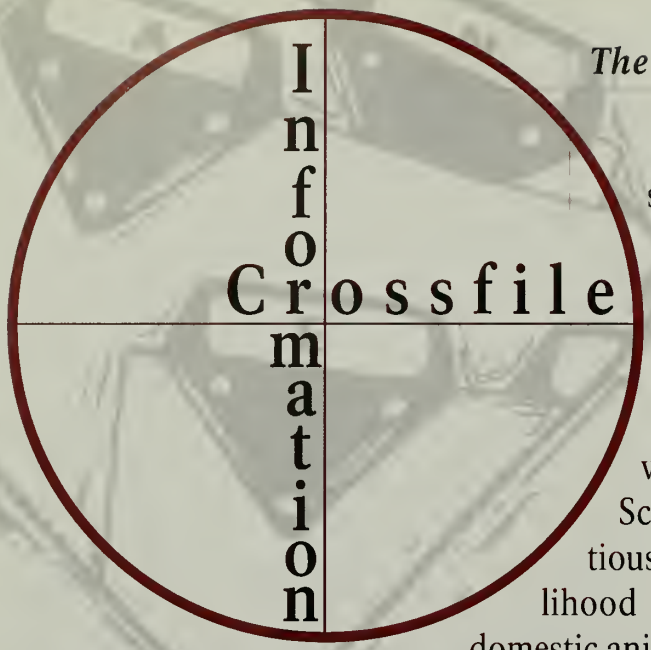
The public heavily uses the park. Two million visitors a year come not only to see the historic sights but also for recreation in a densely urban region. Park managers were hesitant to reduce the lawn acreage when the plan to create the meadows was first implemented in 1994, so they introduced the change slowly, a hundred acres a year. Public reaction was at first undecided, but now it is very favorable; people like the more authentic setting and there are still 700 acres of lawn for picnics, volleyball, badminton, and other games.

To create the meadows, the regular mowing cycle simply stopped, and grasses already in place were left to mature; no additional seeding was done. What came up is about half native perennial grasses, mainly little bluestem *(Andropogon scoparius)* and purpletop *(Tridens flavens)*, and half exotics, including sweet vernal grass *(Anthoxanthum odoratum)*, orchard grass *(Dactylis glomerata)*, and creeping red fescue *(Festuca rubra)*. The latter is being closely monitored. It spreads via underground stolons with which it invades clumps of existing grasses. At present the native grasses seem to be competing well. If the creeping fescue or other invasive nonnatives should begin to take over, the park would need to periodically kill all vegetation in a field with herbicide and then seed the native grasses. Current management includes mowing the meadows once a year to prevent succession of woody plants that would lead to brushy cover and ultimately to forest. Mowing is accomplished before April 15 to prevent disturbing ground-nesting birds.

The "new" mowing program at Valley Forge allows some areas to grow up as meadows that are similar-looking to the farming community as it existed in 1777. Fifteen-foot-wide swaths maintain visitor access and enhance safety.

The change in management from lawn to meadow has undoubtedly affected the wildlife population at the park. Unfortunately, baseline population information was not collected before the meadows were established, so no data are available to show that populations of small mammals, snakes, frogs, songbirds, and raptors might have increased. However, that is the impression of frequent visitors to the park. Wildlife inventories are now under way.

An unquantifiable factor in the current Field Management Plan is the aesthetic one. The meadows covering the rolling hills of Valley Forge are beautiful. The largest field is 180 acres in an area in the middle of the park called the Grand Parade. In late summer when the purpletop blooms, the whole field has a purple cast, and close viewing reveals speckles of wildflowers among the grasses. Even in the winter, when the stalks are dead, little bluestem colors the landscape, not blue, but a warm, red ochre. PS



The threat of pathogens to biodiversity

The introduction of nonnative plant and animal species and habitat loss are commonly viewed as two of the primary causes of the decline and loss of species. However, the introduction of infectious disease-causing agents may be a threat of similar importance (Daszak, P., A. A. Cunningham, and A. D. Hyatt. 2000. Emerging infectious diseases of wildlife: Threats to biodiversity and human health. Science 287:443–49). The number of emerging infectious diseases of wild animals is increasing, as is the likelihood for transmission of diseases between humans, domestic animals, and wildlife. This poses a risk to the conservation of biological diversity in America's national parks and globally.

In addition to the well-known Lyme disease, rabies, and brucellosis, other infectious diseases can be transmitted among animal species and from animals to humans. In the United States these diseases include cryptosporidiosis, hantavirus pulmonary syndrome, and plague. Other diseases that can be transmitted between domestic and wild animals include canine distemper and canine parvovirus disease (that primarily affect members of the dog family), and strains of Newcastle disease (that affect poultry and waterfowl). An emerging fungal disease, chytridiomycosis even affects amphibians.

Human encroachment into wildlife habitat increases the likelihood for transmission of disease between humans, domestic animals, and wildlife species. Pathogens are also spread by people in several ways. The widespread introductions of animals into new areas poses a risk of transmitting infectious diseases to native animals that have never been exposed to the diseases. Infections may cause disease outbreaks, resulting in widespread mortality and possibly the extinction of local populations. This risk is particularly grave to endangered species.

Pathogens also may be introduced by international traffic in agricultural materials, domesticated animals, food crops, timber, and biologically contaminated wastes and ballast water. Evidence of this pathogen pollution (i.e., pathogens introduced by people) seems to be everywhere, even in Antarctic wildlife: antibodies to the infectious bursal disease virus, a domestic chicken pathogen, have been found in Antarctic penguins.

The authors noted the means to detect and control wild animal infectious diseases are inadequate. Although the conservation community has guidelines for preventing the spread of pathogens through the release of animals into areas where they have not lived, the guidelines have not always been followed. Between 1973 and 1986, conservation programs in the United States, Australia, Canada, and New Zealand translocated 700 terrestrial vertebrate animals, but 24% were not screened for diseases.

The authors called for extending the integrative, multidisciplinary approach taken to detect and control infectious diseases in humans to diseases in wild animals. Detecting and controlling diseases in wild animals must include investigations of the ecology, pathology, and population biology of host–parasite systems, and the identification of underlying causes of diseases and spread of diseases. Rapid dissemination of information by modern media and far-reaching legal support are also needed to control these diseases.

The effect of white-tailed deer on forest bird populations

Browsing by ungulates can cause measurable changes throughout a forest ecosystem, affecting the cycling of nutrients, energy flows across trophic levels, food webs, species composition, and the relative abundance of herbaceous and woody plants. In the United States, the conservation of game raised the densities of deer beyond previously known magnitudes. White-tailed deer *(Odocoileus virginianus)* are dominant herbivores in the eastern United States and may play a significant role in the structuring of forest ecosystems and the shaping of food webs. Such effects should be particularly noticeable in bird populations because bird species are sensitive to changes in vegetation volume and composition. W. J. McShea and J. H. Rappole monitored the density and diversity of vegetation and birds in eight 9.9-acre (4-ha) sites in northern Virginia to determine the effect of white-tailed deer on forest bird populations (2000. Managing the abundance and diversity of breeding bird populations through manipulation of deer populations. Conservation Biology 14 (4):1161–70). Four of the sites were fenced to exclude deer.

The density and diversity of plants in the understory of the fenced sites increased significantly. The abundance of birds, especially of species that feed on the ground and in the intermediate canopy, increased after the exclusion of deer. However, the species diversity of birds did not increase because the bird species changed with the succession of understory vegetation.

McShea and Rappole concluded that in protected areas deer may cause significant changes in the abundance and species composition of birds and that such changes can be reversed by removing deer to increase the diversity and density of understory vegetation.

State clean water programs and endangered species

Two key statutes that affect the National Park Service's efforts to protect fish and wildlife are the Clean Water Act and the Endangered Species Act. The goals of both laws refer to the protection and viability of organisms. The Clean Water Act called for eliminating the discharge of pollutants by 1985, attaining fishable and swimmable water by 1983, and prohibiting the discharge of toxic pollutants in any amount. The act contains statements about necessary improvements to conserve waters for the protection and propagation of aquatic life and wildlife. It established qualitative water standards that favor the propagation of fish and wildlife and set quantitative discharge limits that must meet these water quality standards. The Endangered Species Act called for the conservation of endangered and threatened species until they recover sufficiently to no longer need the protection of the statute. Various sections of the act define the roles and responsibilities of governments and private parties.

The protection and recovery of threatened and endangered aquatic species would benefit from a concerted application of both acts (E. Rosan. 2000. EPA's approach to endangered species protection in state Clean Water Act programs. Environmental Law 30(2):447–85). An impediment has been the role of states under the Clean Water Act. The act authorizes states to administer their own clean water programs and to issue their own permits for point source discharges into waters (National Pollutant Discharge Elimination System [NPDES]). Such programs must comply with minimum requirements of the Clean Water Act, but because discharges under state clean water programs are not federal actions, they do not trigger compliance with the federal Endangered Species Act. (However, in cases where the Environmental Protection Agency (EPA) retains approval authority over state programs or final permit actions [e.g., NPDES permits], the EPA is required to determine what effect a permit may have on threatened and endangered species.)

The EPA, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service spent almost a decade developing an interagency memorandum of agreement and national coordination procedures to protect endangered species from adverse effects of the state-administered clean water programs. Under the 1999 draft memorandum of agreement (that was subsequently implemented on 22 February 2001), the EPA agreed to consult with the Fish and Wildlife Service (and the National Marine Fisheries Service when appropriate) in the review of state discharge permits and water quality standards to protect listed species.

Although some issues still need to be resolved, the memorandum of agreement is expected to help improve communications between the agencies, help the conservation and recovery of threatened and endangered species, and generally improve water quality in the country.

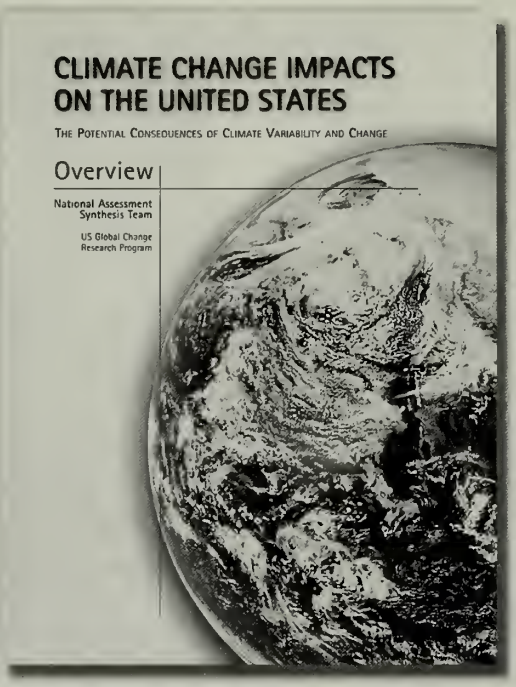
Problems in documenting population trends of the desert tortoise

Documenting trends of a species that is widespread but sparsely distributed can be difficult. Such is the case with the Mohave Desert populations of the desert tortoise *(Gopherus agassizii)*. Desert tortoises occur over a huge area and can be abundant in places. The listing of tortoises as threatened in 1990, because surveys suggested that some populations were declining rapidly, affected human activities in much of the desert Southwest. However, questions have arisen regarding the survey methods used before listing the tortoise.

Desert tortoises were studied at Joshua Tree National Park for six years to establish baseline population estimates and document changes over time (Freilich, J. E., K. P. Burnham, C. M. Collins, and C. A. Garry. 2000. Factors affecting population assessments of desert tortoises. Conservation Biology 14(5):1479–89). The researchers found that population estimates that do not account for weather changes are likely to be misleading. Their estimates, based on weekly spring surveys, varied substantially, particularly during wet and dry years. They found that apparent changes in population size were most strongly related to changes in the susceptibility of capturing the animals. In dry years the tortoises' home ranges decreased, captures decreased, and the effort required by the researchers to find each tortoise nearly doubled. The researchers concluded that tortoises are likely to be undercounted during dry years and that earlier studies conducted during droughts are probably not accurate, particularly if few tortoises were found.

The authors noted that the case of the desert tortoise may be true for other wide-ranging species. They urged that the U.S. Fish and Wildlife Service must ensure that listings of these species be based on tested methods and reliable data. Survey techniques must be carefully analyzed and reviewed to ensure that they are sufficiently robust to encompass both temporal and spatial heterogeneity inherent in ecosystems. Otherwise, the credibility of the Endangered Species Act can be challenged.

Climate change impacts on the United States



Long-term scientific observations show that the Earth's climate is now changing at a rapid rate, and indications are that even greater climate change is very likely this century. The National Assessment of the Potential Consequences of Climate Variability and Change, part of the United States Global Change Research Program, is a major ongoing effort to understand what climate change means for the United States. In 2000, the National Assessment Synthesis Team, a committee of government, university, industry, and nongovernmental organization experts, wrote an Overview of the Assessment (*Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*. Cambridge University Press. 154 pages). This overview is based on a longer, referenced "Foundation" report. The National Park Service participated in workshops on this report and reviewed various draft documents.

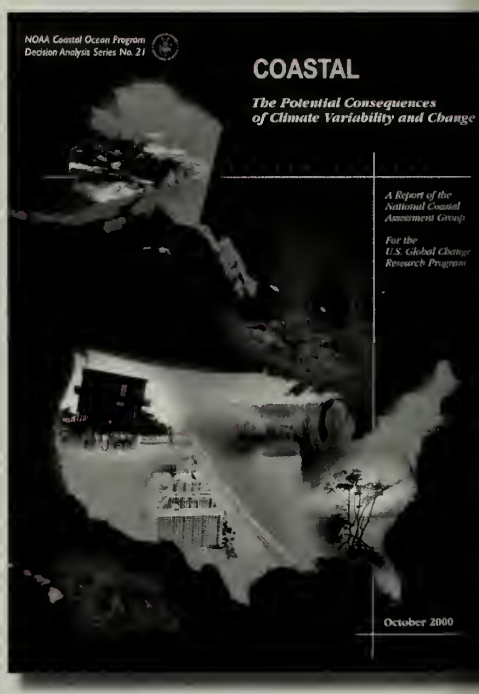
The overview summarizes past and predicted changes in America's climate, and discusses how the nation and its ecosystems may consequently change in the future. Regional overviews are also provided, focusing on possible climate changes in different parts of the country and key issues facing each region. The regional reviews cover the Northeast, Southeast, Midwest, Great Plains, West, Pacific Northwest, Alaska, islands in the Caribbean and the Pacific, and native peoples and homelands. In addition, the report addresses the key issues and implications of climate change for five sectors: agriculture, water, human health, coastal areas and marine resources, and forests.

Mike Soukup, Associate Director for Natural Resource Stewardship and Science, observed "This document contains much useful information relevant to the future of every park.... Although it does not focus on national parks or protected areas per se, potential impacts to them can easily be inferred." Among the key findings of the report of relevance to national park units:

- The United States will very likely become substantially warmer. Droughts and flash floods are also likely to become more frequent and intense. Heat waves are very likely to increase in frequency, but milder winters also are likely in some areas.
- Many ecosystems are highly vulnerable to the projected rate and magnitude of climate change. A few, such as alpine meadows in the Rocky Mountains and some barrier islands, are likely to disappear entirely in some areas. Others, such as forests of the Southeast, are likely to experience major species shifts or break up into a mosaic of grasslands, woodlands, and forests. Losses in local biodiversity are likely to accelerate.
- Sea-level rises are very likely to cause the loss of some barrier beaches, islands, marshes, and coastal forests through the 21st century.
- Increased carbon dioxide and ocean temperatures, combined with other stresses, will possibly exacerbate coral reef bleaching and die-off.
- It is very probable that rising temperatures will cause further permafrost thawing, damaging roads, buildings, and forests in Alaska.
- Reduced summer runoff, increased winter runoff, and increased demands are likely to compound current stresses on water supplies and flood management, especially in the western United States.
- Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands.
- Coastal inundation from storm surge combined with rising sea level will very likely increase threats to water, sewer, transportation and communication systems, and buildings.

Those interested in reading the overview will find it posted on the Internet in html and pdf formats. The URL is: http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overview.htm.

Implications of climate change for coastal and marine resources



One product of the National Assessment of Potential Consequences of Climate Variability and Change, which was used in preparing the Overview of the Assessment, focused solely on the implications of climate change on U.S. coastal and marine resources (Boesch, D. F., J. C. Field, and D. Scavia, editors. 2000. *The Potential Consequences of Climate Variability and Change on Coastal Areas and Marine Resources:*

Report of the Coastal and Marine Resources Sector Team, U.S. National Assessment of the Potential Consequences of Climate Variability and Change, U.S. Global Change Research Program. NOAA Coastal Ocean Program Decision Analysis Series No.21. Silver Spring, MD. 163 pages). Prepared by a team of scientists, and subjected to peer review and public comment, this report compiles scientific studies by the government, private sector, and academia. The report examines changes in climate forces, including ocean temperatures, currents, hurricanes and storms, precipitation and freshwater runoff, and sea levels. Potential impacts of current climate variability and future climate change on shorelines and coastal developed areas, wetlands, estuaries, coral reefs, and ocean fisheries and other marine species are identified. Case studies are provided on several topics, including impacts on the South Florida regional ecosystems and mid-Atlantic estuaries. The report also outlines strategies for adapting to and coping with the consequences of climate change, and identifies areas of needed research.

This report has many implications for coastal parks. Among its findings:

- The rise of sea level is projected to accelerate during the 21st century, with dramatic consequences in low-lying regions. Coastal erosion, already a widespread problem, will be exacerbated by the sea-level rise. The Atlantic and Gulf coastlines are especially vulnerable to a rise in sea level, as well as an increase in the frequency of storm surges or hurricanes.
- As a result of changes in ocean conditions, the distribution and abundance of major fish stocks will probably change substantially.
- Unprecedented declines have occurred in the condition of coral reefs. Increasing atmospheric carbon dioxide is likely to further threaten coral, resulting in weaker skeletons, reduced growth rates, and increased vulnerability to erosion.

The report is available on the Web in PDF format at http://www.cop.noaa.gov/pubs/das/das21.html.

Paleontological inventories of caves

The Geologic Resources Division (GRD) recently published a technical report entitled *An inventory of paleontological resources associated with National Park Service caves* (Technical Report NPS/NRGRD/GRDTR-01/02). Authors Vincent L. Santucci (Fossil Butte National Monument), Jason Kenworthy (also at Fossil Butte), and Ron Kerbo (GRD) summarize the results of paleontological cave resource inventories conducted in 35 units of the National Park System since 1998. The inventories document both fossils preserved in the cave-forming bedrock and in the caves themselves. The authors discuss the significance of fossils associated with caves and the protection and management of these resources. The 50-page report includes color and black-and-white photographs. Copies are available by contacting the Geologic Resources Division, P.O. Box 25287, Denver, CO 80225-0287, and referring to publication NPS D-2231 (September 2001).

Sixth fossil conference proceedings available

Also available from the Geologic Resources Division is the recent *Proceedings of the Sixth Fossil Resource Conference* (Technical Report NPS/NRGRD/GRDTR-01/01). Editors Vincent L. Santucci (Fossil Butte National Monument) and Lindsay McClelland (GRD) have compiled 20 articles from the conference that deal with paleontological resource management or science and paleontological research on public lands. The fossil conferences began in 1986 and have grown into a rich partnership among federal, state, and local land management agencies and the professional and avocational paleontological communities. This report presents the papers given at the sixth conference: "2001: A fossil odyssey." The 214-page report includes color and black-and-white photographs. Copies are available from the Geologic Resources Division, P.O. Box 25287, Denver, CO 80225-0287; refer to publication NPS D-2231 (September 2001).

Book on lichens, mosses, and liverworts illuminates lesser-known forest life

Editor's Note: Botany professor Bruce McCune (mccuneb@bcc.orst.edu) of Oregon State University kindly reviewed the book *101 Common Mosses, Liverworts, and Lichens of the Olympic Peninsula* (ISBN 016-066471-3, copyright 2001) by Martin Hutten, Karen Hutten, and Andrea Woodward. This guide is part of a habitat-based survey of non-vascular cryptogams in the Olympic Peninsula and is published cooperatively by the U.S. Geological Survey, Canon U.S.A., Inc., the National Park Foundation, Olympic National Park, and the Northwest Interpretive Association. Copies are available from the Seattle (206-553-4270) or Portland (503-221-6217) U.S. Government Printing Office bookstores. McCune's report follows.

