PARK SCIENCE
INTEGRATING RESEARCH AND RESOURCE MANAGEMENT
Volume 18 • Number 1 • July 1998
National Park Service • U.S. Department of the Interior

Social science in the national park system:
An assessment of visitor information

BY ROBERT E. MANNING AND BENJAMIN WANG

IT IS BECOMING A TRUISM THAT MANAGING national parks means managing people (fig. 1). The national park system will accommodate nearly 300 million visits annually by the turn of the century. Growing numbers of visitors present challenges to the National Park Service to meet its mission of protecting park resources and providing for public enjoyment.

People play an important role in this mission. Visitors are a primary cause of impacts to park resources, and research suggests that such impacts are a function of visitor behavior (activities, spatial and temporal use patterns) in addition to resource characteristics (Hammitt and Cole 1987). Moreover, public enjoyment of the national parks must be defined through understanding of the visitor experience, which research suggests may sometimes be at odds with the perceptions of park managers (Manning 1986). This issue is further complicated by the diversity of sites within the national park system and the concomitant diversity of visitors. And visitors are only one of the publics of concern to national park managers: others include employees, residents of local communities, concessioners, interest groups, and, ultimately, society at large.

Important management tool

The relationship between people and parks suggests the importance of social science. Within the National Park Service, social science has recently been defined as "the disciplines of science that study humankind in relation to its cultural, social, and physical environment" (Machlis 1996). Social science is one of the three main divisions of human knowledge (along with natural sciences and the humanities) as traditionally defined by academic institutions. Social science typically includes the disciplines of anthropology, archaeology, economics, geography, human psychology, political science, and sociology. All of these disciplines can contribute to our knowledge and understanding of visitors to the national park system.

© 1986, JEFF SCHULTZ

Figure 1. Backpacking, sight-seeing, enjoying wildlife....The pursuits of visitors to national parks are numerous and diverse. Yet, scientific information about the behavior of visitors and their park experience (motivations, level of satisfaction, and attitudes) is not commonly available to park managers according to the recent study. With a mission to protect park resources and provide for public enjoyment, the National Park Service needs consistent visitor information in order to manage parks and people as effectively as possible.

Given the general importance of social science and the particular importance of information on visitors, to what extent is such information available to park managers? What types of information are available? What are the primary sources of this information? A recent study provided insight into these and related questions.

In 1996, the National Park Service was authorized by the Congress to design and implement an experimental user fee system, now commonly known as the Recreation Fee Demonstration Program. This legislation requires the National Park Service to monitor and evaluate the effects of this new fee system. This information will be used by the Congress to help determine if this new fee system will be continued on a permanent basis.

Continued on page 16

PARK SCIENCE

Integrating Research and Resource Management

Volume 18 – No. 1 • July 1998

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

Director
Robert Stanton

Associate Director, Natural Resource Stewardship & Science
Michael Soukup

Editor
Jeff Selleck

Editorial Board

Chair
Ron Hiebert
Assistant Regional Director for Natural Resources
Midwest Region

Members
Gary E. Davis
Senior Scientist and Marine Biologist
Channel Islands National Park

John Dennis
Biologist
Natural Systems Management Office

Vacant
Superintendent

Elizabeth Johnson
Chief, Research and Resource Planning
Delaware Water Gap National Recreation Area

Regional liaisons for natural resource stewardship and science

Alaska • Judy Gottlieb
Intermountain • Dan Huff
Midwest • Ron Hiebert
National Capital • Bill Anderson
Northeast • Bob McIntosh
Southeast • Suzette Kimball
Pacific-West • Jim Shevock

Park Science (ISSN-0735-9462) is a science 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 refereed peer review. *Park Science* is also available online (ISSN-1090-9966) at *www.nature.nps.gov/nrid/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. Make check payable to National Park Service and send to the editor.

The editor encourages submissions from all readers and would especially like to stimulate resource managers to write for the Highlights column. Please refer to guidelines published in volume **16(3):**5-6 and online, 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
E-mail: *jeff_selleck@nps.gov*

Printed on recycled paper

Contents

Departments

Features

In the next issue...

Graduate student Paul Lachapelle describes an experiment to test solar energy as a way to treat human waste from backcountry composting toilets. Also look for reports on tumors in gizzard shad at Chickasaw National Recreation Area (Oklahoma), a real-time air quality data display at Great Smoky Mountains National Park (Tennessee and North Carolina), and exploring the carrying capacity issue on the carriage roads of Acadia National Park (Maine).

The human dimension

Social science studies are the focus of two articles in this issue. An important management tool, social science can provide answers not only to questions about the basic kinds of activities that visitors engage in, but also about their motivations, level of satisfaction, and attitudes related to their park experience. However, as our cover story indicates, this information is not commonly available to park managers. Clearly, we need to be asking more of these kinds of questions, which is what Rocky Mountain National Park and the U.S. Geological Survey have done in their study on the attitudes of backpackers and day users in the park, our second social science report. Both stories are reminders that park management is as much about managing people as it is about managing natural and cultural resources.

Another facet of the human dimension in park management is the quality of leadership within our own ranks. In an interview, our first, Lake Mead National Recreation Area Superintendent Alan O'Neill discusses his success in building a top resource management program at the park during the last decade. His talents as a manager are inspirational and his methods for redirecting a park's energies toward resource preservation and gaining support for increased resource management program funding are insightful.

Editorial board openings

Park Science needs to fill several vacancies on its editorial board. The superintendent slot, formerly occupied by Wrangell-St. Elias Superintendent Jonathan Jarvis, is now open. (Thanks, Jon, for your keen insights and experienced views). Also, the editorial board has decided to add two new positions to its ranks to help round out the expertise available to the editor. The new slots are for a social scientist and a natural resource interpreter. Terms are six years in length except for the superintendent term, which is three years. Terms are staggered to offer continuity. To fit in with the current staggered rotation, the superintendent will serve for three years, the social scientist six years, and the interpreter four years. New terms begin in January 1999.

Responsibilities

With a purpose of furthering the application of research in park management, *Park Science* relies on the expertise of its editorial board members to provide guidance on the technical content and general management of the publication. The primary responsibility of board members is to review articles submitted for publication and provide feedback on the general soundness of the research methods and findings. They also evaluate the implications of the research for park planning and management, ensuring the relevance of articles. Board members suggest topics for articles and thematic issues, contribute materials, and help funnel Highlights and other appropriate stories to the editor. They are also available for consultation in matters related to the routine management of the publication (e.g., planning, circulation, funding). Time commitment varies, but usually does not exceed 16-24 hours per year. Board meetings are usually conducted annually by phone and every other year at a gathering convenient to all (e.g., the George Wright Society conference). Routine business is conducted by e-mail and phone.

Eligibility

The superintendent who will serve on this editorial board must have a good understanding of the role of science in park management. The social scientist must be able to relate social science research to managing people and parks. The resource interpreter must be familiar with environmental education and outreach techniques to help improve the educational value of the information presented.

Nominations

Nominations for the superintendent, social scientist, and resource interpreter board positions are now being accepted by the *Park Science* editorial board chair. Please submit a brief (one to two paragraph) statement on your interest in serving on the editorial board, for which slot, and the skills you offer the group. Nominations are due August 15. Please forward them to Ron Hiebert; Associate Regional Director for Natural Resources; Midwest Region; 1709 Jackson Street; Omaha, Nebraska 68102; 402-221-4856; e-mail: *ron_hiebert@nps.gov*.

• • •

Year-in-Review articles needed

The second annual *Natural Resource Year in Review* was recently circulated to parks, partners, environmental organization, and academic institutions. A comprehensive summary of the year's most significant trends and issues, the *Year in Review* is intended to increase interest in, understanding of, and support for natural resource management in the national park system. Although 1998 is only a little more than half way past, it is time to begin planning the next edition!

The 1998 calendar year report will present a balanced selection of the year's major issues and trends, sharing both national and park stories. Our task is to select the most compelling stories that help us explain our role and responsibility in preserving park natural resources. Most important is the analysis of issues and trends, explaining what they mean for natural resource management in the National Park Service.

Organization

Organization of the report will grow out of the materials submitted; however, the following categories may help potential authors envision the kinds of stories being sought:

1. Threats (the complexity and diversity of threats to natural resources);
2. Meeting Demands (initiatives and staffing and funding issues);
3. Resource Knowledge (gathering information on resources and their condition);
4. Planning and Preservation (the role of planning in natural resource preservation)
5. Working Together (the indispensable nature of partnerships);
6. Restoration (ecological restoration);
7. Legislation, Policy, and Legal Challenges;
8. New Horizons (the demand for innovation in attacking problems);
9. People and Preservation (the vital role of a professional staff in resource preservation);
10. Dealing with Dilemmas (controversial or complex natural resource management problems and evolving solutions).

Call for article proposals

The editor is now soliciting article proposals for the 1998 *Year in Review* and would like to encourage broad participation. Please review the major trends and resource issues your park and the agency faced during 1998 as potential stories for the report. If you would like to propose an article, please provide a one-paragraph (50-100 word) synopsis of the story. Clearly relate the proposed story to calendar year 1998. Identify trends and analyze how the issue demonstrates local, regional, or national significance. What typified 1998? Where did the NPS gain or lose ground? Give a larger meaning to the story if possible.

Deadline

Please submit proposals by e-mail to *Park Science* editor *jeff_selleck@nps.gov* by August 30. If your proposal is selected, you will be contacted to develop the story into a feature (~450 words) for an October 30 deadline. Proposals not selected for articles may be used as factoids or as Highlights in *Park Science*. PS

ALASKA

Harbor seal decline studied in Kenai Fjords

Marine wildlife including harbor seals *(Phoca vitulina)* are major visitor attractions in the productive, deep-water fjords adjacent to Kenai Fjords National Park (Alaska). Numerous tour boats bring hundreds of visitors to these waters daily to view seals hauled out on ice calved from tidewater glaciers. However, disturbing declines in harbor seal populations prompted park resource staff to study impacts to the population. In 1980, more than 1,600 seals were counted at the head of Aialik Bay, yet fewer than 300 seals have been counted annually in the same waters since 1989. One ongoing study documents the relationship between an approaching vessel and a seal's behavior to avoid the disturbance. Results may aid the park in developing and recommending guidelines for vessels approaching seals.

This issue is further complicated by park legislation mandating that the Park Service actively protect seals and haulouts in marine waters outside the park. To comply with the mandate, the park initiated a cooperative, multiagency study in 1997 to identify factors contributing to the continuing population decline. Park resource managers and biologists from the National Marine Mammal Laboratory (Seattle, Washington) collaborated for the first-ever live-capture of harbor seals that use floating glacier ice as a primary haulout. The multiagency team includes biologists from the Alaska Department of Fish and Game, University of Alaska–Fairbanks Institute of Marine Science, and a visiting Russian scientist. The team used a floating "gill net" to capture the seals. After each seal was safely lifted onboard the boat, its condition was determined and vital statistics, including sex and weight, were recorded. Blood and tissue samples were obtained from each animal and a small radio transmitter was attached to its rear flipper. The radio transmitter will provide critical information on harbor seal migration, habitat use, and haulout patterns. The new capture method is being used again this year by park staff and National Marine Fisheries Service researchers. The research team is working to develop an understanding of harbor seal population dynamics, declines, and effects of human-induced disturbance in waters adjacent to the park.

SOUTHWEST

Low lake levels spawn archeological discoveries at Amistad

Following five years of regional drought in southwest Texas and northern Mexico, lake levels at Amistad National Recreation Area plunged to historic lows–more than 55 feet below normal levels. Archeological surveys conducted by park archeologist Joe Labadie and six SCA/AmeriCorps members in draw-down areas have identified over 110 previously undocumented archeological sites that date from about 6,000 B.C. to about A.D. 1500.

Most sites consist of fire-cracked rock features and range in size from several small hearths to sites that cover more than 5 acres with more than 140 hearths and burned-rock middens. Initial studies have demonstrated that, in many cases, archeological deposits within previously inundated fire-cracked rock features have been replaced by modern lake deposits associated with wave action even though the features look (morphologically) to be intact.

The initial hypothesis is that an optimum ground slope seems to exist where wave-action effects are negligible; above or below this angle wave action is intensified, producing predictable dispersal patterns across the site. Typically, archeological sites with ground slope angles above 10 degrees will have a series of individual cut-banks often resembling stair-steps. Sites with low ground-slope angles (>3 degrees) will exhibit a parallel series of drift lines (similar to high tide lines at an ocean beach) consisting of chert flakes, artifacts, and small fraction fire-cracked rocks. In such settings, horizontal relationships among artifacts or feature-specific lithic associations are tenuous given the number of times most archeological sites have been subjected to the repeated cycle of inundation, exposure, and reinundation.

• • •

Rare pronghorn behavior photographed at Organ Pipe

Resource Managers at Organ Pipe Cactus National Monument (Arizona) recently documented the use of open-water pools by the endangered Sonoran pronghorn *(Antilocapra americana sonoriense)*. As part of an NRPP (Natural Resources Preservation Program) project, resource managers placed infrared-triggered Trailmaster camera systems at selected water sources and travel corridors in the park to determine use of these features by pronghorn.

Use of freestanding water by the Sonoran pronghorn is the subject of continuing scientific and management debate. Before this project, the only confirmed use of freestanding water by the subspecies was from a photograph of a pronghorn drinking at a muddy bomb crater on the Barry M. Goldwater Bombing Range, northwest of the monument. Last summer, Organ Pipe Wildlife Biologist Tim Tibbitts and Biological Technician Lara Dickson secured several photographs of Sonoran pronghorn drinking from natural bedrock pools (tinajas) in the Bates Mountains.

Still unknown is how frequently, or under what conditions, Sonoran pronghorn will use freestanding water. Research by Lisa Fox (University of Arizona, Tucson) suggests the forage plants constituting the diet of the pronghorn may meet its water requirements. A previous Trailmaster camera study on neighboring Cabeza Prieta National Wildlife Refuge by Tricia Cutler (University of Arizona, Tucson) failed to document the animal using an artificial water catchment that had been constructed specifically for its use.

The events photographed in Organ Pipe came during a prolonged drought, when animals might have been particularly in need of water. The tinajas used by the pronghorn had received water from the first, meager rains of the summer thunderstorm season. After more extensive rains,

the pronghorn apparently did not revisit this water source, or any others where cameras were stationed. Photographs of a mountain lion visiting the Bates Mountains tinajas the day before the pronghorn suggest that this rare water resource also provides a dependable ambush site for predators. Sonoran pronghorn, and other wildlife, indulge their thirst at some risk

GREAT PLAINS

Disease documented in Badlands sheep

Between 1991 and 1995 research on the Rocky Mountain bighorn sheep population in Badlands National Park (South Dakota) resulted in a decision to restore sheep to areas of unoccupied, suitable habitat. In October 1996, the park translocated twelve ewes and four young rams from the park's Pinnacles herd. All of these sheep survived the transplant and subsequent harsh winter. Three of the four young rams returned to bachelor groups in their origin herd during the spring. By the end of May 1997, nine ewes had given birth to ten lambs. However, between mid-July of last year and mid-March of this year, six of the mother ewes and one spinster ewe died. One of four carcasses recovered was positively diagnosed for epizootic hemorrhagic disease (EHD), a virus more often associated with white-tailed deer. Infected gnats carry the disease.

The Pinnacles herd had been thought to be an appropriate source population; however, following the translocation, the park noted a change of status in the source herd. A ground and air count in October 1997 revealed a skewed ewe-to-ram ratio of about 1:3. While the overall population decline in the source herd may be as much as 50%, no causative factors for the attrition have been found. The USGS Biological Resources Division and the National Park Service continue to evaluate the habitat model and monitor both the translocated and source sheep populations. Plans tentatively call for a translocation of out-of-state animals to found another subband. This is in keeping with the restoration plan to create a metapopulation linking several herds in the Badlands landscape, or, if deemed biologically appropriate, to augment the present population during the next two years.

COLORADO PLATEAU

Grant funds endangered plant monitoring

A 1997 grant from the National Fish and Wildlife Foundation's Native Plant Conservation Initiative allowed botanists to monitor the federally endangered sentry milk-vetch *(Astragalus cremnophylax var. cremnophylax)* and three of its varieties on public and Navajo Nation lands in Arizona. A member of the pea family, the sentry milk-vetch is a dwarf, evergreen, cushion plant that is confined to "ledge pavement," the rimrock habitat overlooking the South Rim of Grand Canyon National Park. In 1990, it was listed when surveys showed it to be declining following decades of trampling by park visitors who crossed the habitat to reach the canyon view. Three other closely related varieties are spatially distinct: (1) the cliff milk-vetch, a species of special concern, is located on Forest Service and Bureau of Land Management lands north of the park, (2) the Hevron milk-vetch is located on the Navajo Nation lands overlooking Marble Canyon, and (3) a newly discovered population, which may prove to be a new variety, is located on the North Rim of the Grand Canyon.

As a result of the grant, permanent monitoring plots have now been established at all four sites. Over 500 plants have been tagged using small, numbered, plastic pennants attached with stainless steel wires. Cartesian coordinates (x and y locations) along the transect have been documented to enable individual plants to be identified should the tags be broken, lost, or removed. Basal cover or size of the plant mats was determined by tracing the perimeter or outline of the plant on clear mylar. The tracing was cut out, weighed, and the area (in grams) determined by dividing the average weight of the mylar per unit area (yielding square centimeters)[1]. Substrate and associated species information was also collected in quarter-meter "Daubenmire" plots. Growth, reproduction, and mortality for each plant mat will be tracked in the coming decades. This demographic work will complement genetic research on the species; the species is threatened by inbreeding depression.

The three varieties of the sentry milk-vetch will be included along with 150 other plants in a *Rare Plants of Arizona* fieldguide currently being coordinated by The Nature Conservancy with the cooperative effort of over 25 botanists throughout the state. This effort is also being funded by a grant for the 1998 National Fish and Wildlife Foundation's Native Plant Conservation Initiative.

[1]For additional information on the methodology, see the 1996 paper "A perimeter tracing method for estimating basal cover: Monitoring the endangered sentry milk-vetch at Grand Canyon National Park, Arizona" by Peter G. Rowlands and Nancy J. Brian. The Southwest Naturalist **41**(2):169-178.

GREAT LAKES

Piping Plovers nest at Apostle Islands

After a fifteen year hiatus, the federally endangered Piping Plover has once again nested on Long Island within Apostle Islands National Lakeshore. The lakeshore, consisting of 21 islands and a mainland unit surrounded by Lake Superior in far northwestern Wisconsin, was established in 1970. In 1986, Long Island (now a barrier spit) was added to the lakeshore, in large part to protect nesting Piping Plover habitat. Despite this action, the bird species had not nested in the lakeshore since 1983–that is, until this year.

For years, lakeshore staff and cooperators have been on the lookout for the bird on Long Island in the spring. During migration, they are occasionally seen, but nesting was not occurring. However, in 1998, Sumner Matteson, a Wisconsin Department of Natural Resources (DNR) avian biologist, saw a pair of Piping Plovers exhibiting courtship behavior. A scrape was later found with four eggs. To protect the nest from mammal and avian predators, an exclosure was placed over the nest. It worked–three eggs have successfully hatched.

Protection of these birds has truly been a cooperative effort. Involved are park staff, the Bad River Tribe, the DNR, the U.S. Fish and Wildlife Service, researchers from the University of Minnesota, and The Nature Conservancy. This nest is indeed important, not just for the lakeshore, tribe, and cooperators, but also for the Great Lakes Piping Plover population. Although over 800 pairs nested throughout the Great Lakes historically, no more than 20 pairs have done so in the last 15 years. PS

New Zealand experiments with island sanctuaries

The adverse effects of nonnative plants and animals are universal problems in the preservation of native fauna, flora, and biological diversity of native species. In many places worldwide, introduced predators dominate, and the continued existence of native species, if not endangered or already absent, is threatened. Comprehensive eradication of exotic species is frequently not possible. In its efforts to save local endangered species, the New Zealand government secures offshore islands as protected sanctuaries (Pryde, P.R. 1997. Natural Areas Journal **17(3):**248-254). Selected small offshore islands are comprehensively cleared of introduced mammals and, if necessary, revegetated. Declining and endangered native species, particularly endemics, are then released. Initial results on one of three islands, Tiritiri Matangi, are encouraging.

Sheep that had been grazing for almost 100 years had largely denuded this island of vegetation. Rehabilitation of the island began in 1970 with the removal of the Polynesian rat *(Rattus exulans),* which took five years. Between 1984 and 1994, thousands of volunteers revegetated the island with more than 200,000 native trees. Then native bird species, including endangered and even almost extinct species, were reintroduced. The introductions have been so successful that some birds are now relocated to other rehabilitated islands. A rail system on Tiritiri permits visitors to view the relocated species. Other offshore islands are used for the establishment of other types of endemic species such as plants, amphibians, and reptiles.

The creation of island sanctuaries, however, is not without problems and does not guarantee the preservation of species. The maintenance of the islands is labor intensive and costly; the native species are vulnerable to destruction from random events; and migratory species that breed on the island sanctuaries of New Zealand may be threatened elsewhere.

• • •

Culvert design important to vertebrates

Roads and railway tracks are among the main obstacles to movement by land vertebrates. The consequences may be a reduction of genetic diversity from increased inbreeding, risk of local extinction because of population dynamics and catastrophic events, and decreased recolonization. In central Spain, analyses of movements by vertebrates through 17 culverts under roads and railways during one annual cycle revealed that adequately designed culverts aid the conservation of vertebrate populations and can eliminate costly construction of special passages for fauna. Most crossings were by small mammals (77%). The crossings of mammals, including carnivores, did not differ by season, but the number of crossings by reptiles was greater in summer than in other seasons and seemed to depend on animal abundance.

Detritus pits impaired the passage by reptiles. Rabbits and carnivores did not use culverts with detritus pits. The number of crossings by small mammals was lower when roads were surrounded by pasture. The crossing of medium-size mammals (rabbits and carnivores) was affected by the total width of the road and not by the width of the portion of the road used by traffic. The height of boundary fences may prevent access to culverts by some animals. The authors (Yanes, M., J.M. Velasco, and F. Suarez. 1994. Permeability of roads and railways to vertebrates: the importance of culverts. Biological Conservation **71:**217-222) recommend that fences be constructed to funnel animals toward culverts but not impede access to them and to eliminate detritus pits or modify them with ramps. Further study of culvert design that eases passage by animals is necessary.

• • •

Buffer zones for nesting eagles researched

Like humankind, wildlife responds psychologically to disturbances before responding behaviorally. Yet, the dimensions of spatial buffer zones to protect wildlife from disturbances–for example, human activities in public parks–may not exceed distances at which wildlife responds with behavior (such as flight). Camp, Sinton, and Knight (1997. Wildlife Society Bulletin **25(3):**612-615) used a geographic information system (GIS) and a global positioning system (GPS) to develop spatial buffer zones that included the protection of the view or *viewshed* from six nests of the Golden Eagle in the Phantom Canyon Preserve, Colorado. The recommended buffer zone for a Golden Eagle nest when the birds are rearing young has a 333-meter radius. In the preserve, such buffer zones for the six nests would have encompassed 145 hectares (358 acres). The additional protection of the viewsheds extended the area of the collective buffer zones to 434 ha (1,072 acres). By creating viewsheds for sensitive species–for example, with vegetation that blocks a species' view of disturbances–natural resource managers may improve the regulation of visitors with trails, access to panoramic views, and tours. A viewshed database with information about the distribution of wildlife can be helpful with the evaluation of effects on wildlife from proposed activities for visitors of a park or preserve.

• • •

Small parks significant for biodiversity

Authors M.B. Falkner and T.J. Stohlgren (1997. Evaluating the contribution of small national park areas to regional biodiversity. Natural Areas Journal **17(4):**324-330) collected information on species richness of vascular plants, mammals, and birds in 44 national park system units in the former NPS Rocky Mountain Region. The data revealed that because of species composition differences among units, small units add a considerable number of species to regional species lists. An estimated average of 718 species of plants, birds, and mammals inhabit a 100-km^2 (39-mi^2) reserve and includes 84 species unique to the system. If the same amount of land were added to existing units, this would add only 35 species to a large, seven to a medium, and one to a small reserve. Most small parks in the region were initially established

as cultural or historical sites. The authors' study, however, revealed the significance of the smaller units as biological refugia, dispersal corridors, and migration corridors or rest stops. Small units have a disproportionate share of regional biodiversity and an understated role in the conservation of biodiversity in the region.

• • •

A rationale for large ecological reserves

Biological diversity must be protected at genetic, population, and landscape scales, and such protection requires an integrated system of large nature reserves and ecosystem management according to Edward Grumbine (1990. Protecting biological diversity through the greater ecosystem concept. Natural Areas Journal **10(3):** 114-120). Merely protecting species fails to capture important elements of biological diversity such as ecosystem patterns and processes. The current network of nature reserves will not protect many species for more than 50 years. A large nature reserve must provide the primary habitat for all native species in the area. It must be sufficiently large to accommodate natural disturbance regimes, and its human occupants and human use must not result in ecological degradation. The reserves will have to be monitored to determine whether management is indeed protecting biological diversity. Preservation of biological diversity with ecosystem management requires consistency and coordination of policy, administration, and techniques.

Ecosystem management presents biological, legal, educational, cultural, and economical problems that will have to be resolved. As yet however, the science for protecting biological diversity is still in its infancy. Citizens of industrial countries are only marginally informed about the magnitude of ecology in the lives of people. Governmental agencies employ few conservation biologists. Managers, politicians, and many citizens do not favor the establishment of large nature reserves and revenues for their maintenance and management. Divergent land management by the USDA Forest Service and the National Park Service must be resolved. Federal agencies must support legislative reform for the protection of biodiversity. An endangered ecosystems act is needed. The public must be educated and persuaded to become party to decisions that bear on the long-term protection of biological diversity. Equal weight cannot be given to all interest groups because many would destroy biological diversity for short-term economic gain. Time to implement the preservation of biological diversity is short.

• • •

Sources of water pollution traced at Buffalo Nat'l River

Water quality monitoring by the National Park Service has shown that Mill Creek contributes 96 percent of the nitrate/nitrite-nitrogen load to the Buffalo River. Analysis of the macroinvertebrate community within the creek demonstrated that this nitrate load detrimentally affects the benthic biota. Consequently, the Park Service, Arkansas Department of Pollution Control and Ecology, U.S. Geological Survey, and Ozark Underground Laboratory launched a series of water resource investigations to learn more about the sources of the pollution. A synoptic survey revealed that nitrate and orthophosphate concentrations continually rise from the mouth of Mill Creek to the Dogpatch springs at its head. Two qualitative dye traces confirmed interbasin transfer of groundwater from the Crooked Creek basin to the springs at Dogpatch. In both traces, fluorescein dye moved over 2.5 miles from injection to recovery point in less than five days.

These preliminary findings justified more detailed studies to determine not only the recharge area for the Dogpatch springs, but also the causal mechanism driving the interbasin transfer. New detailed geologic mapping reveals that the 120-m-thick cherty limestone of the Mississippian Boone Formation is the main host of karst features and the dominant aquifer. This region was mildly deformed, probably during the Pennsylvanian time, by a system of normal and strike-slip faults and associated monoclines that vertically offset the strata from 15 to 120 m. These structures influence the hydrogeology of the Boone Formation by changing its elevation and hydraulic properties. Several large springs in the Buffalo River watershed are spatially associated with structural troughs in the Boone Formation, suggesting that these troughs preferentially drain water from adjoining regions. The Dogpatch springs lie at the head of a 30- to 45-m deep, keel-shaped trough cored by the northeast-striking, right-lateral Elmwood fault zone. The interbasin flow coincides with the area where the trough crosses the watershed boundary. Conceptually, this fault-cored trough gathers recharge from its limbs within the Crooked Creek watershed and allows it to flow southwest across the watershed boundary in a network of solutionally enlarged fractures that envelope the Elmwood fault zone. The exit of groundwater at the Dogpatch springs coincides with a corner-shaped upstep of the Boone caused by intersection of the Elmwood fault zone with the east-striking Cutoff Road normal fault.

A second phase of the study includes quantitative dye tracings to delineate the interbasin recharge area and test the conceptual hydrgeologic model. Chemical analyses are also being conducted at spring and stream sites in an attempt to correlate land-use activities with water quality. Most of the water quality sampling and dye tracing should be completed this summer.

Coauthors of a paper on the studies (David Mott of NPS and Mark Hudson of USGS) will present their findings at two upcoming conferences: (1) "Karst Processes and the Global Carbon Cycle," a collaborative meeting between Mammoth Cave National Park and Western Kentucky University from September 23-25; and (2) "Gambling with Groundwater," a conference sponsored by the International Association of Hydrogeologists in Las Vegas, Nevada from September 27-October 2. Web sites providing additional information on the conferences are located at *http://www2.wku.edu/~grovecg/* and *http://www.uark.edu/depts/geology/faculty/jvbrahana/iah/index.html, respectively.* PS

Vital Signs conference focuses NPS sights on "perpetuity"

By Jean Matthews

A stereoscopic vision of "in perpetuity" (part of the NPS organic mission) began to emerge at the April 1998 Vital Signs conference in Portland, Oregon, attended by more than 150 Pacific-West Region National Park Service people from all walks of the Service. The conference subtitle, "Assessing natural and cultural park resources," encouraged the crossing of discipline and job description boundaries and invited melding of a fragmented mission.

The week-long conference (April 6-10) aimed at a synergistic stewardship to match the awesome synergy of the ecosystems at risk. The presentations, posters, and workshops produced an ecology of effort from experienced workers in the fields of research, maintenance, museums, law enforcement, and superintendency, who discovered a deeper appreciation for the totality of the job that, together, they are doing.

Evaluation of the conference, as revealed in participant ratings, focused heavily on information-sharing and networking as the highest values received. While time overruns came in for the usual share of gripes, the consensus was overwhelmingly positive. Typical comments included:

- "Organized well–especially [good] integration of disciplines;"
- "The best speakers overall for any conference I've attended;"
- "A great experience and a chance to show others what I do;"
- "Networking is always excellent;"
- "It was a great information sharing session;" and
- "A wonderful opportunity to network and share information. Please keep these up."

Figure 1. Vital Signs can mean many things in many different places. Here at Fort Vancouver National Historic Site in Vancouver, Washington, (destination of one of the conference field trips), being alert to vital signs that signal overall condition of a cultural treasure includes a periodic check for decay at the base of the fort's palisades wall. The palisades are cultural, but the decay agents are natural, so vital signs can overlap and bring together the cultural and natural elements of park management.

Field trips (to Mt. St. Helens and to Fort Vancouver National Historic Site [figures 1, 2, and 3]) received rave reviews. So did Richard Sellars' conference keynote (based on his recent book, *Preserving Nature in the National Parks: A History,* reviewed by Gary Davis in the last issue of *Park Science,* **17(2):**1,8). Numerous other sessions were also very popular and included: Kathy Jope's grant writing workshop; the non-NPS speakers on relevant topics; information on related projects such as the Northwest Forest Plan; the poster sessions; the integrated approaches to NPS land management problems; and several of the plenary session addresses, notably those by Mike Soukup (Associate Director, Natural Resource Stewardship and Science) and John Reynolds (Pacific-West Regional Director).

The natural resources stewardship mission was described by Gary Davis (Senior Scientist at Channel Islands National Park, California) as conservation of healthy, unimpaired parks, and fixing the fragmented parks that are no longer parts of the larger ecosystems from which they were carved. The objective of the stewardship structure (field operations, applied science, and research) consists of knowing, restoring, maintaining, and protecting, Davis said. "Vital signs," he said, "are reliable early warning signals by which we can measure and detect changes that will impair the structure and functions of ecosystems. Networking with others who are similarly engaged can help us pinpoint and sharpen our predictions."

Stephanie Toothman, Cultural Resources Team Leader for the Columbia-Cascades Support Office, observed that management of cultural resources–a record of human interaction with the environment–parallels that of natural resources. Its disciplines–ethnology, archeology, museum curation, architecture, cultural landscapes, and history–likewise involve research, inventory, and management.

Richard Sellars, conference keynoter, identified the culture of the National Park Service itself as the largest impediment to a scientific natural resources program. As in his book, Sellars made a strong plea for

recognition at the NPS director level that "resources preservation is our Service's primary mission and thus should be the primary profession in the Service."

Landscape architecture was the key to the management strategy in the beginning, he said. Preservation was aimed at aesthetics rather than system structure and function. Thus, fire suppression, fish stocking, tourist infrastructure, removal of predators, and road building, all were well established as the primary park mission by the turn of the last century; development and recreation were the early objectives.

Interior Secretary Franklin Lane's decision to borrow science from other agencies rather than installing it as a part of the Park Service contributed to the perception of biologists by the NPS hierarchy as threats to the NPS power structure.

Pacific-West Regional Director Reynolds told the assembled conferees, "I am a strong advocate of full funding and of strengthening the ties between resource stewardship and superintendency. We must implement our full professional grades to protect our functioning resource bases."

He acknowledged the current "atmosphere of need" for better resource protection, and added, "We're the ones who can, and should, be doing that job." And he is committed to getting the money to do it, he said. Parks are threatened by insularity and habitat fragmentation. "We still don't know what we have, but we know enough to know where we need to go. We need natural and cultural resources integration, and we would do well to begin simply by obeying the laws already in existence."

One "small beginning," Reynolds said, "will be to change the standards for superintendent performance. There is no single standard today for resource preservation. I promise you that will change," he told the applauding conferees.

He advised the assemblage to "read every page of Sellars' book. We need to think about it," he said. "It will help us understand why we are the way we are, and that will help us to see what we should be and how to get there."

"One of the main funding difficulties," he said, "is that we've trained Congress to believe that we are something that we don't really want to be." He sees a need for a better science delivery system, and tie-ins with countless other potential allies. "A river running through a park gives us access to people along the river all the way to the ocean," he said. There are opportunities for partnerships with business, with other governmental agencies, and with nongovernmental organizations.

"Sell them, educate them, and incorporate them," he said. "Our ranks need to be as diverse as our nation. Diversity is not just about race and profession, it's about ideas, and our highest idea is excellence. We are protecting the excellence that is our country.… We represent the ideal of this nation."

NPS Director Bob Stanton's plan is excellent and complete," Reynolds said; "now how do we sell it to Congress?" This was the question he left with the conference.

He made it clear that his own plan for achieving it rests on excellent research, improved science delivery systems, incorporation of resource management into NPS career ladders that go clear to the top, the education of public and private entities as to their stake in excellence, and the echoing of this developing sentiment in the halls of Congress.