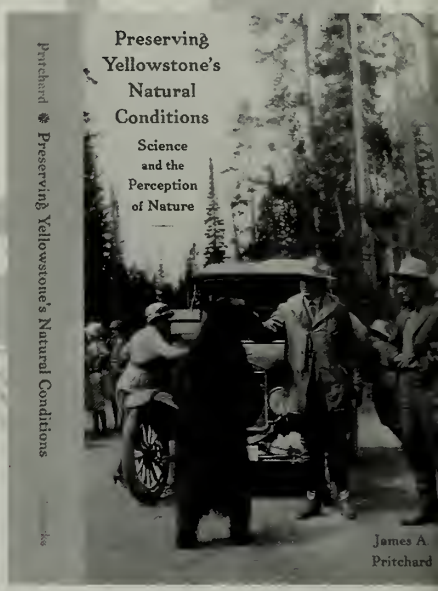
Continued in right column on page 37

Preserving Yellowstone's Natural Conditions

SCIENCE AND THE PERCEPTION OF NATURE

By James A. Pritchard

A book review by Ryan Monello



Park managers, biologists, and other students of conservation generally recognize that some of the most visible management policies in the National Park Service are a direct result of issues that arose in Yellowstone National Park during the 20th century. In *Preserving Yellowstone's Natural Conditions*, James Pritchard provides the reader with a well researched chronology of these events in a novel and unbiased manner. As a resource specialist considering the effects of natural regulation in my own park, I highly recommend the book to anyone interested in or dealing with National Park Service management issues.

On the surface, the core of the book is focused on wildlife management policies in Yellowstone and the scientific, political, and social pressures that brought them about. These issues include ungulate management and the development of the natural regulation paradigm, the struggle to create a more natural bear population that eliminated assured viewing opportunities, terminating pelican control being practiced under the guise of fisheries management, and the creation of a free-ranging bison herd without supplemental feeding and husbandry techniques. Yet the real theme and interesting side of this book lies in the repeated stories of the struggle for the nation's first national park to become more natural, in both the management techniques and overall conditions.

> "The book is focused on wildlife management policies in Yellowstone and the scientific, political, and social pressures that brought them about."

Not surprisingly, Pritchard uses the origins of the park and the ensuing bison and elk management issues to set the stage for the book. At first glance, I imagine any park manager might hesitate to pick up such a book, for these are clearly two of the most well-known topics in the National Park Service. But Pritchard goes well beyond simply describing a history that took place over 100 years ago. He clearly presents the mind-set of the managers: how the fear of bison and elk extirpation shaped management decisions of the late 19th and early 20th centuries and were crucial in bringing about the current abolition of hunting in almost all national parks, early predator control policy, and artificial feeding practices. This leads to an excellent overview of not only the biology associated with elk and bison management in Yellowstone, but also a general understanding of how politics and external forces can affect Park Service management.

Pritchard, an adjunct professor of landscape architecture at Iowa State University, also has a keen ability to relate important park episodes in an accurate manner that is not driven by a particular viewpoint. One of the most often quoted but misunderstood sources in the scientific literature is the Leopold Report (i.e., *Wildlife Management in the National Parks*), which Pritchard sums up in one of the most accurate statements I have read: "Today the Leopold Report is remembered not for its recommendation that direct reduction [of the elk herd] was necessary and proper, but rather for its expression of what the panel members thought about the goals of the parks" (p. 211).

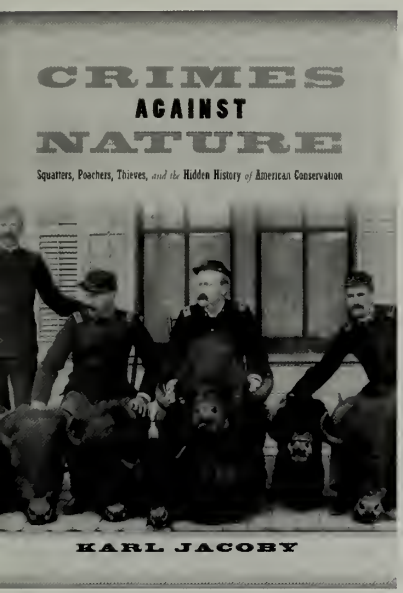
The important role that science can and has played in Yellowstone with respect to various park policies is also clearly shown in this book. Pritchard lays out good motivation and a solid reasoning for managers to rely on well done science to develop park policy and appropriate management decisions—especially with controversial issues. When Newton Drury, the director of the Park Service in the 1940s, was revitalizing an argument to end bear feeding in Yellowstone, he relied on the support of numerous scientists. Conversely, when science is distorted the resource can be threatened. This was the case in Yellowstone when studies indicated the necessity of destroying pelican eggs to protect fishery resources.

Because Yellowstone set the precedent for so many policies in the National Park System, there is a danger that after reading the convincing arguments set forth in this book one may assume that what was good for Yellowstone (e.g., natural regulation) is good for the parks in general. Pritchard does acknowledge the need for active management at times (p. 306), but overall gives a general impression that vigorous management action within a park is equivalent to an unnatural approach. This is not necessarily the case. (Although I certainly agree that unless the scientific evidence and reasoning is especially compelling, a "hands-off" approach is often more appropriate with regard to non-endangered, native species in parks.) Compare the elk scenarios of the Northern Range in Yellowstone with those of Rocky Mountain National Park. The former has an intact predator base, a large hunter harvest, and a largely intact winter range. The latter has no

major elk predators, minimal hunter harvest, and a winter range that is largely developed. What works for one may not necessarily work for the other. Given that the book often engages in a Servicewide discussion, I think this point could have been made more clearly. However, I will be the first to admit that this is a relatively minor and finicky point given the excellent read and understanding of timeless issues that *Preserving Yellowstone's Natural Conditions* provides.

Ryan Monello is a Natural Resource Specialist at Rocky Mountain National Park, Colorado. He can be reached at 970-586-1360 and ryan_monello@nps.gov.

Preserving Yellowstone's Natural Conditions: Science and the Perception of Nature
By James A. Pritchard
Copyright 1999
University of Nebraska Press, Lincoln and London
ISBN 0-8032-3722-7, 370 pages



Crimes Against Nature

SQUATTERS, POACHERS, THIEVES, AND THE HIDDEN HISTORY OF AMERICAN CONSERVATION

By Karl Jacoby

A book review by William Supernaugh

This lavishly referenced work chronicles the social reaction of rural communities when traditional activities are criminalized by the establishment of environmental reserves. The author, an assistant professor of history at Brown University, takes the reader through 150 years of reaction to the creation of conservation laws that made illegal previously acceptable pastimes such as residency, hunting, fishing, and logging.

If you are like me, your bookshelves are lined with conservation-related books outlining the history of the conservation movement, the uplifting social setting that led to the creation of Yellowstone National Park, the setting aside of vast tracts of western land as national forest preserves, and later, establishment of a system of national parks and monuments preserving the places and events that demarcated American history and settlement patterns. Biographies abound of the politicians and patriarchs that are synonymous with the conservation movement—Marsh and Muir, the Roosevelts, and many more. Few books have looked at the seamier side of the conservation agenda—at the people who at the time had their livelihood, subsistence lifestyle, and freedom of movement curtailed by the sectioning off of the landscape for the public good—in effect excluding the local rural public. As noted by the author, "Landscapes do not magically reshape themselves in accordance with the desires expressed in legislation. Establishing a functioning conservation program would require not only new laws but new mechanisms for enforcement as well."

There are lessons to be learned from reading the discussion of the formation of the Adirondack reserves in New York, Yellowstone National Park, and Grand Canyon National Monument. Several books have recently examined past and recent activities that have affected native cultures. This work, too, examines the impact of conservation on the inhabitants and practices displaced by parks and preserves. Park rangers of today can relate to the reports of the Army's acting superintendent of Yellowstone in 1892, documenting the enforcement efforts of the soldiers when faced with the population settling around the fringes of the park, "... whose whole subsistence is derived from hunting and trapping."

Jacoby cites several oft-repeated assumptions—"myths" in his words—that still crop up in any discussions of our nation's conservation history. There is one that I found worth examining—both as the prevailing thought of an earlier time and one repeated even as we establish parks a century later. Our earlier parks were not pristine wilderness areas free of human intervention but rather were and are, "part of a pre-existing native world." Protected areas were often home to significant human populations such as was found in Grand Canyon's Supai Canyon or included portions of a cycle of nomadic wanderings. Euro-Americans conveniently wrote these people out of the picture, following what the author characterizes as a history of pursuing environmental quality at the expense of social justice. This book will not be an easy read for some—but it raises questions and exhaustively documents a history lesson well worth studying. In the words of the author, "Memory ... is rarely an impartial record keeper. Details can fade over time. Understandings can shift as individuals re-imagine the past in light of current concerns."

"Euro-Americans conveniently wrote these people out of the picture, following what the author characterizes as a history of pursuing environmental quality at the expense of social justice."

William Supernaugh (william_supernaugh@nps.gov) is Superintendent of Badlands National Park, South Dakota.

Crimes against Nature: Squatters, Poachers, and the Hidden History of American Conservation
By Karl Jacoby
Copyright 2001, ISBN 0-520-22027-7, 324 pages
University of California Press, Berkeley, Los Angeles, London

New termite baiting technologies for the preservation of cultural resources:

RESULTS OF FIELD TRIALS IN THE NATIONAL PARK SYSTEM

By Mark Gilberg and Nan-Yao Su

Since 1995, the National Center for Preservation Technology and Training (NCPTT)—part of the NPS Directorate of Cultural Resource Stewardship and Partnerships—has sponsored a series of field trials to assess the efficacy and practical application of a new technology for the control of termites in historic structures and buildings. Many of these field trials have been conducted in our national parks where cultural resources are severely threatened by termite activity (fig. 1). These sites have proved ideal settings for this evaluation and for testing other new technologies. Moreover, the field trials have helped ensure the preservation of important cultural resources.

Background

Termites are a significant structural pest in the United States, costing the public nearly $1.5 billion in damage each year. The bulk of this damage can be attributed to subterranean termites. Historic buildings and structures are particularly vulnerable to subterranean termite damage, given the traditional use of wood as a building material. Termite damage to historic buildings is both costly and irreversible and can diminish the historic significance of the structure through the loss of original building fabric. Cultural landscapes are also vulnerable to termite damage. In New Orleans, many of the historic oak trees that add shelter and beauty to the city are threatened by an introduced species, the Formosan subterranean termite, *Coptotermes formosanus*.

"Termite damage to historic buildings is both costly and irreversible and can diminish the historic significance of the structure...."

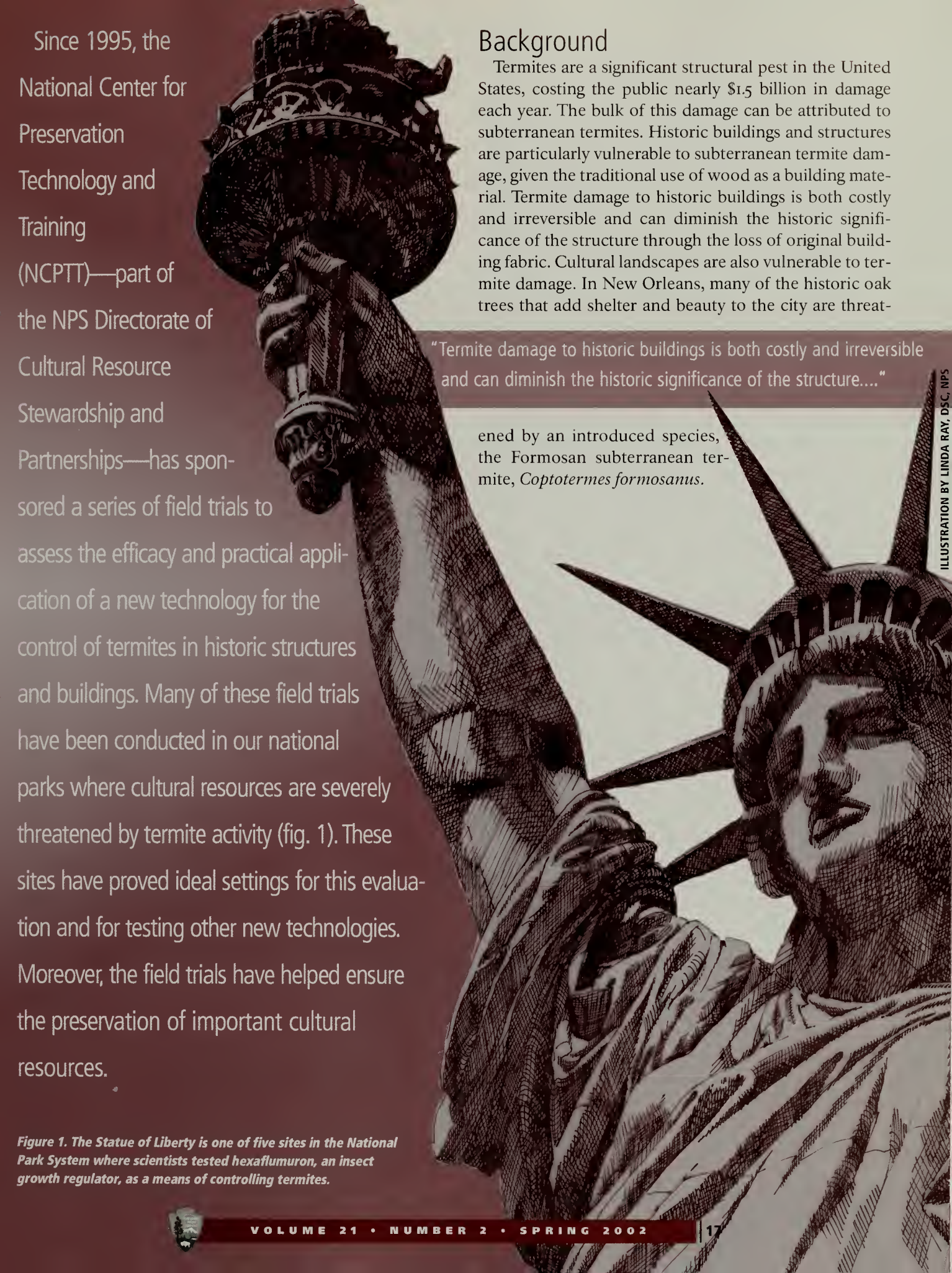


ILLUSTRATION BY LINDA RAY, DSC, NPS

Figure 1. The Statue of Liberty is one of five sites in the National Park System where scientists tested hexaflumuron, an insect growth regulator, as a means of controlling termites.

This species can construct nests within the dead heartwood of the tree eventually weakening it to the point where it is unstable and falls in bad weather.

Conventional methods for the control of subterranean termite infestations rely heavily on the use of organic (i.e., carbon-based) insecticides to provide a barrier for the exclusion of soil-borne termites from a structure. Typically, large volumes of liquid insecticide are applied to the soil beneath and surrounding an infested building. Poisoning the soil is not a sustainable practice and may contaminate groundwater as well as pose health and safety hazards. Moreover, such an approach is not altogether effective. Creating an uninterrupted barrier of treated soil beneath an existing structure is extremely difficult, and gaps in the barrier invariably allow access to the structure. Also, because the soil treatment only deters termite attack, the vast majority of subterranean termites are unaffected. Conventional soil treatments often result in physical damage to the structure; they require the drilling of often disfiguring and unsightly holes in the foundation floor before liquid insecticides are injected into the soil.

"Poisoning the soil is not a sustainable practice and may contaminate groundwater [and] pose health and safety hazards."

New termite baiting technologies

In response to these concerns, a number of new baiting technologies have been developed in recent years as an alternative to conventional liquid insecticides. Of these, baits containing the insect growth regulator, hexaflumuron, have proved most promising in successfully eliminating subterranean termite populations at or near structures. Hexaflumuron inhibits the synthesis of chitin, which is essential for the formation of insect exoskeleton, but is virtually harmless to vertebrates (LD50>5,000mg/kg[1]). The treatment uses a monitoring and baiting procedure, whereby hexaflumuron is delivered by foraging termites to eliminate the entire colony population. The procedure is marketed currently as the Sentricon® Termite Colony Elimination System (Dow AgroSciences, Indianapolis, Indiana) to authorized pest control operators. Studies using the Sentricon system or its commercial prototypes have confirmed that termite colonies of several million individuals can be suppressed to the point of inactivity (or observed elimination) using less than 1g of hexaflumuron. Moreover, elimination of colony populations creates a zone of termite-free soil surrounding a building for several years.

"Termite colonies of several million individuals can be suppressed to the point of inactivity ... using less than 1g of hexaflumuron."

The Sentricon system employs a cyclical process of monitoring and baiting for termite activity. Initially, a technician installs Sentricon stations containing monitoring devices in the soil surrounding a structure. When termite activity is discovered in a station, the monitoring device is replaced with bait containing 0.5% hexaflumuron (fig. 2A). Foraging termites feed upon the baits and thoroughly distribute the hexaflumuron throughout the colony population. Unlike conventional termiticides, hexaflumuron is a slow-acting toxicant that kills termites only when they molt, every 1-2 months. Thus, dead termites do not accumulate around the bait that would otherwise repel other foraging termites and prevent further uptake of the bait. Several months may be required to achieve control but the end result is complete elimination. Once the colony is eliminated, a return to monitoring continues to detect further termite activity.

Hexaflumuron targets only subterranean termites; drywood termites and other insect species remain unaffected. Also, it only impacts those colonies at or near the site to be protected. Hexaflumuron can not be spread over a large geographical area and thus threaten the extinction of *C. formosaurus* as a species. In fact, experimental results to date suggest that re-infestation always occurs but at a slower rate than in the absence of hexaflumuron due to an overall decrease in termite population levels around the site.

Field trials

NCPTT-sponsored field trials involving the use of Sentricon have been conducted at a number of National Park System sites particularly in the Southeast and the Caribbean where subterranean termite activity is most pronounced and threatens many historically significant structures. In the greater New Orleans area the annual cost of termite damage and treatment is estimated at $300 million. The historic French Quarter is particularly threatened because of the widespread use of wood as a building material and shared-wall construction practices that make pest control difficult (Freytag et al. 2000). Much of this damage can be attributed to the Formosan subterranean termite, which was introduced from Asia after World War II. This species is characterized by extremely large colonies and, unlike other subterranean termites, is capable of forming aboveground nests.

[1] Lethal Dose, 50%, refers to the amount of insecticide that, if administered to a population, will cause 50% of the population to die. It is usually expressed in terms of milligrams of insecticide per kilogram of subject body weight.

To date, the National Center for Preservation Technology and Training has sponsored field work involving the use of Sentricon at San Juan National Historic Site, Statue of Liberty National Monument, Cane River Creole National Historical Park, Virgin Islands National Park, and New Orleans Jazz National Historical Park. These trials represent a joint effort by NCPTT and its partners—the University of Florida, the New Orleans Mosquito and Termite Control Board, and Dow AgroSciences—to advance our knowledge of subterranean termite control in historic structures. In addition to establishing the efficacy of Sentricon, these trials yielded considerable information regarding the ecology and behavior of subterranean termites. They also provided opportunities to evaluate several new technologies for detecting termite activity, including thermal imaging and acoustic emissions. We highlight below the methods used to (1) identify termite infestation, (2) measure termite activity for bait efficacy assessment, and (3) apply baits, and the results from several of these trials.