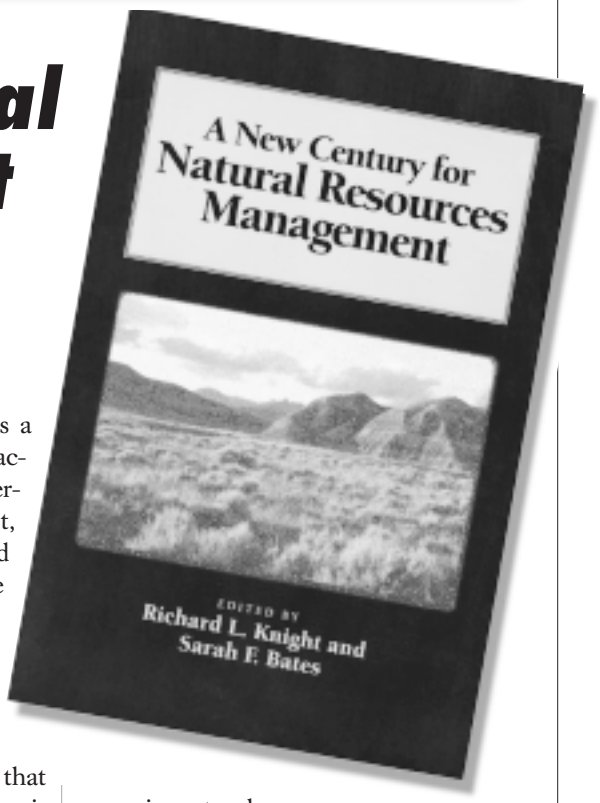
A full conference report, complete with specific recommendations from all five break-out sessions (geographic information systems; fire management and planning; cultural inventory and monitoring; natural inventory and monitoring; research: history, natural and otherwise: and resource treatment and protection), was planned for distribution throughout Pacific-West Region in June. Copies may be had from conference chair Jonathan Bayless at 600 Harrison St., Suite 600, San Francisco, California 94107; (415) 427-1427; FAX (415) 744-4043; e-mail: *jonathan_bayless@nps.gov.* PS

Jean Matthews is the founder and former editor of Park Science. *She is retired and lives in Vancouver, Washington.*

Figure 2 (above). Apple trees are another cultural resource at Fort Vancouver whose upkeep requires intervention by natural resource managers. To reduce spoilage of the fruit by apple maggots, resource managers place traps resembling apples (figure 3, above right) in the trees to control the insect. The look of the trap attracts the insect; no chemical attractant is needed. In this cultural park, fruit from the apple trees is used in interpretive demonstrations of the fort's historic period and enjoyed by the public.

A New Century for Natural Resources Management

Edited by Richard L. Knight and Sarah F. Bates



A book review by Craig L. Shafer

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. The 1995 Island Press book *A New Century for Natural Resources Management,* edited by Richard L. Knight and Sarah F. Bates, suffers from none of this. Good planning and meticulous editing resulted in a logical progression of short, interesting, easy-to-read reviews and essays by diverse topic authorities. This book ought to attract a very wide readership that includes researchers, natural resource management specialists, land managers and planners, policy makers, legislators, environmentalists, and students.

The book's theme–that the way agencies view natural resource management must continue to diverge from the utilitarian tradition of the 19th century–is timely. The twenty-one chapter volume illustrates that views and practices in natural resource management are always changing; for these authors, change is too slow because of the challenges natural resource agencies will face after the millennium. Organized in three sections, the book traces the history and conflicts related to natural resource management before emphasizing new approaches for the future.

The first six chapters focus on U.S. history. **Chapter 1** by Curt Meine is a well-documented account that intermeshes the emergence of forestry, agriculture, range-wildlife-fisheries management, recreation and wilderness with the establishment of the early federal agencies and the influence of Gifford Pinchot, John Muir, and Aldo Leopold. Meine demonstrates that the resource concept (e.g., forests, wildlife) arose first; agencies then formed around such concepts, and the academic natural resource disciplines came later.

Chapter 2 by Robert H. Nelson is a longer analysis of the creation, early activities, and responsibilities of Forest Service, Bureau of Land Management, National Park Service, and U.S. Fish and Wildlife Service. Nelson believes the agencies started out with the progressive era ideal of "scientific" management, and even though their actions quickly became politicized, the ideal still shapes thinking today. The author argues that the outdated belief that economic progress is inevitable with science guiding resource management should be replaced by a more "values-oriented" model.

Stan H. Anderson's **Chapter 3** focuses on the concept of "sustained yield" as practiced in forestry, range, wildlife, and fisheries management. Perhaps deliberately, the author avoids dealing with the controversial concept of "sustainability."

In **Chapter 4,** Dale Heine analyzes the history of American natural resources education. He observes that both the western "ranger factories" and the midwestern and eastern schools prepared students for jobs with other professionals, all with similar backgrounds and speaking the same jargon. This type of education, perhaps indoctrination, he argues, was found at universities claiming to be sanctuaries for independent thinking. Government employment standards, professional association certification requirements, and special interest groups shaped these academic requirements. The traditional B.S.-B.A. requirements of the 1960s represent the formal educational background of many of today's senior land managers. But today, "many new students soon foresee their education as too prescribed, management-production focused, too narrow, and impersonal," causing them to drop out. Although 4,000 university degrees in natural resources are awarded annually, the author implies that many students will not be prepared for the next century, especially as leaders in policy development.

Chapter 5 by Gloria E. Helfand and Peter Berck reviews "traditional" concepts in natural resource economics. Non-economists will find it uncommonly user-friendly. They argue that environmental degradation results when policies violate basic economic principles like when the Forest Service sells timber on public land below cost.

Next, in **Chapter 6,** Eric Katz traces the evolution of natural resource ethics. The author examines in detail the highly influential views of John Locke, the famous 17th century philosopher, who thought that nature had value only when used as "property." Locke's views have been used to undermine environmental legislation (Duncan 1996). The author might have given more emphasis to how Locke's work has been interpreted to support conservation. Some claim it argues for restrictions on private land use if counter to the public good (Shrader-Frechette and McCoy 1993). Locke influenced thinking of that age.

The second section of the book focuses on conflicts. Relying on his uncommon insight, David W. Orr's essay in **Chapter 7** is about a "sense of place." Orr begins by giv-

ing a personal account of growing up in small-town western Pennsylvania. He explains, "we no longer have a deep sense of place." His honesty in writing about the economics of place is persuasive. "The disorder of ecosystems reflects a prior disorder of mind, values, and thought that…put humanity outside its ecological context…. People need healthy food, shelter, clothing…a vital civic culture…and wildness. But they are increasingly offered fantasy for reality, junk for quality, convenience for self-reliance, consumption for community, and stuff rather than spirit. Business spends $120 billion a year to convince us that this is good…. Our economy has not…fostered largeness of heart or spirit…. And it is not ecologically sustainable." Orr's basic message is profound: people will take more responsibility for their environment when they sense being part of a human community, a feeling being rapidly lost in the United States.

Chapter 8, by Mark W. Brunson and James J. Kennedy, discusses dominant use practiced by the Forest Service, National Park Service, the Bureau of Land Management, and the Fish and Wildlife Service, why social values changed, and how land management agencies responded. In later decades, our technically trained land managers found themselves unprepared for the jobs they landed and were surprised at the skills required. Examples include public relations, negotiating, writing for the public, skills usually advocated for lawyers, legislators, or journalists. In addition, land managers after mid-century encountered new stresses: living with locals in rural western small towns, new laws giving one agency power over another's actions, and employees calling for new paradigms.

The latter meshes with Jeff DeBonis' **Chapter 9**, which shares his experience as a new Forest Service employee and his subsequent disillusionment with their practice of overcutting timber. While there, he formed the Association for Forest Service Employees for Environmental Responsibility (AFSEEE). In 1993, he left that organization to form Public Employees for Environmental Responsibility (PEER). There, disillusioned public employees found a sanctuary of like-minded people and a vehicle to lobby for their points of view. Today, PEER has 10,000 paying members and Jeff has moved on.

Next, in **Chapter 10,** Winifred B. Kessler and Hal Salwasser describe the creation of the 1990 Forest Service "New Perspectives" initiative, which they say led to the June 1992 adoption of an "ecological approach" in Forest Service management, a step towards "ecosystem management." However, all agencies have a long way to go before qualifying as acknowledged ecosystem management practitioners, at least based on some definitions (Grumbine 1994). The December 1995 Ecological Stewardship Workshop in Tucson, Arizona (*Park Science,* **16(2):**13-15) was former Forest Service Chief Jack Ward Thomas' pet initiative.

Chapter 11 provides Rupert Culter's thorough account of the role of environmental NGOs (nongovernmental organizations). Quoting John Rousch, we learn that only about 50 have budgets in the tens of million of dollars. The undisputed giant is the National Wildlife Federation, whose 5.3 million supporters allowed them to spend $97 million in just 1993. The author acknowledges tension between NGO amateurism and agency-industry professionalism but thinks the gap is closing rapidly. Recent analyses produced two primary NGO criticisms–lack of collaboration and little attention to the economic well-being of local people–but we learn nothing else about what NGOs are doing wrong. Since the book provides a large dose of agency criticism, such treatment is unbalanced.

In **Chapter 12,** Vawter Parker reviews the history of public interest lawyers taking agencies to court. For example, the Sierra Club instigated the famous 1969 "Mineral King" case. Although the Disney Corporation planned massive development on Forest Service land, the conflict finally ended when Congress added Mineral King to Sequoia National Park in 1978.

In **Chapter 13,** John B. Loomis documents that government cost-benefit analyses taking into account more than just "marketable goods" was not prominent until the 1960s and reviews techniques to value such "externalities."

Thomas Michael Powers' **Chapter 14** was very enlightening, though heavy in places for non-economists. The old "extractive" economic model may indeed be flawed, and Powers provides some easy-to-understand supportive examples. Relying on graphics, Powers illustrates that the old model predicted the economic demise of some small western communities after their resource extraction industries were curtailed. But this prediction never happened; some towns even became more prosperous than before! Powers lists economic trends that may account for this surprising result and then proposes an updated economic model–one placing far more emphasis on the degree people value environmental quality in their community and surrounding region. Threatened western rural communities reared on this old model could gain insight here or in the author's 1996 book.

A New Century for Natural Resources Management

1995 Island Press

432 pages
Tables, figures, index

Hardcover:
ISBN 1-55963-261-5
$55.00

Paperback:
ISBN 1-55963-262-3
$32.00

The book's third and final section emphasizes new approaches. **Chapter 15** by S.T.A. Pickett and R.S. Ostfeld is timely and analyzes a topic Pickett has addressed before (Pickett et al. 1992). The authors argue that the "classical" (or equilibrium) ecological paradigm has failed and should be replaced with their "flux of nature" paradigm. The authors say their flux model nullified the long-held "balance of nature" metaphor. As they point out, this reexamination has been ongoing for a long time. Scientists working for the Park Service in the 1970s questioned the notion of "steady

continued on page 12

continued from page 11

states." Botkin dealt the "balance" idea its biggest blow in 1990. Pickett and Ostfeld perceive some management strategies are driven by the classical model, including "nature knows best" hands-off management. Vestiges of such thinking can be seen at Yellowstone and elsewhere.

Next, R.L. Knight and T.L. George, in **Chapter 16**, contrast traditional biotic "resources management" disciplines with ideas subsumed under the new field of conservation biology, providing a brief sketch for those unfamiliar with its emergence. The authors do not recommend abandoning traditional natural resource management approaches but supplementing them with conservation biology's more holistic, landscape-process awareness.

In **Chapter 17**, Susan Jacobson provides her thoughts about producing better trained natural resource managers. Predictably, she believes a conservation biology or sustainable development perspective provides a better academic focus than the traditional resource disciplines. She recommends more disciplinary breadth, training in economics and social skills, etc., and legitimately questions whether universities can handle this need. This point is key. For future conservation biologists, Noss (1997) gave universities a scathing assessment, with some notable exceptions. Readers with land management experience may laugh at any suggestion that new resource managers can leave a university with all the knowledge and skills they will ever need. Only in this century, have universities tried to fill a need once reserved for practical experience, apprenticeships, and continued personal study. Jacobson's recommendations are sound, she is well acquainted with the literature (Jacobsen and McDuff 1998), but they lack some insight derived from personal work experience.

In **Chapter 18,** James J. Kennedy and Jack Ward Thomas propose a new model for managing natural resources–manage for social value instead of things! Readers might not reach this awareness on their own. The authors believe their model reflects what students actually encounter on the job, often to their great surprise. For NPS readers, "social conflict management" may sound familiar. The authors do not advocate a "consumer-is-always-right code." They do advocate honoring diverse values and participating in value evolution. Many agencies already do this through interpretation, public hearings and Congressional testimony, publications, videos, TV and radio interviews, etc.

Robert Costanza uses **Chapter 19** to review the new transdisciplinary, problem-focused field of "ecological economics," which he was instrumental in developing. He highlights some key ideas in his previous papers. The presentation is easy to follow.

In **Chapter 20,** Holmes Rolston offers his views on a global economic ethic. However, it is difficult to understand the real, tangible benefits of continual articulation of slightly improved versions of a nature ethic, at least for the book's intended audience. If most land managers understand Aldo Leopold's "land ethic" in the 1949 book *A Sand County Almanac,* they will not be far off course.

Edward Grumbine in **Chapter 21** begins with a Cascades backcountry bear story to highlight his disappointment that some critical population viability factors were not addressed by the Interagency Grizzly Bear Study Committee in 1990, or fixed in a 1992 document revision. The author says the private Greater Ecosystem Alliance did a much better job using similar data. This could be, because the viability determinants he highlights were highly significant. However, to attribute the two results to different organizational value systems (private sector versus government) is speculation. Grumbine has provided valuable technical guidance and insight in previous work (Grumbine 1992), but it unfortunately again gets intermixed with black-and-white essay generalizations driven by his frustration with agencies. The author repeats his five primary "ecosystem management" principles from his significant 1994 paper.

The book ends abruptly with a one-page synopsis. Although each section of the book begins with a useful synthesis, top officials in agencies and elsewhere are conditioned to look for "strategies." Because of this expectation, however difficult or even scientifically naive, the book should have ended by bringing more detailed focus to more of the dominant ideas presented in its many chapters.

A New Century for Natural Resources Management is refreshing for a multiauthored volume. Most chapters are very good and each should teach most readers something new. Unfortunately, those who most need its insights are unlikely to read it, e.g., agency heads, second-or third-level Washington or regional office agency lieutenants, some oversight-providing political appointees, the Congress, natural resource extraction industry officials, western small-town communities, land-rights activists, and some field managers with formal academic training from the 1960s or earlier who have been able to keep up. They should. PS

Craig L. Shafer (craig_shafer@nps.gov) *is an Ecologist with the NPS Natural Resource Stewardship and Science Directorate in Washington, D.C.*

References

Botkin, D. 1990. Discordant harmonies: A new ecology for the twenty-first century. Oxford University Press, New York.

Duncan, M. L. 1996. Property as a public conversation, not a Lockean soliloquy: A role for intellectual and legal history in takings analysis. Environmental Law **26:**1095-1160.

Grumbine, R. E. 1992. Ghost bears: Exploring the biodiversity crisis. Island Press, Washington, D.C.

Grumbine, R. E. 1994. What is ecosystem management? Conservation Biology **8:**27-38.

Jacobson, S., and M. D. McDuff. 1998. Training idiot savants: The lack of human dimensions in conservation biology. Conservation Biology **12:**263-267.

Noss, R. F. 1997. The failure of universities to produce conservation biologists. Conservation Biology **11:**1267-1269.

Pickett, S. T. A., V. T. Parker, and P. L. Fielder. 1992. The new paradigm in ecology: Implications for conservation biology above the species level. Pages 65-88 in P. L. Fielder and S. K. Jain, editors. Conservation Biology: The theory and practice of nature preservation and management. Chapman and Hall, New York.

Power, T. M. 1996. Lost Landscapes and Failed Economies. Island Press, Washington, D.C.

Shrader-Frechette, K. S. and E. D. McCoy. 1993. Method in ecology. Cambridge University Press, England.

Profile of the USGS National Wetlands Research Center

Figure 1. A wetlands ecologist from the National Wetlands Research Center measures soil elevations for baseline assessments at Big Thicket National Preserve, Texas. Known as a sedimentation-erosion table, the device depicted is used in conjunction with marker horizon techniques to measure accretion, erosion, and subsidence at wetland sites. Data are being collected to determine the sediment budget for the Neches River floodplain as part of a larger study of water quality.

By Daryl McGrath

Editor's Note: *This is the second profile to appear in* Park Science *of a research center operated by the USGS Biological Resources Division (see* ***15(3)****:12-13 for a profile of the Midcontinent Ecological Science Center in Fort Collins, Colorado). One of 17 science and technology centers nationwide, the National Wetlands Research Center is a valuable resource for NPS resource managers with research or technical assistance needs related to wetlands. The entire network of centers is profiled online at* http://biology.usgs.gov/pub_aff/centers.html.

If you have wetlands in your park and would like to know more about them, the National Wetlands Research Center (NWRC) in Lafayette, Louisiana, has an ecologist, geographer, or information specialist for you. The NWRC's mission is to develop and disseminate scientific information needed to understand the ecology and values of the nation's wetlands and to manage and restore wetland habitats and associated plant and animal communities. The 71,000-square-foot headquarters is located in the research park of the University of Southwestern Louisiana. The Center also maintains project offices in Gulf Breeze, Florida, Baton Rouge, Louisiana, and Nacogdoches, Texas. Although NWRC research is concentrated in the southeastern United States (the National Park Service administers nearly 50 units in the Atlantic and Gulf Coast clusters in the Southeast Region), the center currently has or previously has had projects or study sites in almost all 50 states, in addition to Mexico, Honduras, Guatemala, England, Italy, Germany, Finland, Micronesia, and Australia.

The NWRC is one of 17 science and technology centers of the U.S. Geological Survey's (USGS) Biological Resources Division (formerly the National Biological Service). The Center originated as the National Coastal Ecosystems Team in 1975 as part of the U.S. Fish and Wildlife Service's Office of Biological Services and was headquartered at NASA's Stennis Space Center near Bay St. Louis, Mississippi. The Team moved to Slidell, Louisiana, in 1979, and in 1986, it was given a research mission and renamed the National Wetlands Research Center. In 1992, NWRC moved its headquarters to Lafayette, and it became part of the National Biological Service (NBS) in 1993. In October 1996, NWRC joined the USGS when the NBS became the Biological Resources Division (BRD) of that agency.

The Biological Resources Division's mission is to work with others to provide the scientific understanding and technologies needed to support the sound management and conservation of the nation's biological resources. While it seeks to provide reliable scientific information for all American citizens, BRD recognizes a special obligation to serve the biological information needs of Department of the Interior bureaus, particularly the National Park Service and U.S. Fish and Wildlife Service. The BRD is led by Chief Biologist Denny Fenn, who started his career in the National Park Service in 1972 as a soil scientist and eventually served as NPS Acting Associate Director for Natural Resources before joining NBS.

The NWRC performs an important role in wetlands research. Wetlands in the United States continue to disappear at an alarming rate, particularly in Louisiana, where coastal wetland loss averages more than 35 square miles per year. Additionally, changes in wetland hydrology or community composition are often propagated up the food web, affecting commercially and recreationally important species such as shellfish, finfish, and waterfowl. Studies at NWRC contribute to scientific understanding of the factors influencing wetland loss and are used to develop management strategies for mitigating those losses. NWRC researchers also study the effects of natural and human-induced impacts on wetlands and the effects wetland changes have on animal communities and populations.

Center organization

The NWRC is staffed by about 150 federal and contract employees who have a broad range of scientific and technical expertise. Research areas and services include plant, animal, and wetland ecology; mapping; remote sensing; modeling; geographic information systems (GIS); computer and electronic technologies; and information technologies and services. The Center is divided into four scientific branches: Animal Ecology, Forest Ecology, Spatial Analysis, and Wetland Ecology, and two offices: Technical Support and Administration.

continued on page 14

NWRC continued from page 13

The Animal Ecology Branch focuses on the survival of animal species and quality of habitat through studies of population dynamics, inventorying and surveying, examining effects of environmental contaminants on ecosystem food webs, and improving statistical models for ecological research. Animal ecologists study migratory bird populations that are declining because of habitat loss or alteration; resident shorebirds and waterfowl that winter in gulf coast wetlands; and the effects of habitat change on songbirds that stop over in coastal wetlands on their way to the neotropics. In a recent study, researchers developed a GIS-based spatial model to study the behavioral responses to factors influencing distribution of the Northern Pintail duck wintering in the lower Mississippi River region.

The Forest Ecology Branch studies the loss, fragmentation, and degradation of forested wetlands from hydrologic alterations and past management practices. Scientists focus on bottomland hardwood forests, cypress-tupelo swamps, pine savannas, coastal oak ridge (cheniers) forests, and mangrove forests, which together account for more than a third of all wetlands remaining in the contiguous United States. They investigate the functions of southern forested wetlands, develop computer models to forecast alterations in forest composition as a result of environmental change, explore the potential for reforestation and forest restoration, and study the annual growth rings of trees to assess the effects of ecological disturbances on forested wetlands. One ongoing study has identified and is seeking to cultivate salt-tolerant strains of baldcypress for use in wetland forest restoration.

Researchers in the Spatial Analysis Branch help fulfill the information needs of natural resource managers by developing and maintaining databases of landcover satellite images for the Southeast, contaminants for gulf coast estuaries, breeding birds for Louisiana, hydrology and vegetation for the lower Mississippi River valley, and the status and trends (1956-93) of wetlands, uplands, and seagrasses along the Gulf of Mexico. Spatial Analysis Branch personnel develop geographic information systems to analyze trends, produce natural resource inventories, and create simulation models. They also conduct remote sensing studies to develop all-weather, day-and-night monitoring tools and map habitats to spatially represent ecological, biological, and other data. Recent remote sensing studies have shown that satellite radar can detect coastal flooding and can be used to monitor the recovery of marshes from burning. In addition to their research, representatives from the Spatial Analysis Branch co-chair the $20 million monitoring program of the Coastal Wetlands Planning, Protection, and Restoration Act with the Louisiana Department of Natural Resources to monitor over 80 wetland restoration projects.

The Wetland Ecology Branch conducts research related to sustainable management and restoration of the nation's coastal saltwater wetlands, coastal and inland freshwater wetlands, submerged aquatic ecosystems, and coastal prairies of Texas (fig. 1) and Louisiana (of which only one percent remains of the 200 million acres present during Colonial times). Wetland ecologists study factors threatening coastal ecosystems and investigate how to stabilize, restore, and manage the coastal landscape. To better understand influences leading to wetland loss, researchers investigate global climate change, accretion and subsidence, herbivory, saltwater intrusion, shading, and disturbances by storm or fire. Studies performed by the Wetland Ecology Branch have demonstrated that estimates for the potential of coastal wetland submergence based on accretion data may underestimate that potential by neglecting the effects of subsidence.

The center's Technical Support Office provides numerous skills that support both the center's and BRD's scientific missions, including technical writing and editing, information management, computer operations, graphics, and education and outreach. Also, the Center's research library, which catalogs and holds many state and federal reports considered as gray literature, is managed by this office. The library is currently engaged in research with the University of Southwestern Louisiana to improve electronic access to environmental information. Technical Support Office staff frequently travel to various events in Louisiana and elsewhere to educate the public about the benefits of wetlands. The NWRC publications staff has edited and produced about 500 technical and series reports and has been instrumental in producing the NBS publication *Our Living Resources* report and the USGS report *Status and Trends of the Nation's Biological Resources*, in addition to the publications *Restless Ribbons of Sand: Atlantic & Gulf Coastal Barriers*, *The Fragile Fringe: Coastal Wetlands of the Continental United States*, and *Willful Winds: Hurricane Andrew and Louisiana's Coast*. The center has won several national and international awards for its publications.

Other services the NWRC offers are conference facilities, tours of the Center, educational programs for local schools and other organizations, a seminar series, and a training workshop series sponsored by the Spatial Analysis Branch, Mid-Continent Mapping Center, and University of Southwestern Louisiana. Schedules for the seminar series and workshop series are available on the NWRC website at *http://www.nwrc.usgs.gov/* under What's New.

Obtaining assistance

The NWRC offers technical assistance in most of its areas of expertise and often relies on cooperative projects to carry out its mission. To initiate a research project with NWRC scientists, contact the appropriate branch chief at the phone number or e-mail address listed in the table (page 15) of research specialties and recent projects. Funding for cooperative research may depend upon current research budgets and planned projects, and parks requesting cooperative projects may be required to provide some funding. Long-term projects may require an interagency agreement or memorandum of understanding. Projects with broad applicability (that is, applicable beyond the boundaries of the requesting park) stand a better chance of being funded or may be funded at a higher level. Regardless of funding considerations, however, the staff of NWRC want to hear from you if you have a wetland problem you would like to discuss. For more information on who to contact or on the areas of expertise at NWRC, consult the Table or visit the center's website. PS

Daryl McGrath is a Technical Writer-Editor with Johnson Controls World Services, Inc. He can be reached at National Wetlands Research Center; 700 Cajundome Blvd.; Lafayette, LA 70506; 318-266-8553; FAX 318-266-8541; e-mail: daryl_mcgrath@usgs.gov.

Table 1

National Wetlands Research Center branches, research areas or services, and ongoing or recent NPS-related projects

Branch	Research Areas or Services	Ongoing/Recent NPS-Related Proj.
Animal Ecology Branch Carroll L. Cordes, Branch Chief 318-266-8654 carroll_cordes@usgs.gov	Ecosystem analysis, environmental electronics engineering, population ecology, and statistical and laboratory support.	Modeling big game populations at Yellowstone National Park (Bruce Pugesek);vegetation survey of Big Bend National Park and the Sierra del Carmen Protected Area in Mexico (Carroll Cordes).
Forest Ecology Branch Virginia R. Burkett, Branch Chief 318-266-8636 virginia_burkett@usgs.gov	Computer modeling, conservation genetics, dendroecology, functions and processes of forests, and reforestation and forest restoration.	Development of a natural resources database, GIS, & predictive computer model to evaluate ecosystem management for surface water and nutria control at Jean Lafitte National Historical Park and Preserve (Tom Doyle); assessment of neotropical bird use on a landscape scale at Big Bend National Park (Wylie Barrow); effects of climate change on forests at Big Thicket National Preserve (cooperative project with Paul Harcombe of Rice University); mangrove community dynamics at Everglades National Park (Tom Doyle).
Spatial Analysis Branch James B. Johnston, Branch Chief 318-266-8556 jimmy_johnston@usgs.gov	Geographic information systems, National Spatial Data Infrastructure, photogrammetry and cartography, remote sensing, GIS-based ecosystem assessment and modeling, and spatial analysis training.	Habitat mapping at Jean Lafitte National Historical Park and Preserve (John Barras); seagrass mapping at Gulf Islands National Seashore (Larry Handley).
Technical Support Office Gaye S. Farris, Office Chief 318-266-8540 gaye_farris@usgs.gov	Information management, outreach, library, technical editing, visual information, and computer support and applications.	Library services (Judy Buys); editing and layout of scientific and technical reports in the report series (Beth Vairin); graphics, exhibits, and multimedia (Sue Lauritzen); informational materials for wetland education workshops at Jean Lafitte National Historical Park and Preserve (Susan Horton); computer support and applications (Jim Capezza).
Wetland Ecology Branch Carroll L. Cordes, Branch Chief (Acting) 318-266-8654 carroll_cordes@usgs.gov	Accretion, subsidence, and sea-level rise, coastal prairie management and restoration, global climate change, marsh management and restoration, nutrient dynamics and biogeochemical cycling, plant community dynamics, and submerged aquatic vegetation.	Baseline assessments of ecological processes, water quality, and suspended sediment in aquatic communities at Congaree Swamp National Monument and Big Thicket National Preserve (Lee Foote and Bill Rizzo); assessment of baseline sedimentation rates at Big Thicket National Preserve and Congaree Swamp National Monument (Don Cahoon).

Visitor information continued from cover

Visitor-related information inventoried

In preparing for this monitoring and evaluation plan, we conducted a baseline study of existing, relevant, visitor-related information available in the 50 park units included in the Recreation Fee Demonstration Program. The purpose of this study was to assess the potential for conducting pre- and post-treatment tests of the new fee system, and to select park units for study that had adequate baseline data available. The overall evaluation project will examine (among other things) the effects of fee changes on visitation patterns and visitor experiences, and their effects on local economies. This paper briefly summarizes the findings of the baseline study.

Methods

The baseline study began by selecting relevant visitor-related variables to be included in an inventory of the 50 park units. This was done in conjunction with the NPS Social Science Program. Eleven variables were selected as shown in figure 2. The specific objective of the inventory was to determine which park units had information on these variables that had been collected sometime between 1990 and 1996.

The inventory was conducted using four approaches. First, a fax requesting information was sent to the office of the superintendent of each park unit. Park units were given the option of faxing back their responses or waiting to be contacted by telephone. Park units that had not responded within three business days were called daily until the information requested had been received. Second, key sources of social science information within the NPS were contacted for inventory data. These sources included regional science liaisons, the Visitor Services Project, the Public Use Statistics Program Center, and the NPS Social Science Program in Washington, D.C. Third, researchers known to be associated with the Park Service were contacted. These included cooperative park studies units, the Biological Resources Division of the U.S. Geological Survey, and academic institutions. Finally, a literature review was conducted using electronic databases and the World Wide Web.

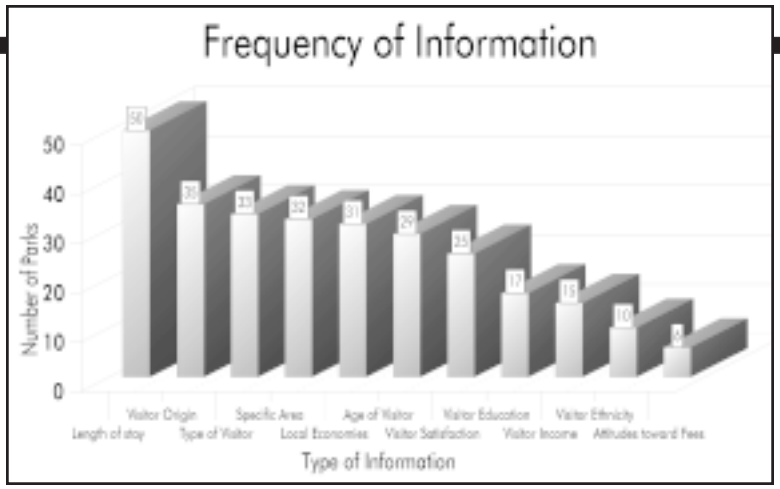


Figure 2. Eleven visitor information variables were inventoried in the 50 Recreation Fee Demonstration Program parks. The objective of the inventory was to determine which parks had information on these variables, collected sometime between 1990 and 1996.

Information spotty

Study findings were compiled into a summary matrix that illustrates the availability of data on each of the 11 study variables for each of the 50 park units. Two conclusions were evident from this matrix. First, availability of visitor information is spotty at best. Only 51.5 percent of the matrix cells indicate data availability. However, this figure may overstate the case. In many instances, available data are very limited in their spatial or temporal character. For example, most data were collected for only one of the six years covered in the study, some were collected in only one season, some were collected for only one type of visitor, and some were collected for only one area within the park unit. Several park units had data on most of the 11 variables, but several park units had no data with the exception of length of stay, which is required for visitor use reporting.

Figure 2 illustrates the relative and absolute frequencies of availability for each of the 11 study variables. Nearly all of these variables should be considered basic to park management as they describe fundamental characteristics of park use and users. Information on park use patterns is important in planning and designing park facilities and services, including planning for visitor and resource protection. Visitor satisfaction is an important component of understanding the visitor experience and how management actions might add to or detract from the quality of the park experience. Knowledge of the economic impacts of park visitation on local economies is vital in maintaining productive relationships with surrounding communities.

Length of stay was the only study variable available to all park units included in the sample; this information is required to estimate annual visitation. However, this information is collected only infrequently. Some measure of visitor satisfaction is available in only half of study park units. Basic visitor characteristics, including education, income and ethnicity, are available in only a small minority of park units. These latter types of data are likely to become more important as society becomes increasingly concerned with matters of cultural diversity, social equity, and justice. To what extent do visitors to the national park system reflect society at large? How well do NPS facilities and services meet the needs of traditionally under-represented groups?

Figure 3 illustrates the sources of social science information. The numbers shown are the sources of each variable for each park unit. The numbers are slightly higher than might he expected because there are occasionally multiple sources for some variables. Scientists affiliated with academic institutions are the most common source of information. However, three NPS programs–the Public Use Statistics Program Center, cooperative park studies units, and the Visitor Services Project–account for nearly half of all available information. Other sources of information are highly varied.

Visitor-related information should extend beyond basic, descriptive patterns of visitor use, i.e., where visitors go, how long they stay, and what activities they participate in

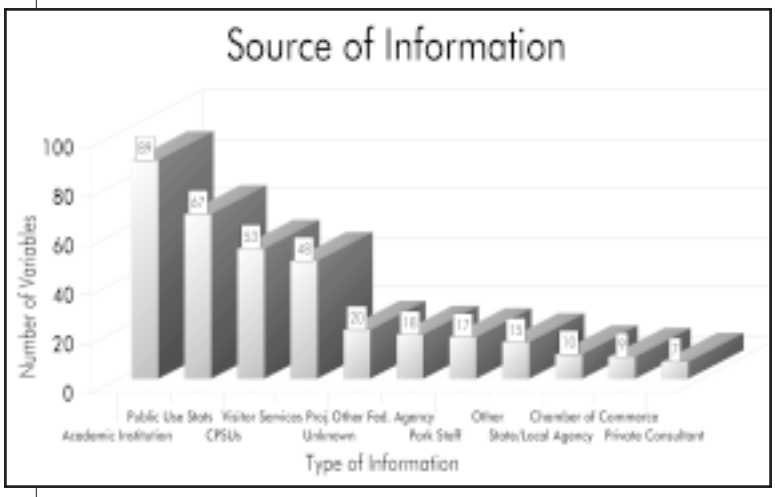


Figure 3. Visitor information is collected through various mechanisms. Numbers indicate the sources of each information variable for each of the 50 park units surveyed. The numbers are slightly higher than might he expected because multiple sources for some variables exist.

Findings troubling

If national park management truly implies visitor management, then the findings from this study are troubling. Though the study was not designed to be a comprehensive assessment of the status of social science information in the national park system, it offers insights into this issue. Enlightened and effective park management requires knowledge and understanding of visitors and other publics. In many, perhaps most, park units, much of this information–that concerning visitors–is largely unavailable. This problem extends beyond visitor management per se. Contemporary paradigms of public land management, including ecosystem management, conservation biology, and human ecology require integration and synthesis of natural and social science information. Lack of social science information suggests that this type of collaboration may be problematic.