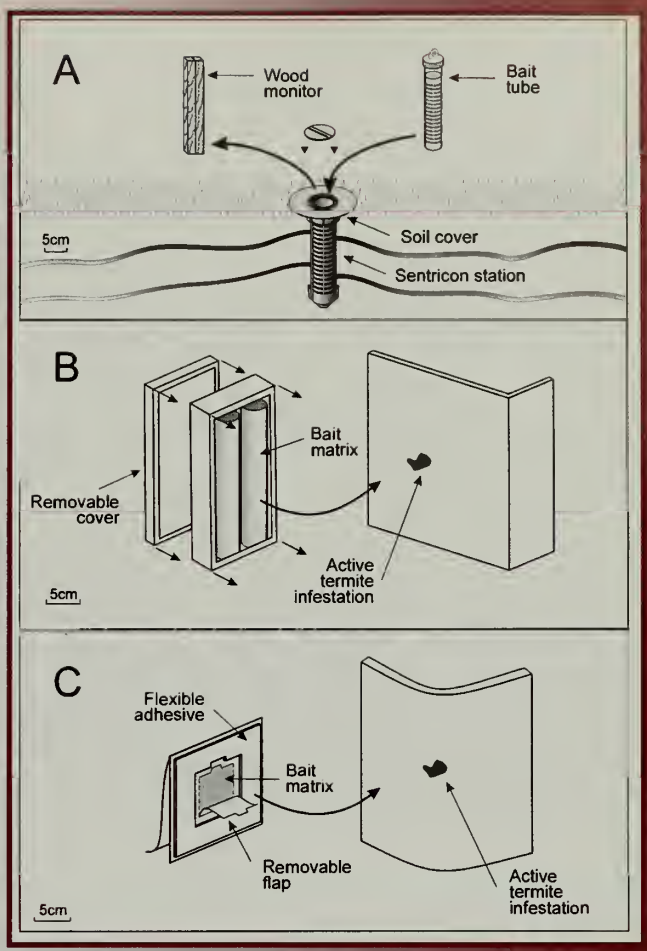


Figure 2. The field trials used three types of bait stations to deliver the hexaflumuron baits: (A) in-ground Sentricon station, (B) hard-style aboveground bait station, Recruit AG, and (C) soft-style aboveground bait station.

Identifying termite infestation

The first step is to identify the whereabouts of termite activity or damage. At the Statue of Liberty National Monument, signs of termite activity such as swarming, wood damage, and mud-tubes as noticed by park personnel led us to identify three sites of live termite activity in the structure (fig. 3): boiler room (BOL), display case (DIS), and sally port (SAL). Another important tool in identifying termite activity in soil is the survey using wooden stakes (Su and Scheffrahn 1986). Researchers drove spruce stakes in soil surrounding the exterior walls of the monument to detect termite activity. The survey revealed two activity sites, one in the soil outside the boiler room and the other at the sally port exit (EXT) (fig. 3). As shown in figure 3, researchers identified four clusters or populations of the eastern subterranean termite, *Reticulitermes flavipes*, at the Statue of Liberty (Su et al. 1998).

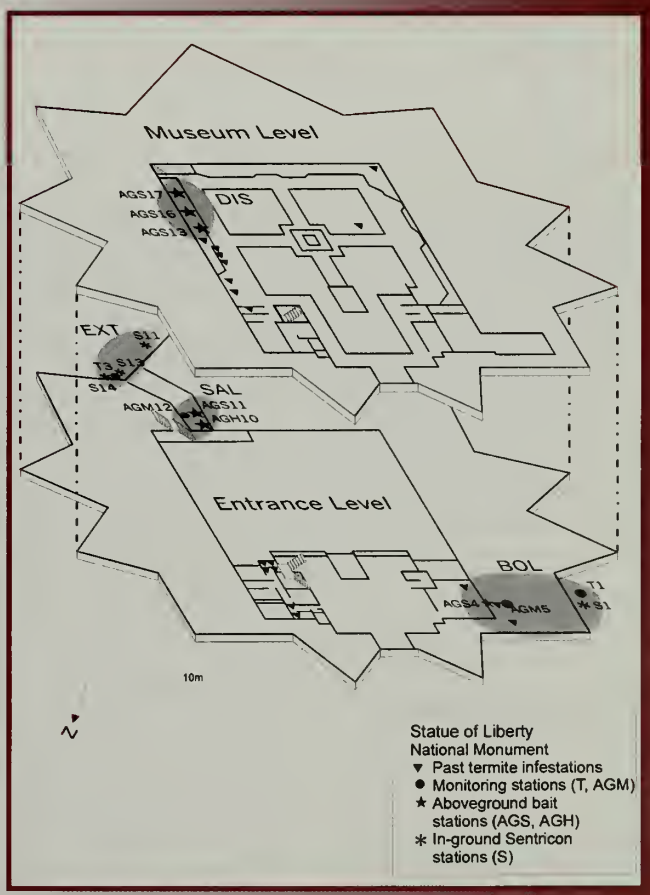


Figure 3. Site inspection and stake survey revealed four clusters of* R. flavipes *activity in the Statue of Liberty National Monument. Termite activity was measured using underground (T) and aboveground (AGM) monitoring stations. Three types of bait stations delivered hexaflumuron: in-ground Sentricon station (S), aboveground bait station Recruit AG (AGH), and soft-style aboveground bait station (AGS).

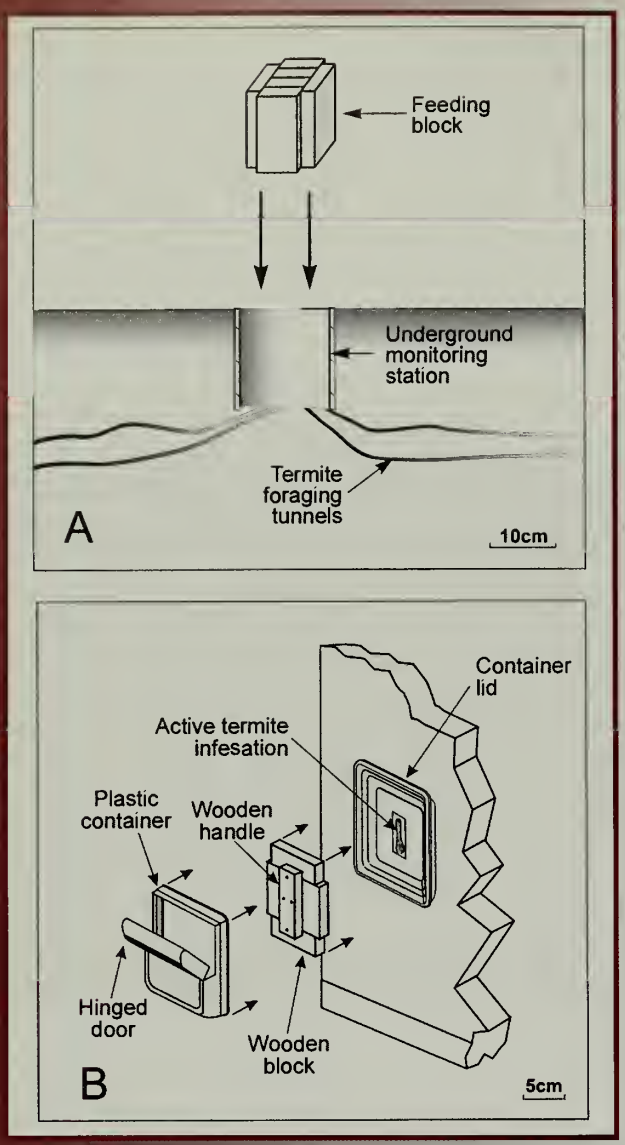


Figure 4. The field trials used underground (A) and aboveground (B) monitoring stations to measure termite activity at several historic sites.

Measuring termite activity

Termite activity must be quantified before, during, and after bait application in order to properly assess the effects of the baits on the populations. Researchers used several techniques to measure termite activity.

Underground monitoring station

At some sites, researchers replaced survey stakes with underground monitoring stations composed of a plastic collar containing a feeding block (Su and Scheffrahn 1986) (fig. 4A). Termite activity is quantified by measuring the wood weight loss of the feeding block. The monitoring stations also provide opportunities to conduct a mark-recapture procedure to identify the foraging range of the termite colony. In the Creole House of the Cabildo complex in New Orleans, for example, researchers collected workers of the Formosan subterranean termite from a station in the courtyard and stained them with a blue dye before releasing them back into the same station (fig. 5). During the follow-up inspection they found blue termites in the wooden floor of the second-floor office (Su et al. 2000).

Aboveground monitoring station

Soil was not always accessible. Therefore, researchers used an aboveground monitoring station similar to that described by Su et al. (1996) (fig. 4B) to measure the termite activity in some sites such as San Cristobal of San Juan National Historic Site.

Acoustic emission device

In addition to the monitoring stations, researchers used other methods such as acoustic emission detectors (AED) to measure termite feeding in wood (fig. 6). The detector recorded sound waves of ultrasonic frequency that were generated when termites broke wooden fibers. Researchers used the device to quantify termite activity in the wooden floor of the display case in the Statue of Liberty National Monument (Su et al. 1998), and in wooden beams of the Fort Christiansvaern of Virgin Islands National Park.

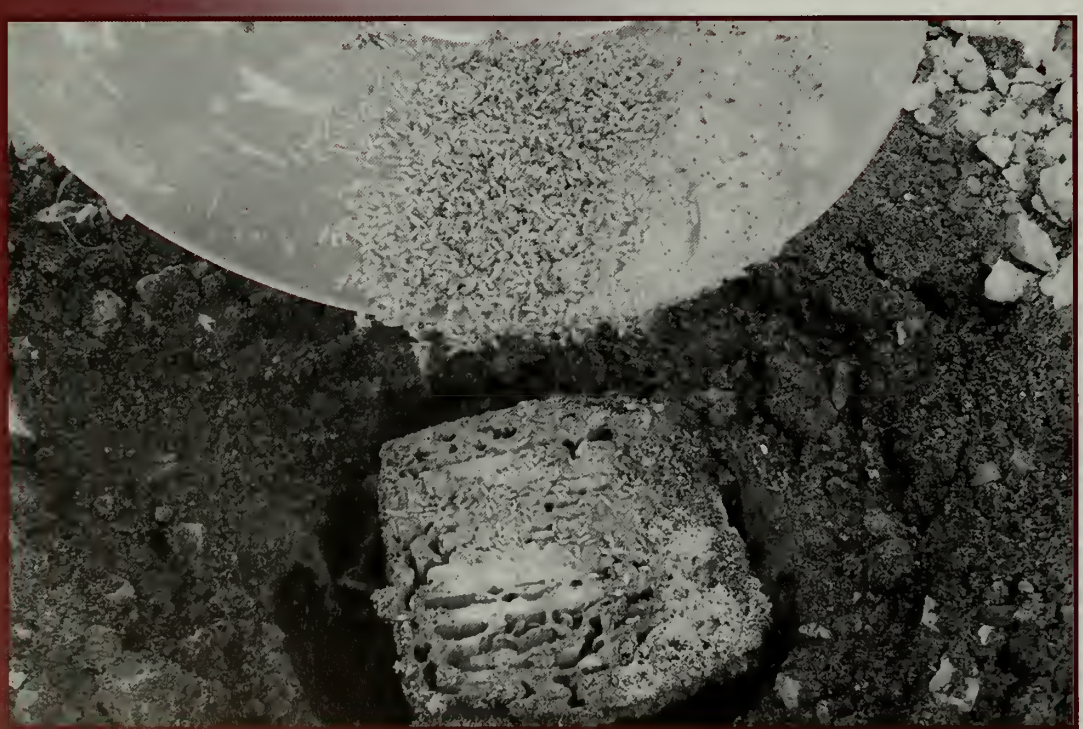


Figure 5. Termites marked with blue dye were released into a monitoring station to delineate colony foraging range.

Other methods of quantifying termite activity

At some historic sites, none of these tools could be used because of preservation concerns. For these sites, researchers counted the number of active monitoring stations and any other signs of termite activity. In Fort Christiansvaern of Virgin Islands National Park, for instance, researchers counted newly emerged foraging tubes of the subterranean termite *Heterotermes* sp. and removed them at each visit so that any new termite activity would be recorded.

Bait application

In some places where soil access was limited, researchers used aboveground stations (Recruit®AG), which consisted of a plastic box containing hexaflumuron bait (fig. 2B, page 19). Researchers attached the open-side of the Recruit AG bait box over an active infestation so that the bait was accessible to foraging termites. Researchers also experimentally constructed another type of aboveground bait station, the soft-style station, for use in several historic sites. This station consisted of a flexible plastic pouch containing hexaflumuron bait (fig. 2C, page 19) and, on its back side, a removable flap surrounded by flexible adhesive. Soft stations were attached over active infestations and the removable flap was pulled to expose the bait. Because of its flexibility, the soft station was adaptable to flat, curved, or contoured surfaces.

Figure 6. The acoustic emission detector (AED) recorded sound waves that were generated when wooden fibers were broken by termite mandibles, and was used to measure termite feeding in wood.

Effects of hexaflumuron baits on termite populations

Researchers measured termite activity at the Statue of Liberty National Monument (see fig. 3) using underground (T) and aboveground (AGM) monitoring stations. Additionally, they used three types of bait stations to deliver baits to termite populations, including the in-ground Sentricon station (S), the aboveground bait station, Recruit AG, (AGH), and the soft-style aboveground bait station (AGS). Termites fed on hexaflumuron baits as soon as researchers placed a bait station inside the display case in August 1996 (fig. 7, DIS). The acoustic emission device detected 20–30 feeding episodes per minute from the wooden floor of the display case through fall 1996 to spring 1997, during which *R. flavipes* continued to feed on the baits. By March 1997, no termites were found in the bait station, and the feeding activity in the nearby wooden floor also ceased.

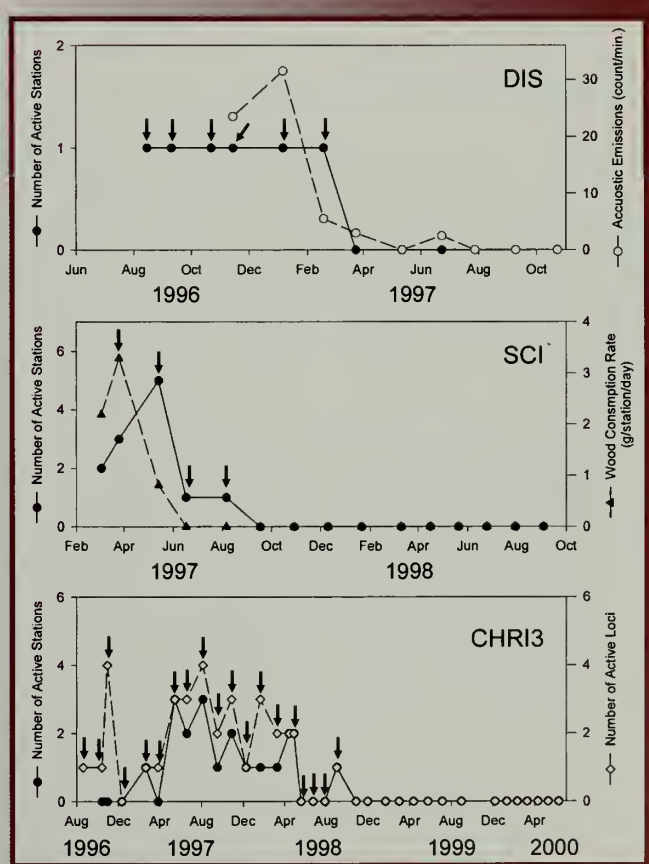


Figure 7. The researchers quantified termite activity as the acoustic emission count (per minute) in the display case of the Statue of Liberty National Monument (DIS), wood consumption rate (g wood per station per day) in the utility room of San Cristobal of San Juan National Historic Site (SCI), and number of active sites such as newly emerged foraging tubes of* Heterotermes *sp. in a storage room of Fort Christiansvaern, Christianstead National Historic Site (CHRI3). Arrows depict applications of hexaflumuron baits. Number of active stations was also included to measure the overall termite activity during and after bait applications.

In March 1997, the subterranean termite *Coptotermes havilandi* fed extensively on wooden blocks in two monitoring stations in the utility room of San Cristobal (fig. 7, SCI). In April, researchers applied hexaflumuron baits to these stations, and after one month, *C. havilandi* activity had declined significantly. By July no termites were found in the monitoring station. Slight feeding on hexaflumuron baits continued in July and August. During this time researchers found *C. havilandi* individuals in the bait station that exhibited apparent symptoms of hexaflumuron effects such as marbled coloration on the worker's abdomen. Since September 1997, no termite has been found in this location.

Unlike *Coptotermes* sp. that is more susceptible to hexaflumuron, the response of *Heterotermes* sp. in Fort Christiansvaern of the Virgin Islands National Park was more erratic. After the initial baiting in a storage room in August 1996, termite activity started to decline in December, but new activity emerged in spring 1997 (fig. 7, CHRI3). Despite repeated applications of baits throughout 1997, termites continued to feed on baits and new foraging tubes kept appearing. Our persistent efforts seemed to pay off when this second wave of termite activity ceased in spring 1998. The cessation lasted for three months, but in October 1998 termites reappeared in one bait station. This third wave of light activity, however, did not last as long as before. Researchers have found no termites or additional foraging tubes in this room since December 1998, two months after termites began feeding on hexaflumuron baits. The repeated cycles of activity during bait application appeared to be common for *Heterotermes* sp., which tend to have many small colonies in one area.

Monitoring and inspection

After successfully eliminating termite populations at a historic site, resource managers must establish a monitoring program to continue protecting the site from further termite infestation. At the Statue of Liberty National Monument, for example, Sentricon stations installed in soil surrounding the exterior wall of the monument have been monitored quarterly since 1998, and no termites have been found on Liberty Island. Termites are abundant in the tropics and subtropics. Even after successfully eliminating all detectable populations of *Heterotermes* sp. at Fort Christiansvaern, Virgin Islands National Park, re-infestation by neighboring populations is likely. To date, the routine inspections by Park Service personnel have not detected any new termite activity. If any sign of a new infestation is detected, the baiting program will resume to eliminate the new population before severe damage occurs.

Conclusions

National Park System sites and monuments are ideal environments for evaluating many new technologies for the preservation of cultural resources. Recent studies involving the use of baits containing the insect growth regulator, hexaflumuron, have demonstrated that they are safe and effective in protecting historic buildings and structures against subterranean termites with no adverse effect upon the cultural or surrounding natural resources. Moreover, the introduction of baits did not interfere with visitor services or the quality of the visitor experience at the sites or monuments.

References

Freytag, E. D., M. K. Carroll, and E. S. Bordes. 2000. Control of Formosan subterranean termites in Perserverance Hall in New Orleans, Louisiana. APT Bulletin XXXI:71–75.

Scheffrahn, R. H., W. P. Robbins, P. Busey, N.-Y. Su, and R. K. Mueller. 1993. Evaluation of a novel, hand-held, acoustic emissions detector to monitor termites (Isoptera: Kalotermitidae, Rhinotermitidae) in wood. Journal of Economic Entomology 86:1720–29.

Su, N.-Y., and R. H. Scheffrahn. 1986. A method to access, trap, and monitor field populations of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in the urban environment. Sociobiology 12:299–304.

Su, N.-Y, P. M. Ban, and R. H. Scheffrahn. 1996. An aboveground station for monitoring structure-infesting populations of the Formosan subterranean termite (Isoptera: Rhinotermitidae). Sociobiology 27:39–45.

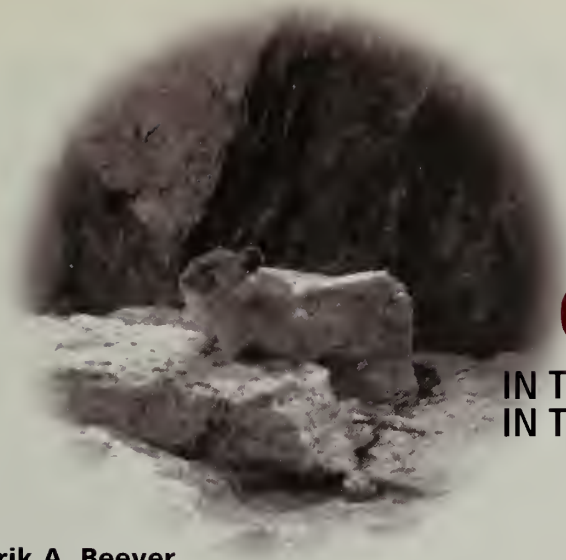
Su, N.-Y., and R. Scheffrahn. 1998. A review of subterranean termite control practices and prospects for integrated pest management programs. Integrated Pest Management Review 3:1–13.

Su, N.-Y., J. D. Thomas, and R. Scheffrahn. 1998. Elimination of subterranean termite populations from the Statue of Liberty National Monument using a bait matrix containing an insect growth regulator, hexaflumuron. Journal of the American Institute for Conservation 37:282–92.

Su, N.-Y., E. Freytag, E. Bordes, and R. Dicus. 2000. Control of the Formosan subterranean termite infestations in historic Presbytere and the Creole House of the Cabildo, French Quarter, New Orleans, using baits containing an insect growth regulator, hexaflumuron. Studies in Conservation 45:30–38

About the authors

Mark Gilberg is Research Director, National Center for Preservation Technology and Training, 645 College Ave., Natchitoches, LA 71457; 318-356-7444; mark_gilberg@nps.gov. ***Nan-Yao Su*** is Professor of Entomology, Fort Lauderdale Research and Education Center, Institute of Food and Agricultural Sciences, University of Florida, 3205 College Avenue, Fort Lauderdale, FL 33314; 954-577-6339; nysu@ufl.edu.



PERSISTENCE OF PIKAS

IN TWO LOW-ELEVATION NATIONAL MONUMENTS IN THE WESTERN UNITED STATES

By Erik A. Beever

From the perspective of island biogeography (MacArthur and Wilson 1967), national parks act as island reserves of restricted management sprinkled within a matrix dominated by commodity production and other human uses. Nonetheless, recent research has highlighted the dramatic changes (e.g., local extirpations, invasions of exotic species) that can occur in flora and fauna even on lands where the primary management mandate is resource conservation (Svejcar and Tausch 1991, Newmark 1995). The legacy of past disturbances, influences from adjacent lands, and climate change, in addition to the isolation and relatively small size of park units may all affect persistence of species within parks. In the western United States, pikas *(Ochotona princeps)* represent a model system that may help ecologists to understand these timely and complex relationships, as well as their implications for management in at least two units of the National Park System.

"Climatic warming during the past 10,000 years led to the extirpation of most low-elevation pika populations...."

RELICTS OF A COOLER TIME

Pikas are small (100-175 g [4-6 oz]) mammals typically found in talus and other rocky habitats such as lava formations and mine tailings (fig. 1). Paleoecological evidence suggests that pikas were far more widespread during the late Pleistocene in western North America than they are today (Grayson 1987). Climatic warming during the past 10,000 years led to the extirpation of most low-elevation pika populations, producing the modern-day relictual distribution of the species. In the intermountain West currently pikas generally inhabit high-elevation areas and are considered montane mammals. However, temperature appears to limit their distribution more than elevation per se (Hafner 1993). For example, high temperatures (25.5-29.4°C [47.9-54.9°F] ambient shade temperature) can be lethal to pikas in as little as six hours, if they are caged on the surface of talus and thus deprived of their behavioral mechanisms to avoid stressful temperatures (Smith 1974). Consequently, pikas may be early sentinels of biological response to global climate change such as increased temperatures, although to date little fieldwork has been done on response of terrestrial vertebrates to climatic changes. Pikas' vulnerability to high temperatures partly results from the thick fur that insulates them against severe cold, because it also inhibits evaporative cooling during warm periods. A mystery remains, however, in whether acute (i.e., short-term) thermal stress, from high maximum temperatures, or chronic thermal stress over a pika's lifetime (resulting from living in hotter, drier climates) most affects pika persistence. Furthermore, as is true for most mammals, we know little about how thermal stresses interact with other potential stresses to pika populations such as small habitat area, catastrophic fires, human disturbance, and livestock grazing.

Figure 1. Often heard but not seen, pikas typically inhabit high-elevation talus slopes in the western United States. However, the unusual occurrence of low-elevation pika populations in two western U.S. national monuments prompted the author to investigate their persistence and to evaluate implications for management of the species.

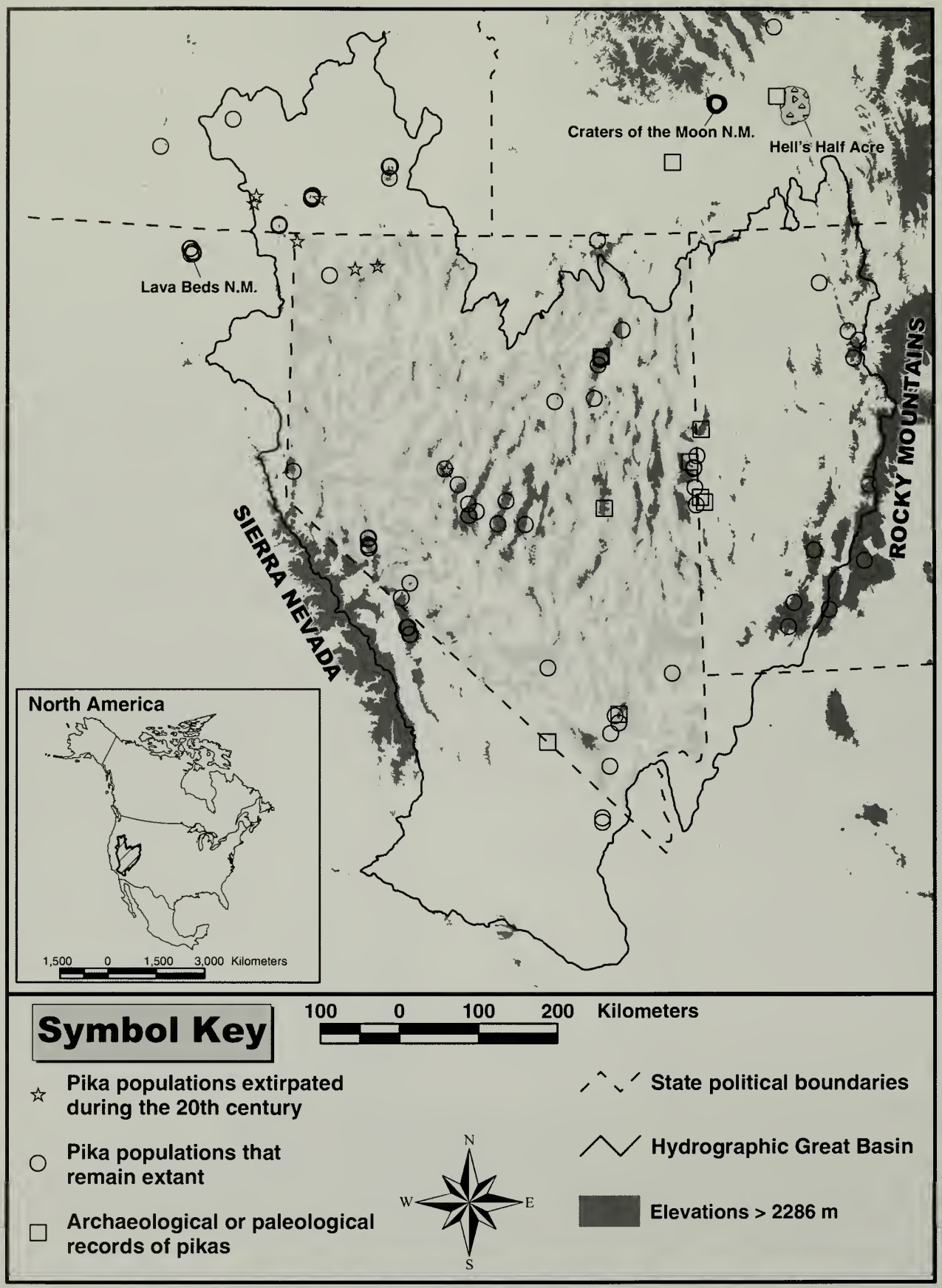


Figure 2. Pika surveys took place at 25 locations in the internally drained (interior) Great Basin; at Craters of the Moon and Lava Beds National Monuments where low-elevation populations of pikas persist; and at Hell's Half Acre, a low-elevation site near the monuments that lacks pikas but has similar habitat.

In the Great Basin (where precipitation drains internally rather than to an ocean; fig. 2), persistence of pika populations during the 20th century was significantly correlated with habitat area, elevation, longitude, distance to primary roads, latitude, grazing status, and management jurisdiction (wilderness vs. non-wilderness), but not with isolation of populations from the Sierra Nevada or Rocky Mountains (Beever 1999). Island biogeography theory predicts greater rates of extinction on islands (which may be oceanic or island-like pockets within continents) that are smaller in area and more isolated from the mainland, but does not make direct predictions about the other factors. Thus, the fact that isolation from Sierra Nevada or Rocky Mountain "mainlands" is not important in pika extirpations suggests that migration of pikas between mountaintop islands is not occurring currently. Rather, it appears that extirpation of populations from montane areas across the Great Basin is occurring without any concomitant colonization events. Average temperatures generally decrease with increasing latitude and elevation, thus latitude must be accounted for when assessing persistence at different elevations. Pikas at Craters of the Moon and Lava Beds National Monuments (hereafter, "Craters" and "Lava Beds") occurred historically at elevations lower than predicted by the monuments' latitude, when compared with the latitude-elevation relationship among historic pika sites in the Great Basin (fig. 3). Pikas do not usually persist at low elevations (and consequently, high temperatures), and many of the lowest-elevation populations in the Great Basin have recently become extirpated, including seven recorded from 1925 to 1941 (see fig. 3). For these reasons I sought to determine whether pika populations that had been noted historically in Craters and Lava Beds have continued to persist. If pikas had persisted, then I also sought to explore potential mechanisms that have allowed them to persist in such apparently harsh conditions.

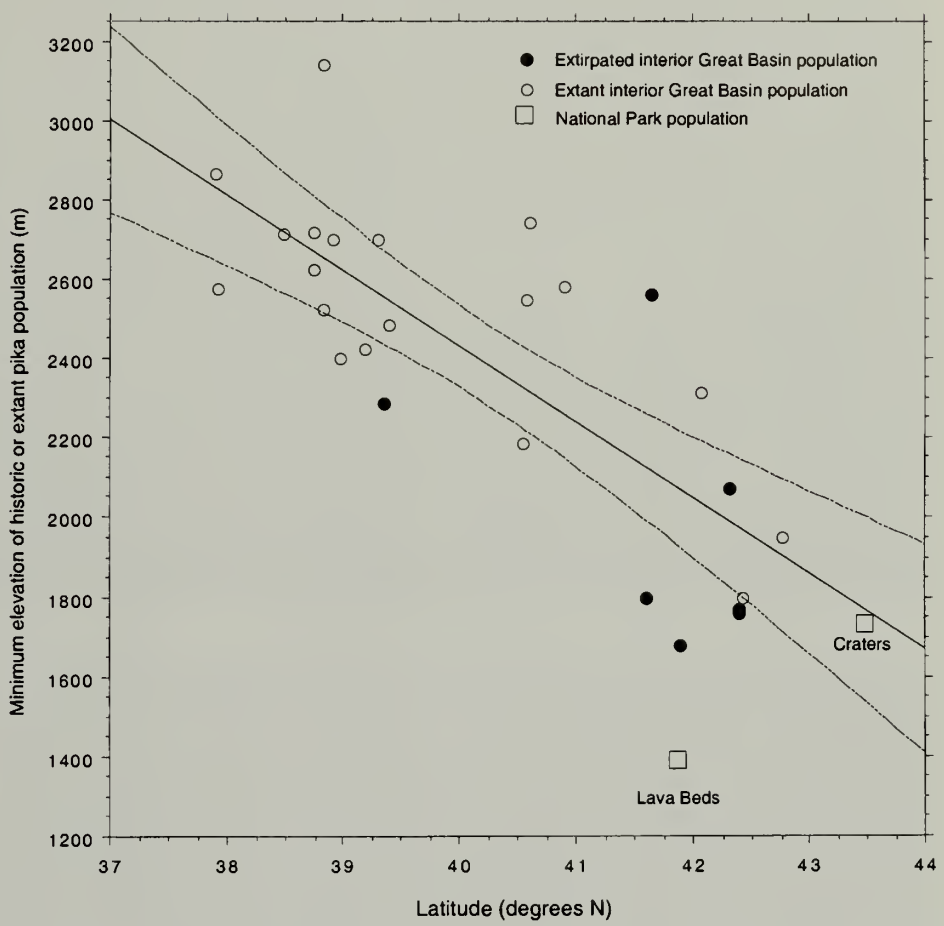


Figure 3. Persistence of pika populations during the 20th century in the intermountain West, at different elevations and latitudes. Open circles represent sites in the interior Great Basin where pikas remain extant, and closed circles represent pika populations that became extirpated in the late 20th century. Open squares represent Craters of the Moon and Lava Beds National Monuments, where pikas were recorded during the mid to late 20th century. The solid line represents the relationship between elevation and latitude among the 25 sites in the interior Great Basin at which pikas were previously recorded, and dotted lines represent 95% confidence intervals around the solid line.

STUDY SITES

Craters consists of 29,000 hectares (71,659 acres) of volcanic craters, cones, 2,000- to 15,000-year-old lava flows, caves, and fissures at the interface of the Snake River Plain and the southeast edge of the high, mountainous region of central Idaho (see fig. 2). Elevations in the monument ranged from 1,590-1,990 m (5,217-6,529 ft) at the time of sampling (1995), but the November 2000 expansion of the monument incorporated areas into the monument as low as 1,280 m (4,200 ft). Lava Beds occurs in northeastern California on the north flank of the Medicine Lake shield volcano that erupted 17 times between 800 and 12,800 calendar years ago (Donnelly-Nolan et al. 1990; see fig. 2). The volcano covers about 2,000 sq km (772 sq mi) and lies about 50 km (31 mi) east-northeast of Mt. Shasta in the southern Cascade Range. The monument's 18,850 ha (46,578 acres) occupy about 10% of the area of the volcano, and encompass cinder cones, spatter cones, and over 440 lava tube caves at elevations between 1,230 and 1,650 m (4,036 and 5,414 ft). Pikas are one of the more charismatic mammal species in the monuments, and are more frequently heard than seen. They are one of six lagomorph and 48 mammal species known from Craters, and one of three lagomorph and 53 mammal species known from Lava Beds.

To provide a comparison of a low-elevation area with extensive potential pika habitat that was geographically closer to the monuments than the interior Great Basin sites, I also sampled three locations in the Hell's Half Acre lava flow in south-central Idaho from 17–19 July (see fig. 2). We chose this site because it has extensive amounts of talus-like habitat, much of which occurs at large distances from primary roads; the site also has a

similar range of elevations to Craters, but experiences different management. These factors played the most important roles in determining persistence of pika populations in the interior Great Basin during the 20th century. Because historic records of pikas in the vicinity of Hell's Half Acre do not exist, it would be difficult to ascribe a cause to the absence of pikas there, if we could not detect them. Ideally, other low-elevation sites outside but near either monument having historic records of pikas would have been preferable, but we were not aware of any such sites. In associated research, I also re-sampled populations of pikas recorded between 1916 and 1990 at 25 sites ranging in minimum elevation from 1,680–3,139 m (5,512–10,300 ft) throughout the interior Great Basin in summer from 1994 to 1999 (fig. 2).

METHODS

I re-visited locations in Craters from 14–17 July 1995 and in Lava Beds from 22–24 July 1995 where pikas had been observed in previous decades, and I sampled sites at Hell's Half Acre from 17–19 July 1995. Sampling occurred on lava formations for three days at each site (i.e., Lava Beds, Craters, and Hell's Half Acre), totaling between 15.5 and 18 hours of censuses per site. I chose specific sampling locations in the monuments based upon presence of precise historic records, relative accessibility, and the desire to sample broadly within each monument. Sampling at interior Great Basin sites occurred on taluses for 8 hours per site in summer between 1994 and 1999, or longer (up to 20 hr) if I could not detect pikas at the site.

During slow-walking transect surveys through lava formations, I recorded locations of pika sign (e.g., sightings, calls, and fresh hay pile sightings) using a handheld global positioning system unit without differential correction (precision ± 100 m [328 ft]). I used standardized recording criteria to avoid counting multiple types of evidence from the same individual. I also made observations on the natural history of pikas sighted within the monuments.

To compare climatic conditions at pika sites in the interior Great Basin and in the monuments, I used PRISM data (Oregon Climate Service, Corvallis) that interpolate values between climate stations across the region, and account for factors such as elevation and aspect. These estimated climatic values represent averages from the years 1961–1990, at a resolution of 4 km (2.4 mi). I compared annual precipitation and averages of the maximum daily temperatures for the months of June, July, and August among sites in the interior Great Basin where pikas have been extirpated recently, sites in the Great Basin where they remain extant, and the three volcanic sites (Craters, Lava Beds, and Hell's Half Acre) adjacent to the Great Basin.

RESULTS

Persistence

In Lava Beds, I detected a minimum of 10 pikas (6 sightings, ≤4 calling individuals) from 9 sites, out of 16 sites visited (table 1). Pikas were detected at five of nine sites very near to where they were documented in monument records (1960–1991), and at four of eight sites more distant from historic locations. In Craters, I detected a minimum of 27 pikas (8 sightings, ≤ 18 calling individuals, and one active hay pile) at 8 of 12 sites visited. Pikas were detected at four of five historic locations (and an inactive hay pile was found at the fifth location), and at four of seven sites slightly more distant from historic locations. No pikas were detected at any of seven locations searched within Hell's Half Acre.

Climatic analyses

Loss of pika populations at study sites in the interior Great Basin occurred at sites that were on average 20% drier and 8–10% warmer than those at which populations persisted (table 2, page 28). However, the Craters and Lava Beds Monuments, where pikas persist, experience climates that are an estimated 18–24% drier annually and 5–11% warmer during the hottest months of the year than climates at areas of even *extirpated* pika populations in the interior Great Basin (table 2). Hell's Half Acre, from which pikas are not known in recent times, received an estimated average of 22–28% less precipitation annually and experienced temperatures 3–5% hotter than Craters and Lava Beds.

Natural history

Other mammals observed in Craters lava fields included chipmunks, yellow-bellied marmots, and golden-mantled ground squirrels. From my observations in Craters, pikas apparently use different parts of the volcanic landscape than chipmunks and squirrels, at least during summer. Whereas ground squirrels and chipmunks are more frequently found on flatter areas with less complex relief (usually *pahoehoe* or short *aa* lava formations or areas with extensive sagebrush vegetation), pikas appear to frequent lava tubes, caves, and valley trenches 2–5 m (6.6–16.4 ft) deep. I observed several mountain cottontails along margins of lava flows in Lava Beds, but did not observe them well within the lava flow, where pikas were often seen. Although other mammals were less plentiful at Hell's Half Acre, birds were relatively more abundant.

Although pikas in the monuments dedicated significant amounts of time to vigilance, numerous individuals were less responsive to the presence of nearby humans than were pikas at sites in the interior Great Basin. Whereas I could never approach pikas to a distance less than 13–15 m (42.6–48.2 ft) in the interior Great Basin, I came within 20 cm (8 in) of stepping on one at Craters. Furthermore, one individual on the Devil's Orchard Trail seemed so habituated to humans that it remained above the lava surface for 5–8 minutes when a group of about 25 relatively boisterous visitors approached it to within 10 m (33 ft).

DISCUSSION

Persistence of low-elevation pikas: climatic and other influences

Loss of pika populations from lower elevations and latitudes, such as the loss of nearly 30% of interior Great Basin popula-

Table 1: Locations sampled for pikas in Lava Beds and Craters of the Moon National Monuments, July 1995.