The past several years have witnessed numerous calls for a greater emphasis on science–including social science–in the national parks (e.g., National Parks and Conservation Association 1989; National Park Service 1992; National Research Council 1992; National Park Service 1993; National Research Council 1993). The recent formulation of a new social science plan for the National Park Service is an encouraging step in this direction (National Park Service 1996). Part of this plan included a review of social science studies in the national park system during the same general time period (1990-1995) covered by the survey reported here. This review also reported a relatively low level of visitor-related research; an average of only 25 studies were completed each year across the national park system.

The study reported in this paper has two important limitations. First, it does not encompass all social science research in the national park system. It focuses only on visitor-related research and information. Second, the 50 parks included in the sample were chosen for their inclusion in the Recreation Fee Demonstration Program, not because they were representative of the national park system as a whole. However, the park units studied include a wide diversity of type, size, and geographic location.

Recommendations

Study findings lead to two broad recommendations. First, information on visitors to the national park system needs to be collected on a more regular and systematic basis. Only one of the eleven variables addressed in this study–length of stay–is collected at all sample parks. This variable is required for public use reporting. It is apparent that when there is no policy or program directing collection of visitor use information, this information is largely unavailable to park managers. Second, visitor-related information should extend beyond basic, descriptive patterns of visitor use–where visitors go, how long they stay, and what activities they participate in. Visitor satisfaction, motivations, attitudes toward management, and other experiential variables are needed to understand and manage visitors–and parks–more effectively. PS

Literature cited

Hammitt, W. and D. Cole. 1987. Wildland recreation: Ecology and management. John Wiley and Sons. New York, New York.

Manning R. E. 1986. Studies in Outdoor Recreation. Oregon State University Press. Corvallis, Oregon.

National Parks and Conservation Association. 1989. National parks: From vignettes to a global view. National Parks and Conservation Association. Washington, D.C.

National Park Service. 1992. National parks for the 21st century: The Vail Agenda. Chelsea Green Publishing Company. Post Mills, Vermont.

National Park Service. 1993. Science and the national parks II: Adapting to change. U.S. Government Printing Office. Washington, D.C,

National Park Service. 1996. Usable knowledge: A plan for furthering social science research and the national parks. National Park Service. Washington, D.C.

National Research Council. 1992. Science and the national parks. National Academy Press. Washington, D.C.

National Research Council. 1993. A biological survey for the nation. National Academy Press. Washington, D.C.

Robert Manning is a Professor in the Recreation Management Program at the University of Vermont. He conducted research at Arches National Park (Utah) for the application of VERP, a framework to address park visitor management and carrying capacity issues, 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, Vermont 05405-0088; phone 802-656-2684, fax 802-656-2623, e-mail: rmanning@nature.snr.uvm.edu. *Benjamin Wang is also with the School of Natural Resources at the University of Vermont.*

Visitor satisfaction, motivations, attitudes toward management, and other experiential variables are needed to understand and manage visitors and parks more effectively

Figure 1. The study at Rocky Mountain National Park used a technique called visitor employed photography. The researchers compared the attitudes of backpackers and day users toward park management, human-habituated wildlife, and human impacts. Both the day user and backpacker groups studied considered park scenery a positive and important feature of their park visit.

Attitudes of backpackers and casual day visitors in Rocky Mountain National Park

By Sarah Flick and Jonathan Taylor

The Biological Resources Division of the U.S. Geological Survey and the National Park Service conducted a study at Rocky Mountain National Park (Colorado) to determine the aspects of the park that were most important to visitors (Taylor et al. 1995a, b). We felt that it would be useful for land managers to know if the needs of certain groups of visitors are being met better than others during trips to the park and whether different groups of visitors are seeking experiences that conflict with each other. Park visitors were grouped into four categories–backpackers, day hikers, car campers, and tourists who were casually visiting for one day (day users). Previously, we had compared the four groups' attitudes towards natural features such as mountain vistas, water bodies, wildlife, and vegetation (Taylor et al. 1995a, b). In this study we compared backpackers' and day users' attitudes about park management, human-habituated wildlife, and human impacts on the environment. We chose backpackers and day users because preliminary analyses determined that these were the two groups that utilized the park most differently from each other.

Methods

During July and September 1993, we passed out 50 single-use, 12-exposure cameras to backpackers and another 50 to day users at the start of their park visit. The participants were asked to photograph the scenes, features, or situations within the park that had the most important effects on their trip. Participants were also given a log in which they recorded, for each photograph, why they had taken it, where it was taken, its subject, and whether the subject had a positive or negative effect on their trip. This method, called visitor employed photography is discussed in Taylor et al. (1995b). Participants were mailed a copy of their photographs, along with a follow-up survey that contained a list of park features that participants rated 1 to 10 on a scale of importance to their experience at the park.

What participants photographed, to some extent, was dependent upon where they went, and on what they happened to see. However, there is a paved road system through several areas of the park, and numerous trails of varying levels of difficulty. There are roads, trails and parking lots adjacent to water, mountain vistas, meadows, areas where animals congregate, and park buildings. All of the participants, therefore, could be assumed to have access to many of the same sorts of features, and we made some assumptions based on the photographs. For instance, if a person took no photographs of streams they probably did not find streams as important as a person who took six photographs of streams.

Results and discussion

Importance ratings

The park features that participants rated in the follow-up survey according to "importance to [their] experience at the park" can be grouped into two categories: (1) management improvements such as campgrounds, trails, and paved roads, and (2) natural features such as wildlife, lakes, wildflowers, and mountain vistas. The ratings showed that both groups highly valued the natural features (fig. 1), but there were significant differences in how the groups rated two of the management improvements–paved roads and campgrounds. Thirty percent of the day users felt that paved roads were important to their experience at the park while only 11% of the backpackers felt the same. On the other hand, 53% of the

Figure 2 (left). Both groups photographed nearly equal numbers of park management features, but focused on different ones. For example, backpackers photographed more trails; day users more roads.

Figure 3 (below). Backpackers shot far fewer photographs of animals than day users. The data indicate that viewing animals that are accustomed to crowds of humans was an important part of the day users' experience but not of the backpackers'.

backpackers rated paved roads as unimportant, while only 9.5% of the day users did so ($X^2 = 24.218$, $p<0.001$). Fifty six percent of the day users rated campgrounds as unimportant compared to 14% of the backpackers. One other difference was notable: more day users (35%) than backpackers (19%) felt that well-maintained trails were important.

Management features

Day users and backpackers took almost the same number of photographs of management features (fig. 2; day users n=68; backpackers n=63), and both took management photographs that were mostly positive (81% for day users, 83% for backpackers), but they valued different aspects of management. For backpackers, the most photographed management features were trails (n=25), and for seven of these photographs they wrote that they liked the trail because it was primitive, narrow, or unimproved. Only ten of the day users photographed an unimproved trail, and none of them praised one. Three of them, however, wrote that they appreciated trails that were wide or flat, and two day users photographed trails that they felt should be further developed so that they would be easier to walk on.

Roads/lookouts/parking lots made up the most photographed management feature category for day users (n=25). Most of these photographs were positive, praising road smoothness and exciting turns, and the fact that roads and lookouts were in attractive terrain, but five of the day users criticized a road closure and one respondent thought the roads should have higher retaining walls. Backpackers, on the other hand, took no photos of lookouts, and only one road photograph that criticized how close the road had been built to a river. The second most popular of the management features for backpackers were backcountry campsites (n=12); buildings were second for day users (n=12). No day users photographed campsites and only one backpacker photographed a building.

Mirroring the importance ratings, backpackers did not appreciate management features that intrude on wilderness, but they did like "primitive" trails, and backcountry campgrounds. In almost perfect counterpoint to the backpackers, day users liked improved trails, paved roads and lookouts, various buildings, and any other feature that helped them view large areas of the park easily and in physical comfort.

Wildlife

Virtually all of the wildlife photographs from both groups were positive (fig. 3), but the backpackers shot far fewer photographs of animals. Although both rated wildlife as an important feature of their visit to the park, day users took a total of 115 wildlife photographs while backpackers took 36. The day user average was 2.34 wildlife photos, more than twice as many as the backpacker average of 0.878 ($F=21.904$, $p=0.00001$). This suggests that day users had an easier time getting close enough to animals for a photo opportunity, that they were photographing more animals that were accustomed to humans and cameras than backpackers were, and that the relative tameness of the animals did not bother them. Although backpackers spent much of their time away from the park's crowded

continued on page 20

Attitudes continued from page 19

developed areas, they would have had some easy animal photo opportunities when they went to pick up backcountry permits, or on their way to and from trailheads. The data indicate that viewing animals that are accustomed to crowds of humans was not an important part of the backpackers' experience.

Both groups photographed animals that are partially habituated to humans (fig. 3, page 19). Throughout Rocky Mountain National Park visitors commonly encounter animals that do not flee when they see people, and some animals beg for food. Backpackers shot wildlife photographs from trails and designated backcountry campgrounds; animals that spend time near these areas must be somewhat accustomed to people. However, the day users shot all of their wildlife photographs out of car windows, alongside roads, at lookouts, picnic grounds, or along popular day-hike trails where hundreds or thousands of people per day may easily visit during the summer and fall. Wildlife habituation is probably worse in these locations, and 34 day-user photos actually featured animals sitting in or standing on structures such as lookout railings. Nevertheless, habituated behavior did not detract from most day users' satisfaction that they were seeing animals in what they considered to be a relatively natural habitat.

On 17 photographs, day users commented about the friendliness of the animals. Examples include: "the animals have little fear; they watch us as we watch them;" "it's nice to see wildlife so close by;" "[I am] impressed by [chipmunks'] friendliness and seeming to be so tame;" "we had been hearing about this friendly deer from other hikers on their way down;" "[the deer] is so calm and unafraid. She posed for us, looking right at the camera." An additional seven day users shot positive photographs of people feeding animals and one noted that the "squirrel actually came to get the peanuts from the kids' hand." We recorded five negative comments based on photographs of people feeding animals.

Human impacts on the environment

Backpackers put considerable physical effort into hiking away from the developed "frontcountry." Unless day users hiked vigorously to escape the frontcountry during their brief visits, they presumably spent most of their time within sight and sound of people, paved roads, buildings, or popular trails. Backpackers, however, took more human impact photos (backpackers n=28, day users n=16), and the mean number of impact photos per person was twice as high for backpackers (0.683) as for day users (0.327) ($F=5.084$, $p=0.027$). This suggests that day users are somewhat desensitized to impacts such as litter and horse manure, and accept these conditions as part of their experience in a wilderness park more readily than do backpackers. Backpackers took more photos, on average, of all the human impact categories except for trail impacts.

In almost perfect counterpoint to the backpackers, day users liked improved trails, paved roads and lookouts, various buildings, and any other feature that helped them view large areas of the park easily and in physical comfort.

Negative and positive photographs

Over all the photographic categories, day users took a total of 525 positive photos and 28 negative; the backpacker total was 411 positive and 38 negative photos. Backpackers took 60% more negative photographs per person (mean=0.927) than the day users (mean=0.571), indicating that backpackers had a greater number of negative impressions of the park.

Conclusion

We had first hypothesized that backpackers would have a greater desire for pristine nature and solitude than day users would and this hypothesis is supported by some of the results. Although day users and backpackers both indicated that they came to Rocky Mountain National Park to enjoy the natural environment, they had different strategies for doing so that required different, sometimes opposing, park management practices. Backpackers did not appreciate management features that make the park easily accessible (such as paved roads and buildings), while day users did. Even though backpackers felt that wildlife, in general, was an important part of their visit, they did not think that human-habituated, roadside wildlife was important enough to their experience to photograph in large numbers. Backpackers also disliked human impacts on the environment much more than day users did, although day users generally spent more time in impacted areas. These results suggest that the backpackers placed a high priority on getting away from other people and the impacts that people have on wilderness and wildlife.

We also hypothesized that backpackers, because of their higher expectations, would have more negative impressions during their visits to the park than day users would. This was true, although both groups who took part in this study were largely pleased with the park and took many more photographs of important, positive experiences than negative experiences. Mountain vistas and water were the most popular photography subjects, not human impacts or negative management features (Taylor et. al 1995a, b). Visitors appreciate Rocky Mountain National Park, but people who visit casually and briefly, spending much of their time driving or taking short dayhikes, may enjoy their visit more than people who care intensely about having an active, wilderness experience. PS

Sarah Flick, at the time of the study, was a Social Science Researcher with Johnson Controls World Services in Fort Collins, Colorado. Dr. Jontahan Taylor is a Research Social Scientist with the Midcontinent Ecological Science Center, USGS Biological Resources Division, in Fort Collins. He can be reached at 970-226-9438; e-mail: jonthan_taylor@usgs.fov.

References

Taylor, J. G., N. R. Sexton, and K. J. Czarnowski. 1995. Visitor employed photography at Rocky Mountain National Park: A valuation technique. Park Science **15(1):**10-12.

Taylor, J. G., K. J. Czarnowski, N. R. Sexton, and S. A. Flick. 1995. The importance of water to Rocky Mountain Park visitors: An adaptation of visitor employed photography to natural resources management. Journal of Applied Recreation Research **20(1):**61-85.

Paleoclimate during the Redwall karst event, Grand Canyon National Park

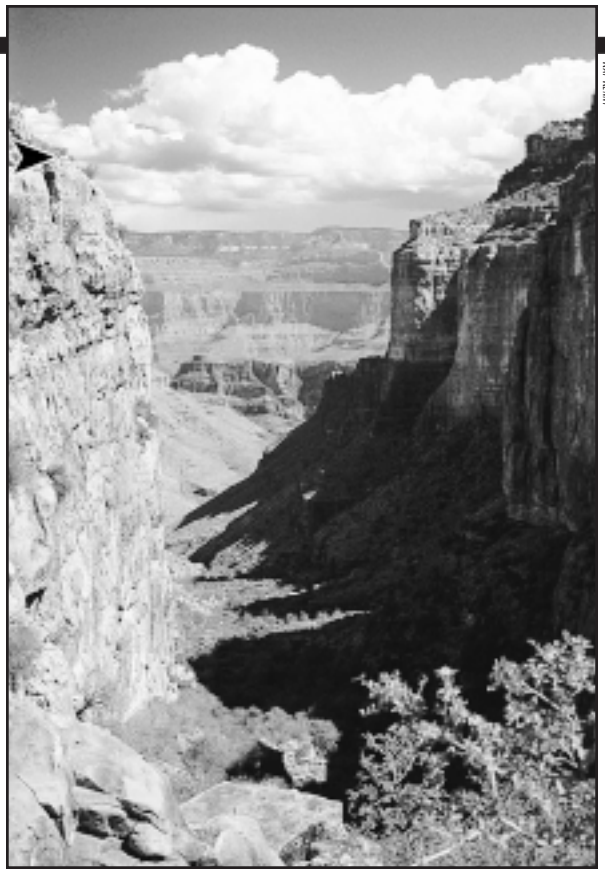


Figure 1 (right). The Redwall Formation (top shown by arrow) holds many clues to the ancient climate in what is today Grand Canyon National Park, Arizona. The research focused on chemically resistant deposits, rather than fossils, within the limestone layer to provide insight into the terrestrial climate about 325 million years ago.

By Ray Kenny

Grand Canyon National Park (fig. 1) has always been known as a Geologist's paradise (Kenny 1993). The rock formations exposed in Grand Canyon (fig. 2) range in age from the 1.7-billion-year-old Vishnu schist of the Precambrian Era (exposed in the Inner Gorge of the Grand Canyon), to the 250-million-year-old Kaibab limestone of the Paleozoic Era (exposed along the north and south canyon rims). Exposed upstream of the park in the northernmost portion of Marble Canyon is the lower part of the younger, 195-210-million-year-old Chinle Formation (late Triassic Period). At the western end of the park, 1.16-1.25-million-year-old (Late Cenozoic Era) basaltic lava flows are also prominently exposed (Hamblin 1994). Both the age and variety of rock formations, in addition to the excellent exposure of these rock formations, make Grand Canyon a spectacular area for geological research.

At first, it might seem that much of the geological research has already been accomplished at the park, but the application of new technology and instrumentation has resulted in new geologic insight. Indeed, ongoing field research has also added to the baseline geologic information about Grand Canyon (Beus 1989; Bloeser 1985). This study has combined both fieldwork and new technology and has focused on the Redwall Formation (Mississippian Period).

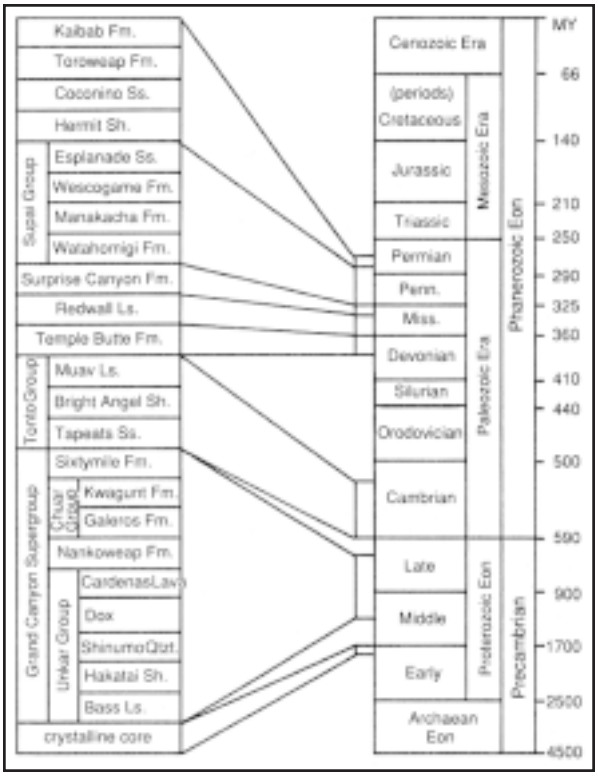


Figure 2 (left). Stratigraphic column of the major rock formations in Grand Canyon compared to the geologic timetable (after Haq and Van Eysinger 1987; in Beus and Morales 1990). The abbreviation "MY" refers to millions of years before present.

The Redwall Formation

The Redwall Formation has been the subject of numerous and diverse geological and paleoecological studies. The Redwall was deposited in a warm shallow sea about 330 million years ago and has many well-preserved fossils. It consists primarily of light-colored, blue-gray limestone and chert[1] lenses with minor dolomite. However, much of the formation has been stained red by iron oxide weathered out from the shale of the overlying Supai Formation. The ubiquitous red surface "stain" is the reason for the name "Redwall." The fossil record, extracted from previous studies of the Redwall Formation, is both extensive and well-preserved, and has yielded much qualitative information about the paleoenvironment of the ancient shallow sea (e.g., McKee and Gutschick 1969).

Scientists have derived information about the Redwall through the identification and study of foraminifera, crinoid, coral, cephalopod, brachiopod, and other fossils from this formation. Additionally, scientists have also been interested in the formation because its upper member, the Horseshoe Mesa Member, was exposed to the atmosphere

[1]A hard, dense, fine-grained rock made up of silicon and oxygen. Flint is a dark-colored variety of chert.

continued on page 22

Paleoclimate continued from page 21

for an extended period of time (approximately 325 million years ago) before the deposition of the overlying Supai Formation sediment. During the time the Redwall Formation was exposed to the atmosphere (subaerially exposed), the limestone was severely altered by chemical dissolution and reprecipitation and developed a recognizable karst (limestone) topography replete with caves, caverns, sinkholes, chert-lag breccias, red-residual soil, and related solution features. Detailed and ongoing research on karst features (Kenny 1989) has produced new insights into information about the ancient terrestrial climate (Kenny in press).

New karst features

During the Redwall karst event, chemical dissolution of the chert-rich limestone produced numerous large- and small-scale features. In many areas of northern Arizona (outside and south of Grand Canyon National Park), much of the limestone was completely dissolved away, leaving behind a heap of more chemically resistant, partially weathered, and cemented chert breccias or "lag" deposits. In some areas, these residual chert-lag deposits are quite extensively developed (fig. 3). In other areas, such as in the park study area, the residual deposits are not as well developed. In all cases, the chert-lag deposits are held together by silica (quartz) "cement," and locally contain preserved soil features. These residual deposits were cemented together by silica that formed at or near the time of the Redwall karst event, at or near the Earth's surface.

The cement that holds together the residual heaps of partially weathered chert, also called secondary silica (Kenny and Knauth 1992), formed under very different environmental conditions than the chert. The chert formed under marine conditions at approximately the same time as the limestone was forming. The secondary silica cement formed under terrestrial conditions much later than the already solidified chert. The secondary silica cement also has forms and features that are distinct from the chert, owing, in part, to its formation under very different environmental conditions. Figure 4 illustrates some of these unique forms of silica. Both macroscopic and microscopic studies reveal the presence of microlaminated, fibrous, botryoidal (like bunches of grapes), and other forms of silica cement. These distinctive forms of silica may have formed under subaerial, terrestrial conditions (as shown by Kenny and Knauth 1992). In addition, the secondary silica cement is also chemically distinct. It is the chemical distinction that has been used to provide insight into the ancient terrestrial climate, about 325 million years ago.

The ancient climate

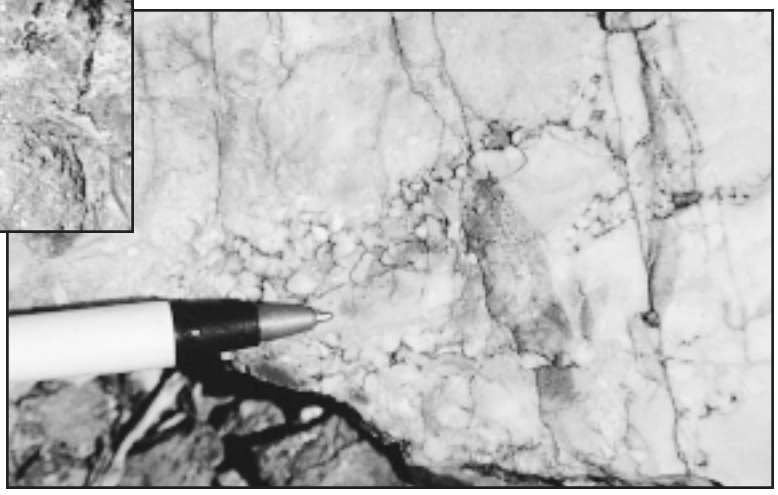
Samples of the secondary silica cement were chemically analyzed for oxygen and hydrogen isotopic values. Each element that makes up the basic chemistry of the silica has its own distinct isotopic value. These values will remain relatively unaltered in silica until the mineral is either destroyed by weathering or altered by relatively high temperature and pressure. Since the secondary silica cement was formed (or precipitated) in the presence of fresh water (on land), it is chemically (isotopically) distinct from the chert (also quartz) that actually precipitated in the presence of seawater. This isotopic difference, dictated by the environment in which the mineral formed, can be clearly and unambiguously determined. The isotopic value for the silica cement can then be used to determine the temperature at which the substance formed because the isotopic value is also determined, in part, by the temperature at the time of precipitation (see Knauth and Epstein 1976; Kenny and Knauth 1992).

Using this information, we determined that the near-surface temperature at which the cement formed was a balmy 27-28ºC (81-82ºF). These preliminary temperature estimates are geologically reasonable values and are in agreement with the range of temperature or climate needed to produce

By studying the rocks and minerals, geologists have shown that global climate change is a natural phenomenon that has occurred countless times in the geologic past

Ray Kenny

Figure 3A (above). Secondary silica deposit at the top of the Redwall Formation (Bass Canyon). The chemistry of the secondary silica was used to determine the ancient terrestrial temperature range.



Ray Kenny

Figure 3B (right). A chert-lag deposit at the top of the Redwall Formation (Bass Canyon). Chert is more chemically resistant to erosion and dissolution than the limestone matrix and is considered evidence for surficial weathering.

an extensive karst event. The paleotemperature estimates are probably a long-term climatic average. The paleotemperature estimates are significant because, until recently, quantifying terrestrial paleoclimate conditions has been extremely difficult, if not impossible.

Benefits of climate research

Modern global climate change is very much on the minds of resource managers, scientists, and the public. By studying the rocks and minerals, geologists have shown that global climate change is a natural phenomenon that has occurred countless times in the geologic past. To understand modern climate change and associated resource concerns, we first need to quantify the conditions and features of ancient, naturally occurring climate shifts. The research at Grand Canyon will provide scientists and resource managers with new information about ancient climate changes. Information from this research can be used in a management and education program designed to inform the public about ancient climates (which were very different from our modern climate) and address public questions about modern global climate change. Resource managers may also find the research useful in terms of describing the importance of the preservation of biological and geological resources–resources that may hold the key to a vast amount of information that has yet to be tapped and used by our modern society.

Finally, the research at Grand Canyon can be used at other national parks and monuments (e.g., Death Valley and Glacier National Parks) to quantify past climate and climate change. But more work remains at Grand Canyon! The 250-million-year-old Kaibab Limestone (the rock formation that makes up the rim of the Grand Canyon) has also been subaerially exposed and karsted. The Kaibab limestone may also provide us with information about ancient climate change from yet another interval of time. In the meantime, the research at Grand Canyon is providing us with greater insight into the climate of the geologic past–a climate that helped produce the stunning array of rocks exposed in Grand Canyon National Park. **PS**

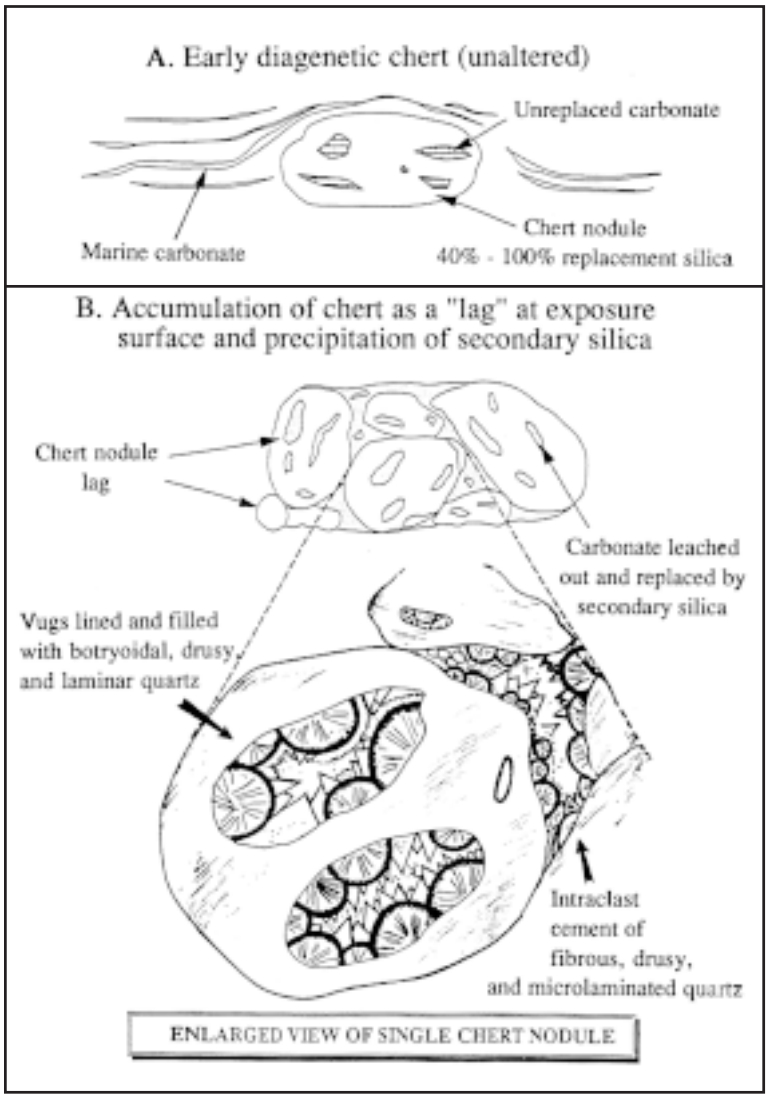


Figure 4. Some of the distinct forms and features of the secondary silica cement that precipitated during the Redwall karst event approximately 325 million years ago: (A, above) early marine chert; and (B, below) examples of secondary silica.

Ray Kenny is a professor in the Environmental Geology Program at New Mexico Highlands University, Las Vegas, New Mexico 87701. He can be reached at that address or by phone at (505) 454-3513; email: Kenny_Ray@merlin.nmhu.edu.

References

Beus, S. S. 1989. Devonian and Mississippian geology of Arizona. Pages 287-311 in J. P. Jenney and S. J. Reynolds, editors. Geologic evolution of Arizona. Arizona Geological Society Digest **17.**

Beus, S. S., and M. Morales. 1990. Grand Canyon geology. Oxford University Press. 518 p.

Bloeser, B. 1985. Melanocyrillium, a new genus of structurally complex late Proterozoic microfossils from the Kwagunt Formation (Chuar Group), Grand Canyon, Arizona. Journal of Paleontology **59:**741-765.

Hamblin, W. K. 1994. Late Cenozoic lava dams in the western Grand Canyon. Geological Society of America Memoir **183.** 139 p.

Haq, B. U., and F. W. B. Van Eysinger. 1987. Geologic time table. 4th edition. Elsevier Science Publishers.

Kenny, R., 1989. Variation in carbon and oxygen geochemistry and petrography of the Mississippian Redwall Formation, north-central Arizona: implications for extricating the diagenetic history of paleokarst carbonates and evidence for the earliest Microcodium microfossils. Pages 16-18 in Cave Research Foundation Annual Report 1989. Cave Books, St. Louis, Missouri.

Kenny, R. 1993. The only one they call the Grand. Earth. May issue, pp. 42-49.

Kenny, R. In press. Preliminary continental paleoclimate averages from oxygen and deuterium isotopes in secondary (paleokarst) silica from the Mississippian Redwall Formation, Arizona. Cave Research Foundation Annual Report 1989. Cave Books, St. Louis,

Kenny, R., and L. P. Knauth. 1992. Continental paleoclimates from delta D and delta 18-oxygen of secondary silica in paleokarst chert lags. Geology **20:**219-222.

Knauth, L. P., and S. Epstein. 1976. Hydrogen and oxygen isotope ratios in nodular and bedded cherts. Geochimica et Cosmoschima Acta **40:**1095-1108.

McKee, E. D., and R.C. Gutschick. 1969. History of the Redwall Limestone of

Northern Arizona. Geological Society of America Memoir 114. 726 p.

The Big Cypress hydrology program

A proactive approach to establishing effective multiagency partnerships

By Don P. Weeks and Christine J. Bates

When asked to identify the national park units in south Florida, many people begin and end with Everglades National Park. A lesser known park unit, which shares a common boundary with Everglades, is Big Cypress National Preserve. At 295,026 ha (729,000 acres) in size, Big Cypress is the 12th largest unit in the national park system in the continental United States. Established in 1974, the preserve is located in southwest Florida within the Big Cypress Swamp physiographic province (fig. 1). This region extends westward from the Everglades to near the west coast of Florida, and southward from the Caloosahatchee River drainage to the estuaries of the Gulf of Mexico.

The physiographic setting

Water is the basic component of the ecosystems within the Big Cypress Swamp. This water-dependent ecology is a result of the subtropical climate and physiographic setting: the climate provides the hydrologic input; the physiographic setting controls the distribution of that input. The natural topography in the preserve is flat, ranging from near mean sea level (msl) in the south to 5.8 m (19 ft) msl in the northeast. Topographic slopes in the area average less than 9 cm/km (0.5 ft/mile). The preserve has two distinct climatic seasons; a wet season (May-October) and a dry season (November-April) (fig. 2). The annual mean precipitation in the preserve is 143 cm (56.3 in), of which about 75 percent normally falls during the six-month wet season. During this time, as much as 90 percent of the preserve is inundated to depths ranging from a few centimeters to more than one meter. As the dry season begins, generally in October, water levels start to recede. The recession continues until May, when approximately 10 percent of the preserve is covered by water in ponds and sloughs. In this predominantly wetlands habitat, the seasonal inundation of land and depth of inundation are critical for maintaining this delicate ecosystem.

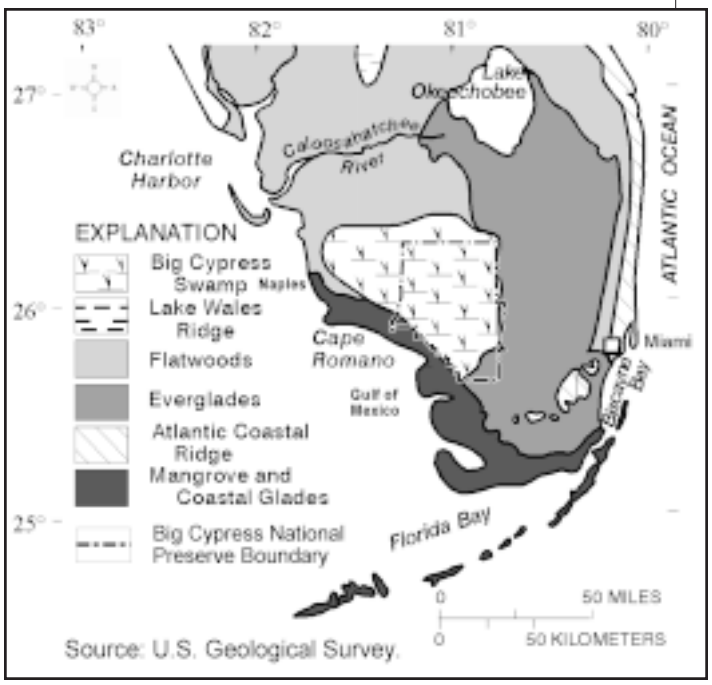


Figure 1. Big Cypress National Preserve lies within the Big Cypress Swamp physiographic region, a large water-dependent ecosystem. Century-long modifications to this delicate system have altered the natural ecology, which the preserve is addressing through its hydrology program.

Water resources management plan

Although the importance of water in the preserve has long been recognized, only limited efforts have been made in the past to document and understand its hydrologic significance. With limited human resources and budget, the preserve had been forced to play a reactive role in the internal and regional water-related issues. Recognizing this as a problem and in response to the increasing multiagency efforts to restore the south Florida ecosystem in the 1990s, the preserve added permanent technical staff and increased funding for the hydrology program. This paved the way for a cooperative effort between the preserve and the NPS Water Resources Division to prepare a Water Resources Management Plan (WRMP) for the preserve. This plan, completed in 1996, provides a review of the current legislation, existing hydrological information, an in-depth analysis of water resources issues, and the development of an action plan (30 project statements) to address both internal and external water-related problems. During the development of the plan, the preserve sought input from the various federal, state, and county agencies, and American Indian tribes to reinforce the cooperative focus of the National Park Service. The WRMP is proving to be an excellent management tool in the dynamic hydrological and political environment of south Florida.