	Location	Elevation (m)	Search effort (hr)*	Date of historic record, if available	Pikas detected in 1995 survey?
LAVA BEDS	Heppe Ice Cave	1610	0.75	1991	No
	Catacombs parking lot	1525	2.00	1961, 1962	Yes
	Juniper Cave	1510	0.50	1960	No
	Catacomb Cave, upper Sentinel entrance	1490–1525	2.50 [3]	1963	Yes
	Maze Cave collapse	1490	1.00 [2]		No
	Merrill Ice Cave	1490	1.50	1962	Yes
	Thunderbolt Cave, upstream entrance	1490	0.25	1990	No
	Lower Sentinel entrance	1475	0.75 [3]		Yes
	Indian Well Cave	1450	0.50		Yes
	Symbol Bridge	1440	1.00 [3]	1972	Yes
	Skull Cave road	1400	1.00		No
	Fleener Chimneys area	1365	0.75	1984	Yes
	Schonchin Lava Flow	1340	1.00		No
	Trail to Black Crater; Battlefield Trail	1340	0.75		Yes
	Devil's Homestead Lava Flow	1280	0.50		No
	TOTALS (N = 15 sites, 22 searches)	Mean = 1450 m	16.0 hr		10 individuals
CRATERS OF THE MOON	North Crater Flow trail	1830	2.00	1990	Yes
	Base of North Crater	1830	1.25		Yes
	Scenic turnout near Spatter Cones parking lot	1830	1.00		No
	Highway Flow	1810	4.00 [2]		No
	Spatter Cones, trail to Big Crater	1810	2.25		Yes
	Trail to Buffalo Caves	1790	0.75		Yes
	Picnic table turnout	1780	1.00		Yes
	Base of Big Sink, Tree Molds Road	1780	0.75		Yes
	Jct of main loop road and Tree Molds road	1780	0.50	1990	No
	Caves Area Trail to Needles Cave	1760	3.25		Yes
	Devil's Orchard Trail	1750	3.25	1989, 1990	Yes
	Caves Area Trail	1750	2.25	1991	Yes
	TOTALS (N = 12 sites, 13 searches)	Mean = 1790 m	18.5 hr		27 individuals

* Number of searches (if >1) appear in brackets

tions recorded during the 20th century, is consistent with losses that have occurred over the last 14,000 years (Grayson 1993). Given the recent extirpation of pikas from low-elevation sites within 150 km (93 mi) of Lava Beds (Beever 1999; fig. 2), current persistence of pikas in Craters and Lava Beds National Monuments is noteworthy. Although population losses in the Great Basin occurred not surprisingly at sites that were drier and warmer than those at which populations persisted, estimated climates at Lava Beds and Craters were notably drier and hotter than even those locations in the Great Basin where pikas have been recently extirpated. However, the tubes, caves, and deep, complex lava formations that occur across both monuments undoubtedly provide pikas with relatively cool refugia during times of heat stress. Interestingly, though, pikas were not exclusively confined to caves and lava tubes during my July surveys, suggesting that temperature influences provide only a partial solution to the mystery of how pikas persist in these monuments. Pika behavior plays a substantial role in mediating the

Table 2. Estimated climatic conditions at areas in the interior Great Basin where pikas remained extant and where they were extirpated during the 20th century, and at two low-elevation national monuments adjacent to the Great Basin that still contain pikas.

Site(s)	Elevation range*	Average annual precipitation (cm/yr ± 1 SE [standard error])	June maximum temperatures** (°C)	July maximum temperatures (°C)	August maximum temperatures (°C)
Sites (N = 18) in the interior Great Basin with extant pika populations	1,798–3,612 m (5,900–11,850 ft)	58.9 ± 6.2	19.3 ± 0.7	24.7 ± 0.6	24.8 ± 0.5
Sites (N = 7) in the interior Great Basin with extirpated pika populations	1,680–2,877 m (5,512–8,600 ft)	47.4 ± 7.0	21.3 ± 0.5	26.6 ± 0.6	26.7 ± 0.5
Lava Beds National Monument	1,230–1,650 m (4,036–5,414 ft)	36.1	23.6	28.6	28.2
Craters of the Moon National Monument	1,590–1,990 m (5,217–6,529 ft)	38.8	23.5	29	28.1
Hell's Half Acre	1,400–1,630 m (4,593–5,348 ft)	28.1	24.4	30.1	29.0

*Represented are the lower end of talus at the lowest sites in each category (lowest elevation currently with pikas, for the lowest site with an extant population in the interior Great Basin), and the highest elevation of talus habitat within 3 km of the location of the historic record of pikas (among all sites in the group).
**Average of daily maximum temperatures for days in June (values indicate average ± 1 SE when >1 site).

effects of thermal stress, and measuring temperature regimes that pikas experience throughout the day and across seasons may provide another clue to understanding how they persist in these low-elevation areas.

"Pika behavior plays a substantial role in mediating the effects of thermal stress...."

In both monuments, pikas apparently use habitats that fulfill three requirements. First, pikas generally inhabit large, contiguous areas of (rocky) volcanic habitat, as opposed to isolated pockets of lava formations. Second, although pikas were not always located near edges of lava flows, areas with pikas possessed average or greater amounts of vegetation accessible within distances comparable to dimensions of home ranges. Finally, pikas appeared to be associated at the fine scale with microtopography characterized by rocks large enough to provide space for subsurface movement and tunneling (as is found in *aa* and block lava flows), as opposed to the smooth *pahoehoe* lava flows that have little relief. Because collapsed lava tubes, lava flow margins, cave entrances, fault scarps, fault cracks, and internal talus zones all provide talus-like areas that pikas may inhabit, geologic mapping of the monuments may provide additional insight into pika distribution.

In contrast to our relatively clear understanding of the climatic effects on pika distribution, the exact extent to which human-related activities such as livestock grazing, altered fire regimes, clear-cutting of adjacent forest cover, and other influences on lava habitats affect pika population dynamics remains in need of clarification. While the systems of caves and lava tubes have undoubtedly facilitated persistence of pikas in the monuments, other factors that may contribute to their persistence in these low-elevation areas include: extensiveness and connectivity of lava habitats, relatively close proximity (30–80 km [18.6–49.7 mi]) to other known pika strongholds (Hafner 1994; J. Villegas, 2001, personal communication), physical complexity of lava formations, relative inaccessibility for humans, and wilderness management. Although Hell's Half Acre possesses extensive lava flows, amounts of vegetation comparable to that of Craters, proximity (<130 km [80.7 mi]) to three other pika populations, and is relatively inaccessible over much of its area, it has fewer caves and lava tubes, a less convoluted lava structure, and a hotter, drier climate than Craters; and it is managed as a multiple-use recreational area.

This research does not allow conclusive understanding of to what degree the effects of wilderness management, habitat extent, and physical structure of habitats have contributed to persistence of monument populations of pikas while other low-elevation (interior Great Basin) populations have suffered extirpation. Although manipulative experiments, which provide stronger inference about cause-effect relationships, are not feasible within the monuments, two avenues of observational research may prove fruitful. Broad sampling for pikas in numerous caves and tubes within and around the monuments would afford greater understanding of the range of conditions (with respect to temperature, humidity, cave size and habitat extent, isolation from other populations, and human activity) that support pika populations. During sampling, collection of tissue samples from individual pikas would allow comparison of genetic differences among known pika populations and would suggest relative rates of gene flow among them. Correlation of genetic results with potentially isolating features (e.g., roads, surrounding non-talus habitat, different systems of lava tubes) and management actions (livestock grazing, fire frequency) would provide a basis for generating hypotheses as to which factors, if any, have constrained pika distribution.

MANAGEMENT IMPLICATIONS

Persistence of pikas, at least in the interior Great Basin, appears to be a function of extent of habitat, distance to primary roads, and maximum elevation of habitat to which pikas can migrate (which should dictate pikas' ability to respond to climate change) (Beever 1999; Beever et al. forthcoming). Additionally, pika population size relates to the presence of livestock grazing in some cases (Beever 1999; Beever et al. forthcoming). Therefore, management actions may hold great importance for pika persistence. For most species, persistence depends critically on the amount, spatial distribution, and quality of appropriate habitat. Although removal or physical degradation of lava and talus habitats are not likely over ecological time scales, habitat quality for pikas may be compromised by the following: consistently higher ambient temperatures (e.g., due to climate change); altered composition of forbs and grasses in and adjacent to lava flows (e.g., because of altered fire regimes, exotic species, or uncharacteristically intense levels of grazing at flow margins); and significant fragmentation of lava habitats (e.g., road construction). Pika persistence at low-elevation sites may also be affected by disturbance or alteration of pika habitats by humans or livestock (e.g., nutrient deposition by livestock in large caves [J. Villegas, 2001, personal communication], human disturbance of hay piles). Because human disturbance of lava flows to this point has been confined primarily to areas near roads or trails during warmer months, these latter influences probably have been minimal.

Isolation of Great Basin pika populations from the Sierra Nevada or Rocky Mountains is one of few variables that does not predict persistence in the Great Basin. This phenomenon probably occurs because talus habitats in the Great Basin are separated by vast areas of non-talus habitat that usually lie at low elevation, and pikas are unlikely to traverse these areas under current climatic conditions. In contrast, the recent ninefold expansion of Craters' area creates the possibility for promoting pika persistence across the more continuous lava habitats along the Great Rift, to the extent that the monument explicitly manages for vertebrate conservation. Although connectivity among volcanic habitats may not change with monument expansion, changes in management in the area may alter *effective* connectivity. Thus, although Newmark (1995) concluded that national parks in western North America are too small to support viable populations of large mammals, actions such as monument expansion and others described earlier may help prevent loss of noteworthy pika populations from these low-elevation monuments.

ACKNOWLEDGMENTS

Special thanks are due to Chuck Barat and Bernard Stoffel, Chiefs of Resource Management at Lava Beds National Monument, for their facilitation and sharing of pika locations. Natalene Cummings, Vicki Snitzler-Neeck, and Mike Munts, Resource Management Specialists, provided similar assistance at Craters of the Moon. Anna Knipps and Suzette Tay, SCA volunteers at Craters, assisted with sampling. Thanks are also due to the superintendents of Craters (Jim Morris) and Lava Beds (Craig Dorman) for approving scientific collecting permits. Joel Berger of the University of Nevada, Reno, provided helpful discussions on mammalian persistence. The Biological Resources Research Center (BRRC) at the University of Nevada, Reno, provided funding during idea development. Brian McMenamy (of BRRC) prepared the GIS-based figure 2. C. Ray, D. Grayson, and J. Donnelly-Nolan commented on earlier drafts.

LITERATURE CITED

Beever, E. A. 1999. Species- and community-level responses to disturbance imposed by feral horse grazing and other management practices. Ph.D. dissertation, University of Nevada, Reno.

Beever, E. A., P. F. Brussard, and J. Berger. Forthcoming. Patterns of extirpation among isolated populations of pikas *(Ochotona princeps)* in the Great Basin. Journal of Mammalogy.

Donnelly-Nolan, J. M., D. E. Champion, C. D. Miller, T. L. Grove, and D. A. Trimble. 1990. Post-11,000-year volcanism at Medicine Lake Volcano, Cascade Range, northern California. Journal of Geophysical Research 95:19693–704.

Grayson, K. D. 1987. The biogeographic history of small mammals in the Great Basin: observations on the last 20,000 years. Journal of Mammalogy 68:359–75.

Grayson, K. D. 1993. The desert's past: a natural history of the Great Basin. Smithsonian Institution Press, Washington, D.C.

Hafner, D. J. 1993. North American pika *(Ochotona princeps)* as a late Quaternary biogeographic indicator species. Quaternary Research, 39:373–80.

Hafner, D. J. 1994. Pikas and permafrost: post-Wisconsin historical zoogeography of *Ochotona* in the southern Rocky Mountains, U.S.A. Arctic and Alpine Research 26:375–82.

MacArthur, R. H., and E. O. Wilson. 1967. The theory of island biogeography—Monographs in population biology No. 1, Princeton University Press, Princeton, New Jersey.

Newmark, W. D. 1995. Extinction of mammal populations in western North American national parks. Conservation Biology 9:512–26.

Smith, A. T. 1974. The distribution and dispersal of pikas: influences of behavior and climate. Ecology 55:1368–76.

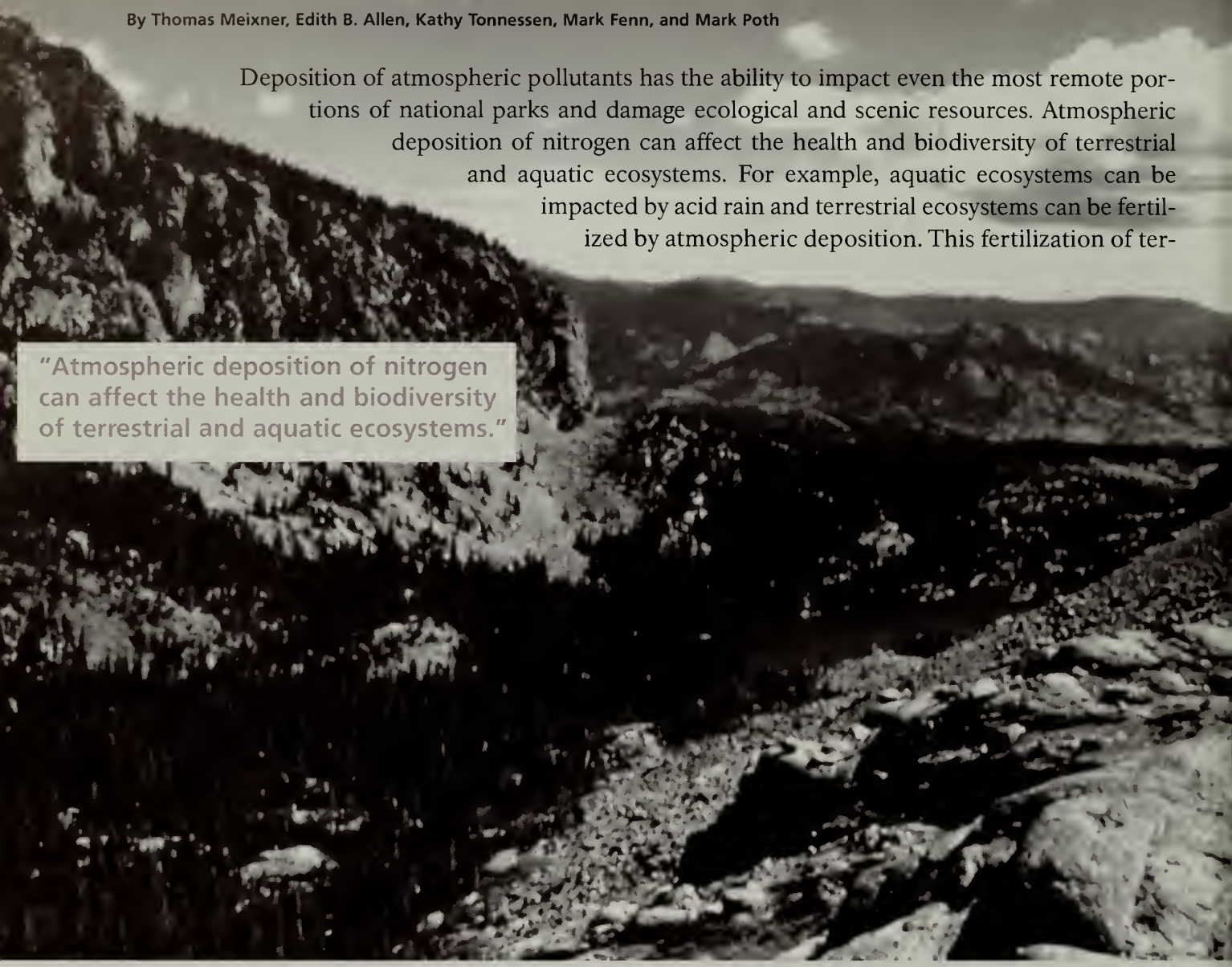
Svejcar, T., and R. Tausch. 1991. Anaho Island, Nevada: a relict area dominated by annual invader species. Rangelands 13:322–26.

ABOUT THE AUTHOR

Erik A. Beever, Ph.D., is an Ecologist with the U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, 3200 SW Jefferson Way, Corvallis, OR 97331. He can be reached at 541-758-7785 or by e-mail: erik_beever@usgs.gov.

ATMOSPHERIC NITROGEN DEPOSITION:
Implications for managers of western U.S. parks

By Thomas Meixner, Edith B. Allen, Kathy Tonnessen, Mark Fenn, and Mark Poth



Deposition of atmospheric pollutants has the ability to impact even the most remote portions of national parks and damage ecological and scenic resources. Atmospheric deposition of nitrogen can affect the health and biodiversity of terrestrial and aquatic ecosystems. For example, aquatic ecosystems can be impacted by acid rain and terrestrial ecosystems can be fertilized by atmospheric deposition. This fertilization of terrestrial ecosystems may in turn lead to decreases in biodiversity. Also, leaching of large quantities of nitrate from terrestrial ecosystems into streams might impact aquatic ecosystems through eutrophication (i.e., nutrient enrichment in places like Lake Tahoe, for example) or possibly by direct toxicity to fish and amphibians.

"Atmospheric deposition of nitrogen can affect the health and biodiversity of terrestrial and aquatic ecosystems."

The impact of nitrogen deposition on terrestrial and aquatic ecosystems depends on a number of variables, including meteorological variability, vegetation type, historical land use, fire history, hydrology, and proximity to the pollution source. In the eastern United States research on atmospheric deposition has generally focused on the problems of acid rain and its impacts on terrestrial and aquatic ecosystems. The problems in the East tend to be more widespread than in the western United States and while many of the issues are similar in the two regions there are differences that prevent simple extrapolation from one ecosystem to the other. This report will focus on western systems since they have historically not been studied as much as the more humid systems typical of the eastern United States. Ongoing research in three different western U.S. ecosystems—alpine lakes and tundra in the Front Range of the Rocky Mountains and the Sierra Nevada, conifer forests in southern California, and the coastal sage scrub of southern California—is examining nitrogen deposition and its varied impact on these systems. While these ecosystems are by no means ubiquitous, they do have analogs throughout the National Park System and the United States.

igure 1. The Loch Vale water-hed in Rocky Mountain National ark, Colorado, has played a rominent role in understanding he impact of nitrogen deposi-ion on ecosystem dynamics. The ont Range of the Rocky Iountains appears to be more ffected by nitrogen deposition han the Sierra Nevada on ccount of thunderstorms that eed on air from the Denver area.

igure 2. The high amount of bio-nass and winter-dominated ydrology of conifer forests in alifornia appear to reduce the orest's short-term susceptibility o nitrogen deposition.

Impacts on western U.S. ecosystems

A comparison of alpine ecosystems in the Rocky Mountains and in the Sierra Nevada and their different exposures and responses to atmospheric deposition can provide insight into how factors such as ecosystem biomass, proximity to urban areas, and meteorology affect ecosystem sensitivity to nitrogen deposition. Alpine ecosystems are sensitive to nitrogen deposition because very little soil and only sparse vegetation exists to cushion the impacts of atmospheric deposition. The alpine zone of the eastern slope of the Front Range of the Rocky Mountains appears to have been impacted by changes in atmospheric deposition, with stream nitrate concentrations much higher than on the western slope of the Rockies. In contrast, the alpine zone of the Sierra Nevada has exhibited no significant change in ecosystem dynamics or in stream water quality despite the proximity of large cities in California to the mountains. The lack of summer rain originating from polluted air masses in the Sierra Nevada and the stable inversion over the Central Valley of California limit nitrogen deposition in the alpine zone during the summer months. Much of the precipitation in the Sierra Nevada is winter snow that comes from clean, Pacific air masses that have limited interaction with industrial or urban areas. The Front Range of the Rockies appear to have higher rates of nitrogen deposition than the Sierra Nevada alpine zone. In part, this is because of its proximity to the Denver metropolitan area in combination with more summer rain. These factors encourage the deposition of pollutants from the urban air mass (fig. 1). Also, dry deposition of nitrogen is likely limited in the Sierra Nevada compared to the Front Range because this form of atmospheric deposition decreases rapidly as distance from the source increases. Nevertheless, although the alpine zone of the Sierra Nevada is not currently being impacted by nitrogen deposition, impacts may be occurring in the lower conifer and chaparral zones of the range. These areas are experiencing much higher dry deposition rates than the alpine zone.

"Factors such as ecosystem biomass, proximity to urban areas, and meteorology affect ecosystem sensitivity to nitrogen deposition."

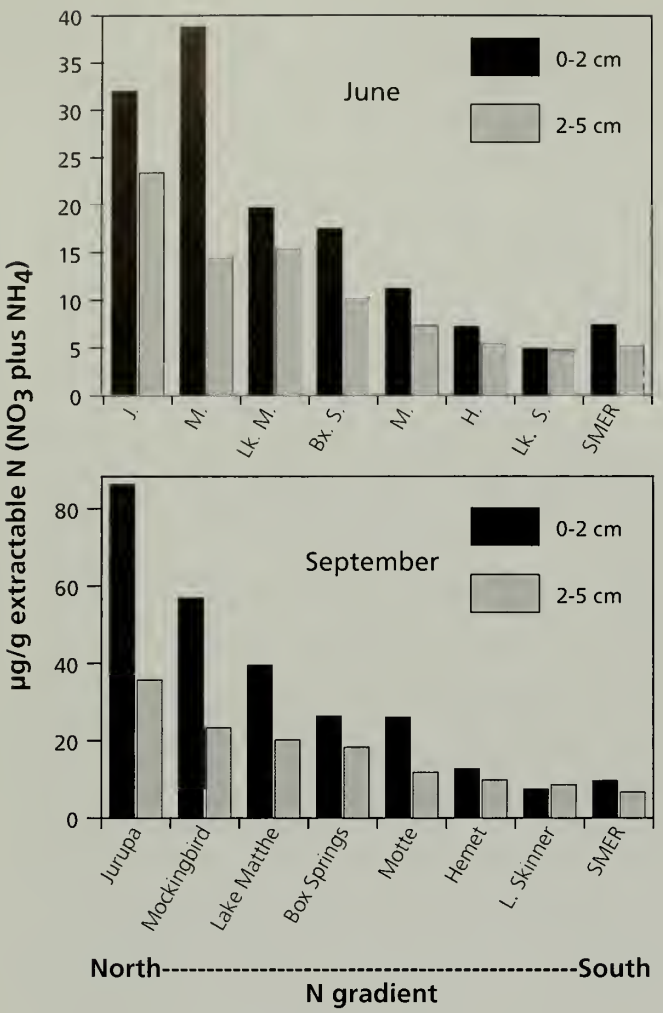


Figure 3. Soil nitrogen gradient in sites lying north to south in the coastal sage scrub ecosystem of the Riverside-Perris Plain, California. Biodiversity at these sites is inversely proportional to nitrogen concentrations in the soil with the highest biodiversity at the southern (low concentration) end of the gradient and the lowest biodiversity at the northern (high concentration) end of the gradient.

Conifer forests demonstrate the importance of hydrological and meteorological processes and ecosystem biomass on ecosystem sensitivity to nitrogen deposition (fig. 2, page 31). In contrast to the sensitivity of alpine ecosystems, the ponderosa and Jeffrey pine forests of southern California appear to be fairly resistant to increases in atmospheric nitrogen deposition at least in the short term. This resistance is despite the 30–40 kg nitrogen per hectare (163–217 lb/acre) per year that the most exposed forests receive (compared to about 2 kg/ha [11 lb/acre] in the alpine Sierra Nevada and 4–8 kg/ha [22–43 lb/acre] in the alpine Front Range). The interaction between hydrology and plant physiology appears to control the susceptibility of this ecosystem to nitrogen deposition. Summertime dry deposition of particulates and nitrogen-based gases dominate deposition in this ecosystem. Winter rains, which arrive when the vegetation is generally dormant, flush the atmospheric deposition rapidly off the vegetation and out of the soil, sending a large pulse of nitrate into the streams of the San Bernardino and San Gabriel Mountains. When trees become active again in spring much of the nitrogen available to the plants has been leached out. The high rates of atmospheric deposition have increased plant nitrogen uptake, and physiological functioning has been altered by increased nitrogen deposition in these systems. Despite these changes fertilization experiments show that the vegetation will still respond to additional nitrogen. Conifer forests might also be more resistant in the short term because of the relative long life of conifer trees. These conditions indicate that nitrogen deposition is having a slower, less visible impact on the terrestrial component of the conifer ecosystem than it is on nearby aquatic systems.

Coastal sage scrub ecosystems may be among the most sensitive terrestrial environments because of their relatively *closed* hydrology and low biomass. Nitrogen deposition has been implicated in the replacement of native grasses and shrubs by invasive grasses, which have led to a decrease in biodiversity in areas of southern California previously dominated by coastal sage scrub vegetation (figs. 3 and 4). Coastal sage scrub is especially susceptible to nitrogen deposition on account of dry summers when nitrogen deposition is highest and nitrogen accumulates, followed by moist, relatively warm winters when the accumulated nitrogen becomes available for the growth of native and exotic species. Unlike the conifer forests, sage scrub is biologically active during winter, and plants rapidly respond to the onset of winter rains with the growth of shrubs, annual forbs, and grasses. Low rainfall in the coastal sage scrub accounts for very little nitrogen leaching out of the root zone of most vegetation. Thus, atmospherically deposited nitrogen in soil is available throughout the winter growing season. The exotic grasses are biologically designed to take advantage of the excess nitrogen, while

Figure 4. This coastal sage scrub site near Riverside, California, has been degraded by atmospheric nitrogen deposition. Note smog in the background.

the sage scrub has lower rates of nitrogen uptake. Exotic grasses are prolific seed producers and have an increased fire cycle. These factors along with increased productivity from nitrogen deposition are allowing exotic grasses to replace the native sage scrub.

Susceptibility of ecosystems

These three case studies allow us to derive a number of rules of thumb about the susceptibility of natural ecosystems to nitrogen deposition in the near future. (In the long run, if nitrogen deposition continues, all of these ecosystems will likely change.) The closer an ecosystem is to a large city the greater the likelihood for ecosystem damage from nitrogen deposition (e.g., Front Range of the Rockies and coastal sage scrub). Ecosystems dominated by storms originating at sea that do not move through major urban or industrial areas are less susceptible to nitrogen deposition (e.g., the Sierra Nevada, fig. 5). Terrestrial ecosystems that are dormant during the peak time of nitrogen availability are less susceptible to the impacts of nitrogen deposition, whereas aquatic ecosystems might be more susceptible (e.g., the conifer forests of southern California). Ecosystems with high biomass (e.g., conifer forest) are less susceptible to nitrogen deposition than those with low overall biomass (e.g., alpine tundra and coastal sage scrub). Ecosystems with low rainfall (e.g., coastal sage scrub) are more susceptible to the effects of nitrogen deposition than systems with relatively high rainfall rates (e.g., southern California coniferous forests) because the nitrogen is not substantially flushed out of the root zone of most plants.

Implications

Work remains on the occurrence and susceptibility of ecosystems to atmospheric nitrogen deposition. Still, enough evidence has been compiled for managers to be concerned about the possible impacts of nitrogen deposition on the natural resources of our western national parks. Western U.S. problems with nitrogen deposition are more localized in areas impacted by urban air masses. Thus these problems differ from the more widespread, and in some cases more severe, problems present in eastern national parks such as Shenandoah and Great Smoky Mountains National Parks. In particular, managers of western national parks near urban areas (e.g., Rocky Mountain, Sequoia-Kings Canyon, Joshua Tree, Yosemite, and Saguaro National Parks and Santa Monica National Recreation Area) should be aware of issues involving atmospheric deposition, and resource managers should be encouraged to spend their time and funds on studying this issue. The types of studies that might be done to understand the susceptibility of ecosystems to nitrogen deposition include water quality monitoring in the parks over a number of years, measurements of soil or litter carbon:nitrogen ratios, and monitoring of vegetation to investigate nutrient ratios of standing vegetation.

"Resource managers should be encouraged to spend their time and funds on studying [nitrogen deposition]."

Figure 5. Researchers conduct a survey of the quantity and quality of snow in the Emerald Lake watershed in Sequoia National Park. Sierra Nevada alpine watersheds appear to be unaffected by atmospheric deposition due to the clean, marine-air origin of much of the precipitation in the range.

Additional reading on the effects of nitrogen deposition on ecosystems

Baron, J. S., H. M. Rueth, A. M. Wolfe, K. R. Nydick, E. J. Allstott, J. T. Minear, and B. Moraska. 2000. Ecosystem responses to nitrogen deposition in the Colorado Front Range. Ecosystems 3:352–68.

Egerton-Warburton, L. M., and E. B. Allen. 2000. Shifts in arbuscular mycorrhizal communities along an anthropogenic nitrogen deposition gradient. Ecological Applications 10(2):484–96.

Fenn, M. E., M. A. Poth, J. D. Aber, J. S. Baron, B. T. Bowman, D. W. Johnson, A. D. Lemly, S. G. McNulty, D. F. Ryan, and R. Stottlemyer. 1998. Nitrogen excess in North American ecosystems: A review of geographic extent, predisposing factors, ecosystem responses, and management strategies. Ecological Applications 8(3):706–33.

Williams, M. W., J. S. Baron, N. Caine, R. Sommerfeld, and R. Sanford. 1996. Nitrogen saturation in the Rocky Mountains, Environmental Science and Technology 30:640–46.

About the Authors

Thomas Meixner (tmeixner@mail.ucr.edu) is with the Department of Environmental Sciences, University of California, Riverside. ***Edith Allen*** is with the Department of Botany and Plant Sciences, University of California, Riverside. ***Kathy Tonnessen*** is with the National Park Service Rocky Mountains Cooperative Ecosystem Studies Unit in Missoula, Montana. ***Mark Fenn*** and ***Mark Poth*** are with the Pacific Southwest Research Station, U.S. Forest Service, Riverside, California.

An innovative training program enhances science-based management

By Kathleen Kodish Reeder

Figure 1. Formed during the last Ice Age, kettle ponds are a primary resource of Cape Cod National Seashore. One of the first participants of the Natural Resource Professional Development Program, Krista Lee, studied the geochemical processes that influence water quality of the ponds.

The Northeast Region's FY 2001–2005 Natural Resource Challenge plan emphasizes that information derived from rigorous scientific research is the best foundation for making management decisions affecting natural resources. Many natural resource managers are working to make their parks centers for broad scientific and scholarly inquiry by using science-based standards to determine the condition of their natural resources, and to evaluate the success of resource preservation and restoration strategies. Accordingly, the Northeast Region (NER) has established agreements with scientists at universities and research agencies such as the U.S. Geological Survey to conduct research in the parks. In many instances, however, natural resource managers believe that they can implement science-based management most effectively by improving the level of scientific expertise within the parks.

In 1998 this belief led the Northeast Region to create an ongoing program designed to support two National Park Service (NPS) employees, one from the New England Cluster and the other from the Chesapeake-Allegheny Clusters, in their pursuit of an approved, graduate-level course of study in the natural and physical sciences. According to Marie Rust, Regional Director, "It is our intent, through this Natural Resource Professional Development Program [NRPDP], to enhance the natural resource academic credentials and skill levels of our region's resource managers so that we will have the ability to effectively resolve the many complex issues threatening our park resources." Once a participant has completed the development program, new applications are accepted from that cluster for the subsequent fiscal year.

Program profile

Participants, who must be permanent park or support office employees, are competitively chosen by a panel comprising regional and park natural and human resource professionals. While individuals may pursue advanced training in any of the natural or physical sciences, certain academic disciplines are given priority: hydrology, limnology, coastal geology, fisheries biology, aquatic ecology, botany, forestry, and wildlife ecology. In the essay that accompanies the application, applicants describe their previous or current graduate-level courses and explain the field of study or research (if appropriate) they would pursue. If selected for the program, they sign an agreement that formally describes their objectives and stipulates the length of time that they are expected to continue working for the National Park Service after training (typically time equal to the length of participation in the program). To remain in the program, individuals must maintain a "C" grade point average; employees who fail to complete the program or meet any of the other requirements are liable for the full cost of any funds received while participating in the program. Since the purpose of facilitating advanced education is to raise the staff's level of scientific expertise, the review panel gives priority to individuals who show promise, but have limited or no experience designing or supervising research studies involving natural resources in the parks.

According to Mary Foley, Regional Chief Scientist of the Boston Support Office, the Natural Resource Professional Development Program offers the flexibility and financial support that make pursuing advanced study more feasible than traditional post-graduate or training options. For example, the regional Natural Resource Program provides each participant up to $25,000 per year to cover the costs of tuition, books, or research activities while the employee continues to receive regular pay and benefits. After completion of training or study, the employee returns to his or her duty station. The training objectives are individually designed by the selected applicant, his or

her supervisor, the support office chief scientist, and the appropriate university faculty so that the skills being acquired (and even the research activities themselves) can complement the park's natural resource goals. Within the parameters of the program (a maximum of three consecutive years), the natural resource professional and his or her park manager can determine the best schedule for the employee and the park, resulting in a variety of possible combinations of part- or full-time study and regular duty. Negotiations can also result in unused program funds being made available to the applicant's park if they are needed to fill the vacated position while the participant is in training.

With the recent completion of the program by the first two participants, it has already become clear that there is a strong "return-on-investment" on several levels. The knowledge and experience acquired by these graduates have shown that the program can benefit not only the individuals and their respective parks, but also the National Park Service as a whole, and many of the agencies and institutions that are their partners in natural resource conservation.

Cape Cod case study

Krista Lee, a chemist with the North Atlantic Coastal Laboratories at the Cape Cod National Seashore (Massachusetts), was accepted into the development program in fall 1998 and concluded her studies in December 2000. Ms. Lee's course of study included earning 32 credit hours at Boston University and writing her master's thesis in earth sciences with a concentration in environmental geochemistry. When she was not in classes or conducting field research, she was working at her position with the National Park Service. The motivation for her research was the need to analyze the geochemical processes that influence the water quality of the cape's freshwater kettle ponds. These ponds, formed during the last Ice Age, are a primary and unique natural resource at Cape Cod National Seashore.

To understand the influence of groundwater on the kettle ponds, Ms. Lee needed a basic understanding of Cape Cod's hydrologic budget. In this phase of her research she employed mathematical hydrologic modeling and GPS (global positioning system) technology to assess the local hydrologic setting around two of the ponds. Duck Pond, an isolated basin primarily influenced by precipitation and groundwater, and Gull Pond, which is stream-fed, were chosen by Ms. Lee because their differences offered the opportunity to learn the effects of several variables on kettle pond geochemistry (fig.1).

"To understand the influence of groundwater on the kettle ponds, Ms. Lee needed a basic understanding of Cape Cod's hydrologic budget."

In order to analyze the water quality of both sites and the surrounding groundwater, Ms. Lee quantified trace elements by using a spectroscopy technique that reveals very low levels of elements in the samples based on the light energy those elements emit. Ms. Lee identified the nutrients present in the pond water and groundwater by conducting flow injection analysis, a technique that uses color chemistry to indicate levels of nutrients in the samples. Identifying the primary internal and external sources of nutrients yielded the "nutrient budget" of the ponds. Knowing how to determine the typical annual budget for a pond will be helpful in determining the source and impact of nutrients and trace elements on the ponds in the future.

Ms. Lee's advanced studies have already benefited Cape Cod National Seashore because they quantify the trace elemental and nutrient levels of the surrounding groundwater influencing the ponds. Since the quality of the kettle ponds will be affected by future development and visitor use, managers must have the ability to monitor groundwater and pond water changes. With her new analytical skills, Ms. Lee will be able to participate in ongoing monitoring programs and new initiatives, as well as recommend strategies to address external threats, such as septic tank leaks. According to Ms. Lee, "I can now provide additional analytical and technical assistance to park management regarding water quality issues, and I have learned a bit about the hydrologic processes that influence the ponds on the cape." She has begun sharing both her research findings and the techniques she has learned by attending professional conferences and making presentations.

Assateague Island case study

The effectiveness of the development program has also been evident in the accomplishments of Christopher Lea, a plant ecologist at Assateague Island National Seashore (Maryland). In 1994, Mr. Lea, a full-time National Park Service employee, began using his personal time to take courses and gather field data to earn his Master of Science degree at George Mason

Figure 2. An early participant in the Natural Resource Professional Development Program, plant ecologist Chris Lea of Assateague Island National Seashore described the relationship between the plant communities near the Potomac River Gorge and the flooding of the river. Part of the project involved recording data on bedrock cover on South Bear Island, which floods every five to ten years on average.

University in Fairfax, Virginia. When the Northeast Region created its professional development program in 1998, Mr. Lea applied for the program to facilitate completing the last stage of his studies. From August 1998 (when he was accepted in the program) until April 2000, he continued to work for the National Park Service while taking his last required course, analyzing data, and writing his thesis. Although he most likely would have completed the requirements for a degree without NRPDP assistance, the program (combined with other resources) alleviated educational expenses and enabled him to expedite his studies and conduct a research effort that was much more sophisticated and challenging than a typical research project at the master's level.

Mr. Lea's master's thesis reflects his desire to understand ecological theory and to apply his research to the resolution of park conservation issues. His two objectives were to describe the nature of the relationship between the vegetation (plant communities) near the Potomac River and the flooding of the river; and to classify and describe the plant community types (associations) in the Potomac River Gorge (Great Falls Park, Virginia, and part of the C&O Canal National Historical Park, Maryland) by using the National Vegetation Classification System (NVCS) (fig. 2, page 35). The sophistication of this research is evident in the cross-sectional diagram (fig. 3, below) depicting an imaginary "slice" across the gorge. In this side view (taken from a larger, conceptual model), Mr. Lea depicts the correlation of plants growing at various elevations with the frequency that flooding inundated those areas. As he developed his conceptual model, he incorporated field data about the various vascular plant communities relative to flooding frequency and "flood energy." Concepts such as the energy of a flood (river volume and speed) were based on calculating the percentage of rock covered in "high energy" areas, and by determining the mean soil texture in "low energy" areas.

> "His study ... examines fluvial environmental effects on vegetation by directly measuring flooding frequency and ... measure[s] the effect of river energy as a factor affecting riparian vegetation."

The prestige of Mr. Lea's research has already enhanced both his career and the reputation of the National Park Service. His study has been one of the few that examines fluvial environmental effects on vegetation by directly measuring flooding frequency, and one of the first to measure the effect of river energy as a factor affecting riparian vegetation. Mr. Lea has also provided vegetation classification data for several parks, and the first classification of vegetation in the Potomac River Gorge, an area well known for its nationally significant biological diversity. While classifying vegetation, he identified several community types that are currently believed to be globally rare, including *Quercus bicolor-Fraxinus pennsylvanica-Chasmanthium latifolium* woodland. His survey also revealed new locations of rare, threatened, or endangered plant species, including some that had not been found in the area for more than 70 years. These inventory results have been used in two Expedition Into The Parks research projects funded by Canon U.S.A., Inc., and included in the USGS-NPS Vegetation Mapping Program.

Other professional opportunities for Mr. Lea to share his findings have been plentiful. Individual parks in the Northeast have asked for technical assistance in classifying vegetation, and several conservation-oriented agencies and national associations have asked him to address conferences and to assist them in conservation planning. Among those interested in—and benefiting from—his research are The Nature Conservancy, the Maryland Department of Natural Resources, the Ecological Society of America, the Virginia Natural Heritage Program, and the Washington Botanical Society. In referring to the significance of these interactions, Mr. Lea observes, "The NRPDP allowed me to create professional presentations, both in the thesis (which will be further used in publishing) and at meetings. The public relations benefits and professional recognition for the National Park Service cannot be underestimated."