Hydrology Program and accomplishments

The preserve's technical staff recognizes the importance of improving the quality, consistency, and efficiency of hydrological data collection to meet the increasing internal and regional management needs. Since cost was the limiting internal factor, the preserve looked outside the Park Service for long-term cooperative support. The hydrological information was not only important to the preserve, but also important to other federal, state, and county agencies in south Florida. The South Florida Water Management District (SFWMD), a state agency, provided this support. A five-year cooperative agreement was executed between the SFWMD and Big Cypress National Preserve in 1995 to combine

The decision to create a technical water resources staff and prepare a water resources management plan helped the preserve define its water resource objectives and forge strong local partnerships

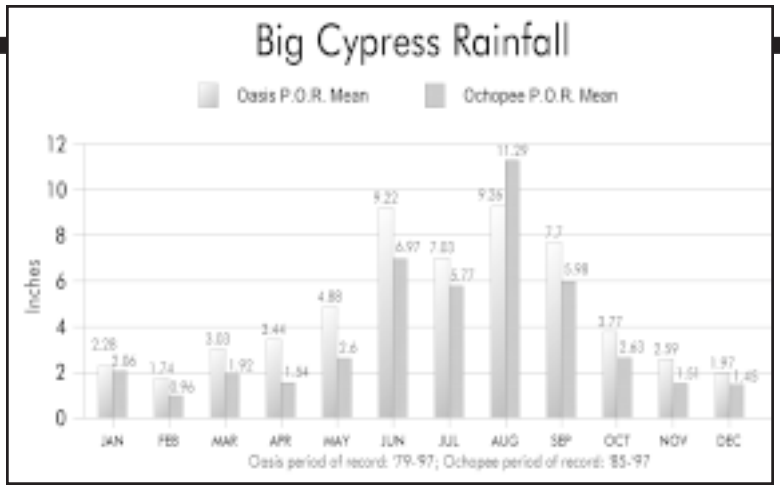


Figure 2. The preserve is characterized by a six-month dry season during winter, followed by a summer wet season when 75 percent of the annual precipitation occurs. During the wet season, as much as 90 percent of the preserve is inundated.

resources to support and improve the preserve's water stage and water quality monitoring program. Since 1995, the SFWMD has contributed over $130,000 in field equipment upgrades, water quality analyses, quality assurance/quality control (QA/QC) inspections, data processing, staff support, and training. Under this agreement, the preserve collects continuous water stage data and monthly water quality samples following a strict quality assurance project plan approved by the SFWMD. This hydrological information is stored on the SFWMD regional databases, making the data available to all interested groups.

Given the intent of the WRMP to define the preserve's water resources objectives and the strong support from the SFWMD, the preserve has become more active in the regional scientific efforts. In 1996, under the authority contained in Section 528 of the 1996 Water Resources Development Act, nominations for critical restoration projects in south Florida were solicited. The nomination and prioritization of the critical restoration projects were based on these criteria:

1. the project produces independent, immediate, and substantial restoration, preservation and protection benefits;
2. the project can be initiated prior to September 30, 1999;
3. it is consistent with components of the integrated plan to restore, maintain, and protect the ecosystem, developed by the Florida Governor's Commission for a Sustainable South Florida;
4. the total project cost estimate is less than $50 million; and
5. a cost sharing partner has been identified.

The preserve has submitted a proposal for consideration as a critical restoration project that addresses a significant hydrological problem identified in the WRMP. The proposal would help to restore a more natural hydropattern to southwest Florida, including the preserve, by improving the conveyance of surface water through U.S. Highway 41 (Tamiami Trail; fig. 3). The Tamiami Trail, constructed in the 1920s, is a two-lane highway that bisects the preserve and connects Miami to Naples. This elevated roadbed impedes the natural north-south "sheetflow[1]" in the region. The existing bridges and water control structures are inadequate for distributing this sheetflow beneath the Tamiami Trail. This results in the interruption of natural seasonal hydropatterns (quantity, timing, and distribution of surface water flows) for the area.

Over 90 project proposals were submitted and reviewed by the South Florida Ecosystem Restoration Task Force[2], U.S. Army Corps of Engineers, and Florida's Governor's Commission. After several meetings to prioritize the numerous candidates, the $15 million proposal submitted by the preserve was ranked second, and was one of five proposals presented in Washington, D.C., as an example critical restoration project proposal. The preserve has since taken the lead to identify a project management team consisting of representatives from the U.S. Army Corps of Engineers, Florida Department of Transportation, SFWMD, Florida Department of Environmental Protection, and the National Park Service. The Environmental Research Institute of Michigan is currently involved in an EPA-funded project that is evaluating the utility of synthetic aperture radar (SAR) collected by the ERS-1 satellite for monitoring wetland vegetation communities in southwest Florida. This information, currently being reviewed by the project management team, may assist with the project design by identifying appropriate locations for additional water conveyance structures within the 70 km (43.6 mi) project area of the Tamiami Trail.

Big Cypress National Preserve, Christine Bates

Figure 3. Built in the 1920s, the two-lane Tamiami Trail interrupts the natural north-south flow of water through Big Cypress National Preserve and Everglades National Park. Improving the conveyance of sheetflow through the highway is a critical aspect of ecological restoration in the preserve.

The preserve's technical staff has also taken a lead role in a multiagency effort to produce a comprehensive science plan for southwest Florida. At the request of Interior Secretary Bruce Babbitt and the South Florida Ecosystem Restoration Task Force, a science workshop steering committee has been established to initiate the effort. A multiagency effort is currently underway to develop this regional science plan for the Big Cypress Basin. Comprised of public land managers, regional planners, researchers and agricultural landowners, the steering committee's efforts focus on the Big

continued in right column on page 27

[1]A broad expanse of moving water that spreads as a thin, continuous film over a large area, and is not concentrated into well-defined channels.

[2]A federal-state partnership, established in 1993, that is working to coordinate the development of consistent policies, strategies, plans, programs, and priorities for addressing the environmental concerns of the south Florida ecosystem.

CECIL SCHWALBE

Figure 1. One of the rarest and oddest frogs in the Southwest, the barking frog was confirmed on Coronado National Memorial (Arizona) in 1993. This discovery, apparently of a thriving population, provided an unexpected opportunity to study this reclusive species, whose natural history is almost totally unknown.

Ground-truthing a troll

Studying the barking frog at Coronado National Memorial

BY CECIL SCHWALBE AND BARBARA ALBERTI

LIKE THE SUBTERRANEAN BEINGS IN Scandinavian mythology that lurked underground for unwary prey, the barking frog *(Eleutherodactylus augusti* [fig. 1]) often waits under rocks or in holes and crevices for dinner to wander by, a dinner of invertebrates, not goats or humans. One of the rarest, and oddest, frogs in the Southwest, the barking frog is known in the United States only from isolated localities in southern Arizona, southeastern New Mexico, and west Texas. It ranges south in Mexico to the Isthmus of Tehuantepec, but nowhere is it considered abundant.

Until 1993, when an apparently thriving population of barking frogs was confirmed on Coronado National Memorial, the barking frog was known in Arizona only from a handful of individual frogs collected from four isolated mountain ranges. This discovery provided an unexpected opportunity to study this reclusive species, whose natural history is almost totally unknown. Biologists from the Cooperative Park Studies Unit at the University of Arizona (Tucson) and Coronado National Memorial are coordinating a study of this population with other university and agency scientists.

A member of the large tropical frog family Leptodactylidae, the barking frog is the only anuran in Arizona and New Mexico to undergo direct development; that is, females lay 20–80 eggs not in pools of water but in wet spots under rocks and in crevices, where barking frogs go through the tadpole stage in the egg, hatching into small frogs about a month later. The males supposedly tend the underground nest, guarding the eggs from small predators and hydrating the eggs by urinating on them.

Barking frogs are named for the explosive breeding call of the males, like the bark of a dog when heard at a distance, but a more guttural "whurr" at close range. At Coronado National Memorial, the call is less doglike, often sounding like the croak of a raven. We believe some barking frog populations may have been overlooked in Arizona because casual listeners may have thought calling barking frogs were Couch's spadefoot toads *(Scaphiopus couchi)*. At Coronado, most male barking frogs call from small chambers or crevices. They sometimes respond to other calling males and vocalize while active on the surface. At Coronado, barking frogs are associated closely with limestone outcrops (fig. 2). In other areas, they may be found on rocks other than limestone, and in southeastern New Mexico they may occur in extensive rodent burrows in barren creosotebush flats.

CECIL SCHWALBE

Figure 2. Habitat for the barking frog at Coronado is a surprisingly rugged limestone outcrop, replete with boulders and crevices.

In Arizona, breeding of barking frogs is tied closely to onset of the summer rainy season. There is

The barking frog is named for the explosive breeding call of the male, like the bark of a dog when heard at a distance. However, at Coronado, the call sounds more like the croak of a raven.

CECIL SCHWALBE

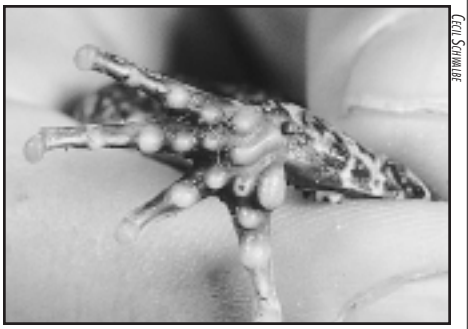
Figure 3 (above). Radiotranmitters belted around the waists of four study frogs helped researchers answer some basic questions about the life history of the reclusive animal. For example, home range was limited to the limestone outcrop where the frogs were originally captured, tagged, and released.

frenzied calling, apparently by most of the adult males in the population, during and following the first heavy (>1 cm; >0.4 in) rain, with fewer and fewer males calling during subsequent showers. We have not been fortunate enough to observe breeding by barking frogs at Coronado yet, but we did capture (and release) a single hatchling frog in 1996.

With funds provided by the National Park Service and Southwest Parks and Monuments Association and with the assistance of more than 30 volunteers, we captured, marked, and released 13 barking frogs on a single limestone outcrop in the memorial in 1996. Frogs were active from the first summer rain on June 30 until early September. Captured frogs ranged in size from the 0.83-g (0.03-oz), 21-mm-long (0.83-in [snout-to-vent length]) hatchling to a 55-g (1.93-oz), 85-mm (3.35 in) adult female. Using radiotelemetry (fig. 3), we followed four frogs for up to a month. Frogs roamed over much of the approximately 100 x 100-m limestone hill, but did not cross over to adjacent outcrops. Although often choosing to walk or climb, barking frogs are prodigious jumpers (fig. 4). Even while carrying a radiotransmitter belted around the waist, barking frogs easily made leaps of 70 cm (27.6 in) or more from boulder to boulder.

Based upon scat analysis and observations, barking frogs at Coronado feed on field crickets *(Gryllus* spp.*),* silverfish *(Lepisma saccharina),* centipedes *(Scolopendra* sp.*)*, scorpions *(Vaejovis* sp.*)*, and kissing bugs *(Triatoma* spp.*)*. At other localities, they have been reported to eat cave crickets *(Ceuthophilus* spp.*)* and land snails *(Bulimulus* and *Succinea)*.

Figure 4 (below). To help them negotiate the rough terrain of their rocky home, barking frogs feature tough "Vibram" soles on their feet.



CECIL SCHWALBE

On the night following the first significant summer rainfall in 1997, we used over 30 volunteers to capture 15 barking frogs on several limestone outcrops on the memorial. We caught six frogs on our primary study site of the previous year, all recaptures, indicating that we have most of that subpopulation marked. Using PIT-tags (passive integrated transponders), we now have marked 22 frogs at five sites at Coronado. This summer we plan to bring a graduate student onto the project to further study the ecology of this interesting frog, to estimate population sizes using mark-recapture, to evaluate various monitoring methodologies, and to begin assessing metapopulation dynamics.

From our preliminary data and the scanty life history known of the species, we believe the barking frog has very low population densities and is long-lived. These characteristics make barking frog populations vulnerable to overcollecting; it is fortunate that the population at Coronado occurs on Park Service lands, where collecting is forbidden. This protected population will provide important information on the life history of this unusual species and perhaps allow us to test metapopulation models applicable to anuran conservation and management. PS

Cecil Schwalbe is Research Ecologist, U.S. Geological Survey, Cooperative Park Studies Unit at The University of Arizona; 520-621-5508; cecils@srnr.arizona.edu. *Barbara Alberti is an Interpreter with Coronado National Memorial; 520-366-5515;* barbara_alberti@nps.gov.

Big Cypress continued from page 25

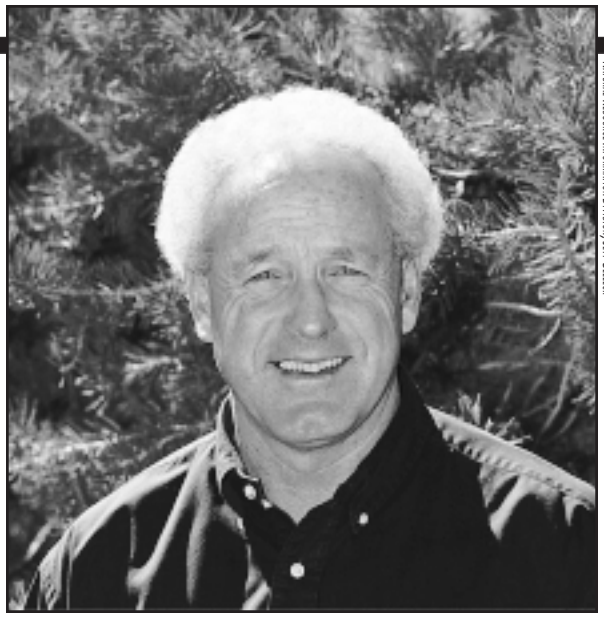
Cypress Basin with the goal of accomplishing three tasks: (1) conduct an issues characterization workshop, targeting the scientific community in the Big Cypress Basin to identify, characterize, and prioritize the natural resource issues within the Big Cypress Basin; (2) conduct an inventory of existing research and monitoring information within the Big Cypress Basin; and (3) conduct a second workshop to link priority natural resource issues and science information needs for the development of a Big Cypress Basin science plan.

The issues characterization workshop was conducted in 1997 and was attended by over 70 regional scientists. During this workshop, the participants identified, characterized, and prioritized natural resource issues within the Big Cypress Basin. In March 1998, three workshops were held to prioritize natural resource issues in the Big Cypress Basin, and currently the initial draft of the science plan is being written. Also, the inventory database of monitoring and research projects was completed this year and can be reviewed on the Internet at *http://library.fgcu.edu/big_cypress.*

Big Cypress National Preserve is beginning to produce successful results for defining, monitoring and managing its water-dominated ecosystem. The approach has been aggressive and the recent results have been rewarding. In the future, the preserve's ability to continuously seek improvement for evaluating and managing its hydrological system will be the key for meeting the dynamic resource management needs within its boundary and south Florida. PS

Don Weeks was formerly a Hydrologist at Big Cypress National Preserve; he is now a Hydrologist with the NPS Water Resources Division in Lakewood, Colorado. He can be reached at 303-987-6640; e-mail: don_weeks@nps.gov. *Christine Bates is a Hydrological Technician at the preserve; 941-695-2000, x345;* christine_bates@nps.gov.

An interview with Superintendent Alan O'Neill



Natural Resource Information Division, Jeff Selleck

Alan O'Neill, Superintendent of Lake Mead National Recreation Area.

By the editor

In eleven years as Superintendent of Lake Mead National Recreation Area (Nevada and Arizona), Alan O'Neill has helped build one of the leading resource management programs in the Pacific-West Region. A brilliant manager with a human style, O'Neill listens, offers support, and invites participation, building trust with his staff and park partners. In recent years his leadership skills have landed him collateral assignments as the chair of the Pacific-West Region's resource management taskforce and as a partner in the initial planning phases of the California Desert Ecosystem Management Initiative, a complex interagency framework for managing over 25 million acres of public land. Twice during the last fifteen months, our featured guest talked with me about the remarkable transformations in the resource management program at Lake Mead, the benefits of collaboration, and the importance of managing a desert park in its ecological context.

Q: What role did strategic planning play in building your resource management program?

A: When I came to Lake Mead in 1987, I found that this park was driven by operations. About a quarter of all the visitor protection incidents for the National Park Service come out of this park. I looked at that and said, I'm going to learn about that. But we need to think strategically. We have to know where we want to take this ship. I'd ask our people what business they thought we were in and I could never get any consistency. That made quite an imprint on me. So, one of the first things we needed to do was to develop a strategic plan.

Q: To accomplish what?

A: We needed to interpret what it meant to be a recreation area. We had bought into the perception that we were just a law enforcement park, and the local people thought of this as their local recreation area. We needed to define our desired future conditions so we could build a path to get there. I said, we *can* define what we're all about. We have an obligation and a duty to define what we're all about. I said, this is a serious exercise, and whatever we decide on *collectively* is what we'll put our efforts toward.

Q: How did resource management come to the forefront?