From a management perspective, the skills Mr. Lea developed while participating in the development program have enabled him to conduct his duties

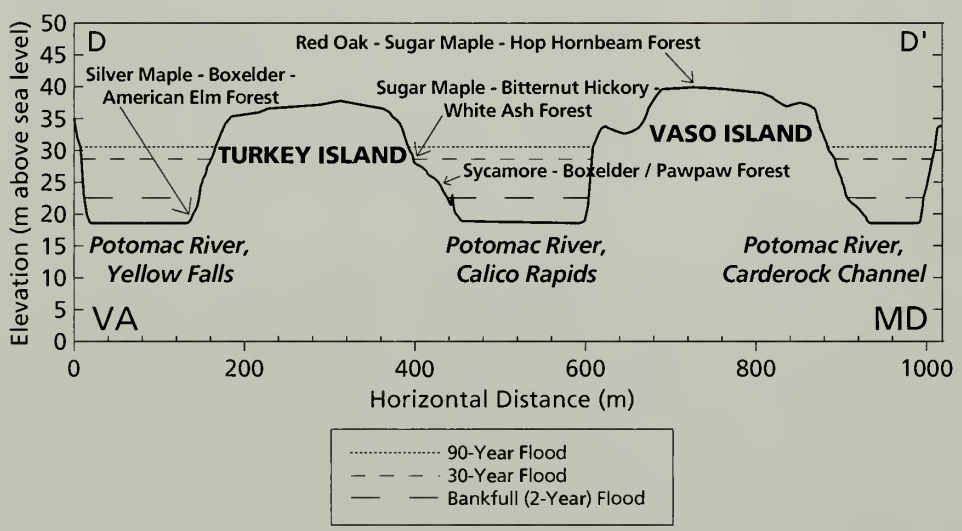


Figure 3. Taken from a larger conceptual model, this side view of the Potomac River Gorge depicts the correlation of vegetation growing at various elevations with flood frequency. Mr. Lea was able to conduct a research effort that was much more sophisticated than a typical research project at the master's level because of the support he received in the development program.

with a degree of professionalism that has made him indispensable. For example, when a threatened plant species, the seabeach amaranth *(Amaranthus pumilus)* was recently re-discovered on Assateague Island after an absence of 30 years, the park needed a comprehensive protection and restoration plan that included evaluating the species' habitat requirements and testing several restoration strategies. Carl Zimmerman, Assateague Island National Seashore's Chief of Resource Management, states that "this effort demanded strong analytic skills, the ability to research and synthesize a broad range of disparate ecological information, and a thorough understanding of research design and hypothesis testing—all of which were markedly enhanced by Chris' participation in a graduate degree program."

Acadia participant

Both Ms. Lee's and Mr. Lea's newly acquired skills have clearly benefited their respective careers and their parks. Most importantly, these participants are fulfilling the purpose of the development program by using science-based standards when they assess the condition of park natural resources and propose management strategies. A newly approved participant, Linda Gregory, also illustrates the multiple—and mutual—advantages of the program. On leave from her duties as a botanist at Acadia National Park in Bar Harbor, Maine, Ms. Gregory will receive full pay and benefits while attending graduate classes and conducting research in her park. Moreover, as part of a team examining the effect of exotic plants on the pollination of native species, she will combine the results of her graduate work in botany with the results of research by biologists with the USGS Biological Resources Division, the USGS Patuxent Wildlife Research Center, and the University of Maine.

Such a close synchronization of goals among career-minded individuals, the National Park Service, and affiliated conservation agencies is what David Manski, Chief of Resource Management at Acadia National Park, envisioned as one of the developers of the Natural Resource Professional Development Program. The equation for the program's success is aptly summarized by his observation that "Park employees earned advanced degrees before the NRPDP was established, but this program formally promotes and supports graduate study in a way that attracts and motivates employees." In effect, the Northeast Region has confirmed that designating funds and time for the development of the parks' human resources is one of the most effective strategies for meeting the Natural Resource Challenge.

About the Author

Kathleen Kodish Reeder (kkr1@psu.edu) is the former Writer-Editor for the Northeast Region, National Park Service; University Park, Pennsylvania. For more information about the development program, contact either of the Northeast Region's Chief Scientists, ***John Karish*** (john_karish@nps.gov) or ***Mary Foley*** (mary_foley@nps.gov).

"Information Crossfile" continued from page 13

The rain-drenched mountains and valleys of the Olympic Peninsula are covered by a jungle growing on a jungle. This small, attractive, spiral-bound field guide helps people to see the jungle on top—the mosses, liverworts, and lichens. In northwest Washington lichens and mosses seem to sprout from any object moving slower than one mile per hour.

A short introductory section orients novices making their first excursion into this minute world. Topics include structure and reproduction of lichens and bryophytes, their human uses, and their important roles in the ecosystem.

The main part of the 109-page book features 101 species, with mentions of 140 more. Featured species are illustrated with a good-quality color close-up photograph, ecological notes, the elevation range of its habitats, and pointers for distinguishing similar species. The species are grouped by substrates: forest floor, logs, conifers, hardwoods, streamsides, and rock.

An accessible, inexpensive, color-illustrated book like this should open a new realm for lots of people. It should help park managers and naturalists understand and appreciate these components of biodiversity that are increasingly recognized for their indicator value and contributions to the ecosystem. This book should be sold in every bookstore, interpretive center, and gift shop on the Olympic Peninsula. Many people nearby in the Vancouver-Seattle-Portland swath will find it useful, too.

I hope this book will inspire similar efforts for other wild remnants of the continent, especially those with conspicuous mosses and lichens, such as the north country of Minnesota, the Acadian mountains and shore, the Appalachians, the swamps and sand ridges of Florida, the alpine tundra of Colorado, the forests of the northern Rockies, and of course the Alaskan mountains and tundra.

USING SURVEY RESEARCH

to analyze regional economic impacts from a change in park management

A CASE STUDY AT FORT SUMTER NATIONAL MONUMENT

By Benjamin Sigman and Naomi Kleckner

The Organic Act of 1916 charges the National Park Service with the primary responsibility of preserving park resources and values unimpaired for the enjoyment of future generations. Fulfillment of this conservation mandate requires managers to acknowledge that parks are components of larger environments, influenced by activity outside park boundaries. Park Service management policy directs park managers to address the effects of external activities on park programs, resources, and values. Furthermore, NPS policy instructs managers to consider the impact that their park management decisions will have outside park boundaries. In striving to uphold these goals of NPS policy, park managers rely on strategic planning, program coordination, scientific information, communication, and other tools. Management policy affirms that managers will use all available authorities to protect park resources and values, emphasizing the importance of understanding the complicated union between a park and its locality:

> Strategies and actions beyond park boundaries have become increasingly necessary as the National Park Service strives to fulfill its mandate.... Recognizing that parks are integral parts of larger regional environments, the Service will work cooperatively with others to ... protect park resources and values and ... address mutual interests ... such as compatible economic development and resource and environmental protection. *(Department of the Interior, National Park Service, Management Policies 2001, Section 1.5 External Threats and Opportunities)*

Survey research may be employed to augment economic input-output analysis and better understand the regional effects of management alternatives. In cases where positing the initial effects of a change in management is difficult, survey work can help park managers to better understand the implications of their decisions. For example, if managers are unsure what visitor reactions to modifications in management will be, careful survey research can provide qualitative and quantitative estimates of the change. This article describes an analysis of the new commercial services plan at Fort Sumter National Monument (hereafter, the fort) in Charleston, South Carolina. It is a strong case study in the use of survey research to assess regional economic effects attributable to complicated management changes with direct effects on area attractions.

"Survey research may be employed to augment economic input-output analysis and better understand the regional effects of management alternatives."

Case study: Fort Sumter National Monument

For over 40 years, the National Park Service has sought a facility in historic Charleston that would provide permanent tour boat access to Fort Sumter National Monument. Under the previous commercial services plan, a concessioner provided access to Fort Sumter from two departure points, the City Marina in Charleston and Patriots Point in Mount Pleasant (fig. 1). The National Park Service had no control of the lease, operation, or management of the tour embarkation points used by the Fort Sumter concessioner. The Charleston peninsula tour boat facility at the City Marina on the Ashley River was inadequate, even on average use days. Parking was limited; the site lacked an NPS visitor contact station, NPS presence, and rest rooms. A second tour boat dock provided in 1985 at Patriots Point in Mount Pleasant had adequate parking and rest rooms but did not have a visitor facility with NPS interpretative services. Additionally, both locations lacked adequate handicapped access. (Fort Sumter tour boat facility webpage, http://www.nps.gov/fosu/dockside/index.htm.)

Figure 1. Map showing location of new and former departure points and visitor services facilities for Fort Sumter National Monument, South Carolina.

After two failed attempts to develop a suitable dock site and visitor center in historic Charleston in the late 1970s and early 1980s, the National Park Service entered into an agreement to develop a site on the eastern side of the Charleston peninsula. In 1986, the Park Service purchased this riverside site, and the master plan was amended with a cooperative proposal for the National Park Service to co-develop this site. The Fort Sumter project was viewed as a perfect match with the City of Charleston, which was seeking a site for a state aquarium. This site offered enough space for the integration of the NPS facility and the envisioned South Carolina Aquarium, an IMAX theater, and a restaurant. In addition, a parking garage was constructed across from the NPS site. Fountain Plaza (i.e., South Carolina Aquarium and IMAX theater) and the parking garage opened in 1999. The NPS facility opened to the public in August 2001 (fig. 2), and a formal opening and dedication was held in November. In addition to a museum, which is free to the public, the new facility provides docking space for the concessioner ferries that facilitates access to the fort; offers shade shelters, landscaped areas, and rest rooms; and creates a significant NPS presence in Charleston.

The opening of the NPS facility and its boat launch called for a new commercial services plan. Under the new plan, the National Park Service would consolidate the ferry operations providing transport to the fort. The new boat dock on the Charleston peninsula would become the sole departure point from which the public would access the fort.

Figure 2. The new Fort Sumter visitor center and boat dock began public operation in August 2001.

Concerns surrounding the management change

From November 1999 to January 2000, Fort Sumter National Monument made its commercial services plan available for public comment. Several interested parties raised concerns, including the Patriots Point Development Authority (the Authority). The Authority believed that discontinuing the departure point at Patriots Point would negatively affect the town of Mount Pleasant, Patriots Point Naval and Maritime Museum, and the national monument.

In response to comments received from the Authority and other stakeholders, Fort Sumter Superintendent John Tucker commissioned a study assessing the potential regional economic impacts of the new management plan. Specifically, Superintendent Tucker intended to estimate the impact on the Mount Pleasant economy from changing Fort Sumter's departure points; the financial impact on Patriots Point Naval and Maritime Museum; and estimate the change in fort visitation. In addition, Superintendent Tucker hoped to learn whether fort visitors would take advantage of a proposed water taxi service from Mount Pleasant to downtown Charleston and whether fort visitors would benefit from the option to spend more time at the fort.

ILLUSTRATION BY PHILIP THYS, DSC, NPS

The analysis

Assessing the potential impacts of the change in Fort Sumter commercial services faced several analytic challenges. First, limited information existed to assess the relationship between fort visitation and visitation at Patriots Point and the South Carolina Aquarium. Originally, both the National Park Service and Patriots Point saw mutual benefits to the Fort Sumter departure point at Patriots Point. The two attractions have similar appeal to a subset of Charleston area visitors, and Patriots Point had space capable of accommodating a limited docking facility. The Patriots Point Naval and Maritime Museum, like Fort Sumter National Monument, is focused on American military history, offering tours of a World War II aircraft carrier, destroyer, and other exhibits. It was assumed that visitors planned to visit both the fort and Patriots Point on the same trip or that sharing a site generated incidental visits among visitors planning to see only one of the two attractions. These assumptions were supported by visitation data that showed similar trends over time for both attractions. The National Park Service was not sure to what degree Patriots Point would be affected by the management change and whether this type of relationship might be created between the fort and the South Carolina Aquarium.

Furthermore, limited information was available to characterize how fort visitors, especially those departing from Patriots Point, contributed to the economic trends of the Charleston area. Mount Pleasant had seen strong economic growth and development in tourist services, especially overnight accommodations, in recent years. Without primary research, the National Park Service was uncertain of the extent to which the Fort Sumter boat launch at Patriots Point had helped support tourism growth in Mount Pleasant. Also unclear was the extent to which fort visitors would alter their selection and use of tourist services (e.g., location of lodgings) in response to offering a departure point only from the City of Charleston.

To complete this assignment, we developed three distinct surveys and administered them to fort visitors, Charleston area visitors, and Charleston area residents using a self-administered intercept approach (i.e., respondents complete questionnaires on-site).[1] The effort to survey Fort Sumter visitors took place on the boats returning from the fort, while Charleston area visitors and residents were interviewed outside of the recently opened aquarium. Collectively, the survey results established a profile of Fort Sumter's role in the region's tourism and economy, defined the existing

[1] The survey effort was exempt from Office of Management and Budget survey instrument review due to the litigant nature of the research.

patterns in visitation, and projected the potential changes due to the Fort Sumter visitor center opening.

The survey of Fort Sumter visitors asked respondents about the details of their Charleston visit. The first section of the survey gathered information on reasons for visiting the area and how a fort visit fit into their plans for the day and overall Charleston area visit. The second section addressed satisfaction with the fort experience, followed by a section that gave respondents the opportunity to choose between two carefully developed management alternatives (table 1). With each alternative, respondents considered attributes of the fort experience, such as the value of park ranger presence, interpretive displays, admission to exhibits, seating while waiting for the tour boat, parking, boat departure times, and departure location. The choice required respondents to collectively consider the trade-offs among eight attributes pertaining to the two management alternatives. The survey also asked which factors were the most important in making their decision. Finally, the survey asked visitors about the logistics of their visit, focusing on party size, length of stay, lodging location, important attributes of accommodations (e.g., location, price, amenities), as well as demographic and socioeconomic information.

Charleston area visitors and residents interviewed at the South Carolina Aquarium answered similar questions about the details of their visit to the aquarium, activities planned for the day (and for area visitors, overall plans for their trip to Charleston). The surveys asked respondents about their familiarity and interest in Fort Sumter National Monument (e.g., plans to visit the fort), interest in the new visitor center, and how they might have combined their visit to the aquarium with a visit to the fort under the future commercial services plan. Area visitors also answered the same set of questions about their trip logistics (e.g., lodging questions); both area visitors and residents answered the demographic and socioeconomic questions.

The three surveys were carefully developed with input from Superintendent Tucker and several peer-reviewers and then pre-tested. The administration of surveys to fort visitors took place over three days in June 2000, resulting in approximately 580 collected surveys. One month later, a two-day survey took place at the aquarium, with nearly 500 surveys collected. The scientific approach to survey design provided reliable data defining baseline trends in Fort Sumter visitation, future trends in Fort Sumter visitation, and the regional economic impacts associated with a change in management practice.

"No evidence suggested that Charleston area visitors will alter their use of tourism services based upon Fort Sumter's new departure site."

Findings

The data suggested minimal impacts on the Mount Pleasant economy as a result of consolidating the two departure points. The analysis used questions about lodging choice (i.e., lodging attributes such as cost,

Table 1. Potential management options for Fort Sumter from the survey of Fort Sumter visitors.
"[Below] are two options for boat departure points to Fort Sumter, Option A and Option B. The differences between the two options are described for each. Considering all of these factors which option do you prefer?"

		Option A	Option B
A	Amount of time spent at the Fort.	Stay at the fort for one hour.	Option to stay at the fort longer than one hour.
B	Park rangers available to answer questions and give historical talks.	Available only at the fort.	Available while waiting for the boat, on the boat, and at the fort.
C	Displays and exhibits about Fort Sumter while waiting for the boat.	At Patriots Point: displays about Civil War on outside building wall. City Marina: no exhibits.	National park museum about Fort Sumter at departure site. Also, displays in nearby park along walkways.
D	Admission to the exhibits.	At Patriots Point: free admission to displays. City Marina: no exhibits.	Free admission to museum.
E	Seating while waiting for the boat.	At Patriots Point: seating in shaded open air food service area. City Marina: no sheltered area.	Seating in air conditioned museum and shaded outside seating.
F	Parking near the departure point.	Free parking in a lot at Patriots Point. Street parking near the City Marina.	Paid parking in garages across the street from the departure point.
G	Number of times per day that a boat leaves for the fort.	3 times per day (one boat every 2 1/2 hours) from each departure point.	On average 6 times per day (about one every hour).
H	Fort Sumter departure point location(s).	Two departure points-Patriots Point (in Mount Pleasant) and the City Marina (in Charleston).	One departure point-beside the South Carolina Aquarium in Charleston.

location, and proximity to attractions) as an indicator of how area visitors might change their use of services supporting area tourism and, consequently, of the magnitude of regional economic effects. Responses to these questions showed no statistical difference in the lodging choice of Fort Sumter visitors and aquarium visitors (who did not plan to visit the fort). Lodging choice was driven by the cost of the room and the ease of getting to a *variety* of attractions in the Charleston area. Consequently, no evidence suggested that Charleston area visitors would alter their use of tourism services based upon Fort Sumter's new departure site. The town of Mount Pleasant should experience little, if any, change in hotel revenues (and hotel spin-off revenues) due to the new Fort Sumter departure site.

The survey research did confirm that the Patriots Point Naval and Maritime Museum will experience some loss in gross revenues on account of the new commercial services plan. Research indicated that Patriots Point may see a reduction between two and twelve percent of its annual gross revenues as a result of the change in the Fort Sumter departure point to downtown Charleston. The upper bound of the estimated change in total revenues is roughly equal to what the Authority had presented as a lower-bound estimate of lost revenue in their position paper.

"Patriots Point may see a reduction ... of its annual gross revenues as a result of the change in the Fort Sumter departure point to downtown Charleston."

An important finding of the survey research was that the new visitor center would significantly increase fort visitation. The new visitor center increases the exposure of Fort Sumter National Monument to Charleston area visitors, resulting in a significant increase in visitation. This gain in visitation will more than offset the loss in visitors who preferred the former departure options. Specifically, we estimate that consolidation of Fort Sumter departure points will lead to a net increase in Fort visitation of 16,000 to 25,000 visits per year (recently the fort has supported approximately 240,000 visits annually). We also estimate that the national monument will serve approximately 29,000 additional visitors per year who are interested in seeing the visitor center but do not have the time to visit the fort.

Additionally, the survey revealed information regarding visitor preferences. For example, the research determined that one-third of visitors to Fort Sumter want to spend more time at the fort. Such information supports the management change and informs future boat scheduling options. The survey also investigated the feasibility of a water taxi, running between Mt. Pleasant and downtown Charleston. Approximately one-third of fort and aquarium visitors, stated they would "definitely" or "most likely" use a taxi service. These results suggested that Patriots Point's revenue loss could be significantly offset by offering a commercial water taxi service between Patriots Point and Fountain Plaza. The tourist traffic using a water taxi would also increase Patriots Point's visibility to Charleston area visitors who did not plan on visiting it.

Finally, survey research provided useful and specific information on the visitors themselves. A strong understanding of Fort Sumter visitor gender, race, age, educational attainment, employment, income, and home residence was obtained. This information will help Fort Sumter managers to make educated decisions on issues affecting the entire visiting population.

Conclusion

The regional economic analysis of a change in management at Fort Sumter National Monument proved to be a successful exercise in using survey research to gain information important to park management. A significant amount of information on visitation, future trends in visitation, and the regional economic impacts associated with the change in management practice was collected. This analysis was an essential first step in understanding how Charleston area visitors and residents would react to management change at Fort Sumter. Without the information provided by this survey effort, the ramifications of the change in management could not have been quantified before the implementation of the new commercial services plan. In addition, the completion of the analysis cleared the path for further analyses that may include input-output modeling or an examination of the changes in social welfare associated with the consolidation of departure points at Fort Sumter National Monument.

In the future, an analysis of visitation data collected after the implementation of the new commercial services plan will allow for verification of the survey's accuracy. Tracking visitation trends under the new commercial services plan will allow researchers to compare visitors' actual behavior to their stated responses to management changes. Examination of the projected effects versus actual effects will allow for methods used in this survey effort to be further refined for future use. PS

About the Author

Benjamin Sigman (Bsigman@indecon.com) and ***Naomi Kleckner*** (Nkleckner@indecon.com) are with Industrial Economics, Inc., Cambridge, Massachusetts, an economic and environmental consulting firm that conducted the economic analysis for Fort Sumter under contract to the National Park Service.

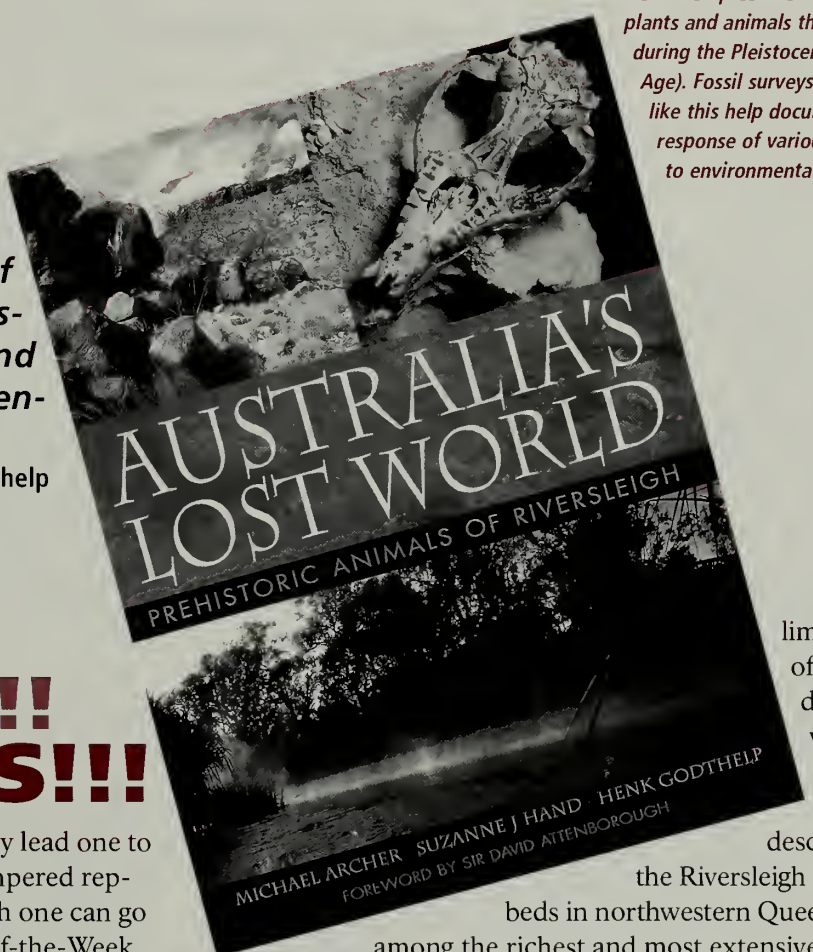
Hindsight makes better foresight: PALEONTOLOGY AS A NEW TOOL FOR CONSERVATION

Figure 1. Caves like this one at Glen Canyon National Recreation Area often preserve fossils of plants and animals that lived during the Pleistocene (Ice Age). Fossil surveys at sites like this help document the response of various species to environmental change.

By Dan Chure, Ph.D.

"In this chapter, we consider what ought to be paleontology's most vital calling: use of the vast record of life's prehistory to help understand and conserve its threatened descendants."

—Archer, Hand, and Godthelp



DINOSAURS! DINOSAURS!! DINOSAURS!!!

TV, movies, and popular books could easily lead one to believe that those huge, brooding, bad-tempered reptiles were the only life of the past. Although one can go broke subscribing to the Dinosaur Book-of-the-Week Club, there are some other popular books that focus on the many other wonderful creatures that have populated our planet over the past millennia. These non-dinosaur books introduce us to past life otherwise still buried in the pages of scientific journals.

The recently published book *Australia's Lost World: Prehistoric Animals of Riversleigh* by Mike Archer, Suzanne Hand, and Henk Godthelp (2000) adds to the limited list of non-dinosaur works. This book describes the Riversleigh fossil beds in northwestern Queensland, among the richest and most extensive in the world. Their significance was formally recognized by the Australian government when the fossil beds were incorporated into Lawn Hill National Park in 1992 and when UNESCO designated them a World Heritage Site in 1994. Among its important values, this fossil treasure provides a record of how Australia's ancient rainforests were transformed into a largely arid landscape in response to climate change over the last 15 million years.

PALEONTOLOGY AND CONSERVATION EFFORTS

However, *Australia's Lost World* is more than just a book about spectacular fossils. It is also about conservation biology and how paleontology can provide critical information for developing strategies for conserving our living biota. The authors make a strong case that the conservation status of living species can not be determined solely on information gathered over a few decades of modern field studies. As the authors write, (p.9) "Rarity can not be interpreted as anything other than rarity. To tell if a lineage is in the process of decline, stability, or rise, we must have an historical perspective—and not just that of the last few centuries." And for that reason this book should be of interest to the readers of *Park Science*.

"*Australia's Lost World* ... is also ... about conservation biology and how paleontology can provide critical information for developing strategies for conserving our living biota."

"Conservation status of living species can not be determined solely on information gathered over a few decades of modern field studies."

The book provides several examples of how paleontology can be important for conservation issues. One of the more interesting ones involves the recent "plagues" of the crown-of-thorns starfish *(Acanthaster planci)* on Australia's Great Barrier Reef. The recent blooms of this reef-eating starfish have been attributed to human interference, such as the over-collection of *Triton* snails, an important predator of this starfish. As a result, aggressive control programs were implemented to reduce the populations of *A. planci*, including having divers inject starfish with heavy metal solutions. However, this strategy was called into question when the fossil record of this starfish was more closely examined. Walbran et al. (1989) cored the Great Barrier Reef for just that data and found evidence for episodic blooms of this starfish going back more than 4,000 years, well before Europeans came to Australia. This has raised serious doubt as to whether or not these "plagues" are human induced. It also raised the intriguing question as to whether or not humans may have disrupted what may well be a normal, if cyclic, process, and that disruption might actually have had a detrimental effect on the very reef systems those actions were designed to protect. Might not these starfish population explosions be the marine equivalent of a forest fire?

In some cases, paleontology can help identify both positive and negative impacts of what the authors call the "heavy hand of humanity." Using the Late Quaternary record of fossil vertebrate accumulations in caves, Alex Baynes (1990) determined that small to medium-sized Australian mammals show remarkable stability throughout the record preserved in caves. Changes in distribution patterns since the arrival of Europeans are many times greater than over the last 10,000 years. Here we can see that recent human activities have had a detrimental impact on species.

Flannery (1990), on the other hand, argues that the loss of many medium-sized arid and semi-arid Australian mammals is likely the result of a secondary chain of extinctions (a "trophic cascade") following the great extinction of Australia's megafauna some 20,000-40,000 years ago. That this cascade did not immediately follow the megafaunal extinction event is likely due to the Aboriginal use of fire, which maintained complex vegetation systems and thus delayed the trophic cascade. With the arrival of Europeans, and the subsequent loss of Aboriginal land management practices, extinctions accelerated to Late Pleistocene levels. One conclusion Flannery draws is that maintaining Aboriginal fire practices may well be important in preventing further extinctions.

IMPORTANCE OF THE PLEISTOCENE AND QUATERNARY RECORD

Australia's Lost World makes it clear that the Pleistocene and Quaternary fossil record of Australia has important information that needs to be incorporated into conservation plans for species and ecosystems. In fact, ecologists are now working as co-investigators on the Riversleigh projects because of their recognition of the potential for establishing long-term trends in Australian ecosystems.

The Pleistocene and Quaternary fossil record also contains valuable information for the United States (fig. 1, page 43). An understanding of this history is fundamental to the preservation of our current biota. Over the last 19,000 years in North America we have gone from the maximum southern spread of continental ice sheets to the present reduced glacier distribution. During this same time period the ecosystems shifted in

Figure 2. Discovered in Grand Canyon National Park, Arizona, this fossilized condor skull is evidence that the large, scavenging bird once lived in the area. This information was important in considering reintroduction of the species in the past decade. COPYRIGHT STEVE EMSLIE

response to the retreat of the ice sheet, the arrival of the first humans in North America, and a continent-wide megafaunal extinction. These tremendous changes are the crucible in which our modern biota was forged. Quaternary geologists and paleontologists have amassed a phenomenal amount of data for this time interval. Correlation of physical events, flora, and the fauna over the last 50,000 years of prehistory can be excellent, thanks to refined C^{14} dating techniques, which can yield dates with errors of only ±50 years! Thus, fine-scale calibration of events and species distributions is possible. And while getting genetic material out of dinosaur bones is something best left to the movies, the wizards of molecular biology have successfully extracted DNA from more recent fossil bone. This allows us to trace the stability of or changes in population genetics, sometimes in still living species, over tens of thousands of years.

The fossil record also often includes species that are either still alive or are the immediate ancestors of living species (fig. 2). Even DNA is preserved! Here we have the record of very recent extinction and evolution, biotic crisis and biotic response. This is critical data for understanding how the present came to be and where it may head in the future. To ignore this record is unwise.

"There has been little interdisciplinary overlap between Quaternary earth scientists and the modern conservation and restoration communities."

Surprisingly, in spite of all this branch of paleontology has to offer, there has been a lack of communication between Quaternary earth scientists and the modern conservation and restoration communities. There is, however, some recent work that shows just how valuable such collaboration can be. Cooper et al. (1996) have used fossil distribution and fossil DNA data for the Laysan duck *(Anas laysanensis)* to show that in the past this species occurred on more islands than at present and that the fossil populations were genetically quite similar to extant populations. This information can be used to identify islands and areas where the reintroduction of the Laysan duck may be most successful.

The research of Wayne et al. (2000) is another example of how paleontological information can help conservation efforts. Studying the mitochondrial DNA of brown bears *(Ursus arctos)* preserved in the permafrost, these scientists have been unraveling the complex pattern of population genetics changes in this carnivore. Some 36,000 years ago the brown bear was much more diverse genetically, but by 15,000 years ago the level of genetic diversity had dropped to that of modern populations. The details of this work suggest that relying solely on the genetic diversity data of living brown bear populations could lead to erroneous conservation management decisions.

NEW ROLES FOR THE NPS IN PALEONTOLOGY?

What does all this mean for the National Park Service and the preservation of our living treasures? The Service has an extensive Inventory and Monitoring Program (I&M) under way—one that is monitoring both the living and nonliving components of our ecosystems. A predetermined core of basic data themes

is being gathered nationwide, while more specialized inventories, such as paleontology, are left to the responsibility of individual parks. Now I have heard some lamentations about fossils not being included in the I&M Program. In my view as a research paleontologist, fossils are generally not directly relevant to the problem the I&M Program is addressing—systematically gathering standardized information to establish a statement of the condition of the present-day ecosystems in relation to their unimpaired state. In particular, although we have learned much about dinosaurs from fossils, it is difficult to apply that knowledge directly to the problems of our present-day biota.

"Our fossil resources need to be inventoried, monitored, studied, and protected because of our mission and their scientific and educational value...."

But do not get me wrong. Fossils—even those that are not dinosaurs—are extremely important. They are, after all, the record of the history of life on our planet. Many national parks with fossils are international benchmarks for particular times in the past. Literally thousands of scientific papers have been published on fossils of the National Park System units and the list is continually growing. Our fossil resources need to be inventoried, monitored, studied, and protected because of our mission and their scientific and educational value, regardless of what they may or may not tell us about the future. Let us hope that the monies available through the Natural Resource Challenge for resource inventories will free up other sources (such as the Natural Resource Preservation Program) to fund systematic fossil inventories. Another possibility would be to develop Servicewide funding for paleontological inventories through the Natural Resource Program Center, where such inventories could be prioritized by resource and management needs.

It seems unlikely that the current NPS I&M Program can fund fossil surveys—even those with an emphasis on the Quaternary record. However, that should not prevent us from exploring how Pleistocene and Quaternary earth scientists might work with us to understand the time aspect of the resources we care for. Knudson (1999) and McDonald and Chure (2001) have recently made a similar plea. This cooperation will require partnerships with other land management agencies as well—the canvas on which the recent fossil history of North America is painted is larger than the lands administered by the National Park Service. Maybe the Service, as the nation's leading conservation agency, can help bring the paleontological and conservation professionals together. To do so may well reap great rewards.

"Maybe the Service ... can help bring the paleontological and conservation professionals together."

ACKNOWLEDGMENTS

My thanks to NPS Paleontology Program Coordinator Greg McDonald for fruitful discussions on this topic.

REFERENCES

Archer, M., S. J. Hand, and H. Godthelp. 2000. Australia's Lost World: Prehistoric Animals of Riversleigh. Indiana University Press, Bloomington and Indianapolis. ISBN 0-253-33914-6. 264 pages.

Baynes, A. 1990. Biogeography of non-volant mammals in southwestern Australia: past and future. Australian Mammalogy Society Newsletter, Spring 1990.

Cooper, A. C., J. Rhymer, H. F. James, S. L. Olson, C. E. McIntosh, M. D. Sorenson, and R. C. Fleischer. 1996. Ancient DNA and island endemics. Nature 381:484.

Flannery, T. F. 1990. Pleistocene faunal loss: implications of aftershock for Australia's past and future. Archaeology in Oceania 25:45–67.

Knudson, R. A. 1999. Using the past to shape National Park Service policy for wildlife. George Wright Forum 16(3):40–51.

McDonald, G. H., and D. J. Chure. 2001. The fossil record and contemporary problems in ecology: contributions from semi-deep time. Pages 167–72 in Santucci, V. L., and L. McClelland, editors. Proceedings of the sixth Fossil Resource Conference. Geologic Resources Division Technical Report NPS/NRGRD/GRDTR-01/01.

Walbran, P. D., R. A. Henderson, A. J. T. Jull, and M. J. Head. 1989. Evidence from sediments of long-term *Acanthaster planci* predation on corals of the Great Barrier Reef. Science 245:847–50.

Wayne, R., A. Cooper, and J. Leonard. 2000. Population genetics of Ice Age carnivorans. Journal of Vertebrate Paleontology 20 (supplement to no. 3):77A.

ABOUT THE AUTHORS

Dan Chure is Research Scientist, Dinosaur National Monument, Box 128, Jensen UT 84035; dan_chure@nps.gov.

Meetings of Interest*

June 2–5

Indiana University, Bloomington, is the venue for the Ninth International Symposium on Society and Resource Management, titled "Choices and Consequences: Natural Resources and Societal Decision Making." This symposium centers on the contributions of the social sciences to a better understanding of resource management issues. A major premise is that complex natural resource issues are societal problems and must be addressed through an interdisciplinary social science perspective that includes decision making within multidimensional social and cultural frameworks. Dialogue and interaction among natural resource managers, social scientists, policy makers, and the public is anticipated. Themes include: identification, management, and resolution of natural resource conflict; models, measurement, and public participation in capacity management; emerging natural resource issues management; and integrating natural resource management in a context of public norms, expectations, and managerial systems. Further information can be found on the Web: www.indiana.edu/~issrm/.

June 2–7

The Society of Wetland Scientists is hosting its 23rd annual meeting in Lake Placid, New York, focused on "Wetland Linkages: A Watershed Approach." Scientific dialogue will explore how wetlands are being integrated into watershed management initiatives and how they are linked to issues about economics, ecology, and energy. A technical program will examine wetland issues making news today. Visit www.sws.org/lakeplacid/ for further information.

August 4–9

The Ecological Society of America (ESA) and the Society for Ecological Restoration (SER) will be meeting jointly in Tucson, Arizona. The theme of the meeting is "A Convocation: Understanding and Restoring Ecosystems." The organizers are calling this conference a convocation because it is the coming together of two organizations, ESA and SER, that share the common purpose of using basic ecological knowledge to solve practical environmental problems. The meeting will include practitioners, managers, regulators, academic scientists, agency researchers, educators, and interested citizens. The organizers also are encouraging ecologists and restorationists in Mexico and Latin America to attend. Esteemed Harvard biologist E. O. Wilson will be giving the keynote address to the conference. For further information on the conference, consult www.esa.org/tucson, or contact the program chair: Paul H. Zedler, Institute for Environmental Studies and Arboretum, University of Wisconsin–Madison (608-265-8018; esa@mail.ies.wisc.edu).

September 30–October 2

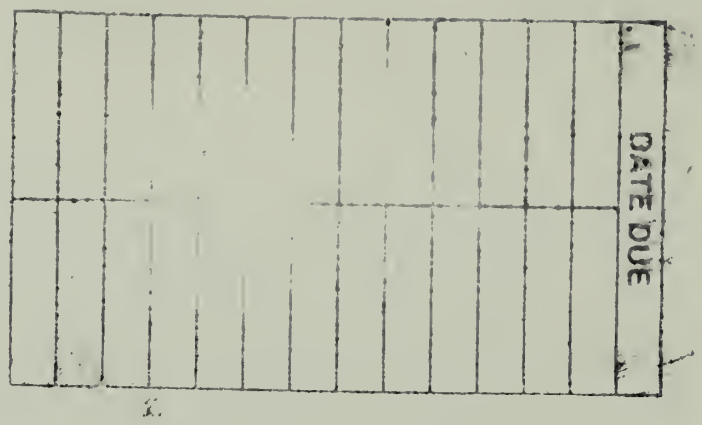
The symposium "Innovations in Species Conservation: Integrative Approaches to Address Rarity and Risk" will convene in Portland at the Oregon Convention Center. Focusing on the conservation of rare and poorly known species, invited speakers and audience participants will discuss the ecological, social, and legal contexts for various conservation strategies and the risks and uncertainties associated with each species. Target audiences include public and private resource managers, scientists, policy makers, conservation organizations, and the public. The symposium is sponsored by the USDA Forest Service, U.S. Geological Survey, U.S. Fish and Wildlife Service, Bureau of Land Management, Oregon State University, Society for Conservation Biology, The Nature Conservancy, and others. The registration fee is $150. More information is available at http://outreach.cof.orst.edu/species/.

October 2-5

The 29th annual conference of the Natural Areas Association will take place in Asheville, North Carolina, exploring the "Power of Nature and the Empowerment of Natural Areas." Participants will be challenged by new information and new ways of thinking about the conservation and management of natural areas. Organizers hope to raise awareness and optimism among attendees who can make a difference in the conservation of natural lands and biodiversity. Several session tracks revolve around the concept of adaptive management and include: adaptive management and climate change, adaptive management in fire-dependent communities, prioritizing invasive species management in an adaptive context, and hydrologic alteration and adaptive management. Additional information is available at www.natareas.org.

*Readers with access to the NPS Natural Resources Intranet can view a comprehensive listing of upcoming meetings, conferences, and training courses at www1.nrintra.nps.gov/NRMeet/.

PARKSCIENCE
National Park Service
WASO-NRID
P.O. Box 25287
Denver, CO 80225-0287



PARKSCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT

VOLUME 21 • NUMBER 2 • SPRING 2002

www.nature.nps.gov/parksci

ISSN-0735-9462

EDITORIAL OFFICE Jeff Selleck
National Park Service
P.O. Box 25287
Denver, CO 80225-0287
E-mail: jeff_selleck@nps.gov
Phone: 303-969-2147
FAX: 303-987-6704

Park Science is a resource management bulletin of the National Park Service that reports recent and ongoing natural and social science research, its implications for park planning and management, and its application to resource management. Published by the Natural Resource Information Division of the Natural Resource Program Center, it appears twice annually, usually in the spring and summer. Additional issues, including thematic issues that explore a topic in depth, are published on occasion. Content receives editorial review for usefulness, basic scientific soundness, clarity, completeness, and policy considerations; materials do not undergo anonymous peer review. Letters that address the scientific content or factual nature of an article are welcome; they may be edited for length, clarity, and tone. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

Send articles, comments, address changes, and other information to the editor at the e-mail address above; hard copy materials should be forwarded to the editorial office address. Deadline for submissions is January 15 for the spring issue and April 15 for summer.

Park Science is also published on-line (ISSN-1090-9966). All back issues of the publication, article submission guidelines, and other useful information can be viewed and downloaded from the website www.nature.nps.gov/parksci.

Park Science accepts subscription donations from non-NPS readers. If you would like to help defray production costs, please consider donating $10 per subscription per year. Checks should be made payable to the National Park Service and sent to the editor.

Sample article citation
Beever, E. A. 2002. Persistence of pikas in two low-elevation national monuments in the western United States. [National Park Service publication] Park Science 21 (2):23–29.