A: Bill Burke, the park's first resource manager, had labored for years trying to bring respect to the resource. He kept trying to make improvements, but he was a lone voice in the wilderness. When we went through the strategic plan it all came out that we had an incredible resource. Some of our people had not appreciated this. Until we embraced the resource, and could feel it, see it, and understand it, how in the world were we going to dedicate ourselves to the tough task ahead of protecting it? So, this was one of the first things we focused on.

Q: Did the staff just naturally buy in to this?

A: We had to do a lot of work internally first. We wanted the entire staff to understand the resource and have a chance to experience it. We did this through a series of three-day campouts where we would discuss the work that we're all about, the resource that we had, and build that commitment and dedication to protecting the resource. Once we had educated ourselves, then we were prepared to go out and build partnerships and community support.

Q: Any revelations from that experience?

A: Eighty-seven percent of the park's million-and-a-half acres is land on which we had done very little resource management. We had acquiesced our responsibilities to other agencies like the state fish and game organizations. The Bureau of Land Management was in charge of burro management and grazing. We were so dependent upon other agencies doing our job for us that we had lost control of what was happening to our resource, and that was unacceptable.

Q: Did the public support this new orientation?

A: Yeah, but we had a massive job to do, because all the politicians, the users, and the local communities related to Lake Mead as a water recreation park. We wanted to wrest back some control over the land resources. So, we started a leadership program to train our people to work interdependently. We brought in scientists to help us think through what the desired future conditions should be. When we knew what the end in mind was, we brought in anybody who would listen to us.

Q: When did you see a change?

A: Once we got the attention of our senior senator, Senator Reid, who was on the appropriations committee, then we started hitting pay dirt. The politicians all of a sudden had a different view of Lake Mead. When we brought them out and educated them, they wanted to see the land resource protected also. And so we started working with them and building base increases.

Q: Were any particular resource issues important in the education process?
A: Tamarisk choking our springs and in the beach areas; the impacts from feral burros; the impacts of grazing. We flew the senator over and showed him how some of our systems were absolutely devastated, that the only community we had left was the creosotebush community. That's how far we had come from not caring properly for this resource. We had to show it on the ground. We had to get them to feel it.

Q: What effect did this have on your program?
A: We have gone from two professionals in 1987 and a $120,000 resource management budget to 13 permanent, 15 FTEs total, and a $1.1 million operating base in 1998. In addition, we have about $500,000 in soft money. That's money we leverage through all kinds of interesting partnerships. It's money we get from grants. It's money we get from Clark County habitat conservation. Most of it requires hard work to keep attracting. We use our base money to make sure the most critical things get done and supplement it with these funds.

Q: Staffing must have been on your mind?
A: We were starting from such a low level that we could offer people a real chance to make a tremendous difference to the resource. Other parks can't always offer that. We had a clear priority staffing strategy and we wanted to get the best people. We went out and recruited who we thought had the interest, commitment, and talent to do the job. In return for that we were going to give them a tremendous amount of professional development. They would have an opportunity to develop a program, implement it, and provide leadership for it.

Q: Kent Turner has obviously been very successful as your Chief of Resource Management.
A: Kent is one of the most effective administrators I've ever worked with anywhere in my federal career. He's not a show horse, he's a work horse. That's what it has taken to build this program. He took the responsibility of making sure we stayed on our strategic course. He kept making improvements and hiring good people, setting up the structure, and getting the money. As a result, our resources are better understood, valued, and supported by the park and local, regional, state, and federal partners.

Q: Was there any resistance to such rapid change?
A: When we started building a resource team some people saw that as taking away from their programs, because they had needs. Our rangers were overstressed, and our maintenance staff was shorthanded, so it was easy to take pot shots. We had to continually go back to the strategic plan that we had all agreed to.

Q: Were their concerns legitimate?
A: We didn't reshuffle park money. All the money for the resource program came as an addition to the park budget. It's true that if you don't get increases for maintenance and ranger activities your costs go up and your capabilities go down. There was some issue with that. But it's simply that the park had a duty by law to take care of the resource, and we had failed miserably in that duty. We had a large catch-up to do. Once we build this program up to where we have a suitable core then we can start adding to some of these other program areas, too.

Q: Have you reached that goal?
A: We think we have a sufficient core staff, so now we're building through partnerships and alternative funding sources. Kent is very, very good at using partnerships and alternative workforces that he can assemble at very little cost. Over the last couple of years, we have had lots of people out doing projects: AmeriCorps, work programs from the court system, SCAs, interns. There really is a way to leverage labor sources. Since we've built a solid core, we can be aggressive in going out to the outside community for private donations and grants that supplement our base program. That's where our emphasis is now.

Q: Is your success a model for other parks with similar needs?
A: We all hope that we can increase our base funding. But this is going to be tougher and tougher. The money in the future is going to come from collaborative initiatives and budget requests. It won't come as much from single agency proposals. The more agencies you can get as cooperators, the more collective agency support behind a proposal, the more chance it has in coming. It's to our advantage to collaborate. We're learning that from the California Desert Ecosystem Management Initiative.

Q: Speaking of which, how will this huge desert area with all these different agencies be managed?
A: We have a philosophy in regard to the California Desert that whether you're the Bureau of Land Management, the Fish and Wildlife Service, the U.S. Geological Survey, the Park Service, or the military, we have a grand experiment. We have collective responsibility for stewardship of the desert, and we all have our individual mandates. There's probably room in the California Desert for a diverse spectrum of recreational activity, but it doesn't necessarily have to take place within the park or even adjacent to it. Like biosphere reserves, we probably should have core areas that are lightly used, that serve as our most pure genetic reservoirs. And then we have managed zones in which we can advance the state of knowledge about mankind's relationship with the bioregion through experimental management and science. And there will probably be areas with concentrated activity, including recreational use.

Q: So Lake Mead really operates within the context of the desert ecosystem these days?
A: Absolutely. We knew we were not going to be able to protect our park unless we were able to be effective in collaborative ecosystem initiatives. We wanted to hire people who were committed to teamwork and collaboration, people who were inclined to work within larger ecosystems. This has served the park resource very well.

Q: Any examples?
A: We invested a fair amount of time working on the Black Mountain Ecological Plan, the Parachant Plan, the Clark County Tortoise Plan, and other plans for the management of areas adjacent to the park. What we got in return was compatible management on a large section of our boundary. About 70 percent of our boundary is now in protected status. We've got about 30 percent left with some tough issues to deal with. To me, that was the advantage of hiring people who think a little more broadly, a little more holistically.

continued in middle column on page 31

Safe, effective, and humane techniques for euthanizing wildlife in the field

By Michael Aprill

Resource managers across the national park system are occasionally faced with the need to destroy wildlife species for a number of reasons, such as protection of endangered species, protection of the public health, and population control of species.

When choosing euthanasia techniques as part of a resource management program, managers must select techniques that are humane for the species being euthanized, safe for personnel carrying out the procedure, not dangerous to park visitors or nontarget species, and appropriate for the location and feasible within personnel and budgetary constraints.

In selecting a euthanasia technique, the manager must first consider that the technique is efficient and humane for the target species (American Society of Mammalogists 1987). The universally accepted standards for these criteria are found in the "1993 Report of the American Veterinary Medicine Association (AVMA) Panel on Euthanasia" (American Veterinary Medical Association 1993). These techniques fall into three general categories: injection (barbiturates), carbon dioxide, and gunshot. Whichever of these techniques the manager selects must be species-specific and correctly performed by trained personnel to be safe and effective.

Euthanasia by the injection of barbiturates (e.g., sodium pentobarbital) is perhaps the most humane euthanasia technique, and it is suitable for most species, safe for personnel performing the procedure, and moderate in cost (Fakkema 1994; Grier and Clovin 1990; American Humane Association 1988). Barbiturates are one of the cheaper euthanasia agents. However, as a controlled substance, the use of barbiturates requires a permit from the Drug Enforcement Administration, secure storage, and veterinarian supervision. The animal must be restrained during administration (e.g., squeeze cage) and personnel performing the procedure must be skilled. Dosages must be correct for the species and the animals' weight. A park's maintenance staff may construct squeeze cages of their own design or by using designs found in the literature. If a veterinarian is not on staff, one may be available from a nearby humane society or a local vet may be willing to consult as a nonpaid volunteer.

Another effective, humane, safe, and inexpensive euthanizing technique is carbon dioxide (Erickson 1994). This technique works well for most animals; however, some species and neonates may have some increased tolerance to carbon dioxide. Because carbon dioxide is heavier than air, care must be taken to completely fill the chamber before exposing the animal to the gas. This is of special concern with tall or climbing animals. Carbon dioxide is low cost. Supplies include a carbon dioxide canister, carbon dioxide, appropriate plumbing, and a chamber that can be constructed by park personnel. The main disadvantage of this technique is that it may not be suitable for remote or inaccessible locations due to difficulties transporting heavy CO_2 canisters.

If done properly by trained personnel, gunshot may be used as a humane form of euthanasia. For each species, the shot must be fired at a specific site on the animal to assure rapid death (Australian Veterinary Association 1987; Longair et al. 1991). One danger of this technique is that a bullet may

Table 1. Humane euthanasia techniques*

Method	Advantages & Disadvantages	Cost
Injection (barbiturates)	Most preferred method of euthanasia Suitable for most species Safe for personnel performing procedure Requires DEA permit, secure storage, and veterinary supervision Requires squeeze cage, which may be easily constructed by park personnel	Moderate
Carbon Dioxide (CO2)	Works well for most species Some species and neonates may exhibit increased tolerance to CO_2 Special care must be taken with tall or climbing animals to completely fill the chamber before exposing the animal CO_2 chamber may be easily constructed by park personnel Safe for personnel performing the procedure May not be suitable for remote locations due to weight of CO_2 canisters	low
Gunshot	Firearm must be of appropriate caliber and impact for species and must be delivered to specific site on animal Requires skilled marksman Possible danger to shooter from ricochet Possible legal constraints in some parks	Moderate

*All methods can be humane and safe if administered by properly trained personnel

ricochet off the substrate or cage and injure the shooter or others. The shooter must also have adequate eye and hand protection due to the possible danger from blood-borne pathogens. Additionally, there may be legal reasons why a manager may not want to use firearms in a park.

Managers wishing to learn more about specific euthanasia techniques are encouraged to consult the resources cited in this article or attend a euthanasia seminar sponsored by an organization such as the American Humane Association. For a summary of humane euthanasia techniques see table 1. PS

Michael Aprill is a recent graduate of the University of Wisconsin–Stevens Point with a degree in biology. During 1994, he served as a Volunteer in the Parks (VIP) for the Division of Resource Management at Hawaii Volcanoes National Park.

Literature cited

American Humane Association. 1988. Operational guide for animal care and control agencies. American Humane Association, Denver, Colorado.

American Veterinary Medical Association. 1993. Report of the AVMA Panel on Euthanasia. Journal of the American Veterinary Medicine Association **202(2):**229-249.

Australian Veterinary Association. 1987. Guidelines on humane slaughter and euthanasia. Australian Veterinary Journal **64:**4-7.

Choate, J. R., editor. 1987. Acceptable field methods in mammalogy: Preliminary guidelines approved by the American Society of Mammalogists. Journal of Mammalogy **3(2) (Suppl.):**1-18.

Erickson, R. 1994. Carbon dioxide euthanasia chamber. Wildlife Control Technology **(December):**12-13.

Fakkema, D. 1994. *Euthanasia 101: 94AHA-46-47.* Two audio cassettes. American Humane Association. Hollywood, California.

Greyhavens, T. 1989. Handbook of pentobarbital euthanasia. Humane Society of the Willamette Valley, Salem, Oregon. 126 p.

Grier R. L., and T. L. Clovin. 1990. Euthanasia guide (for animal shelters). Moss Creek Publications, Ames, Iowa.

Longair, J. A, G. G. Finley, M. A. Laniel, C. Mackay, K. Mould, E. D. Olfert, H. Rowsell, and A. Preston. 1991. Guidelines for euthanasia of domestic animals by firearms. Canadian Veterinary Journal **32(12):**724-726.

O'Neill interview continued from page 29

Q: How valuable is the resource management function to the park?
A: I don't know how we operated without it. I don't know how we were making the decisions we made without asking questions.

Q: Has a different decision-making process evolved?
A: We're learning it's the collaborative process that helps you. More effective solutions just naturally come out of the process of involving scientists and bringing together a broad group. We're learning a lot by grouping parks with similar problems, like the desert parks. Joshua Tree is going to learn something of value to us all, we learn, and we get together and discuss it. The more we share and collaborate, the more we advance the state of science and management.

Q: Any specific advances?
A: We've done a lot of work on how you restore desert systems, particularly those that have been overgrazed by burros, and springs that have been choked by invasive species. We have learned a lot about tamarisk removal through experimental management, trial and error. Finally, we've found some things that consistently work. We now have a multiregion tamarisk-busting crew going out under NRPP money and working in maybe 20 different parks: Zion, Petrified Forest, Capitol Reef. It's more efficient to have a crew go out and help parks than to duplicate that function in each park.

Q: Helping other parks seems to come naturally to Lake Mead. Why?
A: Everyone's got more work that they can be doing. But nothing would get done if we didn't help each other. Let's not forget that we are part of one Park Service. At Lake Mead, we spend between 15 and 18 percent of our budget in support of collaborative park efforts in our cluster and region. The restructured National Park Service follows a shared leadership/shared resources paradigm. Regardless of how busy we are in our own parks, if this paradigm is going to work, we've got to share our resources. A superintendent has got to support that.

Q: What about helping parks with less obvious needs?
A: The Pacific-West Region has a resource task force that is providing some leadership in this area. We have developed a strategic plan for the region that will guide our resource stewardship activities over the next five years. We want to be able to provide the best service to smaller parks that don't have a resource specialist. Is it through a "circuit rider" system made up of people from our advisory committee, combined with Biological Resources Division scientists and university people?

Every park needs to understand the conditions, the "vital signs" of its ecosystems and the normal variation of those vital signs. We need to monitor those vital signs, track them in "state-of-the-park" reports, and then we need to restore them. How do we do that in our restructured environment, knowing that some parks don't have any capability themselves to do that? This is what our strategic plan is aimed to do.

Q: On the whole, where is the Park Service in the process of integrating science in park management?
A: A positive sign was the attention science and resource management got from senior level people at the last George Wright Society conference. I mean, why would a regional director or senior superintendent spend time there unless they're starting to get the message? They're seeing it as important enough to not only send their resource people, but they come and learn, too. And more disciplines are taking an interest, too. Interpreters are taking a much stronger look at their programs, the importance of interpreting, and putting the message out in different forms for our different publics. In the Pacific-West Region, we recently brought back to the Park Service five Senior Scientists who understand the research needs of the parks. They're filling an important liaison role now between park management and the scientific community. To me, these are all good signs. PS

Meetings of Interest

September 28-30

Making Connections, the international conference of the Society for Ecological Restoration, will emphasize the importance of partnerships. Plenary sessions will explore restoration education, rangeland restoration, and restoration across borders, while pre- and post-conference workshops will look at wildlife and riparian restoration and restoration planning. Conference sessions are diverse, including such topics as the restoration of prairies, road removal, and the use of fire in restoration. The gathering will be held at the Austin, Texas, Marriott at the Capitol. Visit *http://www.phil.unt.edu/ser/* on the web for more information.

October 1-3

El Malpais National Monument will host its *10th Anniversary Resource Stewardship Symposium* at The Inn at Grants, New Mexico (505-287-7901). Activities will include research presentations, poster sessions, field trips, and workshops on research planning and stewardship of archeological sites and caves. Registration will be around $30. For registration information contact monument staff at 505-285-4641, x14; for program agenda information contact Herschel Schulz at 505-285-4641, x25 or by e-mail: *herschel_schulz@nps.gov*.

October 6-10

The Natural Areas Association will hold its 25th annual conference at the Mission Point Resort on Mackinac Island, Michigan. Entitled *Planning for the Seventh Generation,* the theme of the conference reflects the Native American tradition of considering how choices made in the present may affect the next seven generations. Primary topics will include a discussion on the past, present, and future of natural areas and the role of natural areas in conservation planning and sustainable development. For more information contact the Natural Areas Association at 517-241-2974 or visit *http://wildlife/dnr.state.mi.us/HomePages/Meetings/Natural_Areas_1998* on the web.

October 13-16

The Fifth Conference on Fossil Resources, *Partners Preserving our Past, Protecting our Future,* will take place in Rapid City, South Dakota, at the Rushmore Plaza Holiday Inn. Like its predecessors, this conference will bring together professionals from numerous federal and state agencies who are involved in the management, interpretation, and protection of paleontological sites. Themes will include science and research on public lands; education and outreach; paleontology and the public trust; technology and paleontology; paleontological resource management; partnerships; and curation and conservation. Contact Rachel Benton *(rachel_benton@nps.gov)* of Badlands National Park for registration information at 605-433-5361.

March 22-26, 1999

The 10th George Wright Society conference on research and resource management in parks and on public lands is now in the planning stages. To be held in Asheville, North Carolina, near Great Smoky Mountains National Park, *On the Frontiers of Conservation: Discovery, Reappraisal, and Innovation,* is organized around three concurrent sessions: a management track, an analysis and synthesis track, and a track devoted to Appalachian issues. Abstracts are being accepted until October 15. For more information visit the website *http://www.portup.com/~gws/gws99.html* or contact the society at *gws@mail.portup.com* or 906-487-9722.

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 673-053